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ТЕЗИСЫ
ABSTRACTS

Volume III

Sections 06 , 07



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Москва 4-14 августа 1984

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ИЗДАТЕЛЬСТВО «НАУКА»
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Третий том тезисов, представленных к 27-му Международному геологическому конгрессу, включает две секции: С.06 Геология Мирового океана с симпозиумом S-07.2.2 "Тектоника северной части Тихого океана и его обрамления" и С.07 Тектоника. Тезисы, представленные ведущими учеными-геологами из разных стран мира, отражают вопросы теоретической и прикладной геологии.

Volume III of abstracts presented for the 27th International Geological Congress includes two sections: C.06 Geology of the Ocean Basins with Symposium S.07.2.3 "Tectonics of the Noth Pacific and its Framework", and C.07 Tectonics. The abstracts submitted by leading scientists from various countries of all over the world cover problems of theoretical and applied geology.

Ответственный редактор
Н.А.БОГДАНОВ

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П Р Е Д И С Л О В И Е

Тезисы, представленные к 27-му Международному геологическому конгрессу, распределяются по 22 секциям и 6 коллоквиумам. Кроме того, в их число включены тезисы докладов к пленарному заседанию "Геологические проблемы охраны окружающей среды", к специальной сессии по Международной программе "Литосфера" и к симпозиуму "Металлогения и месторождения урана".

Все тезисы опубликованы в десяти томах и распределены следующим образом:

том 1 - секции 01-03
том П - секции 04-05
том Ш - секции 06-07
том 1У - секции 08-09
том У - секции 10-11
том У1 - секция 12
том УП - секции 13-16
том УШ - секции 17-22
том 1Х - пленарное заседание "Геологические проблемы охраны окружающей среды", коллоквиумы 01-06, программа "Литосфера", симпозиум "Металлогения и месторождения урана", а также тезисы, присланные в Оргкомитет после 1 ноября 1983 года
том Х - авторский указатель.

Следует отметить, что в каждой секции и коллоквиуме тезисы расположены в алфавитном порядке /латинском/ по фамилии авторов.

Н.А.БОГДАНОВ

Генеральный секретарь
Оргкомитета

Abstracts presented for the 27th International Geological Congress are divided up into twenty two sections and six colloquies. On top of this we have added the abstracts submitted for the Plenary Meeting "Geological Aspects of Environmental Protection", for the Special Session of the International "Lithosphere" Programme and for the Special Symposium "Metallogenesis and Uranium Deposits".

The whole is published in ten volumes divided up in the following way:

volume I - Sections 01 to 03
volume II - Sections 04 to 05
volume III - Sections 06 to 07
volume IV - Sections 08 to 09
volume V - Sections 10 to 11
volume VI - Section 12
volume VII - Sections 13 to 16
volume VIII - Sections 17 to 22
volume IX - Plenary Meeting "Geological Aspects of Environmental Protection", Colloquies 01 to 06, Special Session of the International "Lithosphere" Programme and Special Symposium "Metallogenesis and Uranium Deposits" as well as abstracts received by the Organizing Committee after November 1, 1983
volume X - General authors index.

Lastly, for each section and colloquium, the abstracts are classified in alphabetical order of the authors.

N.A.BOGDANOV
General Secretary
of the Organizing
Committee

ГЕОЛОГИЯ МИРОВОГО ОКЕАНА
GEOLOGY OF OCEAN BASINS

Conveners: W.Hey, Yu.M.Pushcharovsky

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MAGNETOSTRATIGRAPHY OF THE PLIOCENE (?) KAP KØBENHAVN SEDIMENTARY SEQUENCE, PEARY LAND, NORTH GREENLAND

The supposed Pliocene sedimentary series at Kap København in Peary Land, North Greenland, observed in an area covering 10 km x 20 km, consists of about 100 m of offshore marine, coastal lagoon and fresh water unconsolidated sediments, situated below and above till deposits (Funder & Hjort, Reports, Geological Survey of Greenland 99, 99-105, 1980). Palaeomagnetic investigations of 275 oriented specimens from 2 parallel profiles from the fine-grained parts of the series show normal polarity at the top and reversed polarity in the middle part of the profile. The microfossils (probably middle Pliocene) suggest a Pre-pleistocene age of a few million years (R. Feyling-Hanssen, personal communication). The reversed magnetic polarity is interpreted as the Kaena or Mammoth events, although other polarity events cannot yet be ruled out.

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EVOLUTION OF THE GULF OF GUINEA PASSIVE CONTINENTAL MARGIN

The Gulf of Guinea continental margin evolved during the early Cretaceous and is characterised by the occurrence of several long, narrow coastal sedimentary basins. Structural and geophysical evidences show that these marginal basins developed as part of a geodynamic cycle which began with the break-up of the Afro-Brazilian supercontinent and the subsequent formation of the North and South Atlantic Ocean as well as subsidence of the marginal coastal areas. Geophysical data further support a basic geometric and structural pattern typified by oceanic fracture zones, lineaments and steep sides northeast trending normal faults which formed horsts and grabens. Since their inception during the Early Cretaceous, the basins have been filled with thick clastic sediments ranging from continental sands and grits of Neocomian age, through alternating fluvio-lacustrine sands and shales of Middle to Late Cretaceous age to normal marine shales and limestones of Maastrichtian and Paleocene ages.

The post Paleocene period has witnessed increased terrigenous deposition. These latter deposits are not affected by tectonism or volcanism thus suggesting miogeosynclinal open type basins.
A model is developed for the evolution of the coastal basins.

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FERROMANGANESE OXIDE DEPOSITS FROM DIFFERENT ENVIRONMENTS IN THE WESTERN CENTRAL PACIFIC

Chemical and mineralogical analyses of ferromanganese oxide encrustations and nodules, and associated sediments, from the western equatorial Pacific indicate that the crusts are purely hydrogenous deposits whereas some of the nodules contain a diagenetic component. Mineralogically, the crusts consist of δMnO_2 and $FeOOHxH_2O$ and resemble δMnO_2 rich nodules from adjacent basins but are enriched in Mn (to 29%) and Co (to 1.57%) relative to the latter. Crusts from 1-2km depth exhibit higher Mn/Fe ratios and Co contents than deeper crusts or nodules, which may result from enhanced adsorption of Mn and concommitant scavenging of Co in the O_2 minimum zone, or from a greater influence of aeolian input of metals above 2km depth. Metal supply to the nodules is thought to be largely halmyrolytic in the case of Fe, Al and Ti, and from sinking faecal material in the case of Mn, Ni, Cu and some other elements. High grade, Ni and Cu enriched todorokite bearing diagenetic nodules are confined to an eastwards widening equatorial wedge associated with elevated biological productivity, and are thought to develop from Mn, Ni and Cu enriched pore waters in the uppermost sediments. The importance of the sedimentary lysocline in this regard is considered to be that it marks a level below which metal-organic rich phases may be concentrated near the sediment water interface in sufficient concentrations to drive the diagenetic reactions leading to todorokite formation and metal enrichment in the deposits.

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TECTONICAL STRUCTURE OF THE WORLD OCEAN BOTTOM

Recent consolidated crust of the World Ocean bottom has different tectonic nature. New thin oceanic crust is generated in the Mid-Ocean ridge at the expence of spreading (mechanical gaping fault). Over vast space of the World Ocean periphery, including deep sea basins of internal and marginal seas, this thin consolidated crust is formed at the expence of physicopetrological processes, which reworked and thinned the thick continental crust. By geophysical parameters this pseudooceanic crust often does not differ from the new oceanic crust of Mid-Ocean ridges. On the surface, the physicopetrological processes of consolidated crust thinning were expressed in intensive subsidings, which envolved vast water basins of previous relief and continental lowlands into composition of deep sea areas. At last, composition of the recent World Ocean bottom inclu-

des possibly vast areas of ancient (Devonian) oceanic crust. Spreading processes are connected with the approach to the foot of lithosphere of large masses of anomal mantle. This, together with spreading, leads to generation of contrast ascending vertical tectonic movements. The latter form large uplifts of the Mid-Ocean ridge type. The anomal mantle can also approach the pseudooceanic and ancient oceanic crusts, uplifting and rupturing them and forms a new oceanic crust. The spatial relationships between consolidated crust, formed by spreading, physicopetroligical processes and ancient crust within boundaries of the World Ocean still remains unsolved. The teaching on lithosphere plates explains only one of the processes in the interior parts of the Earth forming spreading tectonical structures of the World Ocean bottom. It is not universal as does not consider many other processes within interior parts of the Earth, forming different tectonical structures on continents and in the World Ocean.

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ТЕКТОНИЧЕСКИЕ СТРУКТУРЫ ДНА МИРОВОГО ОКЕАНА

Современная консолидированная кора дна Мирового океана имеет разную тектоническую природу. В срединно-океанических хребтах за счет процессов спрединга (механического раздвига) создается новая тонкая океаническая кора. На обширных пространствах периферии Мирового океана, включая глубоководные бассейны внутренних и краевых морей, тонкая консолидированная кора образована за счет физико-петрологических процессов, переработавших и утонивших толстую континентальную кору. По геофизическим параметрам эта псевдоокеаническая кора часто не отличима от новой океанической коры срединно-океанических хребтов. В поверхностном выражении физико-петрологические процессы утонения консолидированной коры реализовались крупными опусканиями, которые включили в состав глубоководных областей океана обширные акватории прежнего шельфа и низменной равнины материков. Наконец, в состав дна современного Мирового океана входят, по-видимому, обширные пространства древней (доюрской) океанической коры. Процессы спрединга связаны с подходом к подошве литосферы крупных масс аномальной мантии. Она приводит одновременно с раздвигом к возникновению контрастных восходящих вертикальных тектонических движений. Последние образуют крупные поднятия типа срединно-океанических хребтов. Аномальная мантия может подходить и к псевдоокеанической и древней океанической корам, поднимая и разрывая их, и образует новую океаническую кору. Площадные соотношения консолидированных кор, соз-

данных спредингом, физико-петрологическими процессами, и древней коры остаются еще в пределах дна Мирового океана практически не разработанными. Учение о литосферных плитах раскрывает лишь один из процессов, действующих в земных недрах и создающих спрединговые тектонические структуры дна Мирового океана. Оно не универсально, так как не рассматривает многие другие процессы, протекающие в земных недрах, создающие разнообразные тектонические структуры, распространенные на материках и в Мировом океане.

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MAGNETOBIOSTRATIGRAPHIC CORRELATIONS BETWEEN PALEOGENE EPICONTINENTAL DEPOSITS OF NW EUROPE AND THE DEEP SEA: CALCAREOUS NANNOPLANKTON EVIDENCE

The classic Paleogene stages (Thanetian, Cuisian, Lutetian, Bartonian, Ludian and Stampian) defined in the epicontinental deposits of the Anglo-Paris Basin(s) are placed within a standard biostratigraphic framework based on an analysis of their calcareous nannoplankton floras. Comparison and correlation is also made with Paleogene chronostratigraphic units elsewhere in Northwestern Europe (North Sea Basin in Denmark, northern Germany, Rhine Basin i.al.). Relatively precise biostratigraphic correlations can be made with some chronostratigraphic units (e.g., Lutetian), less precise with others (e.g., Ludian) depending upon the stratigraphic extent of fossiliferous sediments, and important hiatuses are recognized between certain chronostratigraphic units. Only the base of the Lutetian (late NP14) and Bartonian (mid-NP16) stages can be precisely determined in terms of calcareous nannoplankton zones. A comparison between the distribution of calcareous nannoplankton zones in the different parts of northwestern Europe reveals their unequal local development; some being better developed (e.g., NP8, NP11, NP12, NP14-16, NP23) than others (e.g., NP9, NP18, NP21). Several zones (e.g., NP10, NP13, NP21) appear to be unrepresented in northwest European epicontinental Paleogene sections.

The irregular development of calcareous nannoplankton zones is interpreted to result from global relative changes in eustatic sea level. With the recent study of the paleomagnetic polarity history of the Paleogene of southern England and recent advances in magnetobiostratigraphic correlations in deep sea cores it is now possible to interpret the Paleogene history of the Anglo-Paris Basin(s) in a synoptic global framework in which the paleomagnetic stratigraphy provides the chronologic, and the eustatic variations the dynamic, element. The redefinition of the boundaries of the standard Paleogene chronostratigraphic units of northwestern Europe within, rather than at the boundaries of (i.e., at unconformities), the eustatically controlled depositional cycles would result in more precise correlations in terms of standard calcareous nannoplankton biostratigraphy.

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DIAGENESIS OF DEEP-SEA CARBONATE SEDIMENTS

Chemical and isotopic studies have been completed on deep-sea carbonate sediments and associated porewaters from continous ooze-chalk-limestone sequences. Samples were taken on Deep Sea Drilling Project

Leg 85 in the Eastern Equatorial Pacific and Leg 90 in the Tasman Sea. We have focused our studies on three problems: (i) developing a general understanding of the lithification of carbonate sediments, (ii) determining the long-term fluxes of chemicals across the seawater -carbonate sediment interface, and (iii) understanding the effects of diagenesis on the paleoclimatic and paleoceanographic record derived from the isotopic and trace elemental composition of carbonate microfossils.

Using strontium concentration data from the porewaters and sediments we have quantified the rates of carbonate recrystallization. The sections we studied contain about 30% diagenetic carbonate formed over the past 40 million years (an average age for many of the core bottoms). A linear reaction rate vs. dept model implies that Eocene sediments contain 60% diagenetic calcite and only 40% original biogenic calcite. We have used these data to constrain model calculations of the influence of diagenesis on the oxygen, carbon, and strontium isotopic compositions of sediment components through the Tertiary. The calculations show that diagenesis has had an important role in determining the Tertiary oxygen isotopic signals of sediment components. This has been confirmed by isotopic measurements on different sediment components.

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ABOUT THE MECHANISM OF MANGANESE NODULES FORMATION

Asimmetry of forms, composition and formation rate of the nodules attract the attention to the possible clue to solve the most complicated question of the problem of manganese nodules - the mechanism of their formation. The asimmetry in manganese phase oxidation of the nodules was observed at the first time in the leg 28 of r/v "Dm.Mendeleev". The upper part is less oxidized than the bottom. In connection with other known facts describing the nodules' asimmetry this observation gives the evidence of the controlling role in the process of intra-nodular diagenesis. Gradient of physico-chemical medium indicators, surrounding the nodules, strongly affects the course of these processes. The paper discusses the detailed mechanism of intra-nodular diagenesis. The questions of the metal supply sources to the surface of the nodules are discussed. The evidence is given in favour of the diagenetic supply of ore material from the sedimentary layer.

The questions of the variational reasons in the chemical composition of the manganese nodules from neighbouring oceanic floor areas in

the ore province Clarion-Clipperton are being discussed.
The form of the nodules is suggested to be in relation with the mechanical properties of the underlaying sediments.

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О МЕХАНИЗМЕ ОБРАЗОВАНИЯ ЖЕЛЕЗО-МАРГАНЦЕВЫХ КОНКРЕЦИЙ

Асимметрия форм, вещественного состава и скоростей роста конкреций привлекает внимание как возможный ключ к разгадке наиболее сложного вопроса в проблеме железо-марганцевых конкреций - механизма их образования. В 28 рейсе нис "Дмитрий Менделеев" впервые была обнаружена асимметрия в окисленности марганцевой фазы конкреций. Верхняя часть значительно менее окислена, чем подошва. В сочетании с другими известными фактами, характеризующими асимметрию конкреций, это наблюдение свидетельствует о контролирующей роли в формировании вещественного состава конкреций процессов внутриконкреционного диагенеза. Градиент в физико-химических показателях среды, окружающей конкреции оказывает большое влияние на ход этих процессов. В докладе обсуждаются детали механизма внутриконкреционного диагенеза. Рассматриваются вопросы об источниках поставки металлов к поверхности конкреций. Приведены доказательства в пользу диагенетической поставки рудного вещества из осадочной толщи.
Обсуждаются вопросы о причинах вариаций в химическом составе железо-марганцевых конкреций из соседних участков океанского дна в рудной провинции Кларион-Клиппертон.
Высказано предположение о связи форм конкреций с механическими свойствами подстилающих осадков.

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PHOSPHORITE FORMATION IN THE OCEAN

The understanding of phosphorite genesis is extensively moved forward due to detailed study of marine geochemistry of phosphorus and discovery of the phenomenon of Resent and Late Quaternary phosphorite formation on oceanic shelves.

The streams supply to the ocean makes about 10 mln.t. of terrigenous phosphorus of which not more than 0.01% is involved in phosphorite formation. The phosphorites receive their phosphorus ultimately from sea water containing on the average 0.07 $mg \cdot l^{-1}$ or totally about 100 billion tons of phosphorus whose residence time in the ocean

makes about 200 000 years.The sea water phosphorus is found to be in stable phosphate-carbonate-calcium complex form producing considerable P-undersaturation and excluding the least possibility of chemogenic precipitation of calcium phosphate.

The phosphorite formation in the Ocean is a regular phenomenon borne by exchange of substances and energy in the system comprising atmo-,hydro-,bio- and lithospheres.Such exchange is most extensive in marginal zones of the Ocean influenced by mighty currents and upwelling.The productivity and biomass of plancton,rates of biogenic sedimentation and intensity of diagenetic processes in these zones are several orders of magnitude higher as compared to open ocean.

The phosphorite formation on continental margins consists of biogenic sedimentation of phosphorus incorporated in organic remains,its subsequent diagenetic mobilisation,and concentration in nodular form and finally hydrodynamic reworking of sediments resulting in separation and accumulation of phosphatic components.

The Recent phosphorites on the Sea floor are represented by grains, nodules,boulders,slabs,phosphatized coprolites and bone detritus.The Pre-Quaternary phosphorites on the ocean shelves are similar to Recent in their geologic setting,lithology and partly in geochemistry implying their common origin.In some of their features these are similar to nodular and granular phosphorites from marine sedimentary sequences on land.

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ФОСФОРИТООБРАЗОВАНИЕ В ОКЕАНЕ

Познанию генезиса фосфоритов значительно способствуют детальные исследования морской геохимии фосфора и открытие явления современного и позднечетвертичного фосфоритообразования на шельфах океана.

В океан ежегодно поступает до 10 млн.т терригенного фосфора, из которого около 0,01% может участвовать в фосфоритообразовании.

Непосредственным источником фосфора фосфоритов является вода океана,где среднее содержание P составляет 0,07 мг/л, а запасы - около 100 млрд.т при среднем времени обновления около 200 тыс.лет. В морской воде фосфор находится в виде устойчивых фосфатно-карбонатно-кальциевых комплексов, благодаря чему она недосыщена фосфором на порядок и его хемогенное осаждение невозможно.

Океанское фосфоритообразование есть закономерное явление, обусловленное обменом веществом и энергией в системе атмосфера-гидросфера-биосфера-литосфера.Наиболее интенсивно этот обмен происходит в окраинных зонах океана,находящихся под воздействием мощных вдольбереговых течений и апвеллингов. Продукция и биомасса планктона, скорость био-

генной седиментации, интенсивность диагенетических процессов в этих зонах на несколько порядков выше, чем в открытом океане.

Фосфоритообразование на подводных окраинах континентов складывается из биогенной седиментации фосфора в составе органического детрита, диагенетической мобилизации и первичной концентрации фосфора в виде фосфатных компонентов и последующей гидродинамической сепарации тонких фракций вмещающих осадков от фосфатных компонентов, образующих пластовые залежи.

Современные фосфориты океана представлены зернами, желваками, глыбами, плитами фосфатных и фосфатизированных пород, копролитами, костным детритом. Дочетвертичные фосфориты на шельфах океана сопоставимы по геологической обстановке нахождения, литологическим и некоторым геохимическим признакам с современными и позднечетвертичными, что свидетельствует в пользу единообразия их генезиса. По ряду признаков они сходны также с желваковыми и зернистыми фосфоритами из морских осадочных отложений на континентах.

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IDENTIFICATION OF GLOBAL PALEOCEANOGRAPHIC EVENTS USING THE OSTRACODA

The Ostracoda are the most complexly organized fossil evidence of deep oceanic changes found in the cores of the Deep Sea Drilling Project. A global census of the ostracodes from 1630 samples from 156 sites of over 50 legs has yielded 171 genera ranging in age from Albian to Pleistocene. The evolution of some of these genera has been examined in detail.

Four important events or significant faunal changes have been found during this interval. These include the Cretaceous-Tertiary Boundary Event (65 ma), the "Terminal Eocene Event" (40 ma), the Mid-Miocene Event (14 ma), and the Terminal Miocene Event (5 ma).

These events have been identified by the analysis of distribution and diversity data, average assemblage or "community" structure, and morphometric analyses of selected taxa. The techniques used included cluster analysis, polar ordination and other ordination techniques, the calculation of diversity and equitability coefficients such as the Shannon-Wiener and Sheldon, Rho-Groups Analysis, and Resistant-Fit Theta-Rho-Analysis (a form of transformational analysis).

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OCEANIC EVENT STRATIGRAPHY: CORRELATION OF BIOSTRATIGRAPHIC EVENTS AND THE EVOLUTION OF THE OCEANS

The dynamic relationship between ocean-continent geometry is reflected in the deep sea stratigraphic record. Global changes in paleocirculation can be monitored in the biostratigraphic record of calcareous and siliceous microplankton. Seen against the background of the evolution of oceans and climate these "threshold events" are seen to occur relatively rapidly. Some of the major events in the Cenozoic are identified from the evidence provided by planktonic and benthic foraminifera and relationships, albeit tentative, are suggested in some instances, with the geohistorical record.

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SUBSIDENCE AND THERMAL HISTORY OF THE GULF OF LION MARGIN (WESTERN MEDITERRANEAN BASIN)

The Gulf of Lion margin, in the Northwestern part of the Mediterranean basin, has been formed after a rifting stage during the Oligo-Miocene.

1. Two-dimensional backstripping method has been applied to seismic reflexion profiles and well logs. It provides a reconstruction of the history of sedimentation which is consistent with all available geological data. By removing the loading effect of sediments on the lithosphere, the tectonic subsidence evolution can be computed assuming local of regional isostatic compensation.

2. The tectonic subsidence laws trough space and time obtained thus from geological data are compared with those predicted from thermomechanical models of formation of passive margins. These models give an estimate of the heat-flow value at the base of the lithosphere.

3. By applying a two-dimensional heat transfer model taking into account vertical and lateral conduction and forced convection, the history of temperature within the sediments is computed.

4. The location of potential "oil window" can then be deduced from the application of a cinetic model of hydrocarbon generation.

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LES LOIS DE REPARTITION PAR EPOQUE DE LA CROUTE OCEANIQUE

La répartition de la croûte terrestre selon son âge caractérise autant les continents que les régions océaniques de la terre. Ceci a été reconnu pour les continents au cours de l'établissement des cartes tectoniques dans les années 50 du XXe siècle. La cartographie des fonds océaniques a permis de reconstituer le processus de la formation de la croûte océanique, processus très long et complexe. La distribution des zones longitudinales d'âge différent de cette croûte, établie par Bruce Heezen et ses successeurs, a été représentée par les cartes de l'Atlas géologique du Monde (au 1/10.000.000) édité par l'UNESCO (1976-1983) sous la direction des coordinateurs principaux G.A.Choubert et A.M. Faure-Muret (France).

Les surfaces de la croûte océanique calculées à partir des cartes de cet Atlas et groupées par époques géologiques sont égales à (en millions de km^2): Pléeistocène, 5.38; Pliocène, 12.34; Miocène, 47.72; Oligocène, 39.61; Eocène, 36.37; Paléocène, 28.26; Crétacé supérieur, 69.61; Crétacé inférieur, 45.74; Jurassique-Trias, 16.03. La surface totale de la croûte océanique constitue 300.8 millions de km^2 ou 59% de la surface de la Terre (A_o). Les compositions par époques de la croûte océanique obtenues par calcul depuis le Crétacé inférieur jusqu'à l'actuel (dans les limites de précision des données de départ), suivent strictement la fonction exponentielle $A=A_o\ 1-\exp.(-kT)$, où A est la surface de la croûte océanique de tous les âges plus jeunes que l'âge T, pour lequel a été obtenue la surface A selon le coefficient empirique k=6,12 an^{-1}. La distribution de la croûte océanique selon les époques géologiques est définie par la formule $^{d}A/^{d}T=kA_o\exp.(-kT)$. Une telle distribution traduit une prédominance de la croûte d'âge jeune. La valeur maximum de cette répartition $kA_o=3.15$ km^2/an, est obtenue pour l'époque actuelle (avec T=0). Dans la terminologie de la tectonique des plaques le coefficient kA_o est l'équivalent de la vitesse du "spreading". Ceci s'explique par le fait que la croûte qui se forme dans les rift-zones durant une période courte (année, seconde)n'a pas le temps d'atteindre les lieux de subduction éventuels et reste dans sa totalité à la surface de la terre. Cette loi de la répartition de la croûte océanique par époques étant objective, chaque hypothèse tectonique valable doit en tenir compte.

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ЗАКОНОМЕРНОСТЬ ВОЗРАСТНОГО СОСТАВА ОКЕАНИЧЕСКОЙ КОРЫ

Возрастная зональность земной коры свойственна как материкам, так и океаническим областям Земли. Она была обнаружена после составления в 50-х годах XX в. тектонических карт материков. Картирование материков и океанического ложа позволило рассматривать становление земной коры как неодновременный длительный процесс. Размещение латеральных возрастных зон океанической коры, выделенных Брусом Хизеном, содержат карты Геологического атласа Мира (I:I0 000 000), изданные ЮНЕСКО (I976-I983 гг.) под редакцией Ю.А.Шубера и А.М.Фор-Мюре.

Площади океанической коры, подсчитанные по картам атласа и сгруппированные по эпохам, оказались равными (млн км^2): плейстоцен-5,38; плиоцен-I2,34; миоцен-47,42; олигоцен-39,6I; эоцен-36,37; палеоцен-28,26; верхний мел-69,6I; нижний мел-45,74; юра-триас-I6,03. Общая площадь океанической коры составляет 300,8 млн.км^2 или 59% поверхности Земли A_0. Полученный возрастной состав океанической коры от начала нижнего мела до современности (в пределах точности исходных данных) строго подчиняется экспоненциальной зависимости $A = A_0 I - \exp(-кT)$, где A - площадь океанической коры всех возрастов более молодых, чем возраст T, для которого определяется площадь A; к = = 6,I2 год$^{-I}$ - эмпирический коэффициент. Распределение океанической коры по возрастам описывается формулой $d A/dT = кA_0 \exp(-кT)$. Это распределение отражает преобладание океанической коры молодых возрастов. Наибольшее значение этого распределения $кA_0$ = 3,I5 км^2 в год получается для современного типа (при T = 0).

В терминах тектоники литосферных плит величина $кA_0$ эквивалентна площадной глобальной скорости спрединга. Объясняется это тем, что кора, генерируемая в рифтовых зонах, за короткое время (за год, за секунду) не успевает достигать мест субдукции и вся остается на поверхности Земли.

Полученная закономерность возрастного состава океанической коры ввиду ее объективности должна объясняться в рамках любой тектонической концепции, претендующей на признание. Наилучшее объяснение дает концепция расширения земного шара.

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GEOLOGY OF THE BERING SEA DEEP BASINS

Deep basin occupies the whole southern part of the Bering Sea. Its main structures are the Aleutian and Comandor basins separated by the Shirshov-Bowers ridge. The Aleutian basin is filled by 6-7 km thick sediments, magnetic anomalies here have meridianal trend and are perpendicular to the anomalies of the shelf; heat flow - 1,42 - 1.39 UHF, crust thickness - 15-16km, or 3-4 km more than that of the northern part of the Pacific plate. The Comandor basin is covered by 2-3 km thick sediments, magnetic trends are meridianal and coincide with the anomalies of the Olutor zone; heat flow - 2,64 - 3,03 UHF, M surface lays at the depth of 9-10 km, mantle anisotropy in this region is similar to that of young spreading zones, acoustic basement in the east, according to DSDP data belongs to Middle Oligocene, and turnes younger to the west, as per geophysical data. The Shirshov-Bowers ridge, according to magnetic data , is asymetrical; its eastern part is made up of amagnetic rocks (cherts), the western one - of basalts; Middle Miocene sedimentary cover fills only interrand throughs. The crust here is 18-20 km thick. Dragging carried out during the 29th leg of SRV "Dmitri Mendeleev" proved that the western slope of the ridge has nappe structure and is formed by the Oligocene -Miocene basalts as well as of amphibolite and gabbroid nappes; while the eastern slope - of the Upper Cretaceous siliceous rocks interbedded with basalts. The ridge presents the subduction and merging zone, which appeared as a result of spreading and formation of young crust in the Comandor basin. The Aleutian plate is a part of the Pacific plate, separated from the ocean by an island arc and through. Complex tectonic evolution and hetero genity is typical for many marginal seas of the Pacific ocean.

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ГЕОЛОГИЯ ГЛУБОКОВОДНЫХ ВПАДИН БЕРИНГОВА МОРЯ

Глубоководная котловина занимает всю южную часть Берингова моря. Основные структуры в ней - Алеутская и Командорская котловины и разделяющий их хребет Ширшова-Бауэрса. Алеутская котловина выполнена мощной толщей (до 6-7 км) осадков; магнитные аномалии здесь имеют меридиональные простирания , перпендикулярные к аномалиям шельфа; тепловой поток 1,42-1,39 ЕТП; мощность коры 15-16 км или на 3-4 км больше, чем в северной части Тихоокеанской плиты. Командорская котловина по-

крыта осадочным чехлом мощностью до 2-3 км; магнитные простирания меридиональные и совпадают с аномалиями Олюторской зоны; тепловой поток 2,64-3,03 ЕТП; поверхность М залегает на глубине 9-10 км; анизотропия мантии в этом регионе сходна с анологичной в молодых спрединговых зонах; возраст акустического фундамента на востоке по данным DSDP-средний олигоцен, и по всем геофизическим параметрам он омолаживается на запад. Хребет Ширшова-Бауэрса по магнитным данным асимметричен: на востоке он сложен амагнитными породами (кремнями), а на западе - базальтами; осадочный чехол среднемиоценового возраста заполняет лишь межгорные долины; мощность коры здесь 18-20 км. Драгирование, проведенное в рейсе 29 НИС "Дмитрий Менделеев", показало, что западный склон хребта имеет сложное покровное строение и сформирован олигоценовыми - миоценовыми базальтами, а также покровами амфиболитов и габброидов; восточный склон - кремнистыми породами верхнего мела с прослоями базальтов. Хребет представляет собой зону субдукции и скучивания, возникшую в результате спрединга и новообразования коры в Командорской впадине. Алеутская плита является частью Тихоокеанской плиты, отгороженной островной дугой и желобом от океана. Сложная тектоническая история и гетерогенность типичны для многих окраинных морей Тихого океана.

4583

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ON THE GEOCHEMISTRY AND ORIGIN OF POLIMETALLIC CRUSTS FROM THE D'ENCASTIEAUX ZONE, SOUTHWEST PACIFIC OCEAN

This paper presents the results of a preliminary investigation of polymetallic crusts and nodules dredged from horst-like structures comprising the D'Encastieaux zone lying between New Caledonia and Vanuatu in the southwest Pacific Ocean. The results of geochemical, mineralogic and petrographic analyses on 18 samples are given together with details of their extent and possible economic importance. The deposits studies occur mostly at depths of 2000-3000 m in the form of encrustations of thickness up to 6 cm, and only rarely as nodules. Fe-Mn oxides are found mostly on altered volcanoclastics and basalt sunstrates.

2. Зак. 1305

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MANTLE HETEROGENEITY: ALONG STRIKE VARIATIONS OF HYGROMAGMAPHILE ELEMENTS BETWEEN AZORES AND 10° N

A classification of the elements versus their hygromagmaphile character is proposed. An extended Coryell-Masuda plot, which includes non Rare Earth hygromagmaphile elements within the Rare Earths, allows to get a picture of the comparative geochemistry of these elements, makes it possible to use non Rare Earth elements (e.g. Nb/Zr, Ta/Hf, La/Ti) to identify the enriched or depleted character to basaltic samples and allows to evidence discontinuities in magmatic processes due to changes of chemical properties of some elements. The variation of different ration between the Azores and 10° N is consistent with the classification of the elements which is proposed and with previous studies mainly based on La/Sm ratio. The boundary, at the level of Hayes Fracture Zone, between the domain influenced by the Azores and normal ridge segments is confirmed. In addition, samples dredged at 14° N, a zero-age topographic high, present the same character as the samples from the Azores Triple Junction. This is an additional evidence of the correlation that exists at zero-age between the bathymetry and the "enriched" or "depleted" character of basalts.

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STRUCTURE AND HISTORY OF THE BANDA SEA (INDONESIA)

The Banda Sea is surrounded by an external arc made of fragments of continental terraines and of accretionnary wedges and an internal volcanic arc, separated by an interarc trench wich maybe very deep in the eastern part (Weber Trough).
We have made geological reconnaissances to Sumba, Kai and Tanimbar. Sumba, a late cretaceous Sunda shelf terrain, invaded by tertiary transgressions, acted like a part of the interarc trench during Upper Miocene, overline then by thick pelagic oozes and was uplifted during Plio-pleistocene times.
In Kai and Tanimbar achipelagoes there is an east-west succession of different units:
- folded paleogene and miocene series belonging of australian borderland and accretionnary wedges.

- neogene basins with overpressured shales which are the origin of numerous mud volcanoes.
- melange olistolites overthrusting a part of the neogenic basins.
- basement terranes in the internal part.

All these units overthrust a downwarped australian borderland with the subduction plunging NNW in the southern part of the Arc (Timor) and SSW in the Northern part (Ceram).
The Banda Arc would be an "inducted arc" as distribed by BRUNN and the Banda Sea would represent a stretched internal sea.

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ETUDE COMPARATIVE DES SERIES EO ET MESO-CCRETACEES DE PLATES-FORMES MAROCAINES ET OUEST-ALGERIENNES. PLACE DANS L'EVOLUTION DES MARGES "ATLANTIQUE" ET "MESOGEENNE" DE L'AFRIQUE NORD-OCCIDENTALE

Les auteurs étudient dûn point de vue biostratigrapheque, sédimentologique et paléogéographique les successions reconnues d'une part au Maroc, dans les bassins occidentaux d'Essaouira-Agadir et de Safi, ainsi que dans l'Avant-Pays Rifain oriantal et d'autre part en Algérie occidentale, dans les Monts de Daia (zone prétellienne d'Oranie).
Cette étude révèle, pour la période éo et méso-crétacée considérée, des traits communs dans l'évolution géodynamique de ces divers domaines avec, notamment:
- unformisation des faciès au début du Crétacé inférieur (Berriasien) et à la fin du Crétacé moyen (Cénomanian);
- découpage général des séries en deux cycles sédimentaires majeurs, celui de l'Hauterivien-Barrémien et celui de l'Aptien-Albien;
- manifestation de discontinuités importantes dans le Valanginien et le Bédoulien. Cette évolution commune témoigne d'une incontestable influence de l'Eustatisme dans cette partie nord-occidentale du continent africain.

Dans le détail apparaissent néanmoins des différences permettant de distinguer:
- une marge de type "atlantique" (bassins d'Essaouira-Agadir et de Safi) caractérisée par une lacune partielle ou totale du Valanginien en relation avec le "rifting" néocimmérien et par l'accélération progressive de la subsidence au passage Aptien-Albien, due à l'éloignement de l'intumescence médio-océanique;

- une marge de type "mésogéen" (Avant-Pays Rifain oriental, Monts de Daïa), où des réajustements tectoniques locaux sont probablement à l'origine de la soudaine apparition des bassins marneux bédouliens (internes ou externes)et du dévelopment des décharges terrigènes du "Wealdien" (Hauterivien-Barrémien) et de l'"Utrillas" (Albien).

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THE STUDY OF THE MINERAL ASSEMBLAGES AND ITS DISTRIBUTION PATTERNS IN THE SEDIMENTS OF THE CHINA SEA

The mineral components and its distribution patterns in the sediments of the Bohai Sea, Huaghai Sea, East China Sea, Southern China Sea, and Gulf of Tonkin were studied. We came to the conclusion that the fragment light minerals (specific gravity being less than 2.8) quartz and fildspar are the predominant components, that the clastic particles of the heavy minerals hornblende, epidote, muscovite,chlorite, biotite and ilmenite preponderate in number, and that the authigenic minerals are composed of glauconite, pyrite, collophanite, ferro-manganese pellet aragonite, dolomite and et al. of which glauconite accounts for most part.

Distribution patterns of fragmental mineral assemblages in the sediment of China Seas are chiefly comtrolled by the following factors:

1. Huanghe River controls the sediment distribution pattern in the Huangai Sea and the Southern part of Bohai Sea, while Changjiang River is chiefly responsible for that in East China Sea.

2. Sediment type determines the mineral distributions, for example, heavy minerals are lower content in the mud and silt.

3. Genesins type of the sediments affects the mineral distribution, for example, in East China Sea, a high content of heavy minerals was found in the relict sediment.

4. Under the control of submarine relief.
5. Under the control of hydrodynamic condition and direction of current.
6. Under the control of volcanic action.

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TECTONICS AND SEDIMENTATION IN THE ULLEUNG BASIN, EAST SEA (SEA OF JAPAN)

The East Sea (Sea of Japan) is a typical example of inactive back-arc basins in the western Pacific, rifted most likely by a tensional force caused by the heat produced from a small-scale convection in the asthenosphere. Although the initial rifting may have started in the late Mesozoic-Paleogene time, the sea opened extensively in late Oligocene to early Miocene (25-30 Ma). The sea consists of three deep basins; the Japan Basin, Yamato Basin and the Ulleung Basin. In the Ulleung and Yamato Basins the acoustic basement (layer 2) occurs at a depth of 4 km below sea level and at about 6 km below in the Japan Basin, consisted either of 3.5 km/sec (consolidated sediments or green tuff) or 5.8 km/sec layer. Sediments layer (layer 1; 1.6-3.2 km/sec) is up to 2 km thick and thickens toward the shelves.

The sediment layer in the Ulleung Basin consists of up to 1 km thick undeformed Quaternary turbidites underlain by slightly deformed Pliocene and older hemipelagic sediments. Miocene sediments and rocks are block-faulted accompanied by volcanism. On the southern Ulleung Basin margin mass-flow processes prevailed prior to this time filling the progressively subsiding basin (more than 4 km thick) representing slope sequences with numerous paleochannels and mass-flow deposits. Mass-flow processes were still operative in the Quaternary on the present slope of the basin causing extensive distribution of slump and slide, debris-flow and turbidite deposits of contour-parallel zoned facies. On the present seafloor sediments are in general progressivelly finer toward the deeper water, different from canyon-fed continental margins of both active and passive tectonic settings. Fine-grained sediments on the slope contain relatively large amounts or organic carbon.

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THE RED SEA: A SMALL OCEAN BASIN FORMED BY CONTINENTAL EXTENSION AND SEA FLOOR SPREADING

The formation of the Red Sea depression is considered to have developed in response to the separation of the Arabian plate away from the African plate. The first stages of separation probably began in the early Tertiary by incipient crustal extension that produced block faulting and a series of N-S trending morphotectonic depressions. By late Oligocene and early Miocene the main depression consisted of an extensive continental rift valley that was occupied by a large lake that received significant lacustrine sediments. Contemporaneous bi-modal

volcanism within the rift valley produced interlayered pyroclastic and lake deposits along with significant accumulations of mafic and silicic flows. Crustal attenuation continued with the development of extensive dikes and subvolcanic intrusive complexes invading the stretched Precambrian crust. On the flanks of the Red Sea depression thick accumulation of plateau volcanics formed in Saudi Arabia, Yemen, and Ethiopia. The left lateral displacement on the Dead Sea rift in early Miocene marks the first invasion of sea water into the Red Sea depression. Throughout the Miocene a thick evaporite blanket formed above the continental lacustrine and volcanic sequence as the depression continued to subside and extend. During the Miocene, geologic and geophysical observations are not conclusive, but there is very little evidence to support the idea that there was active sea floor spreading and formation of oceanic crust within the depression. At the beginning of the Pliocene (2-5 m.y.), sea floor spreading started in the middle portions of the Red Sea axial trough and continues up to the present time. Plate kinematic models of the Red Sea for the post-Pliocene are generally in agreement and fit nicely with reconstructed plate movements of the Middle East. Utilization of rigid plate kinematics or shoreline matching of the Red Sea where the basement for all of the depression is considered oceanic crust meets with serious geologic objections. Listric faults that rotate blocks of Precambrian crust contemporaneous with bimodal igneous activity provide structural evidence that continental extension was active in the pre-Pliocene history of the depression. The unexplained overlaps in the northern and southern parts of the Red Sea are best explained as areas of attenuated continental crust developed during pre-Pliocene extension. Confining ocean crust formation to the narrow axial trough within the medial portions of the Red Sea overcomes nearly all of the previous rigid plate kinematic problems.

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GEOCHEMISTRY AND ORIGIN OF BASALTS FROM THE WALVIS RIDGE (SOUTH ATLANTIC), A HOT-SPOT LINE OF ALKALINE VOLCANOES

The ~3500 km long nearly linear Walvis Ridge system connects the islands of the Tristan da Cunha group (Central South Atlantic) with the volcanic area of the South-West African coast (Etendeka Volcs.). At present, only the volcanic islands of Tristan da Cunha and Gough are active. This group of islands, probably the tips of a composite alkaline volcanic unit rising above the sea floor from a depth of about 3600 m., marks the intersection with the ill-defined crest of the southern Mid-Atlantic Ridge. In contrast the inactive and aseismic Walvis Ridge system appears to be a subsided volcanic chain resting upon a basement of normal oceanic crust (MORB).

Three different basaltic rock suites interlayered with volcanodetrital sediments, were encountered in Hole 524A on the southern flank of the Walvis Ridge (29°29.07'S and 3°30.74'E) half way between Tristan da Cunha and the West African coast. These rocks include, from top to bottom: an alkali-basaltic pillow lava and a 16 m. thick alkaline diabase sill with an age of ~ 65 m.y. (according to K-Ar dating and planktonic foraminifera) and a second sill of ~ 9 m. thickness (~ 74 m.y. in age) and tholeiitic in composition; thus contrasting strongly with the overlying rocks.

The alkaline basalts are characterized by high contents of TiO_2(3.5 - 4.3 wt.%), K_2O(2.3 - 3.7 wt.%) and P_2O_5(1.1 - 2.07 wt.%) as well as of incompatible trace elements Ba(990 - 1350 ppm), Rb(15 - 77 ppm), Sr(415 - 672 ppm), Nb(37 - 42 ppm), Y(35 - 42 ppm), Zr(255 - 287 ppm) and of LREE (e.g. Ce = 100 - 140 ppm). In contrast Cr(<10 - 21 ppm) and Ni(<3 - 14 ppm) are very low and indicate a high degree of differentiation.

According to a new normative classification scheme for alkalic rock series (Miyashiro, 1978), the alkalic basalts of Hole 524A fit into the "straddle-type B" category, a volcanic association, which may have been differentiated by fractionation of amphibole and magnetite besides plagioclase and clinopyroxene at pressures above 10 kbar or under some hydrous and oxidizing conditions. In this respect, these rocks are very similar to the Tristan da Cunha alkaline rock series. Thus, it is possible that the two parental magmas were derived by partial melting from similar mantle sources. The interpretation of the Walvis Ridge as a hot spot line of alkaline volcanoes is a realistic explanation.

Ocean floor spreading of the South Atlantic could have produced a chain of alkaline volcanoes by moving the African plate northeastward over a nearly fixed mantle hot spot. Dividing the distance of ~ 1600 km between Hole 524A and Tristan da Cunha by the time interval of 60 - 65 m.y. of volcanic activity, yields a spreading rate of 2 - 2.5 cm per year. This fits the approximation of spreading rates derived by extrapolation of the magnetic anomalies in the South Atlantic.

Miyashiro, A., 1978: Nature of alkalic volcanic rock series, Contr. Mineral. Petrol. 66, pp. 91-104.

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THE EVOLUTION OF THE THOLEIITE MAGMATISM IN WORLD OCEAN RIFT ZONES

Two stable groups of the low potassium ocean tholeiites originated in spreading rift zones (MORB-I and MORB-2)* were selected after statistical investigation of their quinched glasses. Eight component discriminant function serves as a criterion for this classification.

The general conclusion about the existence of regular relation between spatial distribution MORB-I and MORB-2 and tectonic of the World ocean was confirmed and specified using the new data of glass composition collected by Smithsonian Institution (over 4000 an.) as well as obtained during recent sea expeditions. MORB-I occures on the vast part of the ocean bottom while MORB-2 appears only on the limited parts of Mid-Ocean Ridges and in Marginal Seas during last 10-20 m.y. Based on the new data on experimental petroligy, melt inclusions studies and determination of fO_2 of crystallisation the petrological model for MORB origin was created. According to this model MORB-I and MORB-2 are the products of differentiation of two different primary melts. Compositions of these melts depend on the depth of their separation from uniform dry lherzolite mantle with 13-15% of partial melting. The primary melt of MORB-I has composition of high magnesian olivine tholeiite transitioning to pycrite and corresponds to melting equilibrium with spinel lherzolite under 10-15 k bar. The primary melt of MORB-2 is the high alumina tholeiite equilibrated with plagioclase lherzolite under 6-9 k bar. The geochemical peculiarities of both groups are controlled by the vertical heterogeneity of mantle in consequence of the change in phaze equilibrium during diapirism.

The change of the geodynamic environment of ocean lithosphere formation results in the change of the depth of primary melt separation.

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* MORB is TOR (tholeiite of Ocean Rift) in russian version.

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ЭВОЛЮЦИЯ ТОЛЕИТОВОГО МАГМАТИЗМА РИФТОВЫХ ЗОН МИРОВОГО ОКЕАНА

Статистическое изучение вариаций состава закалочных стекол низкокалиевых толеитовых лав океанов рифтогенного происхождения (ТОР-толеиты океанских рифтов) позволило выделить среди них две устойчивые группы ТОР-I и ТОР-2. Критерием их отличия является восьмикомпонентная дискриминантная функция, разделяющая эти составы с вероятностью не менее 95%. Использование новых данных по закалочным стеклам ТОР (более 4000 анализов, Смитсониановский институт,США) и результатов последних морских экспедиций подтвердило и уточнило выводы о закономерной связи между распространением ТОР-I и ТОР-2 и структурами дна Мирового океана. Показано, что ТОР-I занимает большую часть дна океана, в то время как ТОР-2 устанавливается только в ограниченных участках срединных хребтов и окраинных морей и проявляется только в последние I0-20 млн.лет.
Новые данные по экспериментальной петрологии, исследованию расплавных включений в минералах и по фугтивности кислорода ТОР использованы для разработки петрологической модели их эволюции. Согласно этой модели ТОР-I и ТОР-2 являются продуктами дифференциации разных первичных расплавов, состав которых зависит от глубины их отделения от сухой лерцолитовой мантии постоянного состава при близкой степени ее частичного плавления (I3-I5%). Исходный расплав для ТОР-I отвечает оливиновому толеиту, переходному к пикриту и равновесен с мантией в условиях шпинелевой фации (P=I0-I5 кбар). Исходным расплавом для ТОР-2 является высокоглиноземистый толеит, равновесный с мантией на уровне плагиоклазовой фации глубинности (P=6-9 кбар).
Геохимические различия ТОР-I и ТОР-2 вызваны вертикальной неоднородностью мантии, связанной со сменой ее фазового состояния при диапиризме.
Смена глубины отделения первичного расплава от мантии является результатом изменения геодинамического режима океанской литосферы при ее формировании.

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FORMATION OF METALLIFEROUS DEPOSITS AT RIDGE CRESTS

Ridge crest metalliferous sediments are composed of the oxidation products of the mixing of high temperature (350°C) hydrothermal fluids with seawater. Elements that form insoluble sulphides precipita-

te immediately as very fine grained "black smoke". Soluble elements such as manganese travel with the buoyant smoke plume and are either oxidised as entrainment of ambient water proceeds or are scavenged by the newly forming particulates. The plumes rise to several hundred meters above the ridge crest and are dissipated in the regional mid-depth circulation. Depending on location within this flow field the metalliferous particles can be transported for long distances either along or off axis leading to the characteristic distribution patterns mapped by many authors over the last 20 years. As oxidation of the sulphide particles and dissolved reduced manganese proceeds there is exchange of material with the ambient waters. The extent of this depends on the chemistry of the element in question.

Thus lead, which is highly insoluble as both the sulphide and the oxide stays in particulate form throughout the entire process. Since it is 50,000 times more abundant in the hydrothermal solutions than in seawater and since it has an isotopic composition identical to its MORB source this signature is retained in the metalliferous sediments upon deposition. Strontium and neodymium do not form sulphides and are only slowly scavenged from solution by oxides. Hence, as shown by their isotopic composition, they are derived entirely from seawater. The prevalence of metalliferous sediments on young crust is an indication of the ore localisation process in hydrothermal fields on sediment-starved ridge axes. A Cyprus-type massive sulphide probably represents only a few percent of the total metal flux carried by its parental hot springs. The long range dispersal of the hydrothermal effluent **makes** metalliferous "umbers" only marginally useful as an exploration tool in ophiolite terrains.

Low temperature Galapagos-type hot springs are formed by the mixing of the 350°C solutions with ambient seawater as groundwater in the highly permeable upper crust. Since this mixing process induces the quantitative precipitation of iron and other ore metals as disseminated sulphides in the basalts while leaving the manganese unaffected these solutions are not important in forming the metalliferous sediments since their Fe:Mn ratios are much higher than observed.

Rather they form the pure MnO_2 crusts commonly dredged on the ridge axis. This is demonstrated by their very low iron contents and by the fact that their lead isotopic composition is identical with that of seawater.

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STAGES IN THE DEVELOPMENT OF THE BAY OF BISCAY

The Bay of Biscay is a large sedimentary basin. The analysis of its time sections allows to single out several types of geological bodies within the sedimentary cover. Variation of their thickness suggest that the pre-Late Jurassic time featured a dissected relief with up to 3 km amplitude here which later was buried under the sediments. Together with deep-water accumulation of thick terrigenous units in the Late Jurassic - Early Cretaceous, shallow-water carbonates were being formed on the uplifted blocks of the basement. Blocks consedimentary subsidence along listium faults were of ancillary significance. At the Middle-Late Eocene boundary, the Bay of Biscay was exposed to intense upward vertical movements. In the post--Middle Eocene - Miocene, deposits accumulated in consedimentary epicontinental troughs primarily in the area of the present continental slope. The beginning of the Pliocene saw a sharp sinking of the central parts of the basin resulting in the formation of an abyssal plain on which sediments began to accumulate. In the Quaternary, a new phase of sinking brought about the present structural plan of the Bay of Biscay which incorporated adjacent parts of epicontinental troughs.

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ЭТАПЫ РАЗВИТИЯ БИСКАЙСКОГО БАССЕЙНА

Бискайский залив представляет крупный осадочный бассейн. Анализ отработанных здесь временных сейсмических разрезов позволяет выделить в осадочном чехле несколько типов геологических тел. Характер изменения их мощностей показывает, что в предпозднеюрское время здесь был сформирован расчлененный рельеф с амплитудой до 3 км, который в дальнейшем захоронялся осадками. Одновременно с накоплением в глубоководных условиях мощных терригенных толщ в поздней юре - раннем мелу шло формирование мелководных карбонатов на приподнятых участках блоков фундамента. Конседиментационное погружение блоков по разломам листрического типа носило подчиненный характер. На рубеже среднего-позднего эоцена Бискайский бассейн был захвачен интенсивной волной восходящих вертикальных

тектонических движений. В постсреднеэоценовое-миоценовое время шло накопление отложений в конседиментационных эпиконтинентальных прогибах преимущественно на площади современного континентального склона. В начале плиоцена произошло резкое погружение центральных участков бассейна, сформировавшее абиссальную равнину, которая начала захороняться осадками. В молодое четвертичное время произошла новая фаза погружения бассейна, в результате которой был создан современный структурный план Бискайского залива и в его состав оказались включены прилегающие участки эпиконтинентальных прогибов.

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LA MER LIGURE: ORIGINE ET EVOLUTION D'UN "BASSIN MARGINAL"

La Mer Ligure, partie nord-orientale du Bassin Algéro-Provençal, est généralement considérée comme un bassin marginal classique à croute océanique. Son évolution est de même vue comme une simple conséquence du processus "d'océanisation". Des études récentes de géophysique et de géologie marine ont mis en évidence plusieures choses qui contrastent avec ce modèle. Surtout l'étude des profils sismique réflexion et de la séismicité naturelle amène à remarquer que:

-les marges continentales sont beaucoup plus étendues qu'on ne pensait. Le substat de la plupart du Bassin est formé par de la croute continentale amincie: la croute "acéanisée", si elle existe, intéresse seulement une zone très restreinte de la plaine bathyale;
-le remplissage sédimentaire atteint l'épaisseur de 8 Km au centre du Bassin. Même certaines dépressions de la marge sont carctérisées par des épaisseurs de sédiments élevées (6 Km environ près de Savone; 2,5 Km de seul Plio-Quaternaire près de Viareggio);
-l'évolution du Bassin au Miocène a été caractérisée par deux phases de transgression séparées par une régression importante qui précède le début de la sédimentation évaporitique messinienne;
-l'évolution plio-quaternaire du Bassin et de sa bordure a été déterminée par une tectonique très active, en plusieures phases;
-l'activité sismique actuelle est,au centre du Bassin, la plus intense de toute la région (Mer Ligure et chaines qui l'entourent).

D'autre part, les études de géologie structurale à terre, viennnent de montrer que la tectogenèse de l'Appennin septentrional est probablement due à la poursuite de la collision entre Europe et plaque apulienne, sans aucun véritable mécanisme de subdution.

On propose donc un nuoveau modèle de la genèse et évolution de la Mer Ligure, dans lequel:
-le Bassin principal et les dépressions des marges sont originés par un processus de rifting continental qui se surimpose aux chaines de collision, bien que certaines structures soient contemporaines ou antérieures à la dernière phase de collision;
-la distension originaire fait place, au Miocène supérieur, à une importante phase de compression, contemporaine aux dernières déformations de l'Appennin ligure, dont

la conséquence est la régression observée (soulèvement du Bassin). La subsidence reprend à la fin du Tortonien: pendant le Messinien, en tout cas, la profondeur moyenne du Bassin devait être limitée;

-la tectonique plio-quaternaire, assez complexe, est schématisée comme une alternance de phases de distension et de compression . Ces dernières intéressent surtout la zone axiale du Bassin et en causent un approfondissement accéléré, ce qui entraine des phénomènes de collapse par failles normales sur les marges. Les dénivellations actuelles sont dues principalement à ces phases dont la prémière, pendant laquelle la structure actuelle du Bassin et de sa bordure commence à se définir, date du Pliocène inférieur. Les mécanimses aux foyers des séismes montrent que la dernière phase quaternaire, encore en cours, est de ce type. Cela expliquerait la profondeur anormale du socle et les anomalies de gravité à l'air libre qui se placent dans la même zone intéressée par les séismes.

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MESOZOIC AND CENOZOIC UNCONFORMITIES GENERATED BY SEA LEVEL FALLS AND PLATE TECTONICS (PASSIVE MARGIN OF ISRAEL)

The Mesozoic and Cenozoic stratigraphic sequence of Israel consists of 6 sedimentary prisms with 5 intervening unconformities. The facies in each of these prisms, although different in details, generally reflects the relative effect of two major provinces - the Arabiar Craton to the SE and the Tethys Ocean to the NW. The 5 conspicuous unconformities can be well correlated with distinct global sea level drops and with regional eastern Mediterranean tectonic events. Opening of the Tethys at the Triassic-Jurassic boundary coincides also with a global sea lever drop. These events are represented by extensive faulting, alkali basalt volcanics and lateritic soils. The global eustatic lowstand of the Jurassic-Cretaceous boundary is marked by faulting, volcanism and regional truncation all over the Levant basin. The Coniacian disconformity discerned also in Europe and in the Western Interior of the U.S. is related to a sharp sea level fall. A conspicuous Late Oligocene global sea level low and Early Miocene opening of the Red Sea system in expressed by a major unconformity, faulting, emplacement of basalt dikes and clastic accumulations. An important truncation, channeling and deposition of evaporites represent Late Miocene-Messinian event. In conclusion, the major unconformities are not localized and therefore probably represent global processes.

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PALEOGENE MAGNETOBIOCHRONOLOGY AND CORRELATION OF MARINE AND CONTINENTAL STRATA

Recent advances in stratigraphic correlation techniques permit more refined correlations than have ever before been possible between marine and continental strata. Integration of information from magnetic polarity stratigraphy; high temperature radioisotopic chronology; palynofloral, mammalian, and terrestrial invertebrate biostratigraphy; and marine invertebrate and micropaleontologic biostratigraphy has resulted in an integrative global Paleogene geochronology (Berggren, Kent, and Flynn, in press). New studies that directly interface biostratigraphy, magnetic polarity stratigraphy and radioisotopic dating allow precise location of biochronologic boundaries within the polarity sequence of the magnetic polarity time scale, and absolute dating of magnetochronologic and biochronologic boundaries. Such Paleogene studies are now available from the Western United States, Canada, South America, Southern England, Greenland, Italy, and deep ocean basins (DSDP results). Following a summary of my recent study on the correlation and geochronology of marine and continental Eocene strata from the western United States, I will discuss the importance of the above studies to Paleogene geochronology, and the recognition and correlation of biologic, geologic and oceanographic events. Preliminary global correlations of Paleogene terrestrial and shallow marine sequences (lacking direct interfacing of biostratigraphy/radioisotopic dating with magnetic polarity stratigraphy) for western Europe, the USSR, eastern Europe, and China/southern Asia also will be presented.

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GEODYNAMICS OF CONTINENTAL MARGINS IN SOUTHEAST ASIA IN RELATION TO THE OCEAN EVOLUTION

The Phanerozoic geodynamics of SE Asia continental margins was in the close connection with cycles of the large oceanic type basin development. Those basins were: Palaeotethys in the Early-Middle Paleozoic, Palaeopacific in the Middle Paleozoic - Early Mesozoic, Tethys at the end of the Paleozoic - beginning of the Cenozoic, the Indian and Pacific Oceans together with their marginal seas in the Late Mesozoic - Cenozoic. The opening of the majority of those basins was due to the

destruction, tension and moving apart some blocks of the continental crust and was laterally accompanied by the simultaneous closing of some earlier existent basins and by accretion and compression of the sialic layer. Thus the relative compensation of the constructive and destructive process manifestation seems to exist in SE Asia. The most clear examples of such interconnected geodynamic systems are the opening of Tethys in the Permian-Triassic (the Indus-Tsangpo Zone, Central Burma, Sumatra) and synchronous closing of Palaeotethys in the same time (Upper Yangtse, Ailaoshan, North and Central Thailand, the Malay Peninsula). The opening of the Indian Ocean and the simultaneous closing of Tethys north of it occured in the same manner from the Late Jurassic till the Early Neogene. All mentioned events are clearly impressed in actual and ancient continental margins and collision zones. These structures can be studied by applying of the structural-formational lateral analysis method which helps in restoring of existent and past geodynamic conditions.

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СВЯЗЬ ГЕОДИНАМИКИ КОНТИНЕНТАЛЬНЫХ ОКРАИН ЮГО-ВОСТОЧНОЙ АЗИИ С РАЗВИТИЕМ ОКЕАНОВ

Фанерозойская геодинамическая эволюция юго-восточных окраин Азиатского континента была тесно связана с циклами развития крупных бассейнов с корой океанического типа. К их числу относятся Палеотетис в раннем-среднем палеозое, Палеопацифик в среднем палеозое - раннем мезозое, Тетис в конце палеозоя - начале кайнозоя, Индийский и Тихий океаны вместе с окраинными морями в позднем мезозое - кайнозое. Раскрытие большинства из них в результате деструкции, растяжения и раздвигания блоков континентальной коры сопровождалось по латерали синхронным закрытием ранее существовавших бассейнов, наращиванием и сжатием сиалического слоя в пределах активных континентальных окраин и зон столкновения, что позволяет предполагать относительную компенсацию проявления конструктивных и деструктивных процессов на юго-востоке Азии. Наиболее яркими примерами таких взаимосвязанных геодинамических систем являются раскрытие бассейна Тетис в перми - триасе (зона Инд-Цангпо , Центральная Бирма, Суматра) и одновременное закрытие бассейна Палеотетис (Верхняя Янцзы, Айлаошань, Северный и Центральный Таиланд, полуостров Малакка). Начиная с поздней юры и до раннего неогена таким же образом происходило раскрытие Индийского океана и одновременное закрытие бассейна Тетис к северу от него. Все упомянутые события отчетливо запечатлены на современных и древних континентальных окраинах и в зонах столкновения Юго-Восточной Азии, изучение

которых с помощью методики латерального структурно-формационного анализа помогает восстановить существующие и прошлые геодинамические обстановки.

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BASIC FEATURES OF GEOLOGY OF THE OKHOTSK SEA

The epi-Mesozoic Okhotsk platform occupies central and northern parts of the Okhotsk sea . The platform basement is composed of deformed geosynclinal formations, covering the stratigraphic range from Cretaceous up to pre-Cambrian inclusively. A slightly deformed cover levels the rough surface of the basement and composed of Paleogene-Neogene terrigenic sedimentary formations, filling the system of structural-sedimentary basins.

The South-Okhotsk Deep-Sea Basin occupies the southern part of the sea. This is an elementary basin, non-compensated by sediments, which is in the back-arc basin of the Kuril geoanticlinal uplift. Two main seismic units are distinguished within the sedimentary cover, the lower of which being, probably, composed of pelagic and the upper one of turbidity deposits covering, as a whole, the stratigraphic range from Cretaceous up to Holocene.

The developing of a system of normal structural-sedimentary basins of the Okhotsk platform is stipulated by the crustal extension beginning from Paleogene in the direction of north-east - south-west, normal to the strike of the basement epi-Mesozoic structural elements. The South-Okhotsk Deep-Sea Basin exists at any rate since Cretaceous as a relict geosynclinal basin, separated from the Pacific as a result of appearance of the Kuril geoanticlinal uplift.

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ОСНОВНЫЕ ЧЕРТЫ ГЕОЛОГИИ ОХОТСКОГО МОРЯ

Центральную и северную части Охотского моря занимает эпимезозойская Охотская платформа. Фундамент платформы сложен деформированными геосинклинальными комплексами, охватывающими стратиграфи-

ческий диапазон от мела по докембрий включительно. Слабодеформированный чехол нивелирует неровную кровлю фундамента и сложен терригенным осадочным комплексом палеогена-неогена, выполняющим систему структурно-седиментационных бассейнов.

Южно-Охотская глубоководная впадина, представляющая собой некомпенсированный осадконакоплением элементарный бассейн в тылу Курильского геоантиклинального поднятия, располагается в южной части моря. В осадочном чехле впадины выделяются два сейсмокомплекса, нижний из которых сложен, вероятно, пелагическими, а верхний - турбидитными отложениями. Чехол впадины охватывает стратиграфический диапазон от верхнего мела по голоцен.

Формирование системы нормальных структурно-седиментационных бассейнов Охотской платформы, заложившихся в палеогене, связано с растяжением земной коры в направлении северо-восток - юго-запад по нормали к простиранию основных эпимезозойских структурных элементов фундамента. Южно-Охотская глубоководная впадина, по крайней мере с мелового времени, представляет реликтовый геосинклинальный бассейн, отчленившийся от акватории Тихого океана в результате формирования Курильского геоантиклинального поднятия.

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THE EFFECT OF SEA LEVEL CHANGES ON STRATIGRAPHIC SEQUENCES OF PASSIVE MARGINS

It is generally believed that transgressive or regressive sequences that may have occurred simultaneously on geographically dispersed continental margins have been caused by worldwide sea-level rise or fall, respectively. Instead, it will be shown that these events may be caused by changes in the rates of sea-level rise or fall. Subsidence of passive margins appears to be of thermal origin, and increases from near zero at a landward hinge zone to a maximum value at the ocean-continent boundary. With the exception of sea-level changes due to glaciation, desiccation, flooding of small ocean basins and other sudden events, the rate of subsidence at the ocean-continent boundary (shelf edge) is greater than the rate at which sea level may rise or fall. These relationships have been quantifield so that the position of the shoreline and the thickness of the sediments deposited during discrete time intervals may be computed as a function of rate of sea-level change, sedimentation rate and rate of subsidence.

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BASALT GEOCHEMICAL TYPES AND PROVINCES IN THE PACIFIC OCEAN

On the basis of numerous published and original data, obtained during deep-sea drilling and dredging of the Pacific ocean floor, we ductinguished 5 main geochemical types of basalts: 1 - MOR Tholeiites, they are of magnesian, magnesian-ferruginous and ferruginous composition: II - primitive intraplate (PIP) tholeiites characterized by louer TiO_2, Na_2O, and large ion lithoplite (LIL) element (Rb, Sr, Ba, Tr, Th, U) contents as compared to MOR tholeiites; III - tholeiites and differentiated alkaline basalts with highner TiO_2, alkali, LIL element (Hawaiian type) contents; IV - transitional subalkaline basalts depleted in TiO_2 and LIL elements in comparison with Hawaiian tholeiites; V - nepheline basanites, slightly differentiated alkaline basalts, and tholeiites with high TiO_2, K_2O, LIL element contents (Samoan or Tahitian type).

Distribution of the basalt types is controlled by the tectonic structures. According to this we mark out 5 main geochemical provinces: (1) East Pacific province composed by MOR tholeiites with subordinate development of Hawaiian and transitional type basalts of both Cenozoic and Cretaceous age; (2) Hawaii-Emperor province with Cenozoic and Cretaceous basalts of Hawaiian type; (3) North-West province with transitional subalkaline basalts, which are likely underline by PIP tholeiites; (4) Transpacific subequatorial province composed by Cenozoic basalts of Samoan type, Late Mesozoic MOR tholeiites (Ontong-Java Plateau), and PIP tholeiites (Nauru Basin, Manihiki Plateau); (5) South-West province formed by the basalts of II, IV and V types.

Vertical and lateral varieties of the Pacific tectonosphere composition and lateral the formation of the geochemical provinces. We suppose the Pacific tectonosphere to consist of there layers: the lower grospydite-eclogite layer enriched in LIL elements and being the main source of thermal energy; the middle wehrilite-eclogite layer with high alkali content, and the upper pyroxenite-lherzolite (pyrolite) layer. We relate the formation of PIP and MOR tholeiites to partial melting of the upper layer, and the formation of Hawaiian and Samoan type basalts - to fluid-magma systems originated in the lower and middle layers.

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ГЕОХИМИЧЕСКИЕ ТИПЫ И ПРОВИНЦИИ БАЗАЛЬТОВ ТИХОГО ОКЕАНА

Обобщение обширных опубликованных и собственных данных, полученных при глубоководном бурении и драгировании дна Тихого океана, позволяет выделить 5 главных геохимических типов базальтов: I – толеиты срединно-океанических хребтов (MOR) магнезиального, магнезиально-железистого и железистого состава; II – примитивные внутриплитные (PIP) толеиты, характеризующиеся пониженными по сравнению с толеитами MOR содержаниями TiO_2, Na_2O и литофильных элементов с крупными ионами (LIL – Rb, Sr, Ba, Tr, Th, U); III – толеиты и дифференцированные щелочные базальты с повышенными содержаниями TiO_2, щелочей, LIL елементов (гавайский тип); IУ – переходные субщелочные базальты с пониженным по сравнению с гавайскими толеитами содержанием TiO_2 и щелочные базальты и толеиты с высокими содержаниями TiO_2, K_2O, LIL элементов (самоанский или таитянский тип).

Размещение выделенных типов базальтов контролируется тектоническими структурами, в связи с чем намечается 5 главных геохимических провинций: I) Восточно-Тихоокеанская, сложенная толеитами MOR с подчиненным развитием базальтов гавайского и переходного (IУ) типов как кайнозойского, так и мелового возраста; 2) Гавайско-Императорская, характеризующаяся распространением кайнозойских и меловых толеитов и щелочных базальтов гавайского типа; 3) Северо-Западная, характеризующаяся распространением переходных субщелочных базальтов, которые, вероятно, подстилаются толеитами PIP; 4) Транс-Тихоокеанская субэкваториальная, сложенная кайнозойскими базальтоидами самоанского типа, позднемезозойскими толеитами MOR (плато Онтонг-Джава) и толеитами PIP (впадина Науру, плато Манихики и др.); 5) Юго-Западная, сложенная базальтами типов II, IУ, У.

Формирование геохимических провинций обусловлено вертикальными и латеральными неоднородностями состава тектоносферы Тихого океана.

Предполагается трехслойное ее строение: нижний гроспидит-эклогитовый, обогащенный LIL элементами и являющийся главным источником тепловой энергии; средний верлит-эклогитовый, обогащенный щелочами; верхний пироксен-лерцолитовый (пиролитовый). Образование толеитов PIP и MOR связывается с частичным плавлением верхнего слоя; базальтов гавайского и самоанского типов – с флюидно-магматическими системами, зарождавшимися в нижнем и среднем слоях.

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ON THE CHARACTERISTICS AND THE MECHANISM OF FORMATION OF THE BACK-ARC BASINS OF THE WESTERN PACIFIC OCEAN AND THEIR GEOTECTONIC SIGNIFICANCE

Based upon the geological and geophysical data the back-arc basins are best differentiated genetically into four types: 1) the back-arc ensialic rifted basin, 2) the foreland basin, 3) the marginal sea basin and 4) the interarc basin. The former two types are characterized by the continental-type crust with a thickness amounting to about 30 km, and the latter two are characterized by the oceanic to transitional-type crust with a thickness amounting to 10 to 20 km. The mechanism responsible for the back-arc basins might be summarized as follows: 1) Since the Western Pacific Ocean Plate's geological age is relatively older, dipping angles of the subduction zone are steeper and subduction rate is faster than those of the Eastern Pacific Ocean Plate, the plate subduction has induced small scale thermal convection body so as to produce micro-spreading and diapiric mantle upwelling. Thus, the marginal sea and interarc basins are formed as a consequence of subduction and microspreading. 2) Owing to the much ticker continental crust of the continental plate and the lithospheric uplifting, the extensional effect has produced so as to produce the ensialic back arc rifted basin. 3) As a result of the closing of the original marginal sea basin, the earth crust has experienced intence compressive and shearing stresses to transform the marginal sea basin into the foreland basin.

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STRUCTURAL, PETROLOGICAL AND GEOCHEMICAL FEATURES OF THE SHEETED-DIKES COMPLEX IN THE DROCEA MOUNTAINS AND ITS SIGNIFICANCE FOR THE MAGMATIC EVOLUTION OF THE OCEANIC ZONE

The Alpine ophiolite series in the Mureş zone is exposed with two complexes: the ocean-floor basalts complex (O_1) and the sheeted-dikes complex (O_2). The latter crops out in the Drocea Mts and consists mostly of basalt, hyalobasalt, dolerite and gabbro dikes beside ferrogabbro, ferrobasalt, spillites, granophyres, plagiogranites and albitic plagiaplites dikes. The dikes are almost vertical, trending E-W and NE-SW; their thickness varies between

0.5-2 m, rarely 5-10 m. On margins they display a zone of rapid cooling or of albitization and brecciation. Most rocks feature ocean-floor type tholeiites, whereas at ferrogabbros and ferrobasalts as well as at granophyres, other albitic rocks inclusively, the geochemical characters change due to the Fe, Ti and V concentration in the first and Si, Na, Zr, etc. concentration in the last. The parental magma formed in a magmatic chamber situated in the mantle, below the spreading zone, at a depth of 100 km. This magma gave rise to dikes of nondifferentiated basic rocks during almost all the period of ocean-floor spreading (180-160 m.y.). Towards the end of the period the magma differentiates, providing: (1) ferrogabbros and ferrobasalts; (2) granophyres and albite-granitic rocks; (3) separation of pyrite and chalcopyrite, which will form the sulphide mineralizations associated to the ophiolite series.

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GEOCHEMISTRY AND GEOTECTONIC SETTING OF OCEANIC BASALTS BY NUMERICAL ANALYSIS - A MODEL

The chemical data of globally distributed oceanic basalts were investigated by numerical methods for geochemical and geotectonic comparison of different rock associations (especially of ophiolites and initialites) in recent continental setting.
Selected informations from international literature and own data from Mid-Atlantic Ridge and western Pacific island arc regions were used.
The identification of the internal relations of geochemical features (i.e. petrogenetic connections) and their geotectonic interpretation are the objectives of the processing.

By multivariate numerical methods, a classification model of basalts was elaborated on the basis of suitable major and trace element data (SiO_2, Al_2O_3, MgO, K_2O, P_2O_5, Ti, Ni, Sr, Y, Zr).

Consequently, a sequence of classes was derived, starting with a class of mainly basalts of mid-oceanic ridges over oceanfloor, oceanic islands up to those of the rock class of marginal oceanic regions (island arcs). The sequence corresponds to an increasing of variability of magmatic processes in this directions.
The model is used for comparison with basaltic rocks from Central European fold belts.

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THE BREAKUP OF PANGAEA, CLIMATIC, EROSIONAL AND SEDIMENTOLOGICAL EFFECTS

The breakup of Pangaea resulted in a sequence of climatic, erosional and sedimentological effects which have dominated the history of the earth's surface over the past 250 my. One-third of all the sediment presently on earth has been eroded, transported and redeposited as part of the breakup process and its aftermath. The breakup of Pangaea also resulted in a series of global climatic changes, from a world dominated by extensive arid landmasses during the early Mesozoic to the broadly flooded continents and equable climates of the late Mesozoic, and finally to the strong equator to pole climatic gradients of the late Cenozoic. Along with the changes in paleogeography and climate there have been significant changes in the bouyancy driven circulation of the ocean, from the Mesozoic oceans filled with warm saline bottom waters formed in the shallow seas of the arid zones to the Neogene oceans filled with cold bottom waters formed near the polar regions. Rifting of Pangaea into the major continental blocks involved uplifts defining drainage basins and exerting significant influence on local and regional climates. Rifts of limited extent may not have a prior history of uplift, and failed third arms of triradiate rifts have often become sites of future organized river input to the ocean.

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WEDGES OF OCEANWARD DIPPING BASEMENT REFLECTORS - ONE END-MEMBER PASSIVE MARGIN TYPE

It is now widely accepted that the extensive wedges of oceanward dipping basement reflectors which have been recognized in seismic data from many passive margins represent one end-member passive margin type, and that their formation was associated with volcanism. Although some results from refraction seismic measurements and gravity modelling show remarkable thickening of layers with velocities equal to those of oceanic Layer 2 in areas over which the oceanward dipping reflectors have been observed, their origin and the nature of the deep structure is still enigmatic. We report here new deep seismic data of two-ship geophysical studies on the continental margin of W-Norway and E-Greenland.

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SEAMARC II ACOUSTIC IMAGES AND BATHYMETRY MAPPING OF TECTONIC FEATURES IN THE PACIFIC OCEAN

SeaMARC is a long-range, 12-kHz, side-scan sonar system that has the unique capability to precisely measure the angle of incidence of returning signals from the seafloor. Thus the system produces a bathymetric map at the same time that it makes a geochemically accurate acoustic image of the seafloor. The SeaMARC II transducer array is towed at shallow depths (typically about 100 meters) at speeds up to ten knots and collects continuos data in a swath ten kilometers wide along the ship's track. Over 4000 square kilometers of seafloor can be surveyed each day.

Although the system (particularly the processing of bathymetric data done post-cruise) is still being developed and refined at the Hawaii Institute of Geophysics. It presently is capable of bathymetric repeatability to better than 35 meters, and can define the shape of objects of the seafloor with dimensions of less than 100 meters. The system is proving to be invaluable as a geological exploration tool in that it can differentiate specular reflections caused by large scale bathymetric relief from variation in backscattering caused by variations in the material covering the seafloor.

Examples of the results of tectonic studies in the vicinity of the Mariana Island Arc, a zone of active plate convergence, and in the Juan de Fuca seafloor spreading system are used in this paper to demonstrate the capabilities of SeaMARC II. In the Marianas region variations in the detailed morphology of arc and fore-arc seamounts are indicative of their origin and of the history of the development to the arc. Large igneous diapirs, smaller mud volcanoes, and seamounts in the process of being fractured prior to subduction have been observed. The Mariana fore-arc has also been subjected to regional fracturing that has produced rift patterns that are indiscernible using standard bathymetric mapping techniques, but which are clearly important as indicators of the tectonic history of the arc.

In active seafloor spreading regions such as the Juan de Fuca Ridge the SeaMARC II delineates extensive fault patterns and related volcanic and diapiric features. The acoustic image allows interpretation of subtle differences in bottom character caused by variations in types of lava flows and in the relative ages of extrusives. Active faults can be differentiated from apparently less active features that are smoothed by minor erosion and draping of thin sediments.

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SEDIMENTS AND STRUCTURE OF THE JAPAN SEA

The Japan and the Yamato Basins consist of an oceanic crust with 8km and I4km thickness, respectively. Neogene and Quaternary sediments are approximately 2km thick in both basins. Horizontally layered acoustic basements in both basins have a velocity of 2.9-3.3 km/sec and are believed to consist of volcanoclastics in Neogene age.

Highs such as the Yamato, the Oki Ridges and the Korean Plateau mainly consist of intrusive and volcanic rocks and commonly have a distinct boundary with the basins. It is in contrast with the boundaries along the Japan and the Asia continents which are modified by sedimentation and by structural movements.

Many ridges and troughs are arranged along the eastern margin of the Japan Sea. Sedimentary basins in the backarc side of the Tohoku Arc are originated by the local deep subsidence since the late Oligocene and characterized by progradation toward offshore (toward west) during the later stages. The latest stage of the basin is controlled by thrusts which formed oil fields onshore and ridges and troughs along the shelf and slope areas since Quaternary.

For the origin of the Japan Sea, a fan spreading is suggested since the late Oligocene and finally the Japan Sea is turned to horizontal compressional field since Quaternary.

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OKINAWA TROUGH - A EMBRYONIC MARGINAL BASIN

The depth to MOHO in Okinawa Trough ranges from I5 to 28km, and the depth to MOHO is I5-20km in southern part of Trough, more 20km in northern, the nature of crust beneath Okinawa Trough is in transformation from continental to oceanic.

In the Okinawa Trough are deposited thick sedimentary strata, mainly, of Neogene and Pleistocene age, and divided into three layers, the upper horizontal layer, the middle layer lightly folded and the lower deformed layer. They are recent to Pliocene, Miocene and Paleogene and older respectivily.

On both slopes of the Trough, are developed many normal faults, along which interrupt the intrusive igneous rocks into the sedimentary strata, and volcanic activity made some seamounts appearing on the bottom of the Trough. The tectonic movement in southern of Trough is stronger than in northern.

The formation of Okinawa Trough started after the Miocene. The Okinawa Trough is a arc-back basin and a embryonic marginal basin in rifting and spreading. However, the true Trough in tectonic sense is the southern part of Trough only.

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MAGNETIC ANOMALY PATTERN, STRUCTURE AND AGE OF THE ARABIAN SEA FLOOR

A systematic magnetic survey carried out in the Arabian Sea along a grid of approximately north-south lines provides a more detailed characterization of the magnetic anomaly pattern than with the previous scattered profiles and a better understanding of evolution of the region. To the north-east of the axis of the Carlsberg Ridge, over its crest, flank and the Arabian Basin, two linear paleomagnetic anomaly sequences have been indentified. Over the ridge, a sequence of low-intensity, short-wavelength anomalies parallel to the ridge axis and offset by a number of fracture zones has been revealed. The sea-floor spreading anomalies 1-7 have been mapped. Over the Arabian Basin, a sequence of more intensive, long-wavelength, approximately east-west magnetic anomalies (to the anomaly 29) offset by nearly north-south fracture zones has been delineated. On the east of the studied region, both sequences are juxtaposed, the older east-west sequence progressively reducing to the west, presumably, because of missing of its younger anomalies. The obtained magnetic anomaly pattern has enabled us to reconstruct continuous two-stage evolution of the Arabian Sea floor. During the first stage (67-26 Ma according to the magnetic anomaly time scale of Ness at al., 1980) with opening along the proto-Carlsberg Ridge, an episode of fast spreading (50-60 km/year to the anomaly 23) was followed by that of slow spreading (13-15 mm/year). The second stage (26-0 Ma) was characterized by opening (10-12 mm/year) along the present-day Carlsberg Ridge.
Thus, the earlier proposed interruption in the Arabian Sea floor spreading is unlikely to take place; a shift in the spreading axis must have occurred abruptly and discordantly with respect to the axis of proto-Carlsberg Ridge and may well be accompanied not only by a change in the direction of plate motion but also by a possible attachment of a wedge-like fragment of the Indian lithospheric plate to the Africa (Somali) plate. The analysis of skewness of the east-west anomalies permits a more accurate estimation of the latitude and azimuth of the suggested spreading paleoaxis to be made.

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МАГНИТНЫЕ АНОМАЛИИ, СТРУКТУРА И ВОЗРАСТ ДНА АРАВИЙСКОГО МОРЯ

Систематическая гидромагнитная съемка, выполненная в Аравийском море по сети субмеридиональных галсов, позволила установить структуру аномального магнитного поля с большей подробностью, чем это было сделано ранее по редким профилям, и лучше понять эволюцию изучаемого региона. Северо-восточнее оси Карлсбергского хребта, на его гребне, склоне и в Аравийской котловине развиты две системы линейных магнитных аномалий спредингового типа. На хребте прослежена система слабо интенсивных коротковолновых аномалий, параллельных оси хребта и смещенных несколькими поперечными разломами. Аномалии имеют номера от I до 7. В Аравийской котловине выявлена система более интенсивных, преимущественно длинноволновых субширотных магнитных аномалий с наибольшим номером 29, смещенных несколькими субмеридиональными разломами. На востоке Аравийского моря обе системы смыкаются без перерыва, а в западном направлении наблюдается прогрессивное сокращение более древней широтной последовательности предположительно за счет выпадения ее молодых аномалий. Описанная структура аномального магнитного поля отражает непрерывную двухэтапную историю формирования дна Аравийского моря. На первом этапе (67-26 млн. лет назад по шкале Несса и др., 1980), когда раскрытие происходило относительно оси прото-Карлсбергского хребта, за эпизодом быстрого спрединга (50-60 км/год, до аномалии 23) последовало постепенное замедление скорости спрединга до I3-I5 мм/год. Анализ скошенности субширотных аномалий позволяет уточнить широту и простирание предполагаемой палеооси разрастания. Второй этап, начавшийся практически без перерыва, характеризовался раскрытием относительно современной оси Карлсбергского хребта со скоростью I0-I2 мм/год. Скачок оси спрединга сопровождался не только изменением направления движения плит, но и, по всей вероятности, присоединением клиновидного фрагмента Индийской литосферной плиты к Африканской (Сомалийской) плите. Таким образом, представляется, что ранее предполагавшийся другими авторами перерыв спрединга в Аравийском море вряд ли имел место в действительности, а скачок оси спрединга в ее нынешнее положение произошел внезапно и дискордантно по отношению к ранее существовавшей оси прото-Карлсбергского хребта.

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MICROSTRUCTURE AND THE DEVELOPMENT OF BEDDING IN PELAGIC CHERTS FROM NON-CALCAREOUS SEQUENCES

The thickness, sedimentation rate and distribution of noncalcareous chert facies in the present-day ocean basins illustrates their relative diagenetic immaturity compared with ribbon-chert sequences from orogenic zones on land. The principal difference between the facies is their different diagenetic histories.

Interbedded chert and pelagic brown clay overlies basaltic basement in the south-west Pacific. This was sampled during Leg 91 of the DSDP and is the first occurrence of a bedded-chert facies (without carbonate) overlying oceanic crust in the present-day oceans. Magnetic anomaly interpretation gives a Jurassic (Callovian) age for the oceanic crust. The sediment pile is only 70 m thick and the lower 30 m consists of chert interbedded with unconsolidated zeolitic clay. Chalcedony is the most abundant silica phase, however, opal-CT is still present in porcellanite samples. This chert is still in its original basin of deposition and has been subject to little overburden pressure and no tectonically induced pressure. After burial the siliceous ooze undergoes slow differential solution, compaction and silicification. This leads to segregation of incipient chert layers and lenses as the first step in the formation of the characteristic argillite-chert couplets. The changes in porosity and permeability dominate the formation of chert in this environment. Primary precipitation of quartz is quantitatively more important than opal-CT in this type of bedded-chert. Intraformational brecciation, "shrinkage" cracks, internal sedimentation and bioturbation all support compaction and segregation of authigenic silica as the principal processes operating.

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MAIN FEATURES OF SEDIMENTATION IN PALAEOZOIC GEOSYNCLINE BASINS AND THEIR COMPARISON WITH SEDIMENTATION IN RECENT OCEANS

The sediments at early stages of Palaeozoic geosynclinals (including magmatic arcs) are compared with recent oceanic deposits. The clastic (terrigenous, volcanogenic), carbonate and siliceous deposits the paper considers. The geosynclinal clastic sedimentation in general is similar to that of active marginal zones of oceans. The role of different mass-flows was important in both cases, showing presence of steep slopes. The types of carbonate sediments and their distribution in both environments are not similar. Unlike the oceans, the geosynclines locally are abundant in dolostones, micritic limestones often enriched in organic matter and they occupied relatively small areas. Siliceous accumulation was very intensive in geosynclines; carbonaceous (phthanites) and ferruginos (jaspers)

ribbon cherts are distinguished here. Phthanites were widely distributed and couldn't be all ascribed to zones of upwelling. Assemblage of jaspers and volcanic rocks is very typical in geosynclines; jaspers usually directly cover basalts, while in many cases rhyolites occur at the same level, as jaspers. This assemblage is absent in the oceans, where distribution of siliceous sediments and volcanites are not linked. Such typical abyssal deposits as "red cleys", ferromanganon noduls and matalliferous sediments consanguineous to Mid-oceanic Ridges were not recorded in Palaeozoic geosynclines. At the same time some types of sediments which are characteristic for geosynclines are absent in the oceans. These differences may be explained not only by general evolution of sedimentogenesis, but the distinctions in morphometry and volcanism. Geosyncline formations have many common features with the sequences of active oceanic margins. However depressions in Palaeozoic basins had a different bathymetry then the recent marginal seas and were not abyssal but bathyal ones. Though in the course of geosyncline development, zones of extention and subsidence were formed, the main tendency was stacking and as a result shallowing of the basins; this trend was reversal to that of open oceanic basins.

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ОСНОВНЫЕ ЧЕРТЫ СЕДИМЕНТАЦИИ В ПАЛЕОЗОЙСКИХ ГЕОСИНКЛИНАЛЬНЫХ БАССЕЙНАХ И ЕЕ СРАВНЕНИЕ С СЕДИМЕНТАЦИЕЙ В СОВРЕМЕННЫХ ОКЕАНАХ

Сравниваются осадки геосинклинальных бассейнов ранних стадий (включая островодужную) с океанскими. Рассматриваются обломочные (терригенные, вулканогенные), карбонатные и кремнистые отложения. Обломочная геосинклинальная седиментация в целом сходна с таковой активных периферических зон океанов. В обоих случаях в транспортировке материала большое значение имели гравитационные потоки, свидетели хорошо выраженных склонов. Типы карбонатных и кремнистых осадков и их размещение в геосинклинальных морях и океанах различны. Основные отличия: сравнительно небольшое площадное развитие в геосинклиналях палеозоя тонкозернистых относительно глубоководных известняков и частая обогащенность их органическим веществом, а также обилие доломитов. Кремненакопление в геосинклинальных морях было очень интенсивным; различаются углеродистые (фтаниты) и железистые (яшмы) кремнистые породы. Фтаниты распространены на обширных пространствах и их нельзя связывать только с зонами апвеллинга. Для геосинклиналей характерна ассоциация кремнистых пород (чаще яшм) с вулканитами; на базальтоидах обычно залегают яшмы, а во многих геосинклиналях на том же уровне встречаются риолиты. В океанах такая ассоциация отсутству-

ет и размещение кремнистых осадков не определяется размещением вулканитов. Нет в палеозойских геосинклиналях обширных площадей развития таких "собственно океанических" (абиссальных) образований, как пелагические красные глины, железо-марганцевые конкреции, металлоносные осадки, связанные с срединными хребтами. Вместе с тем в океанах не встречаются некоторые типы отложений, характерные для палеозойских геосинклиналей (углеродистые кремни и известняки, глинисто-яшмовые ритмиты, риолитовые вулканокластические накопления). Это объясняется, по-видимому, не только общей эволюцией седиментогенеза, но и отличиями в морфометрии и характере вулканизма палеозойских геосинклинальных бассейнов и океанов. Больше всего геосинклинальные формации сходны с таковыми активных вулканических поясов периферии океана. Однако депрессионные зоны палеозойских геосинклиналей отличались от современных краевых морей батиметрией и были не абиссальными, а скорее батиальными. Хотя в процессе развития геосинклиналей появились зоны растяжений, в целом основной тенденцией было скучивание и обмеление бассейна, тенденция, противоположная наблюдаемой в развитии собственно океанической впадины.

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CRUSTAL STRUCTURE AND GEOPHYSICAL FIELDS OF THE DEEP-SEA PART OF THE ARCTIC OCEAN

The Arctic Ocean by its average depth (1125 m), relative sizes of shelf area (45%), relative area of continental and subcontinental crust (about 65%) is in extreme row among the other oceans and takes transtional position between continent and typical ocean.

The main morphological features of the Arctic Ocean are: under-development of its continental slopes, fragmentary development of the oceanic bottom and presence in its inner parts of the major offsets of submerged shelves that at present are represented in the form of relic-continental steps, ridges and distinct rises (Lomonosov Ridge, Mendeleev Ridge, Chukchi cap, Northwind Ridge, Yermak plateau, Moris Jessup plateau, Nowgard step etc.).

This relic-continental structural system of scarps and depressions of subsidence - the fundamental basis of abyssal trench generations-is superimposed by polar branch of mid-oceanic ridges extending from the Central Atlantic.

The presence of both relic-continental and anew formed oceanic structures allows to reveal both preoceanic history of the North Polar Region of the Earth and oceanic one.

In the Arctic Ocean three types of magnetic fields can be distinguished:"spreading" field or the field of mid-oceanic ridges and their flank zones; the field of the continental platform and folded shelf and epishelf areas and "cratonic" or "shield" field, attributed to dome parts of the Mendeleev Ridge, Chukchi cap and Canadian side of the Lomonosov Ridge. Lowest values of heat flow, aseismicity, shallow bedding of crystalline basement and the crustal thickness of 20-25 km are characteristics for the shield area of magnetic fielf.

Combined geological and geophysical data permits to distinguish the Central Arctic or the Hyperborean panplatform on the place of the deep sea part of the Arctic Ocean that was the area of washout and removal of rock debris into oceanic marginal parts during Upper Precambrian and Early Palaeozoic times.

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СТРУКТУРА ЗЕМНОЙ КОРЫ И ГЕОФИЗИЧЕСКИЕ ПОЛЯ ГЛУБОКОВОДНОЙ ЧАСТИ СЕВЕРНОГО ЛЕДОВИТОГО ОКЕАНА

Северный Ледовитый океан по средней глубине (1125 м), относительным размерам площади шельфа (45%), относительным размерам площади материковой и субматериковой коры (до 65%) стоит в крайнем ряду среди других океанов, занимая переходное положение между материком и типичным океаном.

Главнейшей морфологической особенностью Северного Ледовитого океана является недоразвитость континентальных склонов, фрагментарное развитие ложа океана и широчайшее присутствие во внутренних частях крупнейших ответвлений погруженных шельфов, представленных ныне в форме реликто-материковых порогов, хребтов и отдельных поднятий (хр.Ломоносова, хр.Менделеева, Чукотский купол, поднятие Нордвинд, плато Ермак, Мориса Джезушпа, порог Ховгарда и др.).

На этот реликто-материковый структурный план выступов и впадин оседания - первоосновы образования глубоководных котловин - накладывается идущая со стороны центральной Атлантики полярная ветвь срединно-океанических хребтов.

Наличие как реликто-материковых, так и новообразованных океанических структур позволяет раскрыть как доокеаническую, так и океаническую историю Северной полярной области Земли.

В Северном Ледовитом океане выделяют три типа магнитных полей: "спрединговое" или поле срединно-океанических хребтов и их фланговых зон, поле материковых платформ и складчатых областей шельфов и эпишельфов и "кратонное" или "щитовое" поле, относящееся к локаль-

ным частям хр. Менделеева, Чукотскому куполу и приканадской части хр.Ломоносова. Для щитовой области характерны наинизшие значения теплового потока, асейсмичность, близкие выходы к поверхности дна кристаллического фундамента.
Совокупные геолого-геофизические данные позволяют наметить на месте глубоководной части Северного Ледовитого океана Центрально-Арктическую или Гиперборейскую панплатформу, являющуюся на протяжении всего верхнего докембрия и нижнего палеозоя областью размыва и сноса обломочного материала в краевые части океана.

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BACK-ARC RIFTING AND ORIGIN OF THE OKINAWA TROUGH

Origin and history of the Okinawa Trough and its surrounding areas were discussed by means of seismic reflection, seismic refraction, dredging and drilling from variable data sources. As the result, it is revealed that rifting of the Okinawa Trough has started since Early Pleistocene time. The lithospheric plate in the northern-half of the Okinawa Trough has not yet opened but only its axial part has been rifted in echelon. On the other hand, the axial zone of the southern-half is regarded to have been opened up to 30 to 40km in the least width since Early Pleistocene and the half-spreading rate is estimated as I cm/yr.
The Okinawa Trough is here defined as a central graben having the width of about 100km, and it develops within the wider graben, width of which reaches to 400 to 600km. The volcanic front (Tokara Volcanic Ridge) west of the non-volcanic Ryukyu Ridge is included in the eastern part of this wider graben, while the Goto Belt west of the Okinawa Trough in the western part. Judging from sedimentation mode of the upper Miocene to lower Pleistocene Shimajiri Group (Layer C), the Okinawa Trough and probably the Ryukyu Trench were formed after the deposition of the group by restarted subduction around the trench.

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GEOCHEMICAL FEATURES OF THE INDIAN OCEAN MANGANESE NODULES

Chemical manganese nodule composition as well as its resources are characterized by a great variability. However, the global principle lies in the fact that manganese nodule-iron-cobalt-specialization prevails in western and southern regions of the Indian ocean and

manganese-copper-nickel specialization - in eastern regions of the Indian ocean. Tectonic framework is distinguished by a great development of continental crust relics (microcontinents) in western regions and of the ocean depressions in the eastern regions.
The most highest content of manganese, nickel and copper in the ocean is discovered in those manganese nodules which were formed on siliceous radiolarian oozes of the Central Indian Depression. It is explained by high porosity of these sediments facilitating upward migration of interstitial water as well as by the ability of the siliceous plankton to accumulate ore-elements from the sea providing ultimately their accumulation in sediments. Manganese nodule incrustation of the seamount tops and slopes is normally rich in iron and cobalt and poor in manganese, nickel and copper in comparison with manganese nodules (Equator-seamount and other Somalia depression seamounts). Regional variations of manganese nodule composition depend on vicinity to continents, to outcrops of volcanic rocks of the ocean ridges and to deep fracture zones. Geological and geochemical parameters of the Amsterdam depression manganese nodules correspond to those of the Diamantina fracture zone; the resources of manganese nodules of richer iron-cobalt content and scarcer nickel-copper content increase in proportion to the regions neighbouring this fracture zone.
Geochemical manganese nodule features mentioned above need further study and exploration.

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ГЕОХИМИЧЕСКИЕ ОСОБЕННОСТИ ЖЕЛЕЗО-МАРГАНЦЕВЫХ ОБРАЗОВАНИЙ ИНДИЙСКОГО ОКЕАНА

Химический состав железо-марганцевых конкреций так же, как и их запасы, характеризуется сильной изменчивостью. Однако намечается глобальная закономерность преимущественного распространения конкреций железо-кобальтовой специализации в западных и южных районах, а марганцево-медно-никелевой специализации в восточных районах Индийского океана. Особенностью тектонического строения западных районов является развитие останцев континентальной коры (микроконтинентов), а восточных - океанических котловин.
Наиболее высокие содержания марганца, никеля и меди в океане характерны для конкреций сформировавшихся на кремнисто-радиолариевых илах Центрально-Индийской котловины. Это обуславливается как высокой пористостью осадков, облегчающих восходящую миграцию поровых растворов, так и способностью планктонных организмов с кремнистым

скелетом концентрировать рудные элементы из морской воды, обеспечивая впоследствии их накопление в осадках. Железо-марганцевые корки, развитые на вершинах и склонах подводных гор и хребтов (гора Эквадор и другие подводные горы Сомалийской котловины) обычно обогащены железом и кобальтом и обеднены марганцем, никелем и медью по сравнению с конкрециями. В региональных вариациях состава ЖМК играет роль близость областей конкрециеобразования выходам вулканических пород на подводных хребтах и зонам глубинных разломов. В Амстердамской котловине, например, удается проследить связь параметров конкрециеносности с зоной разломов Диамантина, по мере приближения к которой возрастают запасы ЖМК, с одновременным обогащением железом и кобальтом и обеднением никелем и медью.

Отмеченные геохимические особенности железо-марганцевого образования нуждаются в дальнейшем изучении и уточнении.

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EARTH'S CRUST STRUCTURE OF THE WORLD OCEAN

At present there is a lot seismometric data dealing with structure and thickness of the Earth's crust. They were obtained mainly by means of reflections. The largest number of DSS sites are in the Pacific Ocean; 1.5-2 times less in the Atlantic and much less in the Indian Ocean.

Catalogues of DSS sites are compiled for the entire World Ocean and so representativity and informativity of observations were analized, this allowed to construct the first index map of the Earth's crust thickness for a gigantic embracing the Atlantic, Indian, and Pacific oceans.

Distribution of crustal thicknesses in the Atlantic clearly reflects latitudinal symmetry of this ocean. The crustal thickness regularly changes from 5 to 8 km in deep basins up to 20 km in zones transitional continents. Along the axial part of a mid-oceanic ridge a thickness varies from 8 to 12 km.

The same is true for crustal thicknesses in the Indian Ocean. A peculiar feature here is an overall submeridional trend of large crustal blocks determined by crustal thickness. An increase of thickness in zones of elongate volcanic uplifts of 10-15 km should be mentioned. The Kergelen Ridge is marked by a very high thickness (up to 20 km). The crust of the Pacific Ocean has a relatively persistant

thickness. Over vast areas it changes monotonously and inconsiderably within 5 to 7 km with drastic increase along the ocean margin. So, along the western margin crustal thickness is maximum (2-3 km per degree on the average).

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СТРОЕНИЕ ЗЕМНОЙ КОРЫ МИРОВОГО ОКЕАНА

В настоящее время накоплен значительный объем сейсмометрических данных, освещающих строение и мощность океанической коры. В основном эти данные получены по методике преломленных волн. Наибольшее число пунктов ГСЗ имеется на площади Тихого океана; в 1,5-2 раза их меньше на акватории Атлантики и значительно меньше в Индийском океане.

Составлены каталоги пунктов ГСЗ на всю акваторию Мирового океана, по которым проведен анализ представительности и информативности результатов наблюдений, что позволило построить первую сводную карту мощности земной коры на гигантскую площадь, охватывающую Атлантику, Индийский и Тихий океаны.

Распределение мощностей земной коры в Атлантике четко отражает глобальную широтную симметрию этого океана. Мощность коры закономерно меняется от 5-8 км в пределах глубоководных котловин до 20 км в зонах перехода к материкам. Вдоль осевой части срединного хребта мощность коры варьирует от 6 до 12 км.

Те же закономерности мощности коры сохраняются и в Индийском океане. Характерной особенностью здесь является общая субмеридиональная ориентировка выделившихся по мощности коры крупных блоков. Особо следует отметить утолщение коры в зонах вытянутых вулканических поднятий до 10-15 км. Особо выделяется повышенной мощностью (до 20 км) хребет Кергелен.

Кора Тихого океана имеет достаточно выдержанную мощность. На громадных пространствах она монотонно и незначительно меняется, оставаясь в пределах 5-7 км. Картина резко меняется вдоль периферии океана. Это особенно ярко проявляется вдоль западного обрамления, где градиенты мощности коры достигают максимальных значений (в среднем здесь они составляют 2-3 км/градус).

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PRINCIPAL RESULTS OF COMPLEX GEOPHYSICAL DEEP OCEAN INVESTIGATIONS

The geophysical deep ocean investigation complex intended for the exploration of mineral resource deposits is realized by means of a ship automatic system "Mars" designed for geological and geophysical data acquisition and processing includes magnetic and gravimetric surveyes in large regions, seismic and seismic acoustic investigation of various density profiles and deep side scan sounding for seismic acoustic ocean floor profiling, continuous and intermittent photosurveying and control sampling at different stations.
New data including geological sedimentary cover structure of the investigated aquatorium as well as some characteristic sedimentary seismic facies were obtained as a result of geophysical complex application in vast areas of the Pacific, Indian and Atlantic oceans. There were obtained data concerning possible features of different distribution types of the ocean floor mineral resources. Geophysical investigation data estimate the earth crust structure and thickness of deep ocean depressions and mid-ocean ridges. Geophysical data set and deep ocean profile indicate that manganese nodule distribution varies greatly.
From geophysical investigations carried out with the help of ship and basic computers have come out data processing results showing that seismologic section features, anomaly distribution of potential geophysical fields correspond with the structure and geological history of the investigated regions.

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ОСНОВНЫЕ РЕЗУЛЬТАТЫ КОМПЛЕКСНЫХ ГЕОФИЗИЧЕСКИХ ИССЛЕДОВАНИЙ ГЛУБОКОВОДНЫХ ЗОН ОКЕАНА

Комплекс геофизических исследований глубоководных зон океана для поиска и разведки местоположений полезных ископаемых, реализуемый в составе бортовой автоматизированной системы сбора и обработки

геолого-геофизических данных "Марс" включает гидромагнитную и гравиметрическую съемки на полигонах, сейсмические и сейсмоакустические исследования по системам профилей различной детальности, глубоководную локацию бокового обзора с придонным сейсмоакустическим профилированием, непрерывное и выборочное фотографирование дна и контрольный пробоотбор на отдельных станциях.

В результате применения геофизического комплекса на обширных площадях Тихого, Индийского и Атлантического океанов выявлены новые данные о геологическом строении осадочного чехла изучаемых акваторий, в том числе ряд характерных осадочных сейсмофаций. Получена информация о возможных особенностях распределения различных видов минерального сырья на дне океана. По данным геофизических исследований удалось оценить мощность и осветить строение земной коры глубоководных котловин и срединно-океанических хребтов. Выполненная в комплексе с геофизическими данными интерпретация глубоководной профильной фотосъемки указывает на значительную изменчивость продуктивности конкреций на площади.

Полученный в ходе работ опыт обработки результатов геофизических наблюдений на судовых и базовых вычислительных центрах свидетельствует о наличии некоторой корреляционной связи между сейсмогеологическими особенностями разреза, распределением аномалий потенциальных геофизических полей со структурой и историей геологического развития изучаемых районов.

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INTEGRATION OF CONTINENTAL AND OCEANIC STRATIGRAPHY: A KEY FOR RECONSTRUCTION OF MESOZOIC AND CENOZOIC HISTORY OF THE SOUTH ATLANTIC

Combined study of foraminifers, radiolarians, nannoplankton, diatoms, macrofaunas (belemnites, ammonites, bivalves) and palynological assemblages from oceanic and on-land sequences allows to reconstruct the climatic, bathymetric and oceanographic conditions. Each of these fossil grou provides information on changes of some parameters of environment only, while their combined analysis suggests mutual control and most reliable paleoenvironmental reconstruction. The Southern Ocean is one of the poorly geologically studied regions of the World. Most complete data are obtained for the Falkland Plateau, Argentine Basin and Walvis Ridge. It is possible here to draw general trend of climatic changes, position of climatic belts and their migration in time, the history of oceanic subsidence, fluctua-

tion of the CCD, and use these data for paleogeographic reconstructions of the Southern Ocean from mobilistic point of view. Two climatic optima are established during the Cretaceous - in the early Albian and Campanian. The Maestrichtian is characterized by well expressed cooling strengthened in the Paleocene. The general trend of cooling during the Cenozoic is interrupted by periods of sharp temperature falls at the Eocene/Oligocene boundary, and during the late Oligocene. Climatic changes caused by the Polar Front migrations are characteristic of the Pliocene-Quaternary time. Shallow-water basin with anoxic conditions existed within the Falkland Plateau during the Jurassic and early Cretaceous, and shallow-water oceanic one - in the Albian. During the Upper Cretaceous and Cenozoic pelagic conditions prevail. Fluctuations of the CCD lead to interchange of carbonate and clay sediments which looks like alternation of relatively shallow-and deep-water sediments. Planktonic foraminifers allow to trace the climatic belts which are geographically disconnected for Cretaceous and Paleogene due to the Gondvana break-up and subsequent continental splitting. Palynological assemblages from the Cretaceous deposits of the South America and South Africa testify to their original closeness.

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ИНТЕГРАЦИЯ ДАННЫХ КОНТИНЕНТАЛЬНОЙ И ОКЕАНИЧЕСКОЙ СТРАТИГРАФИИ КАК КЛЮЧ К РАСШИФРОВКЕ МЕЗОЗОЙСКОЙ И КАЙНОЗОЙСКОЙ ИСТОРИИ ЮЖНОЙ АТЛАНТИКИ

Совместное изучение планктонных и бентосных микроорганизмов (фораминиферы, радиолярии, наннопланктон, диатомеи), макрофауны (белемниты, аммониты, пелециподы) и споро-пыльцевых комплексов из осадков в океане и на континентах позволяет восстановить климатические, батиметрические и океанологические условия. Каждая из этих групп несет информацию об изменении только определенных параметров среды; комплексный анализ фауны и флоры предполагает взаимный контроль и наиболее достоверную реконструкцию палеосреды. Южный океан относится к геологически слабо изученным регионам Земного шара. Наиболее полные данные получены для Фолклендского плато, юга Аргентинской котловины и юга Китового хребта. Здесь удается наметить общую тенденцию климатических изменений, положение климатических поясов и их миграцию во времени, историю океанического погружения, колебания уровня карбонатной компенсации и использовать эти данные для палеогеографических реконструкций всего Южного океана с позиций мобилизма. В меловое время устанавливаются два климатических оптимума - в раннем альбе и кампане. Хорошо выражено похолодание в маастрихте,

особенно усилившееся в палеоцене. В кайнозое на фоне общей тенденции похолодания намечаются этапы резкого похолодания на рубеже эоцена и олигоцена и в позднем олигоцене. В плиоцен-четвертичное время фиксируются климатические колебания, вызванные миграциями Полярного фронта. В юрское и раннемеловое время в пределах Фолклендского плато располагался мелководный бассейн с сероводородным заражением, в альбское время - мелководный океанический бассейн. В позднемеловое и кайнозойское время господствуют пелагические условия. Колебания уровня карбонатной компенсации приводят к чередованию карбонатных и глинистых осадков, что внешне выглядит как чередование относительно мелководных и глубоководных отложений. По планктонным фораминиферам хорошо намечаются климатические пояса, которые для мелового и палеогенового времени географически разорваны, что объясняется расколом древнего континента Гондваны и последующим раздвижением материков. Споро-пыльцевые комплексы из меловых отложений Южной Америки и Южной Африки свидетельствуют о первоначальной близости этих континентов.

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STRATIGRAPHIC CORRELATION OF CRETACEOUS PLANKTIC FORAMINIFERA OF PAKISTAN AND INDIAN OCEAN DEEP SEA CORES

The Cretaceous deposits are well developed in the Lower Indus Basin of Pakistan. Their occurrence is also reported in the deep sea cores of the Indian ocean drilled by the Deep Sea Drilling Project, but a great hiatus is noticed in the continous sedimentation. Pakistan's Cretaceous (Neocomian-Maestrichtian) deposits are designated to Sembar,Goru,Parh,Fort Munro, Pab and Moro Formations. These deposits are characterized by planktic foraminifera, but the planktic forms of Cretaceous deposits of Indian ocean are scare and few imporvished forms were record. Pakistan's Cretaceous deposits are characterized by typical Tethys fauna of planktic foraminifera. On the basin of these forms the Cretaceous deposits are divided into 17 zones. The Early Cretaceous (Neocomian-Albian) deposits are Sembar and Goru Fms. characterized by Hedbergella infracretacea zone to Neocomian, Globigerinelloides blowi, G.algerianus, and G.ferreolensis zones to Early, Middle and Late Aptian. The Albian assemblages are characteristic to Ticinella be jaouaensis, Globigerinelloides breggiensis and Planomalina buxtorfi zones. The Middle Cretaceous (Cenomanian) deposits are designated to Parh Fm, characterized by Rotalipora appenninica, R. greenhornensis and R.cushmani zones. The Late Cretaceous deposits are Parh,Fort Munro, Pab and Moro Fms, characterized by Globotruncana helvetica zone (Turonian),G.renzi zone (Coniacian), G.concavata and

G.carinata zones (Santonian), G.elevata and G.calcarata zones (Campanian) and G.ganssert and Abathomphalus mayaroensis zones (Maestrichtian). The planktic foraminifera of Cretaceous deposits of Indian ocean deep sea cores was summerized by Herb and Scheibnerov (1977). They stated that planktic assemblages of Indian deep sea cores are characterized to non tropical assemblages, only typical Tethys affinity fauna appeared in Late Maestrichtian. Expect of Campanian and Maestrichtian the planktic foraminifera assemblages are impoverished with few species mostly of Hedbergella and Globigerinelloides in Early Cretaceous and few species of Rotalipora appeared in Cenomanian. The Late Cretaceous deposits are characterized by Globotruncana, Heterohelix and Rugoglobigerina. Due to great hiatus and incomplete stratigraphic record no zones were assigned to the planktic foraminifera of Pakistan is most valuable means of correlation in the region.

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A STUDY ON THE CRUSTAL STRUCTURES OF SOUTH CHINA SEA

The crustal structure of the South China Sea is obviously zoned from the north to the south, and blocked from the west to the east.
In the deep sea plain, there are sequences of line magnetic anomalies with the NEE or WE directions, the average thickness of the crust being 6.3km.
The South China Sea could be divided into two parts if a line was drawn from Dongsha Island to Shuangzhi Shoal. In the eastern part of the upper northern margin, there are three uncomformities in the Tertiary system and the Miocene series is folded, but in the western part, these phenomena are not too obvious.

On the lower northern margin (water depth over 2.0km), the sea hills produce stronger magnetic anomalies, and the crustal structure is similar to the deep sea plain. Although there are many sea mountains and hills in the eastern part, this area is a quiet magnetic anomaly zone, the crust being continental in nature.

In the north-western part of the deep sea plain, both the crust and the layer 3 are the thinnest, while in the south-western part, they are the thickest, with a NE direction of the line magnetic anomalies.

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ZONALITY OF EARLY DIAGENETIC MINERAL FORMATION IN THE WORLD OCEAN SEDIMENTS

Sediments of the World Ocean incorporate a mineralogically diverse complex of diagenetic minerals, many of them being of sediment- and oreforming importance. Their distribution is of zonal character, and depends mostly on the amount of reactive organic matter contained in sediments. Relative to distribution of Corg in the oceans, three zones of the global significance are distinguished: reduction peripheral zone, transitional zone and oxidizing pelagic zone. A wide complex of authigenic minerals is developed in the sediments of the reduction zone. It incorporates, first of all, minerals of ferrous iron such as sulphides, glauconite, shamoisite, as well as phosphorites and carbonates of the Ca-Mg row. In the transitional zone carbonates of Fe-Mn row and Fe-Mn nodules with a high Fe/Mn ratio are developed. In this zone the content of minerals typical of the reduction sediments sharply decreases. The oxidizing pelagic zone of the ocean is characterized by authigenic zeolites, barite and Fe-Mn nodules.

The study of the complex of authigenic minerals and the revealed peculiarities of their genesis offer appreciable possibilities for reconstruction of sediment- and ore formation in ocean.

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ЗОНАЛЬНОСТЬ РАННЕДИАГЕНЕТИЧЕСКОГО МИНЕРАЛООБРАЗОВАНИЯ В ОСАДКАХ МИРОВОГО ОКЕАНА

В осадках океанов широко развит разнообразный комплекс диагенетических аутигенных образований, многие их которых имеют осадко- и рудообразующее значение. Распределение их на фациальном профиле от берега к пелагиали имеет зональный характер и зависит от ряда факторов, из которых ведущее значение имеют содержание в осадках реакционноспособного органического вещества, а также скорости седиментации. В зависимости от этих параметров в океанах выделяются три зоны диагенеза глобального значения: зона редуцированных осадков периферии океанов, переходная зона и зона окисленных осадков.

В редуцированной зоне развит широкий комплекс аутигенных образований, включающий в первую очередь минералы, содержащие двухвалентное железо, такие, как сульфиды, глауконит, шамозит, а также фосфориты и карбонаты кальция и магния.

В переходной зоне локально развиты карбонаты Fe–Mn ряда, а также Fe–Mn конкреции с высоким отношением Fe/Mn. Количество минеральных видов, характерных для редуцированной зоны океана здесь резко уменьшается.

Зона окисленных илов пелагиали океана с низкими скоростями осадконакопления характеризуется развитием цеолитов, барита, Fe–Mn конкреций и диагененических смектитов.

Изучение комплексов аутигенных минералов и процессов их формирования в осадках Мирового океана открывает большие возможности для реконструкции условий образования и особенностей локализации диагенетических пород и руд геологического прошлого.

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ORIGIN, SEDIMENTATION, and DIAGENESIS OF PORCELANITE

The term porcelanite has been used as the field name representing an intermediate rock type between porous diatomite and dense chert. Porcelanite is a hard and compact biogenic siliceous rock and composed originally of siliceous skeltons, particularly diatom frustules. Porcelanite together with diatomite, chert, and siliceous shale is widespread in Neogene marine sections in the circum-Pacific region and the high lattitude Pacific Ocean. The rate of sedimentation is very small (2-10 m/m.y.) in the central North Pacific Ocean, whereas it is very large (90-200 m/m.y.) in the continental margin. The oceanic siliceous ooze and porcelanite are usually structureless, while the marginal porcelanite shows stratification of varying thickness interbedded with terrigenous shale.

Four silica phases are noted in the porcelanites; i.e., opal-CT, low cristobalite, low tridymite, and quartz. During burial diagenesis, the transformations of biogenic opal to opal-CT and then to quartz concur with the gradual decrease of porosity from about 80% of diatom ooze to 15-20% of quartz porcelanite at a depth of around 4500 m. It is remarkable that the lithification from porcelanite to chert does not necessarily match the phase transformation. Low tridymite is common in opaline chert in the uplifted siliceous section, whereas low cristobalite coexists with opal-CT in vitric opaline porcelanite.

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CENOZOIC OCEANIC EVENTS: THE INDO-PACIFIC BIOSTRATIGRAPHIC RECORD

As well as traditional, phylogenetically-based datums and related events in microplankton (e.g. coiling ratios in foraminifera), we must use disjunct distributions, extratropical excursions and other biogeographic events, isotopic spikes and whatever other non-phylogenetic configurations can be tested. Oceanic/climatic geohistory requires rigorous, refined correlations between continental, neritic and oceanic sections. In practice, that means an opportunistic groping, "outward" from the most secure and refined realm of our chronology - tropical successions based on planktonic skeletonized protists - toward the more difficult realms: larger benthonic foraminifera in neritic sediments; extratropical neritic and oceanic assemblages; continental faunas, floras and palynofloral successions; and continental geomorphic successions.

Eocene and Miocene reversals in the overall Cenozoic climatic deterioration are short-lived, far-reaching, bipolar, and signalled by solid correlations between diverse biostratigraphic observations. Diachronism no longer is a useful paradigm; it is more heuristic to think in terms of virtually isochronous shifts in climate, watermass, planktonic and benthonic assemblages. Indeed, we can extend that philosophy to embrace two more classes of geohistorical phenomena in the Indo-Pacific region. Thus, plate-tectonic collision and reorganization is reflected in an isochronous intercontinental stratigraphic record. Again, it is reasonable to attack the vexed question of deep continental weathering, with its laterites and silcretes of contentious meaning, in terms of rapid, sweeping alterations in climate, from warm and humid to cool and arid.

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ON THE TECTONIC STRUCTURE CORRELATION IN NORTHWESTERN PACIFIC AND ASIAN CONTINENTAL MARGIN

During many hundred mln.years (up to 1.5 mlrd.years) the East Asian continental margin in the regions of Pyrmorie and Japan seemed not to be moved more than 1000 km to the ocean.The comparatively stable and inert continental plate margin is opposed to the mobile Pacific plate. The processes on their boundary of the last 110 mln.years may be characterised. Here is discussed the structural rebuilding of the end of the Mesozoic tectonic cycle (apt-alb). In the continental margin the rebuilding was manifestated in the wide spread

folding and continental crust forming. In the ocean that time was characterised by total deeping, wide distribution of intraplate magmatic activity, beginning of quiet magnetic epoch, supposed increasing of spreading rate and ocean crust forming, possibly also by acceleration of lithospheric plate moving and intensification of its subduction on the continent-ocean boundary. The enormous manifestation of andesitic volcanic activity and granite intrusion on the whole northern Pacific periphery may be possibly connected with this phenomenon. The proof of the similarity of Late Mesozoic and modern structures of the continental margin is given. The Paleogene time on the continental margin was demonstrated by destruction of the continental structures with its fragments moving ocean ward and the opening of marginal sea basins. How is this phenomenon connected with the absence of sedimentation in the ocean, with the new formation of some large structures and the Emperor volcanic zone in particular? The analysis of the Neogene-Quarternay oceanic sedimentary facies and thicknesses shows their dependance on the development of island arc andesitic volcanic activity. The connection of island arc magmatic activity with the processes in focal zone appears to be doubtless. When using paleontological data about oceanic structures (Emperor zone) and continental margin it is possible to compare their paleolatitudes and relative motions in Cenozoic time. The search of the geological marks in the ocean and continental margin seems to be necessary for tectonic correlation, which may do it possible to estimate the relative motions of structures and correct understanding of the tectonic and magmatic boundray processes.The results may appear decisive in the discussion on the applicability of the plate tectonic theory.

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ВОПРОСЫ КОРРЕЛЯЦИИ ТЕКТОНИЧЕСКИХ СТРУКТУР СЕВЕРО-ЗАПАДНОЙ ПАЦИФИКИ И АЗИАТСКОЙ КОНТИНЕНТАЛЬНОЙ ОКРАИНЫ

Континентальная окраина востока Азии в районе Приморья и Японии в течение многих сотен млн.лет (до I,5 млрд.лет), по-видимому, не перемещалась более I000 км в сторону океана. Сравнительно стабильному, инертному краю континентальной плиты противопоставляется мобильная Тихоокеанская плита. Процессы на их границе могут быть охарактеризованы для последних II0 млн.лет. Рассматривается структурная перестройка конца мезозойского тектонического цикла (апт-альб). В пределах континентальной окраины эта перестройка выразилась в широком проявлении складчатости и формировании континентальной коры. В океане это время было отмечено общим углублением, широким распростране-

нием внутриплитного магматизма, началом спокойной магнитной эпохи, предполагаемым увеличением скорости спрединга и формирования океанической коры, возможно, также ускорением перемещения литосферной плиты и интенсификацией ее субдукции по границе с континентом. Возможно, с этим связана и гигантская вспышка андезитового вулканизма и внедрения гранитоидов по всей северной периферии Тихого океана. Приводятся доказательства сходства структур позднемезозойской континентальной окраины с современными.

Палеогеновое время на континентальной окраине проявилось в деструкции континентальных структур с перемещением их фрагментов в сторону океана и раскрытием котловин окраинных морей. Как связано это явление с отсутствием осадконакопления в океане, с новообразованием некоторых крупных структур, в частности Императорской вулканической зоны? Анализ фаций и мощностей неоген-четвертичных осадков океана указывает на их зависимость от развития андезитового вулканизма островных дуг. Связь островодужного магматизма с процессами в сейсмофокальной зоне представляется несомненной. Использование палеонтологических данных по структурам океана (Императорской зоне) и континентальной окраины позволяет сравнивать их палеошироты и взаимные перемещения в кайнозойское время. Поиски геологических реперов в океане и на континентальной окраине представляются необходимыми для тектонической корреляции. При этом возможна будет оценка взаимных перемещений структур, правильное понимание тектонических и магматических процессов на их границе. Результаты могут оказаться решающими при обсуждении применимости теории тектоники плит.

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MAIN FEATURES OF LITHOSPHERE GEOLOGICAL STRUCTURE IN THE CENTRAL ATLANTIC (INFERRED FROM GEOPHYSICAL DATA)

A sedimentary cover of oceanic lithosphere in the Central Atlantic shows regular changes in thickness from first tens of meters near the Mid-Atlantic Ridge to 10 km and above along the continental margins. It consists mainly of two horizons separated by a reflector. The latter divides the cover into the lower and upper sequences having respectively, velocities of 1.79-1.84 km/sec and 2.09-2.13 km/sec.

The basement structure and that of the Earth's crust underlain the

Central Atlantic suggest a latitudinal symmetry of the region. The crus thickness is 5 to 8 km but drastically increases to 20 km and alove in zones transitional to continents. In places the crus thickness increases towards the axil part of the ocean.
Seismic surveys of the thickness and layered pattern of the crust in the Central Atlantic as well as mean velocities for each layer were used to construct an isostatic model showing its structure. It allows to take into account lateral changes in crustal density with respect to changes in thickness and density of layers.
The comparison of seismic data on a depth to Moho and model values enabled to recognize density heterogeneities in the subcrustal layer of the Central Atlantic. A regular distribution pattern of the heterogeneities with an axial low density zone and gradual increase in density away from the Mid-Atlantic Ridge is complicated in the equatorial part of the Atlantic by zones of large transform faults (Vema, Romanche) which divide a single low density area into separate blocks.

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ОСНОВНЫЕ ОСОБЕННОСТИ ГЕОЛОГИЧЕСКОГО СТРОЕНИЯ ЛИТОСФЕРЫ В ЦЕНТРАЛЬНОЙ ЧАСТИ АТЛАНТИЧЕСКОГО ОКЕАНА (ПО ГЕОФИЗИЧЕСКИМ ДАННЫМ)

Осадочный чехол океанической литосферы Центральной Атлантики закономерно меняется по своей мощности от первых десятков метров в области Срединно-Атлантического хребта до 10 км и более вдоль континентальных окраин. Часто он представлен двумя толщами, граница между которыми предстает в виде отражающего горизонта. Этот горизонт разделяет чехол на верхнюю толщу со скоростями 1,79-1,84 км/с и нижнюю - 2,09-2,13 км/с.
Строение фундамента и земной коры Центральной Атлантики подчеркивает широтную симметрию региона. Мощность коры колеблется в пределах 5-8 км, но резко возрастает до 20 км и более в зонах перехода к материкам. Отмечается локальное увеличение мощности коры к осевой части океана.
Данные сейсморазведки о мощности земной коры Центральной Атлантики и ее расслоенности, а также данные о средних скоростях в пределах каждого слоя используются для создания изостатической модели ее строения. Это позволяет учесть изменение плотности земной коры по латерали в зависимости от колебания мощности и плотности ее слоев.

После сравнения данных сейсмометрии о глубине залегания раздела Мохоровичича с модельными значениями выделены плотностные неоднородности в подкоровом слое центральной Атлантики. Закономерная картина распределения этих неоднородностей с осевой зоной разуплотнения и постепенным повышением плотности по мере удаления от Срединно-Атлантического хребта осложняется в приэкваториальной части Атлантического океана зонами крупнейших трансформных разломов (Вима, Романи), которые разбивают единую область пониженной плотности вещества на отдельные блоки.

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THE OCEANOGRAPHIC EVOLUTION OF THE GULF OF CALIFORNIA

According to micropaleontological and sedimentological data, the Gulf of California is a "young" ocean basin which began its formation approximately 5 millions years ago. At that time, its climatical-oceanographic regime was subtropical as it is today. However, incursion of the California Current water as well as seasonal coastal upwelling processes were not established up to approximately the early Pleistocene.

Coastal upwelling occurs both in the western side (summer) and the eastern side (winter) of the Gulf. At the western side, near the mouth of the Gulf, there is a more direct influence of water from the California Current in the upwelling process, forming thermal fronts in the water mixed layer, and increasing primary productivity. This fact has induced the accumulation of phosphorite nodules in several localities, coupled to conditions of large organic material preservation in the sediments (the oceanic oxygen minimum layer impinges on the bottom slope), as well as little relative dilution by terrigenous debris.

The above deductions have been developped analyzing the geographic and stratigraphic distribution of radiolarian assemblages, through mathematical models.

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PALEOSLOPE MODELS OF FORAMINIFERA

Paleoslope models show the distribution of nearshore to deep basin Foraminifera within a chronostratigraphic interval. The Western Atlantic Basin and the adjacent margin provide an excellent geologic setting within which to generate paleoslope models. The region is structural uncomplicated so that chronostratigraphic intervals can be traced from coastal plain outcrop to wells downdip in the margin and then to DSDP sites in the Atlantic Basin. The distribution of species within a chronostratigraphic interval should reflect oceanographic conditions across the shelf, slope, and deep basin. The effects of sea level change on Foraminifera should also be evident.

A paleoslope model for the Campanian-lower Maestrichtian shows that shelf and upper slope environments were well oxygenated except for localized oxygen

deficient conditions. Distinct foraminiferal biofacies are recognizable and many species had restricted bathymetric distribution. Species diversity trends identify faunal boundaries which may correspond to the depth of nearshore low salinity water, to the maximum depth of the influence of seasonally variable *water masses* and to the division between the outer neritic and upper bathyal zones. Foraminifera migrated with the rise and fall of sea level.

The middle bathyal to abyssal environments were stable and unaffected by sea level change. There was wide bathymetric distribution of species and foraminiferal biofacies were generalized and strongly overlapped.

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LATE NEOGENE PALEOMAGNETIC CORRELATIONS OF MARINE-CONTINENTAL GEOLOGICAL EVENTS

In the past few years rapid strides have bee made in correlating marine and non-marine sediments to the Magnetic Polarity Time Scale. In marine sediments, this has been made possible by the DSDP piston coring program. Interestingly enough, the Neogene from the ocean basins is still not as well known as the Paleogene. However, recent cruises may help to resolve this problem. In terrestrial sediments progress in correlating Neogene vertebrate faunas is proceeding at a slower pace due to the fact that suitable exposures are not uniformly avaitable in time and space. At the present writing, the best known Neogene sections are those of North America, South America and Pakistan. The magneto stratigraphy of all areas will be critically reviewed and future prospects outlined.

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THE NATURE OF LATE QUATERNARY *SEDIMENTATION ON THE CONTINENTAL SHELF* OF THE SOUTH-EAST COASTS OF KOREA

Two hundred suspended-matter samples were collected from 28 stations on the inner continental shelf of southeast of Korea during September 1981 and March 1982. Superficial bottom sediments from 35 stations on the shelf were also taken.

Based on the analyses of TSM distribution and concentration patterns, it has been found that fine-grained suspended matters are restricted to nearshore-inner shelf showing a band or zone paralleling with coastal morphology. This fact suggests a limitation of recent fine grained *sediments* to a nearshore band.

The sand deposits with the mud content of less than 8 percent developed adjacent to the shelf break and on the outer shelf would probably be relict sediments (old beach sediments) deposited in response to a lower stand of sea level during the Pleistocene ice age.

The transgression did little to alter the distribution of sand on the outer shelf in this particular study area. The progress of shore line was so rapid that a given locality was in the beach zone and subject to rapid longshore drift and extensive reworking only for a few years. Probably the most pronounced effect of the transgression was sorting of the sand, and at least partial winnowing out of the finer fractions.

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SIMILARITY OF FACIES AND HISTORICAL-GEOLOGICAL EVENTS DURING THE LATE JURASSIC-EARLY CRETACEOUS OF THE CENTRAL ATLANTIC AND CARPATHIANS

Carbonate facies of early oceanic Tethyan basins, viz., the Ammonitico-Rosso (Upper Jurassic) and Maiolica (lower Cretaceous) were found in blocks of nappe in the Pennine Cliffs zone, the Ukranian Carpathians. A cyclic section of these facies is discribed from a quarry of the Bolshie Kamentsy Mount. Mainly they are characterized by pelagic sediments, a fossil succession similar to that of the coeval sediments of the Central Atlantic, seismic brecciated-nodular structure of limestones, and there is no distinct between the Ammonitico-Rosso and Maiolica limestones. Like in other regions of the Mediterranean Alpides, the Ammonitico-Rosso and Maiolica section in the Ukranian Carpathians suggest that early oceanic basins as a part of a single paleoceanic system stretching from the Carpathians to Central Atlantic were formed under conditions of high seismic activity and dissected bottom topography. The nature of the Tethyan Ammonitico-Rosso and Maiolica facies in the Central Atlantic developed at the same stratigraphic level as in the Mediterranian area implies lesser differentiation and more persistant subsidence of early oceanic basins. As a result zones of the step-wise continental slope become a site of morphostructural changes in the Central Atlantic province of the Tethys.

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ОБЩНОСТЬ ФАЦИЙ И ИСТОРИКО-ГЕОЛОГИЧЕСКИХ СОБЫТИЙ ПОЗДНЕЙ ЮРЫ - РАННЕГО МЕЛА ЦЕНТРАЛЬНОЙ АТЛАНТИКИ И КАРПАТ

Карбонатные фации раннеокеанических впадин Тетиса - аммонитико-россо (верхняя юра) и майолика (низы мела) встречены в блоках тектонического покрова зоны Пенинских утесов на Украинских Карпатах. Цикличный разрез этих фаций описан в карьере горы Большие Каменцы. Они характеризуются пелагическим типом основной массы осадков, одинаковой последовательностью ископаемых с одновозрастными отложениями Центральной Атлантики, сейсмической природой брекчиевато-желваковой текстуры известняков, отсутствием четкой грани между известняками аммонитико-россо и майолики. Как и в других районах Средиземноморских Альпид, разрезы аммонитико-россо и майолики на Украинских Карпатах отражают формирование раннеокеанических впадин, входивших в единую палеоокеаническую систему от Карпат до Центральной Атлантики, в условиях высокой сейсмической активности и расчлененного рельефа дна. Характер тетических фаций аммонитико-россо и майолики в Центральной Атлантике, где они развиваются на тех же стратиграфических уровнях, что и в Средиземноморье, свидетельствует о меньшей дифференцированности и более устойчивом прогибании раннеокеанической впадины. В результате центром морфоструктурных преобразований Центрально-Атлантической провинции Тетиса стали зоны периокеанических уступов.

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DISTRIBUTION OF FERROMANGANESE NODULES IN THE PACIFIC OCEAN

The distribution of manganese nodules in the Pacific Ocean has been determined from bottom photographs, taken at approximately 1,500 stations, and from sediment cores. Sea-floor coverage is quite patchy, down to scales of a few hundred meters; for example, it varies by as much as 75% at individual photographic stations, which may extend over a distance of only 1 to 2 km. When all the photographs at each station are averaged together, however, the following five areas of high nodule coverage can be delineated: (1) The Northeast Pacific Basin, between the Clarion and Clipperton Fracture Zones; (2) southeast of the Musicians Seamounts, also in the Northeast Pacific Basin; (3) the northern part of the Central Pacific Basin; (4) the central part of the Southwest Pacific Basin; and (5) south of New Zealand in the area of the Emerald Basin. The pattern of nodule coverage in the North Pacific correlates strongly with the occurrence of sediment hiatuses for the period 25-0 m.y.B.P. The pattern for the entire Pacific Ocean correlates with sedimentation rate, such that areas of high nodule coverage occur in areas of slowly accumulating sediment.

Nodule coverage bears no simple relation to nodule composition. For example, nodules from an area of high coverage near the Musicians Seamounts have an Ni+Cu concentration typically less than 1.0%, whereas nodules from an area of high coverage in the area of the Clarion-Clipperton Fracture Zones commonly have an Ni+Cu concentration greater than 2.7%.

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RARE EARTH ELEMENTS IN MANGANESE NODULES FROM THE SOUTHWEST PACIFIC BASIN

During cruise SO-14 of R.V. Sonne manganese nodules and sediments were collected from 13 areas on an east-west transect at 42°S between 120°W and 163°W. This transect crosses the eastern part of the Southwest Pacific Basin with water depths varying between 4200 and 5700 m. Manganese nodules of this region show Mn/Fe ratios between 1.5 and 3.5 and abundances up to 65 kg/m². REE contents in manganese nodules and sediments were determined by instrumental neutron activation using Fe_2O_3 as internal comparator. In the manganese nodules the sum of REE varies between 880 and 2600 ppm. Ce/La ratios, ranging from 2.1 in nodules from the margin to 4.2 in nodules from the center of the basin, can be correlated with water depths. Correlations of REE and major and minor elements in the nodules as well as nodule-sediment relationships are given. A comparison of REE in nodules of the Southwest Pacific Basin with other areas in the Pacific is made especially with regard to the formation of the manganese nodules.

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INTERPRETATION OF THE MAGNETIC FIELDS, MEASURED BY A MAGNETOMETER IN OCEANIC DRILLHOLES DURING LEGS 68, 69, 78 "B" OF THE VESSEL "GLOMAR CHALLENGER"

1. The measurements were carried out with the three-component down-hole magnetometer KCM-65 CI (CWM-65 SD). It was developed by the Institute of Geophysics of the Urals Scientific Centre for superdeep holes studying. There were investigated the holes 501, 504"B", 505 and 395"A", that stripped basalts of the oceanic crust.
2. The received data showed, that in equatorial regions it's impossible to establish the fact of magnetic field inversion, if one is limited only to measurements of core magnetization and doesn't use magnetic fields, observed in holes.
3. The results of the hole 395"A" magnetic investigations do not agree with the established ideas of uniform magnetization of the rocks, causing linear magnetic anomalies, because basalts magnetization within the hole's geological profile changes its sign twice. Thus,

magnetic field above each separate basalt zone is a complex function of each its magnetized component-layer deposition depth, of intensity and magnetization sign, of width , of magnetic susceptibility, etc. It such cases it is impossible to use geochronological scale for the age dating of basalts, causing linear anomalies.

4. For more well-grounded confirmation of the Wine-Mattews theory it is expedient to drill in an anomaly on the eastern slope of the Middle-Atlantic ridge, symmetrical to the anomaly N 4, where the hole 395"A" was sunk.

5. First world practice of downhole magnetometry in oceanic holes points out the possibility to receive new information on basalt paleomagnetism. In particular, it will help to receive a detailed picture of rocks magnetization on the hole'log.

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ИНТЕРПРЕТАЦИЯ МАГНИТНЫХ ПОЛЕЙ, ИЗМЕРЕННЫХ МАГНИТОМЕТРОМ В ОКЕАНИЧЕСКИХ СКВАЖИНАХ ВО ВРЕМЯ РЕЙСОВ 68, 69, 78"Б" КОРАБЛЯ "ГЛОМАР ЧЕЛЛЕНДЖЕР"

I. Измерения выполнялись трехкомпонентным скважинным магнитометром КСМ-65-СГ, разработанным в Институте геофизики УНЦ АН СССР для изучения сверхглубоких скважин. Исследованы скважины 501, 504"Б", 505 и 395"А", вскрывшие базальты океанической коры.

2. Полученные данные свидетельствуют о том, что в экваториальных районах невозможно установить факт инверсии магнитного поля, если ограничиться только измерениями намагниченного керна, не используя магнитные поля, наблюдаемые в скважинах.

3. Результаты магнитных исследований скважины 395"А" не согласуются со сложившимися представлениями об однородной намагниченности пород, вызывающих линейные магнитные аномалии, т.к. намагниченность базальтов в разрезе скважины дважды меняет свой знак. В таких случаях магнитное поле над каждой отдельной полосой базальтов будет являться сложной функцией глубины залегания каждого слагающего его намагниченного слоя, интенсивности и знака намагниченности, мощности, магнитной восприимчивости и т.д. Использование геохронологической шкалы для датировки возраста базальтов, обусловливающих линейные аномалии, в таких случаях невозможно.

4. Для более обоснованного подтверждения теории Вайна-Метьюза целесообразно пробурить аномалию на восточном склоне Срединно-Атлантического хребта, симметричную по отношению к аномалии № 4, где пройдена скважина 395"А".

5. Первые в мировой практике опыты скважинной магнитометрии океанических скважин показывают возможность получения новых сведений о

66

палеомагнетизме базальтов. В частности, они позволяют получить весьма детальную картину намагниченности пород по разрезу скважины.

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A STUDY OF TURBIDITY SEDIMENT IN THE OKINAWA TROUGH

The Okinawa Trough located between the continental shelf of East China Sea and Ryukyu Island is a typical back arc basin in the trench-arc-basin systems. Since 80s we carried out the detailed investigations of the sedimentation in the Okinawa Trough. We used the piston core and box core to obtain the core samples. The maximum length of the core was about 8m, it ranged usually from 4m to 6m. In this paper the features of turbidity sediment are described. The turbidity sediment sequences mainly distributed in the southern part of the Okinawa Trough near the side of shelf, the water depth ranged from 1300-2100m. The thickness of turbidity sediments and the sequence numbers varied greatly. Maximum thickness of a sequence is about 2m. But only A and B sequence in the Bouma Sequence were found. So the turbidity sediments presented in the Okinawa Trough are related with the graded bedding and the horizontal bed. The bottom sole marking of turbidity sediments may be divided into the following types: a. line form, b. arc form, c. unreguler form, d. transitional form. Also, the different beds, cross-beds and laminae identified by X-radiography were presented in this paper. A lot of data of study indicated that the turbidity sediments were formed in the certain environments. The formations of turbidity sediment were discussed in this paper.

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HYDROTHERMAL MINERALIZATION AT SLOW-SPREADING OCEANIC RIDGES IN THE ATLANTIC OCEAN AND INDIAN OCEAN

Hydrothermal mineralization on slow-spreading oceanic ridges is considered as the product of multi-stage episodic high- and low-temperature hydrothermal activity controlled by intrusive-extrusive volcanic cycles with a periodicity of the order of 10^3y. Evidence for cyclic hydrothermal mineralization is based on systematic investigations of 1800 km long portions of the Mid-Atlantic Ridge (MAR) crest between latitude 10° and 27°N in the central North Atlantic, and the Carlsberg Ridge (CR) crest between latitude 5°21'S and 10°N in the northwest Indian Ocean. Criteria developed and applied to locate hydrothermal mineralization include characteristic seafloor morphology, magnetic signature, composition and mineralogy of sediments and rocks, and certain water properties (^{3}He; near-bottom temperature). The two slow-spreading (half-rate ≤ 2 cm/yr) oceanic ridges

investigated exhibit a segmented structure with linear sections of rift valley alternating with ridge-ridge transform faults at an average spacing of 75 km. The investigations revealed hydrothermal mineral deposits that were concentrated by high-intensity hydrothermal activity at localized sites of anomalously high thermal gradients and permeabilities within tectonic settings related to the segmented structure of the ridges, as follows: (1) The wall along linear sections of the rift valley where normal faults act as conduits for deep-seated, long-lived hydrothermal activity, with deposition of disseminated, stockwork, and possibly massive sulfides inferred beneath the seafloor as a consequence of subsurface mixing of high-temperature hydrothermal solutions with normal seawater, deposition of Fe-Mn oxides and silicates as layered bodies at the basalt/seawater interface, and precipitation of ferric hydroxide particles from the discharging solution reduced in temperature and depleted in metals; examples are the TAG Hydrothermal Field and five additional candidate sites identified along the MAR. (2) The intersection of the rift valley with ridge-ridge transform faults where thinning of oceanic crust and faulting have exposed disseminated and stockwork Cu-Fe sulfides; examples occur in the Vema and Romanche fracture zones (Bonatti et al., 1976) of the MAR and the Vityaz fracture zone of the CR. (3) The axial zone of the rift valley constitutes an inadequately explored province with the possibility for the occurrence of massive sulfides. Evidence presented indicates that extensive high- and low-temperature hydrothermal mineralization occurs on slow-spreading oceanic ridges but, unlike that found on intermediate- to fast-spreading ridges, the bulk of the high-temperature mineralization occurs beneath the seafloor.

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ROCK COMPOSITION OF THE OCEANIC CRUST IN THE NORTH PACIFIC STRUCTURES

Sufficient differences of magnetic associations are discovered in the abyssal plains (basins), superimposed volcanic zones and rises of the "oceanic land" type. The sections of the second and third crustal layers studied in the Emperor and Hess fault zones represent an undisturbed rocks sequence and may be used as a reference sections. The whole thickness of the sections (2,5 km) is composed by the rocks of an oceanic tholeiitic (MORB) type. The comparison of basalts, dolerites and gabbros show their compositional affinity. During the magmatic fractionation the accumulation of Fe, Zr, Sr, Ti etc. occured with a different rate in different regions and was accompanied by the increasing REE content. However the last phenomenon did not change the REE distribution and La/Sm ratio in each sequence, which property corresponds to the model of crystall magma differentiation taking place through the olivine and plagioclase control. The tholeiitic series similarity in the abyssal plain and spreading ridge proves the similar condition of their melting and differentiation in a deep seated chamber. Among the rises we may distinguish the structures of "oceanic land" type, where the crust was formed simultaneously with the abyssal plains, and the young zones formed on the ancient oceanic crust. Among the last mentioned the Emperor and Ha-

waiian zones may be considered as etalons. There is evolution of magmatic activity from island tholeiites to alcali basaltic series rocks. The genetic affinity of the whole association appear to be doubless. Sometimes the isolated seamounts and abyssal hills are composed of alcali basaltic series rocks formed directly on the ancient crust without a stage of island tholeiite eruptions. On the rises of "oceanic land" type both the typical oceanic tholeiites and alcali basaltic series rocks are discovered in the second layer. On the Hess Rise the trachyte section is extended down for 2 km by alcali basalts hawaiites and mugierites. The enrichment of the alcalic rocks with all lithophyllic elements and light REE happens more intensive than in Hawaii and Emperor zone series. The reasons of such difference may be conditioned by the character of primary smelting. The change of tholeiitic lavas to alcalic ones took place during a short time interval. The tectonic conditions of alcalic melts appearance on the Hess Rise may differ sufficiently as compared with the superimposed volcanic zones.

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ВЕЩЕСТВЕННЫЙ СОСТАВ ОКЕАНИЧЕСКОЙ КОРЫ В СТРУКТУРАХ СЕВЕРНОЙ ПАЦИФИКИ

Выявлены существенные различия магматических комплексов в пределах абиссальных плит (котловин), наложенных вулканических зон и поднятий типа "океанских земель". Разрезы второго и третьего слоев коры, изученные в зонах разломов Императорском и Хесса, представляют ненарушенную последовательность пород (2,5 км по мощности) и могут использоваться как опорные. На всю мощность разрезы сложены породами типа океанических толеитов. Сравнение базальтов, долеритов и габбро показывает общность их состава. В ходе дифференциации толеитовых магм накопление **Fe, Zr, Sr, Ti** и др. происходило с различной скоростью в разных районах и сопровождалось также увеличением содержания легких РЗЭ. Последнее, однако, не изменяло распределение РЗЭ и величину **La/Sm** в каждом из разрезов, что хорошо соответствует модели кристаллизационной дифференциации магмы, происходившей при оливиновом и плагиоклазовом контроле. В целом сходство толеитовых серий на абиссальных плитах и в спрединговом хребте говорит о сходных условиях их выплавления и дифференциации в малоглубинном очаге.
Среди поднятий выделяются структуры типа "океанских земель", в которых кора была сформирована одновременно со смежными абиссальными плитами, и молодые зоны, образовавшиеся на более древней океанической коре. Для последних за эталон могут быть приняты Императорская и

Гавайская зоны с эволюцией магматизма от островных толеитов до пород щелочно-базальтовой серии. Генетическое единство всего комплекса представляется несомненным. Отдельные горы и абиссальные холмы иногда сложены породами щелочно-базальтовой серии, сформировавшимися на древней коре, минуя этап излияния островных толеитов.
На поднятиях типа "океанских земель" в составе второго слоя обнаруживаются как типичные океанические толеиты, так и породы щелочно-базальтовой серии. На поднятии Хесса разрез трахитов надстраивается вниз на 2 км щелочными базальтами, гавайитами, муджиеритами. Обогащение щелочных пород всеми литофильными элементами и легкими РЗЭ происходит значительно интенсивнее, чем в сериях Гавайев или Императорской зоны. Причины такого отличия, очевидно, обусловлены характером первичных выплавок. Смена толеитовых лав щелочными произошла, вероятно, за короткий интервал времени. Тектонические условия появления щелочных расплавов на поднятии Хесса, очевидно, были существенно иными, чем в наложенных вулканических зонах.

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STRUCTURE AND TECTONO-MAGMATIC EVOLUTION OF THE PHILIPPINE SEA FLOOR

A regular set of marginal basins, floored by oceanic crust and separated by paleoactive island arcs, is the most distinctive feature of the Philippine Sea floor, evidenced by the bottom morphology, magnetic lineations, gravity anomalies and seismic refraction studies. However,in spite of the crustal heterogeneity the entire region reacts as single lithospheric plate, surrouded by narrow belts of the high seismicity and volcanic activity. Data on heat flow distribution and upper mantle structure indicate the strongly decreased thickness of the plate.
The palinspastic reconstructions display the apparent periodicity of the Philippine Sea plate geological evolution, including the repeated rifting of the ocean-faced island arcs, accompained by the thrusting of their frontal segments over the Pacific plate and by opening of the complementary inter-arc basins behind. The latter is assumed to occur due to sea-floor spreading mechanism, since basalts of the layer 2 in all inter-arc basins are uniform in composition and have characteristics similar to those of mid-ocean ridge basalts. The island arc volcanism with maximal activity in between inter-arc spreading pulses resulted in erruptions of arc-tholeite, calc-alkaline, alkaline and boninite rock series, rather randomly distributed in space and time.

The infered sequence of correlated tectonic and magmatic events as well as new data on geochemistry and isotopic composition of various rock types, including boninites, are indicative for very complex geodynamics of the region. It is concluded, that endogenous processes should play the dominant role in its evolution, while the subduction of the oceanic plate may be considered as a resultant phenomenon, induced by the oceanward migration of the arc segments. Data on the isotope geochemistry at any rate contradict vigorously the possible influence of buried sea-water, sediments and other subducted components on magmas, errupted through various structures of the Philippine Sea floor.

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СТРОЕНИЕ И ТЕКТОНО-МАГМАТИЧЕСКАЯ ЭВОЛЮЦИЯ ДНА ФИЛИППИНСКОГО МОРЯ

Кулисообразное расположение глубоководных котловин с корой океанского типа, разделенных палеоактивными островными дугами является отличительной чертой строения дна Филиппинского моря, проявленной в его морфологических особенностях, в расположении магнитных и гравитационных аномалий, и подтверждаемой результатами ГСЗ. Несмотря на очевидную структурную неоднородность коры, регион в настоящее время представляет собой единую литосферную плиту, обрамленную узкими поясами высокой сейсмичности и вулканической активности. Данные по распределению теплового потока и строению верхней мантии указывают на аномально малую мощность литосферы региона.

Согласно палинпастическим реконструкциям, геологическая эволюция рассматриваемого региона имела периодический характер, проявленный в том, что вследствие неоднократного рифтогенеза обращенных к океану островных дуг происходил надвиг их фронтальных сегментов на Тихоокеанскую плиту, сопровождавшийся раскрытием интрадуговых бассейнов. По многим признакам кора бассейнов формировалась в результате спрединга морского дна, благодаря чему базальты 2-го сейсмического слоя в их пределах довольно однородны по составу и аналогичны базальтам срединно-океанических хребтов. Резко иным является магматизм разделяющих структур, проявляющийся в периоды остановки тылового спрединга и характеризующийся извержением толеитовых, известково-щелочных, щелочных и бонинитовых вулканических серий, достаточно сложно распределенных во времени и пространстве.

Устанавливаемая последовательность взаимосвязанных тектонических и магматических событий вместе с данными по геохимии различных типов пород, включая бониниты, заставляет предполагать весьма сложную геодинамику региона, в которой ведущая роль принадлежит эндогенным фак-

торам, тогда как субдукция океанской плиты в основном является следствием смещения сегментов островных дуг в сторону океана, компенсирующим тыловой спрединг. Во всяком случае данные изотопной геохимии полностью отвергают возможность влияния морской воды, погребенных осадков или других субдуцированных компонентов на процессы генерации магм, извергавшихся в пределах различных структур дна Филиппинского моря.

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EQUATORIAL PACIFIC SEISMIC STRATIGRAPHY AND THE SIGNIFICANCE OF SEISMIC REFLECTORS

High resolution water gun seismic reflection data between the Clipperton and Galapagos Fracture Zones reveal a number of seismic reflectors persistent for thousands of kilometers. These regional profiles, which incorporate detailed surveys at DSDP sites 71, 72, 73, 77, 573, 574 and 575, provide an opportunity to decipher the geologic significance of the seismic stratigraphy in a rectangle extending from about 2°S to 5°N and 133°W to 140°W. North-south and east-west transects enable us to factor out the first-order sedimentation effects related to equatorial productivity and sea floor depth variations, thereby allowing us to examine more subtle time dependant oceanographic and climatic events.

Preliminary analysis suggests that the regionally persistent reflectors are time parallel, that is they are chronostratigraphic surfaces, within the early Miocene to Recent section. These surfaces cross at a significant angle the attitude predicted for paleodepth and paleolatitude surfaces, and they are likely the result of widespread changes or shifts in oceanographic conditions such as carbonate productivity or dissolution. The persistent reflectors do provide the basic chronostratigraphic framework for interpretation of the geologic events recorded in the Equatorial Pacific sediments which are not always sampled in the widely spaced drill holes. These include discrete periods of intensified sea floor erosion, sediment ponding and off-axis volcanism(?). The determination of the physical origin of these persistent reflectors will require additional investigation.

Distinct acoustic characteristics, including amplitude, spacing, frequency, phase and internal geometry subdivide the vertical seismic section into a series of seismic facies also persistent over large areas. We expect that further work on the seismic facies will show a relationship between the facies and factors such as sediment accumulation rates, lysocline level fluctuations, high frequency climatic changes and depositional processes. The combination of the chronostratigraphic framework and seismic facies will provide a detailed description of the Equatorial Pacific geologic history.

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FERROMANGANESE NODULES OF SUB-EQUATORIAL OOZE RADIOLARIAN BELT OF THE PACIFIC OCEAN

The regional variations of productivity and composition of manganese nodules are related to such general regularities of oceanic sedimentation as latitudional, circum-continental and vertical zonality. The hignest values of Mn, Ni, Cu, Zn as well as Mn/Fe and Cu/Ni ratios are found in nodules of sub-equatorial belt of radiolarian oozes. The latitudional zonality of variations of chemical composition of manganese nodules is governed by zonality of biological productivity and sedimentation rates influencing the sediments composition and the diagenetic redistribution of elements in course of nodule formation. The high Mn/Fe ratios in manganese nodules of radiolarian belt are related to reduction and diffusive migration of manganese in the upper peneliquid layer of sediments. Such mechanism is proved by dissolved manganese distribution in interstitial waters and occurence of Mn^{2+} in these sediments. The possible role of reducing diagenic reactions during manganese nodules formation is proved by recent finding of sulphide minerals in their matrix. The increase of Ni, Cu and Zn contents in these nodules is seemingly related to primarily adsorptive character of their bonds with Mn and subsequent entrance into todorokite structure. The increase of Cu/Ni ratio in nodules of sub-equatorial zone is connected to biological extraction of Cu from sea water via sceletal parts of siliceous organisms. The recent detailed investigations carried out in several sites revealed large variations of local productivity, morphological types and composition of nodules. The data gathered in such sites in the Clarion-Clipperton province and in the Central basin during the 28-th cruise of R.V. "Dmitry Mendeleev" present more information concerning morphological characteristics, local variability and formation environment of major genetic types of nodules (sedimentary, diagenetic and sedimentary-diagenetic) of radiolarian belt.

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ЖЕЛЕЗО-МАРГАНЦЕВЫЕ КОНКРЕЦИИ ПРИЭКВАТОРИАЛЬНОЙ ЗОНЫ РАДИОЛЯРИЕВЫХ ИЛОВ ТИХОГО ОКЕАНА

Региональные вариации продуктивности и состава конкреций определяются такими общими закономерностями океанского седиментогенеза, как широтная, циркумконтинентальная и вертикальная зональности.

Максимальные содержания Mn,Ni,Cu,Zn и величины Mn/Fe и Cu/Ni отношения приурочены к конкрециям приэкваториальной зоны распространения радиоляриевых илов. Широтная зональность изменения химического состава конкреций обусловлена зональностью биопродуцирования и скоростей седиментации и соответственно диагенетического перераспределения элементов при формировании конкреций. Высокие величины Mn/Fe отношения в конкрециях радиоляриевой зоны связаны с восстановлением и диффузионной миграцией Mn в верхнем полужидком слое осадков. Подтверждением этого процесса служит как повышенное значение Mn в поровых водах радиоляриевых илов, так и присутствие Mn^{2+} в твердой фазе этих осадков. О диагенетических редукционных процессах при образовании конкреций свидетельствуют также обнаруженные в последние годы проявления сульфидной минерализации. Возрастание же содержания Ni,Cu,Zn в этих конкрециях, по-видимому,обусловлено первоначально сорбционной природой их взаимосвязи с Mn и последующим вхождением в структуру тодорокита. Что касается увеличения Cu/Ni отношения в конкрециях приэкваториальной зоны, то оно обусловлено биологическим извлечением Cu из морской воды в скелетах кремнистых организмов.

Полигонными исследованиями последних лет выявлены значительные вариации локальной продуктивности,морфотипов и состава конкреций. По материалам полигонов 28-го рейса нис "Дмитрий Менделеев" в рудной провинции Кларион-Клиппертон и Центральной котловине рассматриваются типоморфные особенности,локальные вариации и условия образования различных генетических типов (преимущественно седиментационных, диагенетических и седиментационно-диагенетических) конкреций радиоляриевой зоны.

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COMPARISON AMONG EAST ASIA, SOUTHEAST ASIA AND EUROPE IN GEOLOGIC DEVELOPMENT SINCE MESOZOIC

The geosinclinal subsidence followed by orogenic movement occured along the outer side of island arcs of Kuril, Japanese islands and others, and collapse-subsiding basins were formed in the inner side of the arcs and in east Asia during the Mesozoic and Cenozoic. Intense igneous activity was accompanied with the formation of those basins. Such tectonic events attains more than 2,000 km in horizontal extent. The deep eathquake zone is formed along the transitional zone between continental upheaving area and oceanic subsiding one, where the concentration of strain occurs along the inclined plane toward continent corresponding to the earthquake zone. Similar tectonic pattern is observed in Southeast Asia, where the geosynclinal

and orogenic zone occurred along the island arcs of Philippines and Sunda, and collapse-subsiding basins were formed in the inner side of the arcs. The deep earthquake zone inclined toward the inner side is formed along the arcs. The zone might be due to the marginal effect of the subsidence of Indian Ocean and Philippine Sea.
The similar pattern of tectonic movement is observed in Europe, where the geosynclinal and orogenic movement occurred along the outer side of Apenine, Alps, Dinarides and others and collapse-subsiding basins such as Aquitane, Paris, Poland, North Sea and others in the inner side. The deep earthquakes occur along the Mediterranean Sea and to the southeast of the Carpathian Mountains. The horizontal extent of such movement reaches more than 2,000 km.
The driving force of such movement must lie in the mantle of deeper part of the earth, as the movement reaches as wide as several thousand km. The activity of deep earthquakes might be the marginal effect of such movement.

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SMALL OCEANIC BASINS OF THE WESTERN MEDITERRANIAN AND CARIBBEAN

Small oceanic basins of the Western Mediterranian and Caribbean have a lot of common features in their structure - thin close to oceanic type crust, thinner lithosphere, formation due to spreading within comparatively short time periods. Alpine-type nappe folded margins are characteristic of the basins'boundaries. They spread centrifugally from the areas at present occupied by deep sea basins.

Small oceanic basins of the Western Mediterranian had been formed under the condition of convergence of the African and European continental plates at the moment of collision of the Adriatic prominence and Europe, thus leaving free space in the west as well as in the east. Its worthy mentioning that back-arc basins of the south-west Pacific had been also formed due to convergece of lithospheric plates but these ones are of oceanic origin.

Formation of deep sea basins of the Caribbean went on under the condition of dispreading of the American continents which began in the Late Jurassic because of the opening of the Northern Atlantic. The formation of basins as well as that of folded margins can be subdivided into several stages. The first one is connected with the split of the unite island arc, which exsisted near the South American continent since the Early Cretaceous and opening of the Proto-Caribbean basin in the Turonian. It provided the motion of nappes southwards, to South America, while the northern part of the arc moved

northwards. The second stage is connected with the opening of the Yukatan trough and formation of Kayman-Sierra-Maestra volcanic arc, which caused the motion of the nappes northwards, over the adjoining edge of the North American plate in the Maastrichtian - Early Palaeocene.

Thus, small oceanic basins may originate under the conditions of convergence as well as divergence of lithospheric plates; their formation went on under the conditions of tension and compression, intermitting within short time periods.

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МАЛЫЕ ОКЕАНИЧЕСКИЕ БАССЕЙНЫ ЗАПАДНОГО СРЕДИЗЕМНОМОРЬЯ И КАРИБСКОГО РЕГИОНА

Малые океанические бассейны Западного Средиземноморья и Карибского региона имеют много общих черт строения: малую мощность земной коры, близкой по составу к океанической, пониженную мощность литосферы и др., и сформированы за счет спрединга в весьма короткий промежуток времени. Очень характерными для их обрамления являются покровно-складчатые структуры альпийского типа с центробежным движением покровов из районов, занимаемых в настоящее время глубоководными впадинами.

Малые океанические бассейны Западного Средиземноморья сформировались в условиях сближения Африканской и Европейской континентальных плит в момент столкновения Адриатического выступа с Европой, в результате чего осталось "свободное" пространство как на западе, так и на востоке. Следует отметить, что тыловые бассейны юга-запада Тихого океана также образуются в условиях сближения литосферных плит с той лишь разницей, что эти плиты являются океаническими.

Образование глубоководных впадин Карибского бассейна происходило в условиях раздвига Американских континентов, начавшегося в поздней юре в связи с раскрытием Северной Атлантики. В становлении как впадин, так и их складчатого обрамления можно выделить несколько этапов. Первый связан с расколом единой вулканической дуги, существовавшей вблизи Южноамериканского континента с раннего мела и раскрытием Протокарибского бассейна в туроне. Это обусловило движение покровов к югу в сторону Южной Америки и значительное отодвигание северной части дуги к северу. Со вторым этапом связано открытие Юкатанской впадины и формирование вулканической дуги Кайман - Сьерра-Маэстра, что привело к движению покровов на север на прилегающий край Североамериканской плиты в маастрихте - раннем палеоцене.

Таким образом, малые океанические бассейны образуются как в обстановке сближения, так и расхождения литосферных плит и при их формировании близко соседствуют условия растяжения и сжатия.

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INTER-OCEAN DIFFERENCES IN LATE EOCENE AND EARLY OLIGOCENE CARBONATE ACCUMULATION IN THE DEEP SEA

The transition from carbonate-poor late Eocene sediments to carbonate-rich early Oligocene sediments in the deep sea undoubtedly reflects a major reorganization of the way in which carbonate was fractionated between shelf regions and deep basins. During Eocene time extensive carbonate deposits accumulated on the shelves marginal to the Tethys Sea, whereas in Oligocene time carbonate sedimentation generally decreased on the continental shelves and increased in the deep sea. This facies change in the deep sea represents a lowering of the carbonate compensation depth (CCD) with the magnitude of the drop varying in a systematic fashion from one ocean basin to another.

Carbonate accumulation records from sites located above the CCD reveal distinct inter-ocean differences. Sites from both the eastern and western Pacific are consistently characterized by an abrupt increase in carbonate accumulation near the Eocene/Oligocene boundary. Alternately, carbonate records for sites from the South Atlantic show either no change or a decrease in accumulation during this time interval. These contrasting patterns between the Atlantic and the Pacific suggest that basin-basin fractionation of carbonate began in late Eocene to early Oligocene time, and mostly likely reflects a major change in the nature of both deep and intermediate circulation in the oceans.

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THE STRUCTURE AND HISTORY OF DEVELOPMENT OF THE BLACK SEA DEPRESSION

In recent years the structure section of the Black Sea depression has been investigated seismically by method of common depth point down to 15-16 km. So the Black Sea basin became one of the more investigated parts of the World ocean. Mapping of the surface of Mesozoic rocks forming the base of the Black Sea depression has been fulfilled. Within this surface Andrusov elongated uplift separating Western and Eastern Black Sea depressions has been distinguished. Its shape and junction with Arkhangelsky Ridge was established. Western and Eastern Black Sea depressions has been outlined more accurately. Shatsky elongated uplift lying on the continuation of Gudauta arch and separating Sorokin and Tuapse troughs from Eastern Black Sea depression has been mapped. In the Cenozoic filling of these depressions there is distinguished Paleocene-Eocene sequence having

thickness up to 5-6 km. Therefore in Paleocene-Eocene time already intensive sinking of these both large depressions took place. In the Oligocene time the process of sinking continued and Maikopian series in these depressions reache 3-5 km in thickness minimizing nearly up to zero on the arches of Andrusov and Shatsky elongated uplifts. Oligocene time also was marked by origination Sorokin and Tuapse deep troughs. In the post-Maikopian time these arched uplifts were involved in the total process of subsidense and in the result complicated structures of Paleogene age were capped by Neogene-Quaternary sediments. Subsiding of the Black Sea depression was continued during the whole Cenozoic time as it is indicated by gradual increasing of the thickness of all sedimentary units from margins of the depression to its central partion. And in the result the amplitude of bending of stratigraphic surfaces increases from 2 km in the base of Quaternary up to 8 km in the base of Paleogene sequences.For a long time deep-sea basins existed in the depression.

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СТРОЕНИЕ И ИСТОРИЯ ФОРМИРОВАНИЯ ЧЕРНОМОРСКОЙ ВПАДИНЫ

Разрез Черноморской впадины в последние годы изучен сейсморазведкой МОГТ до глубин 15-16 км и Черное море стало одной из наиболее исследованных акваторий мира. Закартирована поверхность мезозойских пород, образующая основание Черноморской впадины. По этой поверхности выделен вал Андрусова, разделяющий Западно- и Восточно-Черноморскую впадины, установлена его форма и сочленение с поднятием Архангельского. Западно- и Восточно-Черноморская впадины приобрели точные очертания. Закартирован вал Шатского, лежащий на продолжении Гудаутского свода и отделяющий прогибы Сорокина и Туапсинский от Восточно-Черноморской впадины. В кайнозойском выполнении впадин обнаружена палеоцен-эоценовая толща мощностью до 5-6 км, следовательно уже в палеоцен-эоцене обе крупные впадины интенсивно погружались. В олигоцене опускание продолжалось: мощности майкопских отложений достигали в них 3-5 км, сокращаясь почти до нуля на сводах валов Андрусова и Шатского. В олигоцене формировались также глубокие прогибы Сорокина и Туапсинский. В послемайкопское время валы были вовлечены в общее опускание и сложные палеогеновые формы оказались скрыты чехлом неоген-антропогеновых отложений. Прогибание Черноморской впадины было непрерывным в течение всего кайнозоя, так как все толщи осадочного выполнения постепенно увеличи-

вались в мощности от ее краев к середине. При этом амплитуда изгиба стратиграфических поверхностей возрастала от 2 км для подошвы антропогена до 8 км для подошвы палеогена. Длительное время во впадине существовали глубоководные бассейны.

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CHILEAN VS. MARIANA TYPE SUBDUCTION ZONES

Various geophysical and geological phenomena characterisitic of subduction zones, such as back arc extension, arc volcanism and seismicity, are difficult to explain in terms of a single model for down-going slabs of cold oceanic lithosphere. Comparative studies of different subductin zones are instructive in this regard and lead to the recognition of two fundamentally contrasting modes controlled by the strength of mechanical coupling between down-going and overriding plates. High stress Chilean-type subduction zones are characteristic of continental arcs, whereas island arcs with actively spreading back arc basins are typified by low-stress Mariana-type subduction.
With this distinction in the mode of subduction, diversity in many other phenomena related with trench-arc-back arc systems may be explained in a consistent manner, e.g. regional stress distribution, vertical movements, heat flow, mineralization, sediment subduction/accretion, crustal accretion/erosion and collision.
The possible factors controlling the degree of mechanical coupling between down-going and overriding plates are the difference in the nature, mainly the density, of the subducting plate and the motion of the overriding palte relative to the position of the trench line. The former is determined by the age and "continentality" of the subducting plate and the latter by the absolute motion of the overriding plate, if the trench line is stationary. It should be noted that trench line can be moved by asthenospheric flow, roll back of subducting plate and trenchward advancement of overrding plate, causing extension and closure of back arc basins. Since all these factors can change with time, the mode of subduction at any particular subduction zone can also change waith time. This may account for the opening and closure of back arc basins in the ancient subduction zones.

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CENOZOIC GEOLOGICAL EVENTS CORRELATION OF THE SOVIET FAR EAST SOUTH AND ADJACENT REGIONS OF THE PACIFIC

Tectono-magmatic activity impulses, coincided with periods of Alpine folding stages, took place in Paleogene and Neogene history of the Soviet Far East South. Old Laramide stage is characterised by general uplifting, orogenesis, intrusive magmatism; Pyrenees stage - by local washouts and changes of sedimentation type, rate of sedimentation increase, Khankay Massif margins crush, changes of basic and average volcanism into acid; Savic stage - by general break of

sedimentation, change of sedimentation type, intrusive magmatism and change of acid magmatism into basic; Steirisch stage - by general washout and basic volcanism activisation; Aleutian stage - by break of sedimentation with changes of its type, including changes of basic volcanism into acid; Attic stage - by general and local washouts and activisation of basic volcanism; Caucasus stage - by uplifting of the whole region, sedimentation discontinuance and by plateau-basaltic volcanism.

Tectono-magmatic activity impulse took place between Paleocene and Eocene and it didn't coincide with time interval of above mentioned Alpine folding stages. It was expressed by break of sedimentation, location of near-fracture graben volcano-tectonic structures, change of basic volcanism into acid and by intrusive magmatism.

Comparative analysis of Paleogene and Neogene geological events evolution and correlation in Priamur'e and Primor'e with conjagated regions of The Far East and Pacific province shows, that in geological history of the Earth there were local, regional and global impulses of tectono-magmatic activity. Form and intensity of tectono-magmatic correlated impulses differ in different geoblocks of the planet.

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КОРРЕЛЯЦИЯ КАЙНОЗОЙСКИХ ГЕОЛОГИЧЕСКИХ СОБЫТИЙ ЮГА СОВЕТСКОГО ДАЛЬНЕГО ВОСТОКА И СОПРЕДЕЛЬНЫХ РЕГИОНОВ ТИХООКЕАНСКОЙ ПРОВИНЦИИ

В истории палеогена и неогена юга советского Дальнего Востока имели место импульсы тектоно-магматической активности, совпадающие с периодами проявления альпийской складчатости. Древнеларамийская фаза проявилась повсеместным воздыманием, горообразованием, интрузивным магматизмом; пиренейская фаза - повсеместно локальными размывами и сменой типа седиментации, увеличением скорости осадконакопления, дроблением окраин Ханкайского массива, сменой основного и среднего вулканизма кислым; савская - повсеместно перерывом в осадконакоплении, сменой типа седиментации, интрузивным магматизмом и сменой кислого магматизма основным; штрийская - повсеместным размывом, активизацией основного вулканизма; алеутская - повсеместным перерывом в осадконакоплении со сменой типа седиментации, сменой основного вулканизма кислым, аттическая - повсеместными и локальными размывами, активизацией основного вулканизма; кавказская - повсеместным воздыманием региона, прекращением осадконакопления, плато-базальтовым вулканизмом. На рубеже палеоцена и эоцена имел место импульс тектоно-

магматической активности, не укладывающийся во временной интервал указанных фаз альпийской складчатости. Проявился он перерывом в осадконакоплении, заложением приразломных грабенных вулкано-тектонических структур, сменой основного вулканизма кислым, интрузивным магматизмом.

Сравнительный анализ эволюции и корреляция геологических событий палеогена и неогена Приамурья и Приморья с геологическими событиями Дальнего Востока и Тихоокеанской провинции показывают, что в геологической истории Земли имели место импульсы тектоно-магматической активности: локальные , региональные и глобальные. Форма и интенсивность проявления коррелятных импульсов тектоно-магматической активности в различных геоблоках планеты различна.

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DEEP SEA METALLIFEROUS DEPOSITS: HOW SIGNIFICANT ARE THEY?

Metalliferous sediments and associated deposits have received increased attention in the past two decades especially as a result of the discoveries of hydrothermal vents on the sea floor in areas of ocean floor spreading. These deposits, notably from the TAG hydrothermal field in the Atlantic, the Bauer Deep region and the crest of the East Pacific Rise have been shown to be part of a continuum of deposits reflecting the degree of subsurface mixing between hydrothermal solutions and groundwaters.

The significance of hydrothermal processes on the sedimentary (as opposed to aqueous) budget of the oceans is unclear. Elements such as Cu which are fixed as sulphides (subsurface) in hydrothermal systems are accumulating relatively rapidly in surface mid-ocean ridge sediments. The input of such elements depends upon the timescale of hydrothermal system development and destruction which may be short in terms of the geologic record. The processes governing the formation of metalliferous sediments are complex as indicated by small scale chemical variations in the composition of recently accumulated sediments.

However metal rich deposits are merely a part of the overall continuum of deep sea sedimentation and should be viewed as such rather than as isolated anomalies.

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ON THE GEOCHEMISTRY AND SIGNIFICANCE OF SAPROPELIC HORIZINS FROM THE EASTERN MEDITERRANEAN

Sedimentological and geochemical studies in the Eastern Mediterranean have revealed the presence of sedimentary horizons of variable thickness which are located in the top few metres of the sediment column and which contain enhanced levels of organic carbon. We have identified these horizons using the criteria of colour, mineralogical properties, X-ray techniques and organic carbon content (> 0.5% C) in several cores taken from the N.W. Aegean.

In addition, these horizons contain levels of certain trace metals (e.g., Cu, Ni, Zn) that are significantly greater than those concentrations found away from the organic rich layers and concentration-depth profiles of Mn that are clearly related to remobilization and oxidising/reducing conditions. These data, and complementary studies on the fauna and flora preserved within the horizons, provide a multi-disciplinary approach to the question as to how these sedimentary layers were formed and whether they are ancient analogues of modern day surface sediments found on continental shelves underlying areas of enhanced upwelling, e.g., offshore *Peru and S.W. Africa. The relevant geochemical and sedimentological* data are presented and interpreted.

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CHANGING SEDIMENTATION PATTERNS WITH TIME IN THE AGULHAS PASSAGE, S.W.INDIAN OCEAN

The Agulhas Passage is a 4.8 km deep, NE-SW trending channel between the South African continental margin and the Agulhas Plateau which connects the Transkei and Agulhas Basins. It was formed during the opening of the S. Atlantic Ocean. Crustal age in the Agulhas Passage is between 88 - 100 my.

The sedimentary regime and oceanic circulation patterns were initially only influenced by circulation patterns in the Indian Ocean until about 84 my when the Falkland Plateau cleared the Southern African margin and oceanic interchange between the S. Atlantic and S.W. Indian Oceans commenced. Since then, Atlantic Ocean circulation has strongly influenced sedimentation in the Agulhas Passage.

The depositional history of sediments in the Agulhas Passage has been interpreted from the acoustic stratigraphy which comprises i) a rugged basement overlain by a smooth reflector, Horizon X, in the central part of the passage, ii) a relatively thick, acoustically transparent, ponded sediment sequence, Layer A, above the rugged basement and Horizon X, which is diachronous on the Agulhas Plateau, iii) the P.E. Horizon, a dense packet of partially truncated reflectors overlying Layer A on the lower continental slope and floor of the passage, iv) a faintly stratified Layer B above the P.E. Horizon which forms thick current moulded mounds on the continental slope and a thin, eroded, and in part condensed, sequence on the floor of the Agullas Passage, v) a thin, highly stratified Layer C which overlies Layer B on the abyssal plain at the NE end of the passage.

The acoustic stratigraphy is interpreted in terms of sinking of the oceanic crust, changes in circulation patterns due to the connection of the S. Atlantic and S.W. Indian Oceans, formation of a deep, worldwide thermohaline circulation pattern and eustatic sea level changes in response to climatic changes.

Initial sedimentation in the Agulhas passage was probably in a restricted, anoxic basin in which terrigenous (turbiditic?) and carbonate material accumulated above the carbonate compensation level (CCL). A change in sedimentation caused by the oceanic crust sinking beneath the CCL at about 90 my is represented by Horizon X. Ponded terrigenous and pelagic clays were rapidly deposited below the CCL (Layer A) without much bottom current influence until the U. Palaeocene/L. Eocene when higher sea levels and a lower sediment input changed the sedimentation pattern (the P.E. Horizon). The truncation of the P.E. Horizon indicates strong current activity in the area for the first time. Current control is important throughout the deposition of Layer B especially on the floor of the passage because of current intensification due to topographic constriction. Reflecting horizons within Layer B represent the Oligocene hiatus related to the intensification of oceanic circulation caused by the glaciation of Antarctica and the L. Miocene hiatus also caused by circulation intensification. During the recent Pleistocene low sea level, terrigenous material was deposited as turbidites on the abyssal plain (Layer C). Recently filled in moats and thin sediment deposits on old erosion surfaces indicate a waning in present current activity.

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ON THE GEOLOGICAL EVOLUTION IN MESOZOIC-CENOZOIC ERA IN EAST ASIA AND THE FORMATION OF THE MARGINAL SEAS OF WEST PACIFIC OCEAN

A series of most spectacular island-arcs and marginal seas distributed in west Pacific Ocean. The cause appearing marginal seas correlated with special geological environment adjacent to East Asia area. Many isolated mantle heat sources (or thermal plume) were produced inside Asian plate during Meso-Cenozoic era. The evolution and track of South China heat source region correlate closely with the formation of the Philippine sea basin. It is formed in Mesozoic, and moved toward SE direction in the drifted speed with 6km per Im.y. By this speed, down to the Eocene the heat source of Fujian-Zhejiang should move at sea area far off the eastern coast of present Taiwan about 600km, it is just located in the west Philippine sea basin. The mantle heat source caused expanding of South China landmass during Mesozoic was the same to that of spreading-up Philippine sea basin during Cenozoic. The sea of Japan, the sea of Ochotsk and the Nan Hai Sea also have the similar origin. The origin of most of marginal seas in west Pacific Ocean is neither partial trap of Ocean crust nor arc-back spreading caused by subduction. They are mainly formed by the strong action of isolated mantle heat source act on continental margin, the rise of high thermal mantle-diapire, the fusion and rupture of continental crust and the multicentral local sea-floor spreading.

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VOLCANIC FORMATIONS OF THE OCEANIC CRUST SECOND LAYER

The formational approach to study of magmatic rocks has considerably promoted the problem of petrogenesis of various magmatic series. Yet the vast Earth's territory occupied by oceans was poorly studied in this aspect. Yu.A.Kuznetsov (1964), and later V.A.Kutolin (1972) distinguished in the oceanic segment of the Earth and characterized only one alkaline-olivine-basalt formation peculiar to certain tectonic structures. By its volume this formation plays a secondary role in the ocean. The following volcanic formations are suggested in the second layer of the recent ocean crust: formation of midoceanic ridges and abissal plates; that of aseismic ridges; arched-volcanic uplifts on abyssal plates; volcanic uplifts on midoceanic rid-

ges; island arcs and marginal seas. The two latter formations are distinguished in the Pacific Ocean only, and they are not concerned in the paper. The above mentioned formations were distinguished by analigy with tectonic structures in whose structure they are determinative. The Earth's crust thickness in this series of tectonic structures increases as follows: midoceanic ridges and abyssal plates- aseismic ridges - volcanic uplifts on the midoceanic ridges - arched-volcanic uplifts on abyssal plates. In all these cases the source of primary melts is mantle substratum - lherzolite of various deep-seated facies (plagioclase, spinelic, spinel-garnet). The depth of primary melts in tectonic structures is different. It is 20-25 km in midoceanic ridges, 40-45 km - in volcanic uplifts on midoceanic ridges, 60-70 km - in aseismic ridges, 60-90 km - in arched-volcanic uplifts on abyssal plates. Melting of the primary substratum in all the cases is selective. The character of differentiation is different. In midoceanic and aseismic ridges this is crystallization differentiation. In uplifts of various kinds this is a combination of crystallizational differentiation with immiscibility. Thus, the formation of some volcanic formations of the oceanic crust second layer is accompanied by a change of volcanism manifestation (fissure volcanism is substituted by central one), with simultaneous thickening of the oceanic crust and deepening of primary chambers of magma generation. The same succession is characteristic of alkalinity of primary melts.

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ВУЛКАНИЧЕСКИЕ ФОРМАЦИИ ВТОРОГО СЛОЯ ОКЕАНИЧЕСКОЙ КОРЫ

Формационный подход к изучению магматических пород в значительной мере продвинул проблему петрогенезиса различных магматических серий. Однако громадная территория Земли, занятая океанами, в этом отношении была изучена слабо. В океаническом сегменте Земли Ю.А.Кузнецовым (1964), а вслед за ним В.А.Кутолиным (1972) была выделена и охарактеризована лишь одна щелочная оливин-базальтовая формация, свойственная определенным тектоническим структурам. Эта формация в объемном отношении играет в океане второстепенную роль.

Предлагается во втором слое океанической коры современного океана выделять следующие вулканические формации: срединно-океанических хребтов и абиссальных плит, асейсмичных хребтов, сводово-вулканических поднятий на абиссальных плитах, вулканических поднятий на срединно-океанических хребтах, островных дуг и краевых морей. Две последние формации выделяются только в Тихом океане и они в работе не рассматриваются. Выделенные выше формации названы по аналогии с тектоническими структурами, в строении которых они играют определяющую роль.

Мощность земной коры в этом ряду структур возрастает следующим образом: срединно-океанические хребты и абиссальные плиты — асейсмичные хребты — вулканические поднятия на срединно-океанических хребтах — сводово-вулканические поднятия на абиссальных плитах. Во всех случаях источником первичных расплавов является мантийный субстрат - лерцолит различных глубинных фаций (плагиоклазовый, шпинелевый, шпинель-гранатовый). Глубина первичных расплавов в разных тектонических структурах различна. В срединно-океанических хребтах это 20-25 км, в вулканических поднятиях на срединно-океанических хребтах-40-50 км, в асейсмичных хребтах-60-70 км, в сводово-вулканических поднятиях на абиссальных плитах-60-90 км. Плавление первичного субстрата во всех случаях селективное. Характер дифференциации различен. В срединно-океанических и асейсмичных хребтах это кристаллизационная дифференциация. В поднятиях различного рода это сочетание кристаллизационной дифференциации с ликвацией. Таким образом, формирование рядов вулканических формаций второго слоя океанической коры сопровождается изменением типа проявления вулканизма (трещинный сменяется центральным) с одновременным утолщением океанической коры и заглублением первичных очагов магмообразования. В такой же последовательности увеличивается щелочность первичных расплавов.

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DSS DATA ON THE CRUSTAL AND SUBCRUSTAL LITHOSPHERE STRUCTURE ON THE ANGOLA BASIN

Long range DSS of the Earth's crust and undercrustal lithosphere were conducted in 1980 and 1982 on the Angola basin and adjacent part of Mid-Atlantic ridge. The total length of DSS profiles was 3 000 km with several sets of ocean bottom seismographs in 40 points and more than 160 big shots. Reliable travel-time curves determined by a large number of observations were obtained to distances of 400 km, separate branches are 600 km long. Complite system of observations were obtained for the base of the Earth's crust and for deeper layers of the lithosphere. The main feature of travel-time curves for the Angola basin is the presence of the long branches of curves with velocity 8,5-8,6 km/s, traced at distances from 70 to 300 km. The waves with 6,7 km/s velocity were observed at small distances. In the interval 35-65 km by a limited number of points we may presume the presence of waves with velocity 8 km/s in the first arrivals. Starting from the distances of about 300 km the velocity of waves in first arrivals increase to 8,8-9,0 km/s, and there in cause

to distinguish a new wave connected with still another layer in the subcrustal lithosphere. This high-velocity wave is not observed on the additional DSS profile of the orthogonal line located at the western margin of the Angola basin. Two versions of seismic cross sections are presented. The first one do not take into account the waves with velocity 8,0 km/s. The boundary with velocity 8,3-8,7 km/s (M-discontinuity) is compiled at the depth of 12-15 km below sea level. The next layer with velocity 8,8-8,9 km/s lies at the depth 25-30 km. According to the second version M- boundary with velocity 8,0 km/s lies subhorisontal at the depth 11-12km, the next boundary with velocity 8,5 km/s have the depth varies from 14 to 20 km. The boundary with velocity 8,8 km/s is at the depth of 25-35 km. The seismic sections are discussed together with another data. Some subpositions are presented about the nature of the seismic layering of the oceanic crust and subcrustal lithosphere.

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СТРОЕНИЕ ЗЕМНОЙ КОРЫ И ПОДКОРОВОЙ ЧАСТИ ЛИТОСФЕРЫ АНГОЛЬСКОЙ КОТЛОВИНЫ ПО ДАННЫМ ГСЗ

ГСЗ с донными сейсмическими станциями и мощными взрывами было выполнено в 1980 и 1982 гг. в Ангольской котловине и на прилегающей части Срединно-Атлантического хребта. На линии общей длиной 3000 км, проходящей с востока на запад, донные станции в несколько этапов были установлены в 40 точках, всего было произведено свыше 160 взрывов. Уверенные годографы были получены до удалений в 400 км, отдельные ветви имеют длину 600 км. Полные системы годографов получены для подошвы земной коры и более глубоких слоев литосферы. Особенностью годографов, полученных в Ангольской котловине, является наличие длинных ветвей годографов со скоростями 8,5-8,6 км/с, прослеживающихся на удалениях от 70 до 300 км. На малых расстояниях в первых и последующих вступлениях выделены волны со скоростью 6,7 км/с. На интервале расстояний 35-65 км есть основание выделить в первых вступлениях волну со скоростью 8,0 км/с, которая при малой плотности взрывов иногда бывает охарактеризована только одной-двумя точками и может быть пропущена. На удалениях свыше 300 км скорости первых волн возрастают до 8,8 км/с, и есть основание выделить новую волну, связанную с границей в подкоровой части литосферы. Такое возрастание скоростей не отмечается на дополнительном профиле, ориентированном примерно перпендику-

лярно основной линии и расположенном у западного борта Ангольской котловины. По полученным материалам построены два варианта разрезов. Первый из них, не учитывающий возможность выделения волны со скоростью 8,0 км/с, предполагает наличие границы со скоростями 8,3-8,7км/с, залегающей на глубинах I2-I5 км, и границы в мантии со скоростями 8,8-8,9 км/с, построенной на глубинах 25-30 км. Во втором варианте разреза граница М со скоростью 8,0 км/с залегает субгоризонтально на глубинах II-I2 км, следующая граница со скоростью 8,5 км/с варьирует по глубине от I4 до 20 км и граница со скоростью 8,8 км/с - от 25 до 35 км. Полученные разрезы рассматриваются совместно с данными других методов, высказываются соображения о возможной природе выделенных глубинных границ.

СЕКЦИЯ / SECTION 07

ТЕКТОНИКА
TECTONICS

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ACCRETIONARY TECTONICS AND MELANGE FORMATION, MESOZOIC FRANCISCAN SUBDUCTION COMPLEX, NORTHERN CALIFORNIA, USA

Varieties of Franciscan melanges include: I) poorly to moderately indurated shaley-matrix melange containing dispersed blocks of chert, clastic sedimentary, igneous and metamorphic rock. The matrix may be unfoliated and block orientation random, or may exhibit pervasive, anastomosing foliation with preferred orientation of blocks. Melanges interstratified with turbidites were deposited as olistostromes in trench slope basins; others may have been emplaced diapirically. II) highly indurated, foliated, black argillite-green tuff-matrix melange containing dispersed, lenticular blocks of chert, basalt and foliated graywacke. This melange appears in km-long lenses thrust-faulted over type I melanges, and in blocks (olistoliths?) within type I melanges. Type II melanges originated by tectonic mixing of stratified oceanic plate basalt, chert and pelagic sediment with trench turbidites during subduction. The tuff-argillite matrix displays soft-sediment intrusions truncated by foliation and shear fractures. Foliation and induration reflect matrix dehydration. Olistoliths of type II melange were derived from upfaulted slabs of accretionary basement exposed on the trench slope, and possibly by plucking within the prism during type I melange diapirism. III) poorly to moderately indurated, mylonitized to foliated, argillite or serpentinite-matrix melange containing dispersed blocks of chert, igneous and metamorphic rock associated with strike-slip and thrust faults. Blocks dispersed in thick gouge zones beneath thrust faults were tectonically transported from hidden type I melanges. The faults reflect profound crustal shortening within a developed accretionary prism. Motion on younger strike-slip faults dispersed blocks in vertically foliated serpentinite or argillite.

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IMPORTANT MESOZOIC FAULTS OF AFGHANISTAN

I. Khokhan-Eshkamesh fault ia a tectonic border between Afghanistan-North-Pamir folded region and North Afghanistan Platform. It is a reverse strike-slip fault having a steep dip plane with an estimated displacement of about 8 km and has a length over 275 km. It is an active fault since Upper Triassic times, as evidenced by earthquake

focuses. Along the fault zone the focal depth is 50-60 km with a maximum magnitude of M=6.5, while towards the eastern part it is commonly up to 300 km depth.

2. Alburz-Mormul fault separates Paropamiz-Bande Turkestan uplift from Afghanistan-South Tadjikistan basin. The length exceeds 295 km and is of late Jurassic age. It is also a reverse fault with a steep plane and is possible that the southern limb moved to the east. The focal depth is up to 70 km, with a maximum magnitude up to M=6.8. Epicentral density along the fault is higher in the east than in the western part.

3. Chaman-Moqur fault separates Katawaz Trough from Dari Rod Trough and also South Afghanistan Median Mass. It appears to have originated during late Triassic times and became active in early Cretaceous and is about 690 km long in Afghanistan alone. The dip of the fault is south-eastwards with 70-80° angle. The fault zone width is up to 2 km and is characterised by the presence of mylonite, cataclasites and hyperbasites. In the fault zone the maximum magnitude is M=5.8 with focal depth up to 50 km.

The above tectonic fault structures, thus, have played a significant role in seismotectonic activity of the northern and south-eastern regions of Afghanistan.

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GEOLOGY AND TECTONIC FRAME OF NAGA HILLS OPHIOLITE, NORTHERN INDO-BURMESE RANGE, INDIA

The Naga Hills Ophiolites representing the main, outermost belt of the three Indo-Burmese Ophiolites, have been nearly mapped in 1 : 50,000 scale and described. These are thrust westward over the flyschoid Disang Formation (Up. Cretaceous-Eocene) and often inturn are overridden eastward by the Naga Metamorphics (? pre-Mesozoic). Klippe of metamorphics and volcanics occur within the ophiolites or the Disang adjacent to the contact respectively. Several disjointed, typical ophiolitic suites are recognized. Alkaline to tholeiitic basic volcanics are usually of seamount-type. Acid-intermediate volcanics are minor. Tholeiitic diabasic dykes and plagiogranite stocks intruding cumulates, meta-ultramafics and volcanics are scanty. Radiolaria, nanno-coccolith assemblages from chert limestone interbeds within basic volcanics and slices elsewhere suggest

Maestrichtian affinity. Slivers of blue-schist and high-grade facies occur juxtaposed within the feeble to low-grade metamorphosed ophiolitic melange. An immature mainly ophiolite derived, marine to paralic, volcano-clastic Pukhpur Formation (Eocene) newly recognised and christened, non-conformably overlies disjointed ophiolitic members. Emplacement of these ophiolites was thus post-Maestrichtian and pre-Eocene. Locally, the Pukhpur is overridden by the continental Naga Metamorphics which are not entirely extrabasinal. Folding and imbrication of the Pukhpur with its ophiolitic basement may be correlated with the first tectonic event and post-Oligocene unconformity recorded from the western miogeosynclinal belt. The evolutionary and emplacement history of the Indo-Burmese Ophiolites have been reconstructed.

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DESTRUCTIVE AND CONSTRUCTIVE PROCESSES OF TECTONOSPHERE FORMATION OF THE MIDDLE ASIA

Variety of observed structural formig construction of Middle Asia is provided by the whole history of its geological development which includes two main types of processes-destructive and constructive. The epocha of destructive and constructive processes of early Precambrian is completed to the end of lower proterozoic and led to the formation of consolidated continental crust. Upper proterozoic is characterised exclusively by destructive processes with formation of consolidated oceanic crust. The leading process is the destruction of consolidated crust due to what the slyst of rifted belts and avlacogens, dividing the vast blocks of ancient platforms are formed. For phanerozoic it is characteristic the existance of the constructive processes which include the formation of geosyncline of three types occuring in a definite sequence and on various substrates; on secondary oceanic crust on front part of geosynclines of previous cycle; on quasyplatform formation. Neogen-quarter time (35 milh. years) is an initial stage of new destructive epoch, in which qualitatively new structural forms are starting to occur - that is ceiling lifting of large radius of curve, which are subjected

to splitting and destroying with the formation of specific structures and occurrence of alkali magmatism.

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ДЕСТРУКТИВНЫЕ И КОНСТРУКТИВНЫЕ ПРОЦЕССЫ ФОРМИРОВАНИЯ ТЕКТОНОСФЕРЫ СРЕДНЕЙ АЗИИ

Многообразие наблюдаемого структурно-формационного строения Средней Азии обусловлено всей историей ее геологического развития, которая включает два главных вида процессов - деструктивных и конструктивных. Эпохи конструктивных и деструктивных процессов раннего докембрия завершились к концу нижнего протерозоя и привели к формированию консолидированной континентальной коры. Верхний протерозой характеризуется исключительно деструктивными процессами с формированием вторичной океанической коры. Ведущим процессом явилось разрушение консолидированной коры археид и ранних протерозоид, благодаря чему формируются системы рифтовых поясов и авлакогенов, разделяющих обширные блоки древних платформ.

Для фанерозоя характерны конструктивные процессы, которые включают формирование геосинклиналей трех типов, происходящее в определенной последовательности и на различных субстратах: на вторичной океанической коре; на передовых прогибах геосинклиналей предыдущего цикла; на квазиплатформенных образованиях. Миграция рядов геосинклинальных систем происходит направленно и центробежно от древних платформ к центру геосинклинально-складчатого пояса.

Неоген-четвертичное время (35 млн.лет) является начальной стадией новой деструктивной эпохи, в которой начинают возникать качественно новые структурные формы - сводовые поднятия большого радиуса кривизны, которые подвергаются раскалыванию и обрушению с формированием специфических структур и проявлением щелочного магматизма.

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THE STRESS-STRAIN STATE OF ROCK IN MOBILE FOLD AREA

The full "stress-strain" diagram of rock under "stiff" loading has 3 branches: rising (prefailure) one, falling (postfailure) one and flat one.

The rock deformation in the upper parts of the crust is due to the tectonic forces present in mobile fold areas. It suggests the post-failure deformation and the failure of rocks on the regional scale. At this stage the fold discontinuous structure is formed and the definite stress state actually becomes steady. The weakened areas and rock mass elements affected by general horizontal tectonic forces experience more intensive quasi-plastic deformation and failure. In consequence the residual stresses have lower values in these areas than in hard rocks which under otherwise equal conditions undergo less intensive failure while possessing relatively high stress values. Rocks in the upper parts of the crust with the same strength in various fold mobile areas all over the world are supposed to have the same stresses at the same depth. It suggests that their measured values correlate with the post-failure flat branch of the full diagram which demonstrates the rock mass deformation.

The stress state of rocks in the modern mobile fold areas is the sum of 3 stress fields: gravitational, modern tectonic and residual one. The horizontal stresses in the above mentioned areas greatly exceed the vertical ones. The in-situ measurements gave us the following relations between the horizontal stress values and depth in mobile fold areas:

$\sigma_x + \sigma_y = 9.5$ (MPa) + 0.075 $(\frac{MPa}{m})$ · H(m). MPa for hard rocks and $\sigma_x + \sigma_y = 5.0$ (MPa) + 0.058 $(\frac{MPa}{m})$ · H(m). MPa for rocks with mean strength.

Here, σ_x and σ_y - principal normal horizontal stresses;

H - depth

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НАПРЯЖЕННО-ДЕФОРМИРОВАННОЕ СОСТОЯНИЕ СКАЛЬНЫХ ПОРОД В МОБИЛЬНЫХ ГОРНО-СКЛАДЧАТЫХ ОБЛАСТЯХ

Полная диаграмма "напряжение-деформация" для горной породы при испытании ее в условиях "жесткого" нагружения имеет три ветви: восходящую (до предела прочности), ниспадающую (за пределом прочности) и горизонтальный участок.

Деформирование породных массивов верхних частей земной коры под действием тектонических сил в мобильных горно-складчатых областях следует рассматривать как процесс запредельного деформирования и разрушения горных пород в региональном масштабе. Именно этот процесс и является главным завершающим этапом формирования складчато-разрыв-

ной структуры скальных массивов и практической стабилизации в них определенного уровня напряжений. При этом под общим воздействием горизонтальных тектонических сил слабые участки и элементы массива испытывают более интенсивные квазипластические деформации и разрушения, вследствие чего сохраняющиеся (остаточные) в них напряжения имеют более низкий уровень, чем в крепких породах, которые при прочих равных условиях подвергаются менее значительному разрушению с сохранением относительно высоких напряжений. Тот факт, что в приповерхностных частях коры породы с приблизительно одинаковой прочностью на равных глубинах в различных горно-складчатых мобильных регионах земного шара имеют практически равные напряжения, свидетельствует о том, что измеряемые их значения соответствуют запредельной горизонтальной ветви полной диаграммы деформирования массива.
Напряженное состояние скальных пород в современных мобильных горно-складчатых областях представляет собой сумму трех полей напряжений: гравитационного, современного тектонического и остаточного.
По своим значениям горизонтальные напряжения в этих областях значительно превышают вертикальные. На базе прямых измерительных работ в массивах пород нами получены следующие зависимости изменения горизонтальных напряжений с глубиной в мобильных горно-складчатых регионах:

$\sigma_x + \sigma_y$ = 9,5(МПа)+0,075 $\frac{\text{МПа}}{\text{м}}$;H(м),МПа для крепких пород ;

$\sigma_x + \sigma_y$ = 5,0(МПа)+0,58(МПа);H(м),МПа для пород средней плотности.

Здесь σ_x и σ_y - главные нормальные горизонтальные напряжения;
H - глубина.

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TYPES OF DEFORMATION OF ROCKS UNDER NONUNIFORMAL COMPRESSION TENSIONS

It's proved experimentally, that crystal rocks under the condition of differencial tensions are deformed stage by stage: initial plastic deformation of rock-forming minerals (translation, twinning, recrystallization), tensions close to maximal-avalanche-like for-

mation of microcracks (spalling, more seldom - break off)with further development of magistral disturbance over spalling . Regulations of alteration of physical properties depending on deformation type have been discovered. Density accompanied by decrease of porosity and volume occurs in practically deformed rocks. Not significant decrease of longitudial waves speed (Vp) and a litte more significant decrease of transverse waves speed (Vs) had been noticed. In friabilly deformed rocks due to sharp increase of jointing secondary redenceninning with sectain growth of porosity and volume is noticed. In these rocks longitudial waves speed decrease considerably while the decrease of transverse waves speed slows down not so noticably. Distruction of rocks is accompanied by magistral disturbance of spalling type. At the initial stage magistral disturbances are caused by exterior limit tensions, further on - due to the energy of elastisity accumulated in the crystals. The latter is proved by selfdevelopment of disturbances under no tension. In distructed rocks porosity increases 2-3-times. In nondeformed granitoids ratio of longitudial and transverse waves (Vp/Vs) lays within the limit 1,58-1,60, in gabbroids - 1,68-1,70. In rocks which have undergone plastic deformation this ratio grows up, in friabilly destroyed rocks - goes down.These data were used to define types of deformation based on friability parameters and for reconstruction of geodynamic tensions existing during intrusives's formation.

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ТИПЫ ДЕФОРМАЦИИ ГОРНЫХ ПОРОД ПРИ НЕОДНОРОДНЫХ НАПРЯЖЕНИЯХ СЖАТИЯ

Экспериментально установлено, что кристаллические горные породы в условиях дифференциальных напряжений деформируются поэтапно: с начальной пластической деформацией породообразующих минералов (трансляция, двойникование, перекристаллизация) при напряжениях, близких к предельным лавинным образованиям микротрещин (скалывания, реже отрыва), и последующим развитием магистральных нарушений по сколу.

Выявлены закономерности изменения физических свойств пород в зависимости от типа деформации.

В пластически деформированных породах происходит уплотнение с уменьшением пористости и объема. Отмечается также незначительное понижение скорости продольных (V_p) и несколько больше понижается скорость поперечных (V_s) волн.

В породах, деформированных хрупко, в связи с резким возрастанием микротрещиноватости отмечается вторичное разуплотнение с некоторым увеличением пористости и объема. В этих породах резко уменьшаются скорость продольных и, несколько меньше, скорость поперечных волн.

Разрушение пород происходит с образованием магистральных нарушений скалывающего типа. Образование магистральных нарушений вначале происходит под воздействием внешних предельных напряжений, затем за счет накопленной упругой энергии в кристаллах. Последнее подтверждается саморазвитием нарушений уже без напряжений. В разрушенных породах пористость возрастает в 2-3 раза.

В недеформированных гранитоидах отношение продольной и поперечной (V_p / V_s) волн укладывается в пределы I,58-I,60, в габброидах - I,68-I,70. В породах, прошедших пластическую деформацию, это отношение растет, а в породах, испытавших хрупкое разрушение,- падает.

Эти данные нашли применение при выявлении типов деформаций по упругим показателям и реконструкции геодинамических напряжений, существовавших при формировании интрузивов.

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COMPLEJOS CAOTICOS DE CUBA

Gran Parte de los complejos caóticos o mixtitas (*mélanges y olistostromas* del arco insular cubano están en la estrecha zona de sutura del geosinclinal Cubano, significativamente marcada por afloramiento del complejo ofiolítico a todo lo largo de la isla. Existe una estrecha e interesante relación espacial: Complejos caóticos - Complejo ofiolítico.

Se destada por su importancia el mélange ofiolítico pre-Campaniano y los olistostromas tectono-gravitacionales asociados al avance de los mantos tectónicos. Subordinamente aparecen olistostromas en las secuencias carbonatadas del miogeosinclinal. En algunas regiones aflora mélange de matriz calcárea o yesífera de las secuencias septentrionales que se emplazaron en superficie no antes del Paleoceno.

Estudiando esas mixtitas se establecen los períodos más intensos de-
formación y avance de mantos tectónicos. En el Maestrichtiano, los
olistostromas se desarrollan ampliamente en el frente de arco de Cu-
ba Occidental, predominando las inclusiones de vulcanitas y del com-
plejo ofiolítico. Esto mismo ocurrió en Cuba Oriental en el intervalo Maestrichtiano-Paleoceno. Durante el Paleoceno-Eoceno Inferior basal se formaron potentes depósitos y bloques de kilómetros de longitud en zonas más septentrionales de Cuba Central, produciéndose la desaparición de la antigua zona estructuro facial de Placetas.
En el Eoceno Inferior-Medio, a expensas de la zona estructuro facial de Camajuaní se desarrollaron potentes depósitos más al norte, mientras que en el Eoceno Medio se registraron fenómenos más locales en la zona estructuro facial Remedios.
En la estructura actual de Cuba Occidental-Central es muy interesante la superposición de los olistostromas del Maestrichtiano sobre los Paleocénicos.
Finalmente se destaca la taslación en tiempo de la activiada tectónica de Sur a Norte, desde el arco de islas extinto hacia la Plataforma de Bahamas. Este transporte tectónico ocurrió en varios momentos principales: Maestrichtiano hasta Paleoceno, Paleoceno-Eoceno inferior basal y Eoceno Inferior-Medio.

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EL ENCLAVE YESIFERO DE SAN ADRIAN, CUBA: OBSERVACIONES SOBRE SU EVOLUCION GEOLOGO-TECTONICA

Se presenta la opinión sobre el desarrollo de una serie compuesta de brecha yesífera y yeso llamada Formación San Adrián.
Como resultado de anteriores movimientos orogénicos, el conjunto original de sedimentos jurásicos miogeosinclinales compuestos en gran medida de yesos intercalados con capas de depósitos clásticos carbonatados, sufrió una presión plástica con carácter diapírico en las partes superiores y más jóvenes de la secuencia sedimentaria. Esta presión tuvo lugar por las superficies principales de las fallas profundas. Debido a un desplazamiento, la serie yesífera original sufrió una intensa desintegración que conduce al surgimiento de una brecha yesífera. La culminación del proceso orogénico lleva al sobrecorrimiento de las unidades eugeosinclinales (nappes) sobre la secuencia miogeosinclinal.
A consecuencia de fuertes presiones laterales relacionadas con la

dirección principal de las desplazamientos, así como con la presión de las unidades eugeosinclinales sobreyacentes, la serie yesífera penetra por las superficies de distensión y las fallas mayores en las partes superiores del macizo que se está formando. Junto con la serie yesífera se desplazan hacia arriba otros fragmentos pequenos carbonatados, determinados faunalmente, de la secuencia miogeosinclinal, que ahora constituye pequeñas escamas dentro de la actual posición de la secuencia eugeosinclinal en esa area.
Durante toda la etapa orogénica, en la serie yesífera se forman superficies de separación que recuerdan la estratificación. Estas superficies surgieron en condiciones de intensas presiones direccionales relacionadas con el desplazamiento de los nappes o mantos, superficies de esquistocidad y clivajes de crenulación.

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HORIZONTAL STRESSES AND TECTOGENES OF THE URALS

Study of the character of tectonic forces acting during the different stages of the the delopment of the Urals is the most important task in the investigation of the mechanism of tectogenesis of this region. Complex of geologic, geophysical and geodetic data has been used to solve the task in conjunction with the data of space survey and rock pressure measurements , reflecting the main features of construction, disturbances and compositions of the earth crust and upper mantle, dependance of the tectonic blocks shift from intrusive massifs and their shape, relations of latest and present day tectonic movements with the character and intensity of isostatic anomalies of gravity forces, regularities of distribution and orientation of faults, stresses of rocks and particularities of seismisity. Analysis of the above data and the results of the study of distribution of stresses in the models of typical structural elements of the Ural earth crust show that neotectonic and recent tectonic movements in the Urals are anti-isostatic and are caused by horizontal tectonic forces. The maximal compression meridianal sresses and higher seismisity are noted in the area adjacent , from the east, the Ufa protrusion of the Russian platform. Tectonic depressions, such as Chelyabinsk, Bulanash- Elkinskaya and the thrusts of Palaeozoic rocks of the East Urals over the Mezoic deposits may serve one of the indicators, characterizing dynamics of the Urals in Mesozoic and Cenozoic. Horizontal compression of the earth crust may explain

the main structural features of the Tagil submergence, formed in Palaeozic, particularities of structures of the Urals western slope and pre-Urals foredeep, thickenning of the earth crust, elastic anisothropy and other features of structure and crust of the Urals.

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ГОРИЗОНТАЛЬНЫЕ НАПРЯЖЕНИЯ И ТЕКТОГЕНЕЗ УРАЛА

Важнейшей задачей в познании механизма тектогенеза Урала является выяснение характера тектонических сил, действовавших на различных этапах его развития. Для ее решения использована совокупность геолого-геофизических и геодезических данных, материалов космических съемок и измерений горного давления, отражающая основные черты строения, нарушенности и состава земной коры и верхней мантии, зависимость между направлением перемещений тектонических блоков и интрузивных массивов и их формой, связь новейших и современных движений с характером и интенсивностью изостатических аномалий силы тяжести, закономерности распределения и ориентировки разломов, напряженное состояние горных пород и особенности сейсмичности.

Анализ перечисленных данных и результаты изучения распределения напряжений в моделях, имитирующих типичные структурные элементы земной коры Урала, показывают, что новейшие и современные движения на Урале являются антиизостатическими и обусловлены горизонтальными тектоническими силами. При этом наибольшие сжимающие широтные напряжения и повышенная сейсмичность отмечены в районе, примыкающем с востока к Уфимскому выступу Русской платформы.

Одним из индикаторов, характеризующих динамические условия развития Урала в мезозое и кайнозое, могут служить тектонические депрессии, например Челябинская, Буланаш-Елкинская, а также имеющие тот же возраст надвиги палеозойских пород восточного склона Урала на мезозойские отложения. Горизонтальным сжатием земной коры можно объяснить основные черты строения Тагильского погружения, формировавшегося в палеозое; особенности структур западного склона Урала и строение Предуральского прогиба; утолщение земной коры; упругую анизотропию и другие особенности строения и развития Урала.

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GEODYNAMICAL MODELS OF SEISMOFOCAL ZONES

Modern hypotheses of the nature of seismofocal zones, their morphology and energy sources are based on the ideas of the existence on continent-ocean boundary of temperature-density heterogeneities, causing isostatic mass dislocations along the surface, inclined to the continent. The conception of oceanic plates subsidence (subduction) in the form of continuous bodies, characterized by isolated stress field, defining regular dislocation of earthquake focus, bears direct evidence of the mechanism of such movements and morphology of seismogenerating volumes. Comparative analysis of the suggested models of seismofocal zones has been done by us in three directions:

1. Physical modelling of dislocations connected with overthrust-underthrust dislocations including oceanic plates subsidence.

2. Recovery of continuous stress field in the sections of the seismofocal zone by actual measurements of the direction of the main stresses in the focuses of earthquakes of Kuril-Kamchatka area.

3. Building of trends of distribution of hypocentres of earthquakes in energy classes.

As the result of all this the structure of the seismofocal zone, fault-underthrust in the section and shift in the plan, has been established. Though within its ranges isolated volumes, corresponding to the subsiding plate, do not settle out distinctly, experimental data show the possibility of the formation of both discontinuous and continuous stress field, general for both segments, during the interaction of continental and oceanic segments. In this connection one may consider that modern level of the study of seismofocal and transition zones is not enough, for choosing any working hypothesis as the leading one. The idea of the participation of upthrust-underthrust dislocations, combining with horizontal shift of Kamchatka oceanic segment to the north, is the less contradictory to the complex of data, elucidating the distribution of stress fields and zones of unstability in the seismofocal zone and its mosaic-block structure.

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ГЕОДИНАМИЧЕСКИЕ МОДЕЛИ СЕЙСМОФОКАЛЬНЫХ ЗОН

Современные гипотезы о природе сейсмофокальных зон, их морфологии и энергетических источниках опираются на представление о существовании на границе континента с океаном температурно-плотностных неоднородностей, вызывающих изостатические перемещения масс по поверхности, наклоненной под континент.
Наиболее прямые указания на механизм таких движений и морфологию сейсмогенерирующих объемов содержатся в концепции погружения (субдукции) океанических плит в виде сплошных тел, характеризующихся обособленным полем напряжения, определяющим закономерное размещение очагов землетрясений.
Сравнительный анализ предлагаемых моделей сейсмофокальных зон нами проведен в трех направлениях.

I. Физическое моделирование дислокаций, связанных с надвиго-поддвиговыми перемещениями, в том числе и с погружением океанических плит.

2. Восстановление непрерывного поля напряжений в сечениях сейсмофокальной зоны по фактическим измерениям направления главных напряжений в очагах землетрясений Курило-Камчатского региона.

3. Построение трендов распределения гипоцентров землетрясений по энергетическим классам.

В результате выявлена сбросово-поддвиговая в разрезе и сдвиговая в плане дислокационная структура сейсмофокальной зоны. Хотя в ее пределах обособленные объемы, отвечающие погружающейся плите, отчетливо не выделяются, экспериментальные данные указывают на возможность образования при взаимодействии континентального и океанического сегментов как дискретных, так и непрерывных общих для обоих сегментов полей напряжений. В связи с этим можно считать, что современный уровень изученности сейсмофокальных и переходных зон еще недостаточен для выбора любой из рабочих гипотез в качестве ведущей. Наименее противоречивым комплексу данных, освещающих распределение полей напряжений и зон нестабильности в сейсмофокальной зоне, ее мозаично-блоковую структуру, является представление об участии в ее образовании взбросо-поддвиговых перемещений, сочетающихся с горизонтальным сдвигом Камчатского океанического сегмента к северу.

100

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TECTONIC REGIONALIZATION AND EVOLUTION OF THE BRAZILIAN AMAZON REGION

With an area larger than 4 million sq.km. the Brazilian Amazon region is entirely enclosed within the Baykalian Amazonian Platform. Its basement is subdivided into three NW trending provinces transected by the EW trending Amazonas Syneclise of Phanerozoic age. The eastern province (Amazonia Oriental) is composed mainly of Archaean high grade metamorphic terrains, strongly reworked during the Transamazonian Event (2000 - 1800 m.y.). Granite-greenstone terrains, preserved from the effects of that event, occur in the southernmost part of the province. At the beggining of the Riphean (1700-1500 m.y.) the central portion of the region was affected by the Paraense Event which begins with granitization of the basement followed by acidic to intermediate volcanism and imature sedimentation, and ending with basic plutonism. This event is known to occur within 2 million sq.km of the region and was used to define the central province (Amazonia Central). The characteristics of this event are very similar to those of the activation processes that occurred in Eastern Asia. The northeastern portion of the western province (Amazonia Ocidental), in the beggining of Middle Riphean (1400-1300 m.y.), was affected by the Madeirense Event, with characteristics similar to the Transamazonian, but with granitic plutonism in inner portions of the central province. At the beggining of the Upper Riphean, the southwestern portion of the western province was affected by the Rondoniense Event (1050-950 m.y.). During this event aulacogenic structures were formed, separated by horsts in which granitic plutonism occured. Exception made for minor basic intrusives, the next tectonic event were the first stages of the Amazonas Syneclise in Lower Palaeozoic. The main stages in the development of this syneclise are strongly sinchronous with events in the Andean geosynclines.

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NOUVEAUX DONNÉS GEOLOGIQUES SUR UNE REGIONS D'ANGOLA AU SUD DE LUCAPA, PROVINCE DU LUNDA NORTE

Dans cette travail est etudiée une région dans le Ne d'Angola dans la limite sud de l'importante zone de fractures de la Lunda connue par le nom de Graben du Lucapa.
Avec des investigations sur le terrain nous voulons faire correspondre les structures definies par l'interpretation des images satélite et photos aériennes à des roches basiques et ultrabasiques du type quimberlite.

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GEOLOGY OF THE ERIMO SEAMOUNT

1. Judging from the rock types and the mineral composition, so-called "continental rocks", such as granitic rocks and arkose sandstone, as well as basaltic rocks, are considered to be a group of the members which constitute the Erimo Seamount.
2. The so-called "continental rocks" may be likely to exist in places under seamounts, plateaus, uplands and islands, such as the Erimo Seamount, the Obruchev Upland, the Takuyo-Daiichi Seamount, the Daiichi-Kashima Seamount, the Amami Plateau, the Daito Ridge, the Kyushu-Palau Ridge, Mikura-jima Island, Saipan Island, and so on.
3. Several berineid molluscs obtained from St. A-4 can be identified as Nerinea (Presioptygmatis) ryofuae Tsuchi (MS name), which was previously reported from the Erimo Seamount. This fact may suggest that the species had predominantly been thriving at that time on the abrasion platform near the top of the Seamount. The geologic range of plesioptymatis is not inconsistent with the K-Ar ages of the bed rock of the seamount at 80 Ma assignable to the Campanian age.

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ALKALI ROCKS AS INDICATORS OF CONTINENTAL RIRTING
(ON THE EXAMPLE OF THE ALKALINE ROCKS FROM THE USSR)

The analysis of time-spacing relations of alkaline rocks with the tectonic structures show that their rock formation was predetermined by the origin and evolution of the global systems from horsts and grabens at some periods of the geological history. Such systems are similar to the recent continental rifts owine to the geodynamic features and magmatism character and they are possible paleoanaloqies of resent rifts to the opinion of E.E. Milanovsky and others. Alkaline rock formations are connected with the origin and evolution of such systems in the Kol'sky, Maimetcha-Kotuy, Aldan, Sette-Daban and others.

Alkali rocks are localized in definite fractures of such systems. These fractures bound and intersect grabens; horsts within grabens; arch-horsts between grabens; horsts between parallel grabens. Also this fractures continue grabens after their edging and restrict cupola-chaped rises which complicate the construction of such systems. In the case when system grows on the one end and dies off on other, alkali rock massifs appeared subsequently along the strile of the system. The process depends on the size of the rift-system: the bigger the systems - the bigger alkaline magmatism.

Thus appearing alkaline provinces are represented by the alkali rocks of only one formation.But in the case when young or modern rift-systems inherit older,the province contain alkali rock massives of different age and formations,and such province massives are distinguished through the depth of their formation and erosive cut (Aldan,Kol'sky,Sayan province).

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ЩЕЛОЧНЫЕ ПОРОДЫ КАК ИНДИКАТОРЫ КОНТИНЕНТАЛЬНОГО РИФТОГЕНЕЗА (НА ПРИМЕРЕ ЩЕЛОЧНЫХ ПОРОД СССР)

Анализ пространственно-временных связей щелочных пород СССР с тектоническими структурами показывает, что их образование предопределялось заложением и развитием в определенные периоды геологической истории глобальных систем горстов и грабенов, которые, как считают многие исследователи (Е.Е.Милановский и другие), по геодинамическим особенностям и характеру магматизма сходны с современными континентальными рифтами и, по-видимому, являются их палеоаналогами. С заложением и развитием таких систем связано формирование массивов щелочных пород Кольского, Маймеча-Котуйского, Алданского, Сетте-Дабанского и других районов их развития.

Щелочные породы локализуются в разломах, ограничивающих и рассекающих грабены этих систем, горсты внутри грабенов, горсты-перемычки между ними и горсты, разделяющие параллельные грабены, а также в разломах, продолжающих грабены после их выклинивания, и в куполообразных поднятиях, осложняющих строение систем. Если система развивалась постепенно, наращиваясь на одном конце и отмирая на другом, приуроченные к ней массивы щелочных пород формировались последовательно вдоль ее простирания.

Масштаб проявления щелочного магматизма определяется масштабом систем: в крупных системах он значительнее.

Возникавшие таким образом щелочные провинции представлены щелочными породами какой-либо одной формации. Но в случаях унаследователь-ти подобных систем более молодыми, а также современными рифтами в связанных с ними щелочных провинциях (Алданская, Кольская, Саянская) наблюдаются полиформационные разновозрастные щелочные породы, причем массивы пород неодинаковых формационных принадлежности и возраста различаются глубинностью формирования и эрозионным срезом.

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PROBLEMS OF MESOTETHYS PALEOTECTONICS

Mesotethys, a vast marine basin that existed in place of the modern Mediterranean and Southern Asia, is considered by many researchers

as a newly formed oceanic structure which is similar to modern oceans. However, the problem of Mesotethys tectonics cannot be regarded as solved irrevocably, since there exist a number of geological data that are not consistent with the hypothesis of its being a uniform oceanic structure analogues to modern oceans. These data include specific composition, content, spatial distribution and relationship within Mesotethys of ophiolitic series and other deep-water and shallow volcano-sedimentary and sedimentary Mesozoic complexes. Paleotectonically these data suggest that though Mesotethys was a wide and extended marine basin, structurally it was not a single big oceanic depression, but a system of deep, restricted in size troughs with the oceanic-type crust, separated by segments of the continental crust covered with shallow seas. Such combination of shallow and deep-sea environments within one and the same marine basin of the Mediterranean type has no analogues in modern times, thus challenging the validity of paleotectonic reconstructions of Mesotethys based on the uniformitarian concept of its similarity with modern oceans. Complex combinations of structures, formed on the continental-crust destruction which was dispersed and, thus, registered in many areas of Mesotethys. Of importance is also dating and correlation of tectonic events that brought about Mesotethys, as well as their development in time and space, in particular, a phenomenon of the migration of zones of peak destruction eastwards in the Jurassic and the Cretaceous.

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ПРОБЛЕМЫ ПАЛЕОТЕКТОНИКИ МЕЗОТЕТИСА

Мезотетис - обширный морской бассейн, существовавший в мезозое в пределах Средиземноморья и Южной Азии, рассматривается многими исследователями как новообразованная океаническая впадина, подобная современным океанам. Вместе с тем проблема тектонической природы Мезотетиса не может считаться однозначно решенной, т.к. целый ряд геологических данных не согласуется с представлениями о нем, как о единой океанической структуре, сходной с ныне существующими океанами. Такими данными являются особенности состава, строения, пространственного развития и взаимоотношения в его пределах офиолитовых серий и других глубоководных и мелководных вулканогенно-осадочных и осадочных комплексов мезозойского возраста. Анализ этих данных в палеотектоническом аспекте приводит к заключению о том, что Мезотетис хотя и был широким и протяженным морским бассейном, однако в структурном отношении представлял собой не единую обширную океаническую впадину, а систему ограниченных по размерам глубоководных прогибов с корой океанического типа, которые были раз-

делены занятыми мелким морем участками развития континентальной земной коры. Подобное сочетание морских и океанических обстановок в пределах одного и того же бассейна средиземноморского типа не находит аналогий в современных условиях и ставит вопрос о правомерности палеотектонических реконструкций Мезотетиса, основывающихся на представлениях о его актуалистическом сходстве с современными океанами. Возникновение сложного сочетания структур, сформировавшихся на коре континентального и океанического типов, может быть объяснено тем, что предопределивший его процесс деструкции континентальной земной коры был пространственно рассредоточенным и проявился во многих частях Мезотетиса. Весьма важной является также проблема хронологии и корреляции тектонических событий, обусловивших возникновение Мезотетиса. Большой интерес представляют закономерности их развития во времени и в пространстве, в частности явление миграции зон наибольшей активности деструкционного процесса в течение юры и мела в восточном направлении.

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DIFFERENT-AGED ULTRAMAFITE-GABBRO COMPLEXES, OLISTOSTROMES, OPHIOLITHOCLASTICS, THRUSTS AS ELEMENTS-INDICATORS OF LITHOSPHERE PLATE MOVEMENTS IN THE VERKHOYANO-KOLYMSK FOLDED SYSTEM

Discovery of new geological formations comparable to those in modern geodynamic environments made it possible to recognize a number of major stages of the Middle Paleozoic - Cenozoic tectonic evolution:
1. The Middle Paleozoic stage of destruction and origination of active Andian-type continental margins. The eastern part of the Siberian continental plate suffered destruction to form an oceanic-type basin and to shift major blocks towards north-east. The Early Devonian witnessed the separation of the Omolon massif, while in the Middle Devonian the Okhotsk massif separated. The block movements resulted in the formation in their north-eastern parts of active Andian-type margins with south-westerly inclined Benioff paleozones and continental Atlantic-type margins in their south-west areas.
2. The Visean stage of active island arc-type margines, which occured behind the Devonian Atlantic-type margins (like modern Antil arcs) of the Omolon and Okhotsk massifs. As a result, accretion complexes of the Alazeya uplift, part of the Uyandina-block with ophiolites, ophiolitclastics, olistostromes and manifestations of glaucophane schist metamorphism were formed.
3. The Carboniferous-Early Permian stage of further destruction of the eastern part of the Siberian plate was characterized by movements of the Selennyakh-Moma microplate. The resultant depression

accumulated thick clayey in the Late Paleozoic and Early Mezozoic. 4. The Early Permian-Late Jurassic stage marked of active island arc-type systems with north-easterly inclined Benioff paleozones. At end the Late Jurassic time an extensive accretion complexes surrounding the Kolyma block (including the Polousnyy and Inyali-Debin sinclinoria) was formed, comparable to the Alaska one, containing ophiolites, ophiolitclastics, olistostromes, ultramafite- gabbro differentiated intrusions, scaly thrusts zones, etc. 5. The Cretaceous stage of the formation of intracontinental absorption zones (Sartang-Derbekin, Kharaulakh - Sette-Daban, etc), which were successively moving towards the Siberian platform (in modern plane), was characterized by a grand granitoid magmatism. 6. The Cenozoic stage of the formation of oroclines.

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РАЗНОВОЗРАСТНЫЕ УЛЬТРАМАФИТ-ГАББРОВЫЕ КОМПЛЕКСЫ, ОЛИСТОСТРОМЫ, ОФИОЛИТОКЛАСТИТЫ, НАДВИГИ КАК ЭЛЕМЕНТЫ-ИНДИКАТОРЫ ДВИЖЕНИЯ ЛИТОСФЕРНЫХ ПЛИТ В ВЕРХОЯНО-КОЛЬМСКОЙ СКЛАДЧАТОЙ СИСТЕМЕ

Открытие новых геологических образований, сопоставимых с таковыми в современных геодинамических обстановках, позволяет выделить в формировании складчатой системы ряд крупных этапов среднепалеозойско-кайнозойской тектонической эволюции. I.Среднепалеозойский этап деструкции и возникновения активных континентальных окраин андийского типа. Деструкции подвергалась восточная часть Сибирской континентальной плиты с образованием бассейна океанического типа и отодвиганием крупных блоков в северо-восточном направлении. В раннем девоне отделился Омолонский массив, в среднем девоне - Охотский массив. В результате движения блоков в их северо-восточных частях образовались активные окраины андийского типа с наклоном палеозон Беньофа на юго-запад, в юго-западных частях - континентальные окраины атлантического типа. 2. Визейский этап активных окраин островодужного типа, располагавшихся за девонскими окраинами атлантического типа (как современные Антильские дуги) Омолонского и Охотского массивов. В результате были сформированы аккреционные комплексы Алазейского поднятия, части Уяндинского блока с офиолитами, офиолитокластитами, олистостромами и проявлениями глаукофансланцевого метаморфизма. 3. Каменноугольно-раннепермский этап повторной деструкции восточной части Сибирской плиты характеризуется отодвиганием Селенях-Момской микроплиты. В позднем палеозое и раннем мезозое в возникшем прогибе накопились мощные глинистые толщи. 4. Раннепермско-позднеюрский этап отмечается образованием активных островодужных систем с наклоном палеозон Беньофа на северо-восток. В конце позд-

неюрской эпохи был сформирован обширный аккреционный комплекс обрамления Колымского блока , сопоставимый с Аляскинским, с офиолитами, офиолитокластитами, олистостромами, ультрамафит-габбровыми дифференцированными интрузиями, зонами чешуйчатых надвигов и др. 5. Меловой этап формирования внутриконтинентальных зон поглощения (Сартанг-Дербекинская,Хараулахско-Сетте-Дабанская и др.), последовательно смещавшихся в сторону Сибирской платформы (в современном плане), характеризуется грандиозным гранитоидным магматизмом. 6.Кайнозойский этап формирования ороклинальных изгибов.

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COMPARATIVE CHARACTERISTIC OF MESOTETHYS OPHIOLITE DEPRESSIONS

Mesozoic ophiolite depressions of Mediterranean and Front Asia are considered as zones of continental crust moderate extension,mantle diapirism,basaltic volcanism and sedimentation.Tectonic reconstractions are based on the typification of ophiolite sequences.The alternation of basic volcanites (island arc and NORB tholeiites,subalkalic and alkali basalts,keratophyres),radiolarites,micritic limestone mainly of Albian-Early Senonian age ("mixed" type) are indicated Front Asia ophiolite zones. Protrusions of ultrabasites (harzburgites e.c.) are placed on a various levels of siliceous-volcanogenous formation. Morphology of ophiolite depression is grabben-like with new formed oceanic crust in axial rift trough. "Isolated" type of sequences that is ultrabasites (mainly lherzolites),overlied by tholeiites of oceanic and partly pericontinental affinities,siliceous deposites and limestones of Middle(?)-Upper Jurassic age are usual in central Mediterranean. Tectonic reconstraction gives a pattern of large deep-water basins with new formed oceanic crust (midridge) and gently sloping carbonate shelf. "Mixed", "isolated" and intermediate types of sequences of Cenomanian-Campanian age are distinquished along Cyprus-Amanus-Zagros zone. The extension zones sectorial migration of Mediterrenean and Front Asia from Late Jurassic to Late Cretaceous is observed.

Deposits of "isolated" type are involved in postophiolite stage nappes, meanwile "mixed" type deposites are heavily tectonized include ultrabasites protrusions representing paraautochtonous melange.

Absence of contemporary homologues of ophiolite depressions of Mesotethys and some resemblance between them and Red Sea intercontinental rift is also discussed.

Preophiolite stage tectonic position differencies, less long time of continental core destruction and further recreation are remarkable for ophiolite troughs evolution.

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СРАВНИТЕЛЬНАЯ ХАРАКТЕРИСТИКА ОФИОЛИТОВЫХ ПРОГИБОВ МЕЗОТЕТИСА

Мезозойские офиолитовые прогибы Средиземноморья и Передней Азии - зоны ограниченного растяжения континентальной коры, мантийного диапиризма, базальтоидного вулканизма и седиментации. Тектонические их реконструкции основаны на анализе и типизации офиолитовых разрезов.

"Смешанный" тип офиолитовых разрезов - чередование основных вулканитов (иногда в верхах кератофиров) с радиоляритами, микритовыми известняками-характерно для Передней Азии. Возраст альб-раннесенонский. Габбро-гипербазиты (гарцбургиты и др.) - протрузии на разных уровнях кремнисто-вулканогенной формации. Вулканиты - толеиты островодужные и типа СОХ, субщелочные и щелочные базальтоиды, в кровле кератофиры; индекс эксплозивности варьирует значительно. Воссоздаются латеральные переходы к флишоидным и карбонатным отложениям краевых бассейнов. Морфология офиолитовых прогибов ультракотловинная с новообразованием в осевой части океанической коры. "Обособленный" тип разрезов - гипербазиты (лерцолиты), выше толеитовые базальты океанические, реже периконтинентальные, далее кремнистые и известняковые толщи - характерен для центрального Средиземноморья. Возраст средне(?)-позднеюрский-ранненеокомский. Реконструируются более крупные и глубоководные бассейны с новообразованием в осевой части океанической коры, возникновеним поднятий типа срединных, а также пологие карбонатные склоны.

И тот и другой тип разрезов и промежуточные между ними выделяются в полосе Кипр - хр.Аманус, Загрос. Вулканиты дифференцированы, развит шитед-комплекс. Возраст отложений сеноман-кампанский. Выявлена секториальная миграция от области Средиземноморья на восток зон растяжения коры и возникновения офиолитовых прогибов в интервале от поздней юры до верхнего мела. Породы "обособленных" разрезов слагают покровы постофиолитового этапа, породы "смешанных" разрезов интенсивно тектонизированы, включают протрузии ультрабазитов, нередко представлены меланжем и размещены параавтохтонно. Современные гомологи офиолитовых прогибов Мезотетиса не выявлены, наибольшее сходство обнаруживается с межконтинентальным рифтом Красного моря.

Отличие состоит в большем разнообразии тектонических обстановок, предшествовавших офиолитообразованию, в меньшей длительности этапа растяжения и деструкции коры и в воссоздании континентальной коры (флишевые и орогенные формации).

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ABOUT SOME ASPECTS -SO CALLED CLASSICAL- OF THE PERIPACIFIC TECTONOCS

Some classical aspects of the peripacific tectonics are discussed here.

The present pacific dissymetry with Cordilleras on the East side and Islands Arcs on the west side, could have been inverse during Mesozoic. The actuel marginal seas are not older than the Tertiary : and, for instance, during the Jurassic there was a franciscan marginal sea on the East whereas Japan was part of the asiatic continent.

If the Andes Cordillera -between Huancabamba and Bariloche transverse zones- seems to correspond to a continuous subduction during Mesozoic and Tertiary, in other parts subduction ended into collision with islands arcs at different times. These collision belong either to "Taiwan type" when the island arc is overthrusted onto the continent or to the "Californian type" when the island arc is underthrusted beneath the continental margin.

The tectonic belts older than the present subduction zone show generally a continental vergency as in the "Periaustralian Ophiolitic Crown" from New Guinea to northern New Zeeland through New Caledonia, in the Phillipina-Taiwan belt, in the Hokkaïdo--Sakhalin belt (in a certain way there is a "Periasiatic Ophiolitic Belt" with continental vergency). Even in western North America there are evidences of an eastern continental vergency for the ophiolitic thrusts during Nevadian orogeny. As a consequence, collision of Taïwan type seems the main tectonic process and marginal seas such as Tasman sea or south China sea are the main model for paleogeographic interpretations.

The big strike-slip motions conducting to "collages" as proposed in western North America have to be examined in the light of their transverse components. What is the part of "charriages" in these collages which are, anyway, examples of collision ?

In some parts as in Northern Chili or Northwestern Mexico, the mesozoic basins, as the present Coast, cut obliquely the paleozoic tectonic belts. Were these regions the margins of a new Pacific born in Triasic-Jurassic time as southermost Atlantic for the first or westernmost Tethys for the second ?

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LOOKING FOR CRITERIA OF OROGENIC DIVISIONS

In the light of plate tectonics, the sequence opening-closing of one ocean gives the best definition of one orogenic cycle. So is defined the alpine cycle by the opening and the closing of the Tethys.

The criteria of ocean opening for the beginning of an orogenic cycle is not clear everywhere. For instance, the opening of the Tethys is clear in southwestern Asia, southern Europe and Caribbean : it is the "Tethys of the reconquest", cut across the Pangea in a scissors shape. But in southeastern Asia where was the "Permanent Tethys", part of Panthalassa from which was inhereted the Pacific, there is no clear definition of the beginning of an alpine cycle.

The criteria of ocean closing is the ophiolitic suture. But there are as many ophiolitic sutures as there were oceanic areas to be closed. That has to be understood by reference with the present western Pacific, with its numerous marginal seas. Only the final collision of two main continents determine the end of one orogenic cycle ; each ophiolitic suture define only sub-cycle as a part of the complete cycle.

One orogenic cycle, with its sub-cycles, has only a regional value, related to the opening-closing of a precise ocean ; there is no clear evidence of worldwide orogenic cycle. For instance, alpine cycle is related to the opening-closing of the Tethys : in the Americas, the alpine cycle can only be defined in the Caribbean area inherited from the Tethys.

The assemblage of all the continents in a Pangea as at the end of the Proterozoic and the end of the Paleozoic determines super-cycles which are universal divisions. In this way, there is only one paleozoic super-cycle, including the caledonian and the variscan cycles ; and the alpine cycle could be part of a super-cycle, the second part of which being, in the future, the possible closing of the Atlantic...

As a conclusion, we can propose : assemblage of all the continents in a Pangea as criteria of orogenic super-cycles of global value ; opening-closing of one ocean as criteria of orogenic cycles of regional value ; ophiolitic sutures as criteria of orogenic sub-cycles of local value.

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A NEW TYPE OF ACTIVE MARGINS : THE CONVERGENT-EXTENSIONAL MARGINS, AS EXAMPLIFIED BY MIDDLE AMERICA TRENCH OFF GUATEMALA

Middle America Trench off Guatemala was drilled during Legs 67 and 84. During Leg 67 the basaltic basement of the oceanic Cocos plate and of the trench itself were drilled through down a relatively thin sedimentary cover of Pleistocene to lower Miocene age. The lower-mid and upper slope of the inner wall were drilled during Leg 84. At the penetration sites, basement was found to consist of ophiolitic rock covered by sediments of Early Eocene (upslope and midslope) to late Cretaceous (downslope). Petrologic studies of the mafic and ultramafic rocks suggest that they could represent the offshore prolongation of the pre-Campanian ophiolitic complexes cropping out in Central America.

As a consequence the DSDP/IPOD Guatemalan transect across the Middle America Trench has defined a non-accretionary convergent margin ; since late Cretaceous time, subduction has not resulted in the development of an accreted complex. So, landward seismic reflectors are either tectonic contacts in the basement or layers in the post late Cretaceous sediments.

On the other hand, seismic and Seabeam data give evidences of normal faulting : on the seaward wall and in the trench, reactivating a primary structural network inherited of the East Pacific rise rifting ; on the landward wall as collapse accompanying the downgoing of the oceanic Cocos plate into subduction.

Thus, we propose Guatemala margin as the model of a new type of Active margins : the "Convergent Extensional margins" without accretion. It is opposed to "Convergent Compresional margins" where accretionary process is working.

We suggest the active margins that exhibit a broad continental shelf (i.e. = Cordilleran margins) belong to the "Convergent-Extensional" type.

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SUBDUCTION METAMORPHITES IN THE OPHIOLITIC ZONES OF KAZAKHSTAN

Metamorphitic blocks and boudins of precambrian continental crust and also metamorphites developed over three layers of the old oceanic crust deposits including cherts of the first layer, basaltic pillow lavas and dike diabases of the second layer and stratiform plutonic ophiolites of the third layer occur in melanges of different-age (O-S,O_1,V-C,K) sutural zones in Kazakhstan. The most typical metamorphic products of radiolarites are plicated ferruginous quartzites with stilpnomelane; of acid tuffites - slates with lawso-

nite and glaucophane; of basic volcanites - albite-epidot-glaucophanic slates, rodingites, hydrogranulites, vinchitic amphibolites; of plutonic ophiolites - drusites, rodingites, hydrogranulites and hydroeclogites (with hornblende, pyroxene, garnet, zoisite, disthen, sapphirine, corundum, rutile, sphene, with or without plagioclase), listvenites. Metamorphism of the basites with hydrogranulite and hydroeclogite formed upon them occurs on great depths, which according to composition of coexistent minerals are rather uncertain - 30 to 100 km. Deepseated metamorphism of basites is accompanied by squeezing granitoids leucosomes and fluidal flows of H_2O,CO_2,H_2S out of them with alkali and silica soluted. A great number of petrographic evidence prove the reality of such flows. The regressive metamorphism reflected in products of subduction indicate the possibility of the reversive moving out of subductive plates. Reversion (obduction) under compressions is easied due to accumulations of critical serpentine masses at 70 km depth. The rapid rise of the secondary diapirs or plates moving out of the Wadati-Zavaritzky-Benioff zones is evidenced by the relicts of unstable minerals (like aragonite), or even by dacitic glass present in metamorphites. These data are consistent with materials from the Western Alps (Desmons,1977), the Northern California (Blake,Jako,1980) and the South-Western Pacific peryphery (Parrot,Dugas,1980).

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ПОДВИТОВЫЕ МЕТАМОРФИТЫ ОФИОЛИТОВЫХ ЗОН КАЗАХСТАНА

В меланжах сутур Казахстана с разновозрастными ($O-S$,O_1,$V-Є$,K) офиолитами присутствуют блоки и будины метаморфитов, развитых по породам докембрийских континентальных кор, а также по всем трем слоям докембрийских и палеозойских океанических кор - преимущественно кремнистым породам первого слоя, пиллоу-лавовым базальтам и дайковым диабазам второго слоя и расслоенным плутоническим базит-ультрамафитам третьего слоя. Наиболее типичными продуктами метаморфизма яшм являются плойчатые железистые кварциты со стильпномеланом; кислых туфитов - сланцы с лавсонитом и глаукофаном; основных вулканитов - альбит-пренит-пумпеллиитовые породы, альбит-эпидот-глаукофановые и зеленые сланцы, винчитовые амфиболиты, родингиты; плутонических офиолитов - друзиты, родингиты, гидрогранулиты и гидроэклогиты (с амфиболами, пироксенами, гранатами, цоизитом, дистеном, сапфирином, корундом, рутилом, сфеном, плагиоклазом или без него), листвениты. Метаморфизм базитов протекает на больших глубинах, оценки которых по составу сосуществующих минералов получаются очень не-

определенными - от 50 до 100 км, и сопровождается выжиманием из них гранитоидных лейкосом и флюидов (H_2O,CO_2,H_2S) с растворенными в них щелочами и кремнекислотой, что доказывается многочисленными петрографическими наблюдениями. Широкое проявление в метаморфитах субдукционного происхождения регрессивного метаморфизма указывает на реальность реверсивного выдвижения субдуцирующих плит. Реверсия с переходом в обдукцию протекает в условиях сжатия благодаря скоплениям на глубинах около 70 км критических масс серпентина. Большая скорость подъема вторичных диапиров или выдвижения плит из палеозон Вадати-Заварицкого-Беньофа определяется наличием в метаморфитах Казахстана реликтов неустойчивых минералов (например, арагонита) или даже стекол дацитового состава. Эти данные находятся в хорошем согласии с материалами по Западным Альпам (Десмон,1977), Северной Калифорнии (Блейк,Жако,1980) и юго-западной периферии Тихого океана (Перро и др.,1980).

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MAIN STAGES OF THE FORMATION OF THE CONTINENTAL MARGINS IN THE WESTERN PART OF THE MESO-TETHYS

The basins of two types existed in deep-water Meso-Tethys Basin: with the attenuated continental crust and with the oceanic crust. Their formation was associated with different stages of four tecto-no-sedimentary cycles, which were 30-40 m.y. long each - T, J_{1-2}, J_3-K_1, K_2.

The main part of the Meso-Tethys was covered with the basins of the first type. They were formed as a result of rapid subsidences of large blocks of the continental crust at the initial stages of each cycle. The Dinarian-Taurian Basin of the inland-sea type was formed in T_2. The Early and Late Jurassic subsidences took place on passive margins of the basin with the oceanic crust, which was formed in T_3. Late Cretaceous basins, which arose after the formation of the active continental margin of the Meso-Tethys in J_{2-3}, were of the type of the marginal seas on its northern slope, and they were incorporated into the passive continental margin on its southern slope. High rate of subsidence in the basins of the first type and the absence of features indicating considerable crustal stretching at the base of deep-water series can be explained by the rock compaction in the basaltic layer as a result of the basalt-eclogite phase transition under the upwelling of water-containing anomalous mantle to the crust.

Periodical uplifts of the Meso-Tethys associated with the break-up of the continental crust, with a formation of two spreading zones in T_3 and J_2 and with the main epochs of folding can be related to the late stages of tectono-sedimentary cycles. The above phenomena are reflecting periodical upwelling of large masses of anomalous mantle to the lithosphere in the Meso-Tethys which caused the cyclic character if its development.

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ОСНОВНЫЕ ЭТАПЫ ФОРМИРОВАНИЯ КОНТИНЕНТАЛЬНЫХ ОКРАИН ЗАПАДНОЙ ЧАСТИ МЕЗОТЕТИСА

В составе глубоководного бассейна Мезотетиса выделяются прогибы двух типов: с утоненной континентальной корой и с корой океанического типа. Их образование было связано с разными стадиями четырех тектоно-седиментационных этапов (циклов) продолжительностью 30-40 млн. лет каждый - T, J_{I-2}, J_3-K_I, K_2.

Прогибы первого типа занимали основную часть бассейна Мезотетиса. Они формировались в результате быстрых и значительных погружений крупных блоков континентальной коры в начальные стадии каждого цикла. В T_2 образовался Динаро-Таврский прогиб типа внутреннего моря. Области ранне- и позднекурских погружений располагались на пассивных окраинах новообразованного в T_3 прогиба с океанической корой. Позднемеловые прогибы, возникшие после образования в J_{2-3} активной континентальной окраины Мезотетиса, на его северном борту имели характер краевых морей, на южном - вошли в состав пассивной континентальной окраины. Высокая скорость погружений в прогибах первого типа при отсутствии признаков значительного растяжения коры в основании глубоководных серий объясняется уплотнением пород в базальтовом слое в результате фазового перехода базальт-эклогит при подходе к коре водосодержащей аномальной мантии.

С поздними стадиями тектоно-седиментационных этапов были связаны периодические общие воздымания области Мезотетиса, сопровождавшиеся в T_3 и J_2 расколом континентальной коры и возникновением двух зон спрединга, а также главные фазы складчатости. Описываемые явления фиксируют периодические подходы к подошве литосферы Мезотетиса крупных масс аномальной мантии, обусловившие цикличность его развития.

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JOINTING IN THREE EOCENE SYNCLINES IN ISRAEL

Slightly folded Eocene formations are confined to a series of basin-like synclines in Israel. Jointing in Lower Eocene rocks was investigated in three synclines, the Lower Galilee in the north, and the Shefela and northern Negev in the south. The axes of these synclines are oriented 040° (N 40° E), 028° and 050°, respectively. Strike measurements of joints in these folds have shown that whereas the two basins in the south have nearly identical regional joint pattern, manifested by six joint sets (308°- 310°, 327°, 344°-346°, 035°-038°, 057°-058° and 082°) the joint pattern in the northern basin is quite different. It is represented by six major sets (286°, 304°, 019°, 031°, 069° and 085°) and additional three minor sets (326°, 341° and 358°). These results imply that the investigated jointing was not in direct consequence to the stresses responsible for the development of the synclines. It leaves room for some structural speculations regarding horizontal stresses that occurred in phases, and the role of deep seated blocks in the jointing process.

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THE CHARACTERES OF THE OPHIOLITES IN THE HEGENSHAN AREA OF INNER MONGOLIA, CHINA

The ophiolites in the Hegenshan area of Inner Mongolia occur in the east of the Tianshan-Inner Mongolia-Daxinganling Variscan orogenic belt and consist of more than 30 ophiolite masses with different sizes. The total area of them is about 2000 km^2, but most of them are covered by the Mesozoic-Cenozoic sedimentary strata.

Based on this study, two different types of the ophiolites may be recognized in this area and they are represented by the Hegenshan and the Chaogenshan ophiolite blacks respectively.

The three rock units in the Hegenshan type were well developed. The low unit is composed of the harzburgite with a lot of dunite, troctolite and gabbro viens. In the mid cumulated complex zone, the cumulated dunite, troctolite and gabbro in layer are present. The upper volcanic unit is the low-metamorphic basalt.

The Chaogenshan type exists the three lithological units, but the low utramafite is predominantly lherzolite, the mid unit is composed of the layered gabbro only. The upper volcanic rock had undergone metamorphism.

According to the evidences of petrology, mineral chemistry and REE, the author suggests that the formation of the two types of the

ophiolites can be attributed to the different latent heat, partial melting and geological structural setting.

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EVOLUCION DEL MARGEN CONTINENTAL PACIFICO DURANTE EL PALEOZOICO INFERIOR EN LA ARGENTINA CENTRAL

Desde el Cámbrico al Devónico, los 400 kilómetros de borde continental pacífico correspondientes a la Precordillera Argentina estuvieron controlados por una masa cratónica cercana (Sistema Pampeano), con un borde occidental de alta estabilidad. La movilidad de este borde fue creciente hacia el oeste, hasta resolverse en una fosa elongada con generación de efusividad simaica a distancias de 15 a 40 kilómetros del frente rígido del bloque cratónico.

La presencia de Grandes Ciclos en el Cámbrico y Ordovícico se asimila a un comportamiento pulsante del fondo oceánico. Hasta el Ordovícico, el área de plataforma intramareal o de planicie calcárea se comportó rígidamente.

Hacia el Silúrico la zona presenta oscilaciones acompañadas de la generación de un mar interior o cuenca marginal, para bascular francamente hacia el oeste durante el Devónico. En este período se acumularon espesos conos submarinos al volcarse la sedimentación terrígena a la fosa marginal.

Finalmente durante el Carbónico se produce el colapso tectónico con la elevación del borde continental y la soldadura definitiva del área al núcleo pampeano.

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TECTONIC SETTING AND COMPOSITION OF LATE CENOZOIC VOLCANIC ROCKS OF THE RIO GRANDE RIFT REGION

The Rio Grande rift occupies a broad region of extensional deformation (>200 km wide). Within this region, alkalic, transitional, and tholeiitic basalts have been erupted approximately contemporaneously and in close spatial proximity for at least the last 8 m.y. Detailed stratigraphic studies in progress suggest that this volcanism is episodic and closely associated with faulting. All basalts are LREE-enriched. Nd and Sr isotopic data for alkalic to transitional basalts indicate that the mantle beneath this region has a depleted "oceanic" character. Tholeiitic basalts generally have lower ε_{Nd} and higher $^{87}Sr/^{86}Sr$, which we tentatively attribute to greater degrees of crustal interaction. We consider the primary control on magma composition to be the degree and possibly depth of partial melting of a relatively homogeneous source.

Eruption of magmas representing different degrees of partial melting in close proximity requires the existence of numerous small, isolated magma chambers. This requirement highlights a petrogenetic problem for which we have no satisfactory physical model at present. However, these data do not support an African-type model of rifting in which a progressive change from alkaline to tholeiitic magmas reflects a rising sub-lithospheric diapir.

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PALAEOALPINE GEODYNAMICS OF THE CARPATHIAN - PANNONIAN REGION

In the Palaeoalpine geodynamics of the Carpathian-Pannonian region two stages can be delineated: ocean opening in the Triassic and Jurassic and its closing from the Late Jurassic. During this process an island arc arose with a marginal sea which was opened behind it within the European lithospheric slab. The Early Cretaceous folding was conditioned by collision of continental parts of the subducting African lithospheric slab with the island arc, and the front of this folding was located approximately along the boundary between the island arc and the marginal sea.

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MAIN FEATURES OF THE DEVELOPMENT OF THE PROTEROZOIDES AND VARISCIDES IN CENTRAL EUROPE

Geophysical results from different countries about the composition of the Earth's crust in Europe indicate an acid to intermediate chemistry for its largest parts. In comparison with values from other regions it is to suppose that significant portions of the crust did originate processes on and in continental crust. Mafic segments with E-W alignement may be explained as rifting features.

The structural divisioning during lower Proterozoic time was probably N-S, that of the younger Proterozoic E-W. We suppose that at the end of the Proterozoic the crust down to the M-discontinuity was broken into large blocks. A tendency to uniform tilting can be explained as dilatation of the upper lithosphere. This intraplate tectonics was caused by a superordinate process outside of Central Europe (? of Cadomian age).

After rotation of the European plate in the lower Paleozoic the NE and NW directions became important for the area of the later Variscides. During Herynian times the region was probably deformed by an oblique compression (? collision). A subduction could be active if at all only in a more southern area.

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RESULTS OF ROCK FABRIC STUDIES BY THE AID OF NEUTRON DIFFRACTION METHODS

Textures of rocks from G D R were investigated by use of neutron diffraction to obtain results about the mineral and deformation specific fabrics (nuclear reactors of the USSR and GDR). Neutrons are suitable for texture analysis of crystalline solids with large sample dimensions owing their high kinetic energy. The penetration capability allows the construction of pole figures enough for a quantitative analysis, even for rocks with cubic mineral symmetry. Differences in the type of measured textures are to correlate with different deformational conditions (degree of temperature or pressure, rate of deformation). The quantitative results comprehend statements about orientation distribution function of separate lattice planes and about the history of rock deformation. Results of texture analyses from granulites, gneisses and saline rocks will be demonstrated.

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GEOCHEMISTRY OF THE TWO SUITES OF VOLCANIC ROCKS IN THE YARLUNG ZANGBO RIVER OPHIOLITE BELT, XIZANG (TIBET), CHINA

There are two suites of volcanic rocks series differing from one another in time and geochemistry in the Yarlung Zangbo ophiolite belt. One is of Cretaceous pillow lavas, the other is of Jurassic-Cretaceous metabasalts.

The pillow lavas exhibit the geochemical characteristics of MORB as follows: The REE pattern is a part of depleted type. The ratio of La/Sm is 0.4-0.5 and belongs to MORB (La/Sm_n = 0.4-0.7). The abundance of TiO_2, P_2O_5 is similar to that of MORB.

The REE pattern for the metabasalt is of a nearly smooth and enriched type. The abundance of LREE is obviously higher than that of the pillow lava. La/Sm_n = 0.79-1.63. The P_2O_5 abundance of pillow lava is very high. All of these reveal that its origin is not related to the oceanic spreading.

The lower ratios of CaO/TiO_2, Al_2O_3/TiO_2 and the higher abundance of Ti, P, Zr of the metabasalt indicate that they are the products of partial melting of lower degree (compared with pillow lava). The pillow lava can be distinguished from the metabasalt by lower abundance of Sr, P. Zr, Cr and Ni.

The significant differences in geochemistry between the two suites of volcanic rocks indicate that they may represent the products formed in different stages of the oceanic evolution. The metabasalts may represent the products of intermittent eruption of basaltic melt along the fractures before the Tethys spreading took place and the pillow lavas were formed at the stage of the Tethys spreading.

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GEODYNAMICS AND LATE CENOZOIC EVOLUTION OF THE ASIA/PACIFIC TRANSITIONAL ZONE

The present geodynamics of the Asia/pacific transitional zone is mainly related with interactions between the underthrusting Pacific plate, overriding small plates and island arc blocks. Plate decoupling and coupling are intermittent in space and time along the transitional zone and during its evolution, and accordingly extentional and compressional conditions gave way to one another. This is a reason for development of strongly different and contrasting geodynamic features within trench - arc - back-arc basin systems.

The Asia continent and the Pacific floor are constantly converged during the Cenosoic and a strip of the ocean floor of no less than 2000 km wide was consumed under the West Pacific trenches since the Oligocene. On the whole, despite of plate convergence, Asia was moving oblique to the Western Pacific subduction system and this, probably, has been and is now accounted for marginal sea opening.

Origination of the present-day Western Pacific island arcs and marginal basins in the Oligocene coincides with the reorganization in plate motion due to Eurasia/India collision and with the change of the Pacific plate motion from northwards to west-north-westwards.

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ГЕОДИНАМИКА И ПОЗДНЕКАЙНОЗОЙСКАЯ ЭВОЛЮЦИЯ ПЕРЕХОДНОЙ ЗОНЫ ОТ ТИХОГО ОКЕАНА К АЗИАТСКОМУ КОНТИНЕНТУ

Геодинамика переходной зоны от Тихого океана к Азиатскому континенту обусловлена главным образом взаимодействием пододвигающейся Тихоокеанской плиты с рядом нависающих малых плит и островодужными блоками. Условия слабого и сильного сцепления между плитами чередуются друг с другом во времени и в соответствии с этим обстановка растяжения в тылу дуг меняется на обстановку сжатия. Характер сцепления, по-видимому, является той причиной, которая обуславливает различие в строении таких структур переходной зоны, как желоба, островные дуги и окраинные моря.

На протяжении позднего кайнозоя Азиатский континент и дно Тихого океана постоянно сближались друг с другом и ширина поглощенного под систему желобов западной части Тихого океана участка океанического дна с олигоцена составляет не менее 2000 км. Несмотря на условия сближения, Азия в целом с этого времени отодвигалась от зон субдукции западной части Тихого океана, что, по-видимому, является причиной раскрытия окраинных морей.

Образование современной системы островных дуг и окраинных морей западной части Тихого океана начиная с олигоцена совпало с перестройкой движения плит, обусловленной столкновением Индии с Евразией и изменением направления перемещения Тихоокеанской плиты с северного на запад-северо-западное, что отчетливо видно по изгибу следа движения от Гавайской горячей точки.

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PRE-ALPINE STRUCTURE OF THE CAUCASUS

To the North of the Small Caucasus tectonic suture contained ophiolite suite, which bounds Gondvan baikalites, there are more three Epi-Baikal lithoslabs in the Pre-Alpine structure of the Caucasus. One of them is made of ophiolites and volcano-sedimentary deposits subjected to the folding and metamorphism in Pre-Silurian period. Pre-Silurian gneissose granite and also granitizational melanocratic rocks take part in the structure of the other lithoslab. These lithoslabs are in the complicated tectonic interrelation and they are the fragments of Pre-Hercynic Continental East-European plate. In some places along the overthrust they are overlapped by geosyncline complexes of Middle Paleozoic (Bechasinskai sone, Foreridge,

south part of the Main Ridge, Dzirulsky massif and oth.) and they take part in Hercynic folding themselves. The greater part of the Main Ridge of the Central Caucasus, supposedly the core of the Lateral Ridge of the East Caucasus consists of rocks of the third lithoslab, which is probably a moving part along right shifts of the Karabogazsky crystalline massif. It is composed of the complex of siallite granitizational rocks overridden partially Middle Paleozoic geosyncline complexes (Azgarinsky tectonic sheet and oth.). The geosuture of the geosyncline of the Great Caucasus has a complex configuration caused by the movement along the shifts. By the end of middle Paleozoic old lithoslabs together with Middle Paleozoic geosyncline sediments were consolidated in the process of Hercynic folding and they form a part of active continental margin of Paleothetis which belongs to the old continent of the North Eurasia.

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ДОАЛЬПИЙСКАЯ СТРУКТУРА КАВКАЗА

Севернее Малокавказского офиолитового шва, как известно, ограничивающего байкалиды Гондваны, в доальпийской структуре Кавказа различаются еще три эпибайкальские литопластины. Одна из них сложена офиолитами и вулканогенно-осадочными отложениями, испытавшими складчатость и метаморфизм в досилурийское время. В строении другой литопластины участвуют досилурийские гранито-гнейсы, а также гранитизированные меланократовые породы. Эти литопластины находятся в сложных тектонических взаимоотношениях и являются фрагментами догерцинской континентальной Восточно-Европейской плиты. В ряде мест они перекрыты шарьированными среднепалеозойскими геосинклинальными комплексами (Бечасынская зона, Передовой хребет, южная часть Главного хребта, Дзирульский массив и др.) и сами участвуют в герцинской складчатости. Третья литопластина слагает большую часть Главного хребта Центрального Кавказа, предположительно ядро Бокового хребта Восточного Кавказа и, возможно, является перемещенной по правым сдвигам частью Карабогазского кристаллического массива. Она сложена комплексом сиалических гранитизированных пород, частично надвинутых на среднепалеозойские геосинклинальные комплексы (Ацгаринский тектонический покров и др.). Рубцовая зона геосинклинали Большого Кавказа маркируется корневой шарьяжной зоной герцинских тектонических покровов и имеет сложную конфигурацию, обусловленную движениями по сдвигам. К концу среднего палеозоя древние литопластины совместно со среднепалеозойскими геосинклинальными отложениями были консолидированы в процессе герцинской складчатости и вошли в состав активной континентальной окраины Палеотетиса, принадлежавшей протоконтиненту Северной Евразии.

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FLUID CONTROL OF TECTONIC MOVEMENT ALONG THE FAULT ZONES

Tectonic movements of the blocks of lithosphere probably controlled by migration of fluids along the fault zones between the blocks. Three mechanisms of control are investigated: non-linear filtration, stress-corrosion and variation of cohesion.
The nature of control explains many observed regularities in the occurrence of the earthquakes and other tectonic phenomena.

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ФЛЮИДНЫЙ КОНТРОЛЬ ДВИЖЕНИЙ ПО ЗОНАМ РАЗЛОМОВ

Тектонические движения блоков литосферы вдоль разделяющих их зон разломов могут контролироваться миграцией флюидов с помощью трех механизмов: нелинейная фильтрация; коррозия под напряжением; изменение сцепления. Характер контроля объясняет ряд закономерностей в возникновении землетрясений и в других проявлениях тектонических движений.

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REACTIVATION OF ANCIENT RIFTS IN THE MID-CONTINENT OF NORTH AMERICA DUE TO MESOZOIC OCEANIC RIFTING

Major northwest- and northeast-trending rifts in the southern mid-continent of North America were reactivated as the North Atlantic and Gulf of Mexico basins developed during the Jurassic and Cretaceous. These rifts form the principal zones of structural weakness in the region and were initially formed during the late Precambrian and early Paleozoic. The main rifts are the northwest-trending ones that lie along the Texas-Mexican border and across southern Oaklahoma and the Reelfoot rift beneath the central section of the Mississippi river. Their reactivation resulted in coastal Mesozoic deposits being thicker and extending farther into the continent over the shoreward ends of these rifts. Thus were formed the Cretaceous basins of the Rio Grande, East Texas and Mississippi embayments. The basin development, reflecting rift reactivation, proceeded at different times and rates. Subsidence was occurring during the Jurassic in the Rio Grande, but apparently not until Late Cretaceous in the Mississippi embayment. Indirect evidence suggests other rifts farther north and northeast also were reactivated. Subsidence continued into the early Tertiary and the present pattern of earthquake activity indicates continued movement.

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DEEP CRUSTAL STRUCTURE OF THE NORTH SEA BASIN REGION

A long range seismic refraction Line across the Central Graben of the North Sea, completed in 1981, has been interpreted by modelling the travel-times and amplitudes of the observed seismograms using a program for laterally varying media. When converted to appropriate densities, the resulting seismic model was used to generate a gravity field which matches the observed anomalies. The model shows thinning of the crust beneath the Central Graben, compatible with a simple extensional model of basin formation. The Moho depth and the basement-to-Moho velocity structure vary continuously across the North Sea model, as, to a lesser extent, does the velocity-density conversion used in the gravity calculation. These variations reflect changes in the structure, character, and history of the deep crust along the profile.
The structure is compared with a reflection profile shot along the same line in 1983 to 15 seconds two-way-time. The Moho identified by seismic refraction falls clearly at the base of a lower crustal layered sequence seen on the vertical incidence profile.
The seismic model has been extended to surrounding crustal regions of Britain and Norway so that the deep crust of stretched regions may be compared with those areas which did not yield to extensional forces. It is possible to identify crustal features characterizing zones of weakness which form the nucleation points for stretching of the lithosphere.

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SEDIMENTATION ET MAGMATISME DU PERMO-CARBONIFERE ET DE SON SOCLE DANS LA ZONE HOUILLERE BRIANCONNAISE (SAVOIE, HAUT VAL D'AOSTE)

La Zone houillère briançonnaise des Alpes occidentales appartiendrait au système des graben continentaux de la marge SE de la plaque européenne.
Le substratum du Houiller, étudié dans le massif du Ruitor, paraît constitué par au moins deux séries d'âge différent: une série ancienne de micaschistes polymétamorphiques à ultrabasites et une série flyschoïde plus jeune. Ce substratum aurait été injecté par des roches

leucocrates (orthogneiss oeillés) et des roches basiques (amphibolites) qui pourraient être à l'origine du dernier métamorphisme antéalpin de ces séries d'âge encore indéterminé.
La couverture permo-carbonifère débute, au Ruitor, par des conglomérats remaniant les gneiss oeillés déformés et les roches basiques épidotisées.
Les 3000 ou 4000 m d'arkoses, grès et schistes charbonneux qui forment la masse du Houiller ont livré des plantes du Namurien au Stéphanien inférieur. Les conglomérats polygéniques qui avaient disparu dans le Houiller réapparaissent brusquement au Stéphanien et correspondent à une reprise de l'érosion des massifs cristallophylliens, consécutive à des mouvements verticaux importants, surtout à la limite orientale de la Zone Houillère, tandis que se développe un volcanisme acide.
Des orthogneiss, accompagnés localement de migmatites, intrudent le Houiller au SE du Ruitor et les arkoses et conglomérats "stéphano-permiens" dans le massif du Sapey et celui de Péclet-Polset où ils succèdent à des émissions basiques.
Au centre de la Zone Houillère on attribue au Permien des sédiments où le matériel volcanique prédomine et où les galets de tourmalinite sont fréquents, tandis que disparaissent les micas détritiques et les éléments de socle.
Le Permien terminal ("Permo-Trias", "Verrucano") se présente comme un dépôt corrélatif de la pénéplaine post-Varisque. Il succède aux dernières émissions rhyolitiques qu'il remanie ainsi que les gneiss du Sapey. Il précède la sédimentation sableuse werfénienne qui inaugure la transgression triasique.

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ROLE OF ANORMAL HIGH PORE PRESSURE (AHPP) AND CONTRUSIONAL ROCKS IN MECHANICS OF DEEP OVERTHRAST FAULTING

Variscian interformational and intraformational covers of Devonian and Lower Carboniferous rocks of Karatau hills (Central Tien-Shan) were formed during the Middle Carboniferous age at the depth of 2.5-4.0 km near the Main Karatau Fault. The roots of the overthrust covers are located in the fault zone. Fault planes of the covers are characterized by a layers of tectonic breccias, contrusional breccias of friction and buddings cutting across the layering at a very acute angle or lying in confirmity with it, and having a thickness ranging from first metres to few hundred metres. As a

result of contrusion (of lat. "contrudo" - to press into, to push in) - no-magmatic injection of breccia into the surrounding rocks and along the bracciated zones were formed contrusional dykes, stoks and sills. The role of AHPP consists in neutralization of the effect of lithostatic pressure (780-1040 kg/cm^2) on mechanical chareeteristics of breccia, of lowering intergranular friction and viscosity of the breccias. On this basis the problem of mechanical paradox of the interformational covers of the middle layers connected with big depth (2.5 - 4.0 km), small thickness (500-700 m), considerable horizontal amplitude (6-10 km) and limited resistance to pressure was resolved (Beliakov L.V., 1969, 1974, 1982). Low viscosity of the breccias along the hanging and the foot walls of the middle formation and its resistance to lateral folding due to overlying competent rocks of big thickness determined the conditions under which the formation of these layers took place in the form of interformational cover plasts. This is more inevitable and the only possible process of lateral contraction as it consumed less energy (Beliakov L.V., 1969, 1982). As a result of plastic deformation of the breccias in the field of AHPP pieces of soft rocks were rounded, taking an "onion type" structure, dynamofluidal pseudolayering took place, uneven contrusional contacts of breccia with surrounding rocks were formed. Crushing of the rock pieces "in situ" also took place. Breccia has high abrasion affinity to polishing in relation to surrounding rocks.

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РОЛЬ АНОМАЛЬНО ВЫСОКОГО ПОРОВОГО ДАВЛЕНИЯ (АВПД) И КОНТРУЗИВНЫХ ПОРОД В МЕХАНИЗМЕ ГЛУБИННОГО ПОКРОВООБРАЗОВАНИЯ

Варисские межформационные и внутриформационные покровы толщ девонских и нижнекаменноугольных пород хребта Каратау (Средний Тянь-Шань) возникли в среднем карбоне на глубине 2,5-4,0 км вблизи Главного Каратауского разлома. В зоне разлома находятся корни покровов. Сместители покровов представляют собой согласные или секущие слоистость под острым углом пластообразные тела тектонических и контрузивных брекчий трения и развальцевания мощностью от первых метров до сотен метров. В результате контрузий (от лат. "contrudo" - втискивать, вталкивать, толкать) - амагматических инъекций брекчий в бока и вдоль брекчиевых зон - образовались контрузивные дайки, штоки и силлы. Роль АВПД заключалась в нейтрализации влияния литостатического давления (780-1040 кг/см^2) на меха-

нические свойства брекчий, в уменьшении интергранулярного трения, в снижении вязкости брекчий. На этой основе решена проблема механической парадоксальности внутриформационных покровов средней толщи в связи с большой глубиной их формирования (2,5-4,0 км), малой мощностью (500-700м) , значительной горизонтальной амплитудой (6-10 км) и ограниченной прочностью на сжатие (Беляков Л.В., 1969, 1974, 1982). Малая вязкость брекчий вдоль кровли и подошвы средней толщи и поперечное сопротивление изгибу со стороны вышележащих формаций компетентных пород определяли условия, при которых формирование этой толщей внутриформационных покровов пластового типа было не только наименее энергоемким, но и единственно возможным процессом латерального сокращения (Беляков Л.В., 1969, 1982). В результате пластических деформаций брекчий в поле АВЦД обломки мягких пород окатывались, приобретали "луковичное" строение, возникала динамофлюидальная псевдослоистость, формировались неровные контрузивные контакты брекчий с окружающими породами. Наблюдается дробление обломков in situ . Брекчии обладали высокой абразивной способностью по отношению к вмещающим породам.

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PRE-RIFT AND RIFT STAGE VOLCANISM IN EAST AFRICA (SE Ethiophia - Somalia and East Kenya)

The relationships between magma evolution and tectonics during the development of rift structures are discussed for large areas of SE Ethiophia-Somalia, East Kenya plateaus and associated sectors of escarpment and rift floor.

Flood basalt volcanism in the northern region of SE Ethiopian plateau (pre-rift Stage: 32-28 M.y.) is of tholeiitic nature while that of escarpment and rift floor (rift Stage: 14 M.y. to Quaternary) is transitional with alkaline affinity. Notably the earlier stages of major rifting are closely related to the extrusion of large volumes of stratoid ignimbrites (comendites). On the other hand, the volcanic activity on the rift floor is associated with central volcanoes with dominance of acid products belonging to transitional basalt-pantellerite or comendite suites (e.g. Boseti).

The pre-rift volcanic activity in SE Ethiopian plateau also extends to Somalia where stratoid basalts with tholeiitic affinity have

34-28 M.y. The rift Stage in Somalia is represented by basaltic volcanism (10 M.y. to Quaternary) related to the opening of Gulf of Aden.
The fissure-type volcanism of the East Kenya plateau developed in two main phases: 1) 12-10 M.y., and 2) 8-5 M.y., respectively. The first phase (pre-rift Stage) is dominated by moderately undersaturated volcanics (e.g. basanites). The second phase is almost contemporaneous with an important fault process (rift Stage), and is represented by relatively abundant oversaturated basic products (e.g. quartz-normative basalts, occasionally with pigeonite). Central-type activity in the East Kenya plateau is represented by numerous volcanic ranges dominated by undersaturated lavas from basanite to peralkaline phonolite (e.g. Nyambeni).
Pre-rift and rift Stage volcanism is discussed in terms of similarity and contrast in magma composition.

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VOLCANIC CYCLES AND MAGMATIC EVOLUTION IN THE TERRITORY SURROUNDING THE TURKANA LAKE (NORTHERN KENYA)

The present work deals with geotectonic and magmatological aspects of the volcanic series cropping out in the Southern part of the wide region sited on the Western and Eastern banks of Turkana Lake (Kenya).

A decrease of alkalinity in volcanic products with time has been recognized:

- during first stage of activity, strongly alkaline products (basanite to phonolite) has been erupted. These range in age 26 to 19 Ma. and were followed by a Miocene (15 Ma. c.a.) basaltic activity showing a mildly alkaline to transitional affinity;
- the Quaternary volcanism (2 Ma.) is still represented by mildly alkaline basaltic products.

Data on bulk-rock composition and mineral chemistry allow to evidence that also within a single cycles of activity, volcanic products evolve toward decreasingly alkalic terms.

The tectonic evolution of the whole Turkana basin and the possible relationship with the volcanism of "Ethiopian dome" is discussed.

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FLOOD BASALT-RHYOLITE VOLCANISM OF PARANA' BASIN (BRAZIL): PETROLOGY, PALEOMAGNETISM AND GEODYNAMIC IMPLICATIONS

Stratoid volcanics of Parana plateau are of Lower Cretaceous age (140-120 Ma) and are dominated by basaltic rocks which in the central-eastern sectors of the basin are closely associated with abundant acidic lavas. In these regions the lower parts of the volcanic sequences are largely composed of tholeiitic basalt types, while the upper portions are essentially represented by rhyodacites (and scarce rhyolites) showing intercalations of basaltic rock-types. Notably volcanics of intermediate compositions (mainly tholeiitic andesites) prevail at the transition between basalt and rhyodacite portions.

Over 800 bulk-rock compositions allow to distinguish the basaltic rocks of Parana basin in low-TiO_2 (southern regions, ca. 27-30° Lat.S) and high-TiO_2 (northern regions, ca. 25-20° Lat.S) types. Petrography, mineral chemistry and bulk-rock compositions (major and trace elements) define tholeiitic suites, and variation element patterns compatible with different degrees of partial melting of heterogeneous mantle material, and "low-pressure" evolutive processes.

Paleomagnetic data indicate high rate of magma emission (e.g. 700 metres in less than 1 Ma) and sometimes the contemporaneous eruption in different areas of basic and essentially acidic lavas, respectively. Moreover the positions of paleomagnetic poles indicate that the stratoid volcanics of Parana and those of Namibia (South Africa) were joined at 120 Ma B.P.

All the data consistently indicate that Parana volcanism occurred during the Lower Cretaceous after the formation of updoming structures and migrated towards the East where major rifting later developed. In this model the initial opening of South Atlantic Ocean, at latitudes of Parana basin, occurred not before 120 Ma B.P.

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THE SUTURE ZONES AND THE GENERAL MECHANISM OF NAPPE-COMPLEX FORMATION

The suture zones of nappe-tectonics regions are of a deep fault nature, and they play a decisive part in the re-modelling of geosynclinal systems into nappe complexes. Great volumes of crustal material sink into their deep bowls in the process of general underthrusting of the outer palaeotectonic units beneath the inner ones accompanied by slicing the Earth's crust and by sliding the lower slices towards the backland in relation to the upper ones. This brings into motion the general mechanism of nappe formation - an action of the couple of forces providing (in combination with the grawity) owerriding of the upper nappes towards the periphery as well as the realization of specific mechanisms such as decollement along the bedding, oblique shearing and rolling of bed fragments within a nappe complex. The amplitude of underthrusting carrying the material into the abysses of the largest suture zones (located within the backlands of the nappe complexes) may reach 200-250 kms (Alps. Dinarides). These zones are void of deep-seated geophysical crustal roots, the fact evidencing in favour of transition of the crustal material well into the mantle. Minor zones (at the foreland of the complexes) show a considerable thickening of the crust as a result of piling up nappes above the Moho boundary. The activity of the suture zones and the general compression of the deep interior of a geosyncline are the main causes of overthrusting. A contribution by the gravity to the nappe-formation process is determined by the overall incline of the tectonically active part of an orogen's surface, during every episode of movement, towards the foreland not yet affected by the overthrusting. In the process of a progressive migration of the tectonic activity from the backland towards the foreland, the horizontal gravitational gradient promotes the nappes in the same direction.

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РУБЦОВЫЕ ЗОНЫ И ОБЩИЙ МЕХАНИЗМ ФОРМИРОВАНИЯ ПОКРОВНЫХ СООРУЖЕНИЙ

Рубцовые зоны областей покровной тектоники, имеющие глубинную разломную природу, оказывают решающее влияние на преобразование геосин-

клинальных систем в покровные сооружения. В их недрах поглощаются крупные объёмы корового материала при общем глубинном поддвиге более внешних палеотектонических единиц под более внутренние с расслоением коры и проскальзыванием нижних пластин к тылу сооружения по отношению к верхним. В результате включается общий механизм шарьяжеобразования – проявляется действие пары сил, обеспечивающей (при участии гравитации) шарьирование верхних покровов к периферии, реализацию частных механизмов срыва по слоистости и косого скола, "кувыркание" фрагментов толщ внутри отдельного комплекса шарьяжей. Амплитуда поддвигов, поставляющих материал в недра крупнейших рубцовых зон (в тылах сооружений), достигает 200–250 км (Альпы, Динариды). Эти зоны лишены глубокого геофизического "корня гор", что может свидетельствовать о переходе корового материала в мантию. С менее крупными зонами (во внешних частях сооружений) связано значительное утолщение коры, свидетельствующее о нагромождении пластин выше раздела Мохо. Функционирование рубцовых зон и общее сжатие глубинной структуры геосинклинали – главные причины шарьяжеобразования. Положительный вклад гравитационного фактора в покровообразовании обусловлен тем, что в каждую фазу движений уклон поверхности тектонически активной части сооружения обычно направлен к более внешним участкам, еще не затронутым шарьированием. При последовательной миграции тектонической активности от тыла к фронту горизонтальный гравитационный градиент способствует продвижению шарьяжей в эту сторону.

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THE FAULT TECTONICS OF EURASIA

The data on disjunctive dislocations of the largest continent are summed up on the first fault tectonics map of Eurasia scaled on 1:5.000.000. The analysis of these data enables to single out the main fault systems of Eurasia differing in their age formation, morphological-kinematic character, fault pattern and the evolution features. They include the fault systems of ancient platforms, mobile belts, regions of riftogenesis and the transstructural fault zones. The ancient platform fault systems were formed in the Archean and Early Proterozoic times, and they underwent a long evolution accompanied

by many times reverses in their morphology and the sense of movement. These disjunctives are mainly faults and reverse faults rejuvenated more than once in the Phanerozoic. The fault systems of the Mediterranean, the Urals-Mongolian, the Atlantic and the Pacific mobile belts are marked for the regularity of their fault trends, the wide variety of morphologicc-kinematic types and the relatively narrow time-span of their evolution. The structural peculiarities of the Pacific system show to an alternation of tension and compression. The modern patterns of the other fault systems have been formed under the predominant compressional conditions. Fault systems of riftogenic regions are superimposed upon the stable tectonic elements, and include long faults and gaps and relatively short cross-cutting wrench faults. Transstructural fault systems cut both the geosynclines and platforms and extend from continents onto the ocean floor (the Urals-Oman, the India-Pamirs and other lineaments). They are of an ancient origin and a long evolution, and show shift displacements. Fault systems form geodynamic couples of a various order. The major seismogenic disjunctives belong to three types: the geosynclinal, platform and transstructural ones.

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РАЗЛОМНАЯ ТЕКТОНИКА ЕВРАЗИИ

На впервые составленной карте разломной тектоники Евразии в масштабе I:5000000 систематизированы данные о дизъюнктивах крупнейшего материка планеты. Анализ данных позволяет выделить важнейшие разломные системы Евразии, различающиеся временем формирования, морфокинематической характеристикой, рисунком сети разрывов, особенностями эволюции. К их числу относятся системы разломов древних платформ, геосинклинально-складчатых поясов, областей проявления рифтогенеза и трансструктурные системы. Системы разломов древних платформ заложились в архее и раннем протерозое, имели длительную историю развития с многократной сменой морфологии и знака движений. Разломы древних систем представлены сбросами и взбросами, неоднократно активизированными в фанерозое. Системы разломов Средиземноморского, Урало-Мон-

гольского, Атлантического и Тихоокеанского поясов отличаются упорядоченностью простирания, широким разнообразием морфокинематических типов, относительной кратковременностью формирования. Особенности строения Тихоокеанской системы отражают чередование сжатий и растяжений. Современный рисунок остальных систем разломов возник в условиях преобладающего сжатия. Системы разломов областей рифтогенеза накладываются на структуры, испытавшие консолидацию, и состоят из протяженных сбросов и раздвигов и относительно коротких поперечных сдвигов.

Трансструктурные системы разломов пересекают геосинклинали и платформы, переходят с континентов в океаны (Урало-Оманский, Индо-Памирский и др. линеаменты). Они имеют древнее заложение, длительную активность и сдвиговые смещения. Системы разломов образуют динамопары различного порядка. Крупнейшие сейсмогенные структуры относятся к трем типам: геосинклинально-складчатому, платформенному и трансструктурному.

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ON THE TRANSITION ZONES BETWEEN CONTINENTS AND OCEANS

A third type of transition zones from oceanic to continental crust here called Columbian, in addition to the two more commonly known types. Subsidence of the Earth's crust, typical of all transition zones, is shown to be connected (by geophysical properties) with the transformation of continental crust into intermediate crust and later into oceanic. The most likely mechanism of such changes is the basification of continental crust, its foundering, block by block, into the heated upper mantle, and its substitution by the new oceanic crust. The evolution of transition zones of Pacific type is largely influenced by deep faults, which reach down to the level of undepleted mantle; from this level to the surface the volatile products rise as the essential means of formation of calc-alkali magmas on island arcs. Benioff zones are deep faults whose inclination is secondary and connected with the density contrast in the upper mantle on either side of the Benioff zone. The denser mantle flows under less dense mantle, whereas the subduction phenomenon, as depicted by plate tectonics, is nonexistent.

On the whole, the evolution of transition zones tends towards growth of the oceans at the expense of the continents, but oceanic crust thickens by addition of volcanogenic layers of andesitic composition in transition zones of Pacific type, on island arcs of the second type.

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О ПЕРЕХОДНЫХ ЗОНАХ МЕЖДУ КОНТИНЕНТАМИ И ОКЕАНАМИ

В дополнение к обычно выделяемым двум типам переходных зон выделен третий тип, названный колумбийским. Высказано предположение, что характерное для всех переходных зон прогибание земной коры связано с превращением (по геофизическим свойствам) континентальной коры в промежуточную и затем в океаническую. Наиболее вероятным механизмом таких изменений является базификация континентальной коры, ее погружение (глыба за глыбой) в разогретую верхнюю мантию и замещение новой океанической корой. В развитии переходных зон тихоокеанского типа большую роль играют глубинные разломы, достигающие уровня неистощенной мантии, откуда к поверхности поднимаются флюиды, необходимые для образования известково-щелочных магм на островных дугах. Зоны Беньофа являются глубинными разломами первоначально вертикальными, наклон которых вторичен и связан с контрастом плотностей в верхней мантии по обе стороны зоны Беньофа. Более плотная мантия подтекает под менее плотную, тогда как явление субдукции в том виде, в котором оно рисуется тектоникой плит, не существует. Хотя в переходных зонах тихоокеанского типа на островных дугах второго типа происходит наращивание океанической коры вулканогенными слоями андезитового состава, в целом развитие переходных зон идет в сторону расширения океанов за счет континентов.

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COMPARATIVE ANALYSIS OF GEOTECTONICAL DEVELOPMENT AND DEEP STRUCTURE OF THE ALPS, APENNINES AND CAUCASUS

The main features of recent structure and the stages of geological evolution and of related magmatic processes in the Alps, Apennines and Caucasus Major show that despite evident distinctions all these regions have abundant evidence of similarity.

Though the Alps and Apennines are much affected by "horizontal" overthrusting tectonics and the Caucasus Major is dominated by "vertical" folding, both regions have common regularities. They are: comparable size of regions and of their segments, transverse step structure which appeared during the last orogenic stage and predetermined by previous development.

The evolution of the regions in time is not only almost synchroneous, but it can also be divided into similar stages, i.e. the stage

of long subsidence, its intensity and differentiation increasing with time, changes to the stage of tectonic inversion which terminates at the final stage of orogenic block motions.
The comparison of the observed structures and development stages with the evolution of magmatic processes and with deep-seated structures of the Earth's crust and mantle allow to some participants of the work to suppose that all the structures and stages of development of the Alps, Apennines and Caucasus are due to a common process of advective motion of material inside the Earth's crust produced by its uneven heating. Within different regions, however, the process develops under different conditions, involves different levels, and reaches different stages.
The distribution of seismic activity within considering folded zones reveals an obvious regularity of decreasing seismic intensity from east to west and from north to south. This is compatible with the changes in movement intensity during the last orogenic development stage.

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ ГЕОТЕКТОНИЧЕСКОГО РАЗВИТИЯ И ГЛУБИННОГО СТРОЕНИЯ АЛЬП, АПЕННИН И КАВКАЗА

Основные черты современной структуры, этапы геологического развития и связанные с ними процессы магматизма Альп, Апеннин и Большого Кавказа показывают, что при всех очевидных различиях эти области обладают рядом существенных черт сходства.
При том, что в Альпах и Апеннинах наблюдается преобладание "горизонтальной" покровной тектоники, а на Большом Кавказе "вертикальной" складчатой, существуют некоторые общие закономерности: равновеликие размеры областей в плане как в целом, так и отдельных их сегментов, поперечная ступенчатость структуры, проявившаяся на последнем орогенном этапе, но предопределенная предшествующей историей. Развитие этих областей во времени оказывается не только близко одновременным, но и подразделяется на сходные по своему смыслу стадии - этап длительного прогибания с нарастающей интенсивностью и дифференциацией сменяется этапом тектонических деформаций (инверсией) и завершается этапом блоковых орогенных движений.
Сопоставление наблюдаемой структуры и этапов развития с эволюцией магматических процессов, а также строением глубоких частей коры и мантии позволяет некоторым участникам работы предположить как возможную модель, что все эти области являются результатом развития

сходного процесса - адвективного перемещения вещества внутри земной коры, вызванного ее аномальным неравномерным прогревом. Однако в разных областях этот процесс протекает в разных условиях, охватывает разные по глубине уровни и достигает в своем развитии разные стадии.
Распределение сейсмичной активности в пределах рассматриваемых складчатых областей обнаруживает вполне ясную закономерность - снижение интенсивности сейсмичности с запада на восток и с севера на юг, что в общих чертах совпадает с изменением интенсивности движений орогенного этапа развития.

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CORRELATION OF PREVARISCAN AND VARISCAN OROGENIC EVENTS OF THE ALPINE-MEDITERRANEAN MOUNTAIN BELT

Correlation in time of the events in the Alpine region from the Western Mediterranean to the Caucasus, sponsored by the IGCP Project No 5, has revealed the following **historico-chronologic features of** the Paleozoic orogeny.
Alpinotype deformations are unevenly distributed in time and concentrate within definite intervals of orogenic phases spaced by relatively anorogenic periods. The duration of the both is commensurable. Compression in the pre-molasse stages is recorded according only to indirect features scattered over the area. It is tension that has more universal significance for the whole belt, with its peak coinciding with the middle-late Ordovician and Llandoverian, and such events as the onset of broad island arc volcanism, and the beginning of flysh (pre-collision) stage of development. The molasse-stage orogeny pulses, accompanied by uplifts, are recorded in numerous stratigraphic hiatuses, occasionally, with weak angular unconformities. In contrast to the alpinotype deformations, the distribution of hiatuses in time is less regular; some of them coincide with phases of folding, while most occur in between. In the pre-molasse stages, there are but few hiatuses of the kind.
Correlative with phases of folding are pulses of general uplifting. The pulses of upward and differentiated tectonic movements, registered according to more coarse molasses, are spaced unevently.
The molasse-stage Variscan volcanism emerged soon after the first phase of folding, which marked the beginning of collision in the fold belt,to continue practically **without breaks from the second half** of the early Carboniferous to the end of the Permian, though more

frequent with its mass eruptions, in certain time intervals of the second half of the middle Carboniferous - the end of the early Permian. Time regularities of granite formation are less understood due to difficulties in their accurate dating.

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КОРРЕЛЯЦИЯ ДОВАРИССКИХ И ВАРИССКИХ ОРОГЕНИЧЕСКИХ СОБЫТИЙ В АЛЬПИЙСКО-СРЕДИЗЕМНОМОРСКОМ ГОРНОМ ПОЯСЕ

Временная корреляция событий в Альпийской области от Западного Средиземноморья до Кавказа, выполненная в рамках проекта № 5 МПГК, выявила следующие историко-хронологические закономерности орогенических процессов в палеозое.

Альпинотипные деформации распределялись во времени неравномерно, концентрируясь в определенных интервалах, фазах складчатости, разделенных относительно анорогенными периодами. Длительность тех и других соизмерима. В домолассовые стадии деформации сжатия фиксируются лишь по косвенным признакам и проявляются разрозненно по отдельным районам. Более общее значение для всего пояса имеют процессы растяжения, главный импульс которых приходится на средний-поздний ордовик и лландовери, и такие события, как начало массового островодужного вулканизма, начало флишевой (предколлизионной) стадии развития. В молассовую стадию орогенические импульсы, сопровождаемые поднятиями, фиксируются многими стратиграфическими перерывами, иногда со слабыми угловыми несогласиями. Сравнительно с альпинотипными деформациями распределение перерывов во времени менее закономерно, часть из них совпадает с фазами складчатости, но очень многие находятся в промежутках между последними. В домолассовые стадии такие перерывы единичны.

Четко коррелируются с фазами складчатости орогенные импульсы общего поднятия. Импульсы восходящих и дифференцированных тектонических движений, фиксируемые по увеличению грубости моласс, также распределяются во времени неравномерно.

Варисский вулканизм молассовой стадии появляется вскоре после первой фазы складчатости, отмечающей начало коллизии в складчатом поясе, и следует затем почти без перерыва со второй половины раннего карбона до конца перми, концентрируясь, однако, в виде массовых извержений в отдельные временные интервалы со второй половины среднего карбона до конца ранней перми. Менее определенно устанавливаются временные закономерности гранитообразования в связи с трудностями их точного датирования.

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VOLCANISM AND TECTONICS OF THE PACIFIC CONTINENTAL MARGINS DURING THE PHANEROZOIC

The andesite volcanism during Mesozoic and Cenozoic and the granitoidal magmatism during the Late Mesozoic-Early Cenozoic determine the special position occupied by the Pacific Tectonic Belt PTB among the Phanerozoic fold regions of the Earth.

Geosynclinal 1 and extrageosynclinal 2 manifestations of volcanism are recognized. The typical representatives of 1 are orthogeosynclines O and andesite geosynclines A while 2 are examplified by continental margin volcanic belts M, volcanic zones of riftogenesis regions, plateau basalts of recent platforms, and areas of volcano-tectonic activation of unknown type. Volcanic (insular) arcs are modern counterparts of A.

A and M are the most characteristic structural elements of PTB. The development of A was edvanced throughout the Paleozoic, Mesozoic and Cenozoic. A drastic increase of this process is taking place since the Late Cenozoic i.e. N, Q.

A and O differ in terms of parageneses of their geological formations as well as the character of their structures and metamorphism. Their space and time relationships are complicated indeed. Many A are superimposed on completely folded structures of O. There are known cases of A superimposed on the oceanic crust while the nearby O occur on the continental crust. O are replaced by A along the strike. Origination of East Asiatic M system took place during Late Mesozoic. M occur on the edge of a heterogeneous mass of continental crust formed during the Mesozoic folding event. M of East Asia and O of cenozoide system striking parallel to them, belonging to the same structural type and also finally laid out during Late Mesozoic compose a single lateral series. Therefore, the formation of M is related to the development of the cenozoides.

A are structures of an active generation of matter of the continental type crust during the Phanerozoic stage of PTB. They relate to deep-seated processes within nondepleted mantle composed of garnet peridotite. In many regions O developed as zones of destruction and subsequent regeneration of the continental type crust. Their development may be due to shallower processes.

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ВУЛКАНИЗМ И ТЕКТОНИКА КОНТИНЕНТАЛЬНЫХ ОКРАИН ТИХОГО ОКЕАНА В ФАНЕРОЗОЕ.

Андезитовый вулканизм в мезозое и кайнозое и гранитоидный магматизм в позднем мезозое-раннем кайнозое определяют особое положение Тихоокеанского тектонического пояса ТТП среди фанерозойских складчатых областей Земли.

Различаются геосинклинальные I и внегеосинклинальные 2 проявления вулканизма. Типичные представители I - ортогеосинклинали О и андезитовые геосинклинали А; 2 - окраинно-материковые (краевые) вулканогенные пояса К, вулканические зоны областей рифтогенеза, платобазальты молодых платформ и ареалы вулкано-тектонической активизации неустановленного типа. Современные аналоги А - вулканические (островные) дуги.

А и К являются характернейшими элементами строения ТТП. В течение палеозоя → мезозоя → кайнозоя развитие А прогрессировало. Резким усилением этого процесса отмечен поздний кайнозой N,Q.

А и О различаются парагенезисами геологических формаций, характером структур и метаморфизма. Сложны их пространственно-временные соотношения: многие А заложены на структурах завершенной складчатости О; известны примеры формирования А на океанической коре, а расположенных рядом О на континентальной; А сменяют О по простиранию.

Возникновение Восточно-Азиатской системы К относится к позднему мезозою. К расположены на краю гетерогенного массива континентальной коры, сформировавшегося в результате мезозойской складчатости. К Восточной Азии и простирающиеся параллельно им (однотипно построенные, также окончательно оформившиеся в позднем мезозое) О системы кайнозоид составляют единый латеральный ряд структур. Поэтому образование К связывается с развитием кайнозоид.

А - структуры активной генерации вещества коры континентального типа в фанерозое ТТП. Они связаны с глубинными процессами в неистощенной мантии, сложенной гранатовым перидотитом. О во многих областях формировались как зоны деструкции и последующей регенерации коры континентального типа. По-видимому, их развитие обусловлено процессами менее глубинными.

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RIFT SYSTEMS GEOMETRICAL STRUCTURE AND MECHANICAL CONDITIONS OF RIFTING

Geometrical regularities of rift systems formation and initial stages of their development are investigated in terms of plastic flow theory and physical simulation with allowance for similarity criteria. It is seen that deformation of lithosphere plates under horizontal uniaxial tension should be accompanied by localization zones or necks formation. Angles of 55-60° are typical between plate movement direction and direction of localization zone of deformation. Necking and rifting result in lithosphere thinning and accordingly in rising of asthenosphere diapir up to the surface following the complete plate rupture. After the complete rupture of the lithosphere the angle between the plate movement direction and the general stretch of plate boundary spreading (more exactly, its fragments divided by transform faults) gradually becomes orthogonal. This adaptation is presented by the configuration of linear magnetic anomalies. Actual data analysis shows that predicted angles between plate movement direction and rift systems general stretches naturally occur rather often and quite strictly. That allowed to use geometrical criteria of rift system origin for reconstruction of paleorifts and passive continental margins formation conditions. The mechanism of en-echelon phenomena of surface structure above localization zone of plastic deformation is proposed. The regional data (Baikal, North Atlantic, Indian Ocean) received by cosmic survey, depth recording, continuous seismic profiling, magnetic and gravity survey are added for illustration.

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СТРУКТУРНЫЕ КОНФИГУРАЦИИ РИФТОВЫХ ЗОН КАК ОТРАЖЕНИЕ УСЛОВИЙ РИФТОГЕНЕЗА

Геометрические закономерности заложения рифтовых зон и начальные стадии их эволюции исследованы на основе теории пластичности и физического моделирования с соблюдением критериев подобия. Пока-

зано, что деформации литосферных плит при одноосном растяжении должны сопровождаться образованием полос локализации деформаций - шеек, расположенных в плане под углом 55-60° к направлению растяжения. Развитие шейки (рифта) приводит к утонению литосферы и, соответственно, подъему кровли астеносферы вплоть до выхода ее к поверхности после полного разрыва плиты. После разрыва литосферы постепенно происходит изменение взаимной ориентации рифтовой зоны (точнее, ее фрагментов, разделенных трансформными разломами) и направление раздвижения плит на ортогональное. Такая перестройка находит отражение в рисунке линейных магнитных аномалий. Анализ фактических данных показывает, что предсказанные теорией и модельным эксперементом угловые соотношения между направлением расхождения плит и простиранием рифтовых зон достаточно строго и часто выполняются в природе. Это позволило использовать конфигурационные критерии генезиса рифтовых зон для реконструкции условий образования ряда палеорифов и пассивных континентальных окраин.

Предложен механизм образования эшелонированных структур в приповерхностном сейсмоактивном слое над полосой локализации пластических деформаций. Доклад иллюстрирован материалами по Байкальскому региону, Северной Атлантике, Индийскому океану, полученными при структурном дешифрировании космоснимков, эхолотировании, непрерывном сейсмическом профилировании, магнитной и гравитационной съемке.

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STRUCTURE AND TECTONICS OF THE GULF OF ELAT (AQABA)

The Gulf of Elat (Aqaba) occupies the southern part of the Dead Sea rift. The rift is considered to be a plate boundary of the transform type (sometimes leaky) which connects the Red Sea where seafloor spreading occurs, with the Zagros-Taurns zone of continental collision. It is 180 km long, 15-25 km wide, with deep water up to 1850 m. The shallow structure of the gulf is dominated by en-echelon faults which delimit three elongated basins that strike N20°-25°E. Crustal models based on gravity data indicate that the basins are rather shallow and do not affect the lower crust. The fill of the basins extends to about 5 km below the seafloor in the northern and southern basins and less in the central basin. The magnetic field over the southern third of the gulf is rather smooth and markedly different from that of the other parts. The heat flow is also higher and the crust is thinner in the southern part of the gulf. This could indicate different tectonic processes in this region than in the northern Gulf of Elat. Overall, it seems that within the Gulf of Elat a transition occurs between crustal spreading that takes place in the Red Sea to a rifting without spreading that takes place along the Dead Sea transform.

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ROLE DES DECROCHEMENTS E-W DANS LA TECTONIQUE RECENTE DE LA TUNISIE SEPTENTRIONALE ET DANS L'INTERPRETATION DU CONTACT AFRIQUE-EUROPE

Par sa situation à proximité de la Sicile et de la Sardaigne, à la limite des bassins occidentaux et orientaux de la Méditerranée, la Tunisie septentrionale offre un champ d'étude privilégié pour la compréhension du contact Afrique-Europe.
L'essentiel des déformations observées dues à la tectonique récente (depuis au moins le Tortonien) s'organisent selon un schéma classique "de Riedel", en compression, induits par des décrochements dextres majeurs d'orientation sensiblement E-W (N 70°E à N100°E). Un tel schéma implique que la contrainte principale majeure ait une direction NW-SE.
Ce style de déformation, mis en évidence dans l'espace jusqu'à la Plateforme saharienne, semble se manifester depuis au moins le Crétacé moyen. A partir de cette époque vraisemblablement, mais à coup sûr depuis le Miocène supérieur le même régime compressif persiste, coupé peut-être d'épisodes de distension qui restent à confirmer.
L'analyse bibliographique des études conduites sur les régions avoisinantes, semble confirmer que ce modèle se maintient à l'approche du contact Afrique-Europe. Ce contact doit donc être envisagé comme une vaste zone, approximativement E-W, de terrains broyés, étirés, parfois jusqu'à être déchirés et dilascérés, témoignant d'un cisaillement dextre de première grandeur. Il est bien certain qu'il s'agit là d'un mouvement relatif, conséquence du déplacement dans le même sens mais avec des vitesses différentes des plaques Européenne et Africaine.

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STRUCTURAL EVOLUTION AND TECTONICS OF THE IRANIAN PLATEAU: A PLATE TECTONIC APPROACH

Iranian crust is an agglomeration of different continental fragments separated from the Gondwanian passive margin, travelled hundreds to thousands of kilometre, and accreted to the active margins of Laurasia-Eurasia during different collisional orogenies. The margins in Iran lie along the present Chapedony (Precambrian?), Herat-Mashhad (Triassic), High Zagros-Oman and Sevan-Akera-Qaradagh (late Cretaceous), Sistan (Middle Eocene), Zagros (Pliocene) geosutures, and the Makran active subduction zone in southeast Iran. A possible fossil island-arc in Central Iran (Chapedony-Posht Badam) may indicate an arc-continent collision during the late Pre-Cambrian which was followed by rifting assemblage of the Hormoz Formation. The northward motion of the Central Iranian continental fragment(s) was responsible for the closure of the Paleo-Tethys in the northern Central Iran, and the apparently simultaneous opening of the Neo-Tethys in the southern Central Iran. Andean-type orogenies associated with northward subduction of the Neo-Tethyan ocean crust under southwestern active margin of Central Iran started in Middle Triassic with Mariana-type (Mesozoic) and Chilean-type (Tertiary) subduction zones. The Paleogene synchronous Andean-arc and back-arc spreading stages are characterized by calc-alkalin volcanism (north of the Zagros geosuture) and alkali volcanism (northwest and north Central Iran). This was followed by large back arc-inter arc extensional areas (Lower Red-Qom basin) contemporaneous with regional compression during Oligo-Miocene.

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MANTLE DIAPIRISM, PENETRATIVE MAGMATISM, AND FORMATION OF RIFT AND RIFT BASIN STRUCTURES IN CONTINENTAL AND OCEANIC CRUST

Gravity, magnetic and heat flow anomalies, presence of anomalous mantle, seismicity and frequent association of volcanism with major rift systems on continental and oceanic crusts indicate an intimate relationship between mantle perturbation, penetrative magmatism, and the process of rifting and ridge-rift valley development. Analyses by mathematical theory of three-dimensional stress around rising mantle diapirs and semiquantitative model experiments with materials rheologically similar to crustal rocks show that the origin of fissure, rift, ridge basin structures by asthenospheric diapirism or magmatic wedging is commonly initiated by broad doming, antiform or plateau uplift; the magnitude and nature of uplift, and fissure or rift pattern development are controlled primarily by flexural rigidity, presence and degree of anisotropy (pre-existing lineament) and their orientation to the direction and magnitude of thermo-mechanical stresses imparted to upper crust. Continued magma wedging produces rifting by brittle to brittle-ductile extensional fracturing, vertical dike intrusions, development of block faulting, graben, graben and horst, and axial valley with slow spreading. This may be followed by flank uplift, block rotation, marginal thrust faulting, axial valley volcanism and eventual disappearance of axial valley with faster spreading. Fault geometry and block rotation play a key role in controlling initiation and localization of volcanic activity along rift-faults. Magma intrusions as sills and sheets in predominantly layered rocks in a rift zone favor greater initial uplift or doming prior to rifting, and is often followed by the development of rift-basin(s) with no apparent signs of volcanism. Theoretical stress analyses explain horizontal compressive stress around magma centers in Iceland and in Rhine graben, and indicate that multiple dike wedging with rapid brittle extensional fracturing in areas of hydrothermal circulation in the spreading center can generate anomalous push force and contribute seismicity.

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THE MAIN CENTRAL THRUST OF THE HIMALAYA: A MODEL AND ITS SIGNIFICANCE

The Main Central Thrust (MCT) is a major geotectonic element of the Himalaya along which the homoclinal block of Greater Himalaya is thrust over the sedimentary belt of Lesser Himalaya. Coinciding with a line of hot springs and seismic activity, this moderately dipping (up to 45° N/NNE) thrust represents a zone of intense deformation giving rise at places to schuppen structures at its base involving both the crystalline and sedimentary sequences in imbricate repetition. On either side it has affected a wide tract of about 5 to 6 km extent, where four classes of deformation intensity (low, moderate, high and intense) are recognized, the MCT zone representing the intense deformation. Strain measurements/parameters reveal a characteristic profile in which the MCT coincides with extreme values (e.g. fold flattening reaching up to 80% to 90% and even more, fold interlimb angle decreasing up to 15° or less, $\sqrt{\lambda_2/\lambda_1}$ interference patterns are typically absent around the thrust. There is a prominent noticeable increase in grade of metamorphism towards the MCT.

The development of the MCT might have involved marked compression over a wide zone of the crust. During deformation, the rock strata around the MCT appear to have undergone marked superimposition of homogeneous strain with consequent flow due to high viscosity contrasts. Considering the various aspects together, the MCT may be regarded as a "ductile thrust" of deep intracrustal character, involving a vertical displacement of about 18 km or so for the crystalline block of Greater Himalaya, which is neotectonically active and is thus rising in its elevation. Based on detailed studies in the Kumaun region, a model of the MCT, vis-a-vis other tectonic planes of the Himalaya, has been presented. As such, the MCT appears to be quite unique not only Himalayan region, but also for other thrust belts of the World.

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REGIONAL TECTONIC FRAME WORK AND THE ARCHITECTURE OF THE WESTERN PERI-CONTINENTAL MESOZOIC BASINS OF INDIA

Kutch-Saurashtra, Cambay and Narmada basins are the three peri-continental rift-basins in the western margin of Indian craton. The three basins formed along three major Precambrian tectonic trends seriatim from north to south during different stages of rifting of India from the Gondwanaland and its northward drift along an anti-clockwise path. The Kutch basin opened up first in Early Jurassic followed by Cambay in Lower Cretaceous and Narmada in Upper Cretaceous. Kutch basin is the major Mesozoic basin with the sediment-fill ranging in age from Early Jurassic to Early Cretaceous. Saurashtra (Kathiawar) block remained as a foundered cratonic block separating Kutch basin from Cambay and Narmada, till Early Cretaceous when Kutch-Saurashtra area became a wide shelf for thick deltaic deposit.

The major Precambrian trends of Rajasthan (Delhi and Aravalli strikes) extend into the Kutch-Saurashtra Shelf across Cambay Graben. The Kutch-Saurashtra Shelf is styled by five sub-parallel east-west striking faults accompanied by uplifts and flexures along these Precambrian trends: (i) Nagar Parkar Fault, (ii) Island Belt Fault, (iii) South Wagad Fault, (iv) Kutch Mainland Fault, and (v) North Kathiawar Fault. A meridional high described as Median High, crosses the Kutch Basin in the middle along the regional hingezone of the shelf, which had a south-westerly palaeo-slope. The margin of the basin is defined by the Precambrian terrain in the north and north-east, and by the Radhanpur-Barmar Arch in the east. The northern and southern margins of the basin are bounded by Nagar Parkar-Alla Bandh and Narmada faults respectively. The structural axis of the basin plunges to the south-west trending parallel and close to the Kathiawar uplift.

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RIFTING OF PROTEROZOIC

Proterozoic rifts at various stages of extension were involved into different types of endogenous activity. As a result, such evolutionary gradation of riftogenous structures is recorded: aulacogenes - continental paleorifts which were not underwent to metamorphism and granite formation; intracontinental ensialic folded systems - originated from continental rifts of higher permeability, which passed

through monocyclic intrageosyncline evolution including granite formation and metamorphism (Gudsonides, Kibarides, Timanides etc.); intracontinental ensimatic folded systems - originated from the rifts of eliminated spreading (Red-sea type), which passed through intracontinental monocyclie evolution (Hoggar-Atacorides, Sayano-Enisey system etc.); marginal folded belts. They were formed on the place of ancient continental margins, underwent polycyclic ortogeosyncline evolution of accretionary type (Arabian-Nubian shield etc.) Proterozoic riftogenous structures are closely connected in their evolution with zones of tectono-thermal reworking of ancient basement (Mozambic belt, Stanovoy belt etc.), which are areas of Scattery rifting.

During the first half of Proterozoic only intracontinental riftogenous structures existed. Real oceanic openings and plate tectonics events occured no sooner as middle Riphean. This reflects the evolution of the rifting as well as tectonic process as a whole. Proterozoic riftogenous folded structures and zones of basement reworking predetermined the location of rifts and oceans of Mezozoic and Cenozoic (Stanovay area - Mezozoic rifts; baikalides - Baikal Rift system; Mozambic belt - East African Rift system; Arabian-Nubian area - Red sea rift; Protoatlantic folded system within Gondwanaland - South Atlantic ocean).

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РИФТОГЕНЕЗ ПРОТЕРОЗОЯ

Рифты протерозоя на разных стадиях растяжения литосферы вовлекались в последующие разнотипные эндогенные режимы, что обусловило эволюционную градацию рифтогенных структур: авлакогены - континентальные палеорифты, не затронутые метаморфизмом и гранитизацией; внутриконтинентальные эпсиалические складчатые системы. Возникли из континентальных рифтов повышенной проницаемости, испытавших моноциклическое интрагеосинклинальное развитие включая метаморфизм и гранитизацию (Гудзониды, Кибариды, Тиманиды и др.). Внутриконтинентальные эпсиматические складчатые системы .Возникли из рифтов с ограниченным раскрытием литосферы (Красноморского типа), испытавших моноциклическое интрагеосинклинальное развитие (Хоггаро-Атакориды, Саяно-Енисейская система и др.).

Окраинно-континентальные складчатые пояса. Возникли на месте рифтогенных континентальных окраин испытавших полициклическое ортогеосинклинальное развитие (Аравийско-Нубийская область и др.).

Рифтогенные структуры протерозоя пространственно и генетически связаны с зонами тектоно-термальной переработки древнего субстрата (Мо-

замбикский пояс, Становой пояс и др.), которые представляли собой области рассредоточенного рифтинга.
Первая половина протерозоя характеризовалась исключительным развитием внутриконтинентальных рифтогенных структур. Достоверные океанические раскрытия и проявления плитной тектоники устанавливаются лишь со среднего рифея, что отражает эволюцию рифтогенеза и тектоногенеза в целом.
Протерозойские складчатые области и зоны переработки субстрата предопределили локализацию рифтов и океанов мезо-кайнозоя (Становая область - мезозойские рифты; байкалиды - Байкальская рифтовая система; Мозамбикский пояс - рифты Восточной Африки; Аравийско-Нубийская область - Красное море; протоатлантическая система на Гондванском суперконтиненте - Атлантический океан).

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СРАВНИТЕЛЬНОЕ ИЗУЧЕНИЕ СЕРИЙ КАРТ "ТЕКТОНИКА" И "ВРЕМЯ ДЕФОРМАЦИЙ" ВОСТОЧНОЙ КУБЫ

В геологическом строении Восточной Кубы принимают участие в основном метаморфические образования зеленосланцевой фации (вероятно, юрского возраста), осадочно-вулканогенные и вулканогенные толщи среднего состава апт-альбского яруса, верхнемеловые молассовые отложения, средние и кислые вулканические и осадочно-вулканогенные толщи от верхнего маастрихта до среднего эоцена, верхнеэоценовые и миоценовые молассовые отложения, а также средне-верхнечетвертичные рифтовые известняки.
Две стадии вулканической деятельности (меловая и палеогеновая) вероятно являются результатом субдукции, при которой участок мантии между североамериканской плитой и карибской островной дугой был погружен под островную дугу (питая ее вулканическую и интрузивную деятельность) в южном направлении до полного исчезновения субдукционной плиты мантии и соприкасания северной плиты (багамский край) с островной дугой. Вдоль сутуры формировались покровы ультрабазитов, сопровождаемые меланжем (олистостромами).
В пределах территории в узких поясах субширотного направления сохранились бывший континентальный склон, ископаемая сутура с меланжем и ультрабазитами, а также реликты неогеновой впадины и палеогеновой островной дуги.
Полученные при геологической съемке масштаба I:250 000 Восточной Кубы материалы позволили выделить структурные единицы зонального распространения, которые имеют относительно малую площадь и существенно различный характер, в результате чего тектоническая карта

территории составлена в двух вариантах. Помимо тектонической карты, составленной по структурным этажам на стратиграфической и диастрофической основах, составлен и вариант по "времени деформаций", который предпочитает время и степень деформаций.
В докладе,кроме представления двух вариантов карт приведены достоинства и недостатки отдельных вариантов со сравнительной оценкой.

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THE ROLE OF PRECAMBRIAN STRUCTURES IN THE CONTINENTAL SEPARATION OF BRAZIL AND AFRICA

A study of basement structures within the Brazilian marginal basins, looking for indications pertinent to the initial rifting between Brazil and Africa, revealed important features of tectonic heritage. The basins were formed as a result of the typical development of a passive continental margin, in which heating and doming preceeded rifting. The mesozoic episode of continental fracturing is simply a differential reactivation of a mosaic of lithological and structural discontinuities within the Precambrian basement, and the initial grabens and semi-grabens were totally conditioned by the pre-existing structures.

Brazil separated from Africa mainly along crustal segments formed or affected by the late Precambrian Brasiliano/Pan-African orogenic cycle. Where the structures were more or less parallel to the rifting, like in SE Brazil (Campos, Pelotas, etc.), the tectonic elements of the sedimentary basins were aligned accordingly. Where the coast line sharply truncated the basement trends, like in NE Brazil (Barreirinhas, Potiguar, Sergipe), initial rifting and subsequent tectonic features developed along transverse structures.

In Pará, Maranhão and Bahia, where the ancient São Luiz and São Francisco cratonic areas reach the coastline, subsidence was moderate, rifting less intense, and sedimentary sequences much thinner, indicating lower crustal mobility during the mesozoic reactivation.

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MORPHOSTRUCTURAL ANALYSIS OF THE MOST SIGNIFICANT MARKER SURFACES OF PLATFORMS SEQUENCES AS BASIS FOR THEIR STUDY AND TECTONIC SUBDIVISION

The problem of deep structure and tectonic subdivision of continental crust is of great theoretical and practical interest as a lot of problems concerning recent geotectonics, searches for mineral resourses and geological mapping are closely connected with it. The greater part of the Soviet Union territory is represented by platforms. All types of folded and fractured disturbances from the simplest (in "cover") to the most complex (in "basement") ones are present here. Just there most distinct vertical structural correspondences are established in them. Therefore platforms should be the regions where the development of methods and principles of tectonic subdivision and mapping of continental crust can yield best results.

Published by authors lately the series of isopachous and structural maps of main stratigraphic complexes of the Eastern-European platform have revealed the most significant features of structure locations and, that is more essential, have shown their sharp discrepancies. It leads to the conclusion that only the whole series of the above mentioned maps, being considered as a peculiar 3d model of the earth's crust, may elucidate its structure with maximum visuslization and completeness. To identify the character and closeness of marker boundaries links of lithosphere differentiation the statistical methods of study should be used and, in particular, correlative and trend-analyses with computer system application. Proposed method of geological generalization is successively used under platform conditions of the earth's crust. At the same time it may be a reliable base for the development of new universal principles of such generalizations applicable to any geotectonic environment.

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МОРФОСТРУКТУРНЫЙ АНАЛИЗ ВАЖНЕЙШИХ МАРКИРУЮЩИХ ПОВЕРХНОСТЕЙ РАЗРЕЗА ПЛАТФОРМ КАК ОСНОВА ИХ ИЗУЧЕНИЯ И ТЕКТОНИЧЕСКОГО РАЙОНИРОВАНИЯ

Проблема глубинного строения и тектонического районирования материковой коры представляет большой теоретический и практический интерес, поскольку с ней теснейшим образом связано множество вопросов современной геотектоники, поисков полезных ископаемых и, разумеется, геологической картографии.

Подавляющая часть территории Советского Союза в тектоническом отношении имеет платформенный тип строения. Здесь присутствуют все виды складчатых и разрывных нарушений от простейших собственно платформенных (в "чехле") до наиболее сложных (в "фундаменте"). При этом именно здесь между ними устанавливаются наиболее четкие структурные связи по вертикали. Поэтому платформы в первую очередь должны являться теми регионами, где разработка приемов и принципов тектонического районирования и картирования континентальной коры может дать наилучшие результаты.

Серии опубликованных авторами в последние годы изопахических и структурных карт основных стратиграфических комплексов Восточно-Европейской платформы раскрыли важнейшие особенности их структурных планов и, что наиболее существенно, показали черты их резких различий. Естественно, что это дало основание для крайне важного вывода: только совокупность указанных выше карт, рассматриваемая в качестве своеобразной трехмерной модели земных недр, может осветить их строение с максимальной наглядностью и полнотой. Для установления характера и тесноты связей между маркирующими границами раздела литосферы необходимы статистические методы исследования, в частности корреляционный анализ и тренд-анализ с применением ЭВМ.

Предлагаемая методика геологических обобщений уже с успехом используется в платформенных условиях земной коры. Вместе с тем она сможет послужить и хорошей основой для разработки новых универсальных принципов таких обобщений, применимых к любой геотектонической обстановке.

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EVOLUTION OF THE INDIAN-ASIAN COLLISION ZONE

On the northern Indian margin, a passive Triassic to Lower Cretaceous continental margin is indicated by Indian-shield-derived clastics on the shelf and Atlantic-type turbidites off the northern continental margin. Mid-Cretaceous initiation of ocean closing is reflected in Pacific-type flysch and associated island arc volcanics, which were initially emplaced over the northern Indian continental margin during the late Cretaceous along a predominantly transform fault junction; resulting in the formation of a fore-deep in which flysch and minor molasse accumulated during the late Cretaceous and Palaeocene. These fore-deep sediments were principally derived from carbonate foreland uplifts in front of the emplaced ophiolite.

A return to carbonate sedimentation in the lower to middle Eocene, and the thinness of the late Cretaceous-Palaeocene flysch-molasse, indicate that the late Cretaceous emplacement formed only small, transient uplifts.

With the upper Eocene, the development of a second fore-deep, this time filled with thick flysch and molasse, indicates a major uplift of the northern Indian plate margin, which is attributed to southward subduction and the development of an Andean type magmatic arc on the northern edge of the Indian plate. Uplift, deformation and molasse sedimentation in this fore-deep continued through the Oligocene and Miocene, when the collision of India and Asia caused extensive deformation of all the sequences. Times of deformation, cooling and uplift will be illustrated with data from $^{40}Ar/^{39}Ar$, Rb/Sr and fission track dating, now in progress.

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INTRALITHOSPHERIC DETACHMENTS AND CONTINENTAL EVOLUTION: EVIDENCE FROM COCORP SEISMIC PROFILING

COCORP seismic reflection surveys of crustal structure in the Paleozoic Ouachita-Appalachian compressional belt of the eastern U S and the Cenozoic Basin and Range extensional province of the western U S reveal crustal-scale, shallow-to-moderately dipping detachment zones which have played dominant roles in the evolution of both, seemingly disparate, tectonic terranes. Three regional COCORP seismic profiles now transect the eastern overthrust. The first, and still most impressive, traces lower Paleozoic shelf strata of the sedimentary foreland southeastward beneath the Blue and Ridge and Piedmont metasedimentary and igneous "core", demonstrating that much, if not all, of

the southern Appalachians is allochthonous. 200 km or more of horizontal transport is suggested, with the allochthons overlying remnants of a former (late Precambrian, early Paleozoic) rifted continental margin. Major thrust structures are recognizable almost as far east as the survey extends, although whether a single detachment or series of detachments underlie the entire orogen is open to debate. Some thrust structures may have been reactivated as later Mesozoic normal faults during the opening of the Atlantic. COCORP results across the Quachita foldbelt in the south central U S and across the Appalachians of New England confirm the importance of large-scale overthrusting in the consolidation of Pangea while exhibiting significant variations on the southern Appalachian model. These variations include differences in the composition of the allochthons, in the degree of basement involvement in overthrusting, in the thickness of the foreland basins and in the amount of the inferred "thin-skin" transport. A feature common to all three traverses is a zone of dipping reflections which has been interpreted to lie near edge of the underthrust continental margin, thus establishing an important reference for structural comparisons. On the other side of the U.S. and addressing a more recent geological period, COCORP surveys in the eastern Basin and Range delineate a series of crustal detachments that have, at least most recently,accommodated extension rather than compression. One, the Sevier Desert detachment, can be traced some 70 km laterally with a regional apparent dip of 12 degrees to a depth of at least 15 km, where it appears to splay into a series of even more deeply penetrating structures. Cenozoic normal offset along this detachment appears to be about 50 km. The high-angle normal faults near the surface, which are responsible for the topography which gives this province its name, do not offset these underlying detachments. It is possible that these Cenozoic extensional faults follow pre-existing Sevier overthrusts. Intracrustal detachments are also indicated by COCORP surveys in the southern Basin and Range and Mojave Desert regions. Such detachments may very well represent the third dimension of the accreted mosaics which now comprise both margins of North America.

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STRUCTURAL EVOLUTION OF THE METAMORPHIC CORE OF THE SOUTHEASTERN CANADIAN CORDILLERA

The metamorphic core evolved in the Jurassic during collision of North America and a western allochthonous terrane. Later shearing

and intrusion affected the region in the Cretaceous and early Tertiary, and in the Eocene a regime of crustal extension was superimposed on the previously shortened and thickened crust.

During the collision event, deformation of the infrastructure migrated from west to east as detachment faults carried the suprastructure toward the North American foreland. The dominant sense of shear on detachment faults and associated mylonitic shear zones is directed toward the east. Folds that are related to detachment faults are easterly verging, but regional fold vergence varies with depth and time of formation. The metamorphic culmination occurred after initial collision and was accompanied by formation of west verging folds that deformed the central and western flank of the core zone.

Easterly verging structures (D_1) reflect an easterly sense of shear that was initially induced by overthrusting of flakes of the western allochthonous terrane. Superimposed westerly verging structures (D_2) are considered to have been induced by the westward overriding of the western allochthonous terrane by North America.

Increasing metamorphic grade of the core zone occurred during formation of the westerly verging folds. As metamorphic grade declined and the orogen was uplifted, the sense of underthrusting of the core zone was reversed. Underthrusting from the west was replaced by underthrusting from the east. East verging folds, shear zones and thrust faults were initiated in the core (D_3) and deformation migrated eastward to form the thrust belt of the Rocky Mountains.

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CONVERGENT MARGIN RHEOLOGY AND DEFORMATION IN SOUTHCENTRAL ALASKA

Neogene deformation in the convergent margin of southcentral Alaska reflects lateral changes in lithospheric rheology. Estimated depths to the transition from frictional to quasi-plastic (F/QP) deformation varies from 10-15 km in the interior of the subduction complex, which is composed primarily of quartzo-feldspathic sedimentary rock to 20-30 km in the crust between the subduction complex and arc-massif, where the lower crust is composed of intermediate to mafic crystalline rocks of the Peninsular Terrane. Crustal shortening in the leading edge of the subduction complex is controlled by frictional behavior, with imbricate thrusting, accretion and folding of sedimentary rocks. However, displacement in the interior of the complex is dominated by vertical uplift, forming a large, partly emergent forearc ridge comprising the Chugach and Kenai Mountains. This ridge developed where the subduction complex is thicker than 15 km, and presumably reflects large-scale quasi-plastic flow and metamorphism of quartz-rich rock deep in the interior of the complex. Deformation in the upper, brittle part of the forearc ridge is characterized by cataclastic faulting. Such faults are important along the northern edge of the subduction complex, where crystalline basement of the Peninsular Terrane has been faulted downward during subsidence of Cook Inlet forearc basin.

Deformation in the forearc region north of the subduction complex, in Cook Inlet basin and adjacent areas, is characterized by NW to NNW crustal shortening, NE to ENE extension and subsidence with respect to the arc massif and subduction complex. The maximum shortening direction is subparallel to the slip-vector between the Pacific and North American plates and earthquake hypocenters extend to depths of 20-30 km in the continental basement, consistent with modelling of the F/QP transition. Crustal strain is accomodated by interacting systems of transcurrent, normal and reverse faults, and folding of Neogene sediments.

Modelling of the F/QP transition is used to limit the expected seismogenic depth of faults in different parts of the convergent margin. This information is then

used to predict hypocentral depths, seismic moments and earthquake magnitudes on fault systems.

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HOW DO RIFTS DEVELOP INTO HIGHLY DEFORMED LINEAR BELTS?

Great progress in the understanding of rift systems has followed recognition during the last 30 years that they are very numerous in both continents and oceans and have developed in diverse tectonic environments through much of earth history. Awareness of this large population has permitted appreciation of the range of structures, igneous rocks, sedimentary rocks and economic deposits that may characterize rifts. The variety of possible rift-histories is coming to be appreciated and a new emphasis is being placed on along-strike variation in rifts.
A paradox is that although rifts are defined as: "elongate depressions overlying places where the lithosphere has ruptured in extension", some workers have interpreted highly deformed elongate fold-belts, including greenstone belts, as representing rifts. The style of compressional structures in such well-known rifts as the Southern Oklahoma aulacogen, the Dneprovsk-Donetsk aulacogen and the Benue trough contrasts with that in very intensely deformed belts. Although there may be rare transitional examples (the Western Alps?; the lower Benue?) it appears that Wilson's assessment is valid and rifts do not normally develop into strongly deformed, linear fold belts without passing through an intermediate oceanic stage.

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HERCYNIAN OROGENIC BELTS OF EUROPE, AUSTRALIA AND ANTARCTICA

Hercynotype orogenic belts have been distinguished from Alpinotype orogenic belts, indeed some have claimed a completely ensialic origin for both. However, syntheses of the Hercynides of Europe and the Lachlan Belt in eastern Australia reveal very few fundamental differences with either the Caledonides or the Alps. Both Hercynian belts have an early history of back arc spreading. In Australia back arc basins may have existed in the Cambrian of western Tasmania and in the Ordovician of Victoria and New South Wales. Comparisons have been made to the modern day Andaman Sea but a South China Sea analogue may be just as appropriate. Similar comparisons may be made between the South China Sea and/or Japan Sea and the Devonian-Lower Carboniferous basins of the Rhenohercynian Zone. 'Thin skinned' interpretations of both belts, promulgated by some for years, but hindered by low relief and poor outcrop, are now becoming more popular and have been proved in Europe by seismology and deep drilling.

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CONTRIBUTION TO A GEODYNAMICAL SYNTHESIS IN THE PROVENCAL BASIN

The Provencal Basin, located in the North Western Mediterranean, has been created after a rifting stage by the counterclockwise rotation of Corsica and Sardinia during Oligo-Miocene times.
We propose here a reconstruction of the opening of this microocean which is consistent with the extensive data which have been collected during the past half decade all over the basin.
Deep seismic data as well as conventional reflection lines and magnetics have been especially considered.
Our results suggest that a rotation of about 20° for Corsica and 35° for Sardinia occured during Aquitanian-Upper Burdigalian times.
The kinematics of the drifting is described through an interpretation of the complex magnetic pattern according to the Vine and Matthews hypothesis:
- a first $5\text{-}10^{\circ}$ rotation occured while Corsica and Sardinia were rigidly bounded.
- a second step lead to different amounts of rotation for each island ($5\text{-}10^{\circ}$ for Corsica, $25\text{-}30^{\circ}$ for Sardinia).
These results are consistent with field data and paleomagnetics.
The processes of margin thinning and oceanic accretion in the Provencal Basin are examined and compared with those reported in the marginal seas of the Western Pacific.

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ПАЛЕОГЕОДИНАМИЧЕСКИЕ ОБСТАНОВКИ ПОЗДНЕГО РИФЕЯ-СРЕДНЕГО КЕМБРИЯ МОНГОЛИИ

К началу кудаша (R_4) вся территория Монголии представляла собой складчатое сооружение, сформированное в результате предкудашской складчатости. Распад палеоазиатского материка к началу кудаша и почти синхронная с ним мировая трансгрессия создали на территории Монголии значительно дифференцированные геодинамические обстановки. На это указывают типоморфные формационные комплексы. Комплексы меланократового и сиалистического основания отнесены к древнему фундаменту. Меланократовым основанием подстилаются океанические и некоторые переходные структуры, а сиалическим основанием сложены южные склоны Сибирского и северное обрамление Китайского континентов, а также отторженцы в пределах океанических структур. Формиро-

вание палеозойского океана началось с заложения внутриконтинентальных рифтовых систем. Рифтогенные комплексы не сохранились в пределах океанических структур. Известны они только по краям или внутри древнего их обрамления: Тувино-Монгольский, Центрально-Монгольский, Тотошаньский массивы. Это говорит о том, что развитие одних рифтов заложило начало океанического пространства, а других - остановилось на стадии рифта. Рифтогенная формация представлена бимодальными вулканитами и кластическими образованиями кудаша. К комплексам океанической и переходной стадии относятся зеленокаменные кремнисто-вулканогенные, вулканогенно-граувакковые, терригенно-карбонатные флишоидно-терригенные образования, а также габбро-плагиогранитные, гранодиорит-гранитные комплексы. При этом одни комплексы являются типоморфными для океанической равнины, островной дуги,а другие - для внутреннего и окраинного моря, а также континентального склона и шельфовых зон. Возраст этих комплексов, выполняющих Озерную, Джидинскую, Керуленскую и другие зоны,определяется как венд-средний кембрий включительно. Таким образом, геодинамические обстановки позднего рифея—среднего кембрия территории Монголии определились, с одной стороны,ее расположением между двумя древними плитами и с другой - неоднородностью ложа океанического бассейна.

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SEAWARD OBDUCTION OF A SEAMOUNT? AT CONTINENTAL MARGIN, OLYMPIC PENINSULA, PACIFIC COAST OF WASHINGTON STATE, U S A

Fifteen kilometers of Eocene tholeiitic basalt crop out in a horseshoe pattern, north, east, and south of the center of the Olympic Mountains. Abyssal marine volcanic rocks fill the lower two-thirds of the section, and east and southeast of the center of the mountains these rocks grade upward into chiefly Hawaiian-type terrestrial tholeiite. The abyssal tholeiite contains continent-derived dioritic boulders as much as three meters in diameter, and intertongues stratigraphically with marginal continental turbites and shales. Thus the tholeiite did not have the usual marine surroundings, with the bathymetric profile of a conventional seamount, during its extrusion. In the mountains, and west of the main body of the tholeiite, sediments with which the western extremities of the tholeiite are intertongued are included in a partly metamorphosed accretionary prism, over which the main body was thrust westward in late Oligocene. Eastern units of the prism, as well as part of the overthrust tholeiites, were tipped over eastward, a little beyond the veritcal, in late Miocene. This movement was probably in response to both domal uplift of the buoyant prism sediments in the

Olympic Mountains and the oroclinal folding responsible for the horseshoe pattern of the main body of tholeiite. Seaward obduction instead of landward subduction of the land-bound seamount is probably to be explained by both its continental attachment and its greater thickness and related rigidity, above the more ductile rocks of the accretionary prism.

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THE STRUCTURAL STYLE AND TECTONIC EVOLUTION OF THE RIO GRANDE RIFT, WESTERN NORTH AMERICA

The Rio Grande rift has undergone deformation by two distinct extension processes: early, relatively large extension at high strain rate, and later small extension at low strain rate. The Oligocene-Miocene, high-strain-rate environment caused crustal extension by low-angle faults, commonly along detachment surfaces between competent and incompetent lithologies (i.e., Precambrian basement and Phanerozoic sediments, or within the Phanerozoic sequence). Deformation in this regime was accompanied by lithospheric thinning, voluminous intermediate and lesser mafic volcanism, widespread thermal activity, and a structurally high brittle-ductile transition in the crust. This deformation might be classified as "active" rifting, that is active involvement of the asthenosphere, mainly in the form of thermal processes, in the formation of the rift. The absence of a broad crustal dome in the early Rio Grande rift, which is commonly associated with "active" rifting, was probably due to isostatic "anchoring" of the lower crust by the intrusion of mafic magma in the form of dikes and sills.

Numerous examples of high-strain-rate structural fabrics are present along the flanks of the bounding uplifts of the Rio Grande rift, and locally in horsts within the rift basins. These areas include, from north to south, the Taos Range, Sangre de Cristo Range, Sandia-Manzano Uplift, Lucero Uplift, Ladron Uplift, Socorro-Lemitar Range, Joyita Uplift, Black Range, San Diego-Tonuco Uplift, San Andres Mountains and Franklin Mountains. Detachment surfaces in Precambrian crystalline rocks commonly are characterized by low-angle cataclastic fabrics formed by slip, with superimposed corrugations due to intersecting Riedel and P-shears. The overlying and younger stratigraphic section generally dips into the Precambrian along the detachment zone.

Low-strain-rate extension characterizes the late-stage, Pliocene-Recent deformation of the rift. High-angle faulting, localized bimodal volcanism, basin filling, and deepening of the brittle-ductile transition are the characteristic processes of this regime. Local exhumation of deep-seated, early rift structures by block faulting, and broad regional doming due to mantle attenuation of the lower crust developed during this period. The primary driving force of extension in the late stage of the rift was essentially "passive", that is regional tensional stress on the lithosphere of the western United States due to plate boundary effects.

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THE MEXICAN THRUST BELT AND THE OIL AND GAS NEW MESOZOIC TRAPS

The thrust and folded belt is a narrow and continous trend through the mexican territory, and divides it in two geological different areas: the Eastern part, circum gulf of Mexico narrow coastal plain and the Western wide Pacific Range. The thrust belt is a high

complex deformed imbricated trend broken by lateral faults in different sectors. The thrust belt is abruptly interrupted in the southern end by the active Polochic-Motagua fault system.
The Northern trend is hardly understand up to now. It abruptly changes its general N-S orientation by a E-W transverse sector between the cities of Torreon and Monterrey and it finishes at the NW into the Basin and Range morphology and below the Sierra Madre Occidental Cenozoic volcanic thick sequence. At the NE starts the Rocky Mountains - Sabinas trend, broken by the basin and Range morphology and by the Rio Grande graben. The thrust belt plays a role of tectonic limit for oil and gas Mesozoic large productive reservoir, which are confined to the eastern Gulfean area. Nevertheless, the exploration in central areas below the broken front of the thrust belt, could lead to discover new large oil fields like the Alberta-Canada and Wyoming in USA.

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THE TECTONOSTRATIGRAPHIC MAP OF MEXICO

The mexican territory is the pass between Northamerican craton and the Central American complex and the caribbean folded areas. The active tectonics show the rupture and desintegration of these areas by lateral tension and compressive movements; - oceanic, inland and mixted fragments of crust were displaced by the lands of the plate kinematics. Every paleofragment here called terrane, has a specific stratigraphy and paleomagnetic record, style of deformation and its boundaries are faults or complex obliterated belts.

The maping criteri of this terranes is different from the classical tectonic and geologic maps and the result are the so-called "tectonostratigraphic maps". This is another principle of tectonic zonation of the continents. The tectonostratigraphic map of Mexico shows that more than the 80% of the territory is not autochthonous southern trending of the Northamerican Craton. The preliminar evidences on the contrast show that it has a complex history of displacements were constructing the continent by ancient accretionary events. The paleographic reconstructions give the possibility of large displacements of more than a half of Mexico before the triassic time.
This tectonostratigraphic map is the base of the new geopetroleum map and the metalogenetic map of Mexico.

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GEOCHEMISTRY OF VOLCANIC-ROCKS INVOLVED IN ANKARA MELANGE, CENTRAL TURKEY

Recent geological studies (Akyürek et al., 1982)has shown that Ankara Melange is composed of imbricated slices of 1) pre-Jurassic basement rocks (Ankara Group): consisting of a) metamorphic rocks (Emir formation) including blocks of ultramafic rocks, b) a tectonic melange with detritic rocks (Elmadağ fm.) and basaltic rocks (Ortaköy fm.), 2) younger (Jurassic) sedimentary cover of basement rocks (Keşikaya fm., Hasanoğlan fm. and Akbayır fm.), 3) a partial ophiolitic slice with peridotite, gabbroic and volcanic rocks (Eldivan Ophiolite) of Lower Cretaceous age, 4) Ophiolitic Melange in "sensu stricto" (Kılıçlar Group) of Senomanian-Campanian age, 5) Maestrichtian-Paleocene sedimentary sequence unconformably overlying the ophiolitic melange and 6) the younger series. Petrography and geochemistry of volcanic rocks involved in these units have been studied. This paper aims at presenting the petrochemical properties of these different volcanic flows and to compare them in regard to their origin, chemical evolution in space and time. Studies have revealed the existance of at least four different volcanism varying in age from Triassic to Upper Cretaceous. First one is associated with metamorphic rocks of greenschist facies and is of "transitional" to "alkaline" character according to Y/Nb ratio (Pearce and Cann, 1973). Second volcanism is associated with late Triassic-Jurassic sedimentary series. It is (Ortaköy fm.) in the form of pillow lavas and has "transitional" to "alkaline" composition. Third submarine volcanism is associated with Eldivan Ophiolite but has a "transitional" character. Fourth one is alkaline, zeolite bearing basaltic volcanism of Campanian age and it is associated with ophiolitic melange (Kılıçlar Group). This is considered as tardiv volcanism after ophiolite emplacement and it is also reported from inner Pontids. It took place during Senonian time where influx of ophiolite derived olistostromes and blocks were depositing in a Senonian basin together with detritic rocks, calciturbidites and radiolarites. Petrochemistry of these different volcanic sequences are compared, interpreted and their implications are discussed.

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REGIONAL TECTONICS' REGULARITIES OF THE UKRAINIAN SSR

There was suggested a new dynamo-metamorphic approach (O.I.Slenzak) for an explanation of tectonic, geochemical, petrological and metallogenic features of Pre-Cambrian formation of the Ukr.SSR, the main

point of which is analyses of kinematics and fields of stresses of moving rigid blocks and deformed zones separating them. These zones are divided into two main types: zones of friction - sliding and zones of friction - swaying. The principal scheme of the structure of zones of friction is: ball- and ellipsoid-shaped nuclei made by granitic rocks are inside, gneissy-shally mantles fringing them are along the edges. On this basis there formed schemes of tectonic and metallogenic zonings of the Ukrainian shield.

Phanerozoic tectonics of the Ukr.SSR stipulated by the dynamics of differentiated moving blocks of the earth's crust and reacting on these movements sedimentory cover. Deep faults' zones, among which there distinguished four main trends for each geological period (two - diagonal and two - ortogonal), determined fault-block structure of the territoty and regularities of the development on it the processes of geomorphogenesis, sedimentogenesis, tectono-magmogenesis, orogenesis, riftogenesis and oregenesis.

Starting from Riphean the development of the geological structure of the Ukr.SSR was on two main trends: in the South - on the line of an expantion of Pre-Cambrian platform on account of the reckoning in it new consolidated parts of Baikalian, Caledonian and Hercynian orogens, in the North - on the scheme of a divide of the platform and a formation of zones (subgeosynclinal) making secondary active (avlacogenes, riftogenes, syneclises and synclinores and etc.). On this basis there formed the scheme of tectonic zoning of the Ukr.SSR and maps of spreading of deep faults' zones, tectono-magmatic structures and potential areas.

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ЗАКОНОМЕРНОСТИ РЕГИОНАЛЬНОЙ ТЕКТОНИКИ УКРАИНСКОЙ ССР

Для объяснения тектонических, геохимических, петрологических и металлогенических особенностей докембрийских формаций УССР предложен новый, динамометаморфический подход (О.И.Сленэак), сущность которого сводится к анализу кинематики и полей напряжений движущихся жестких блоков и разделяющих их деформационных зон. Эти зоны делятся на два основных типа: зоны трения - скольжения и зоны трения - качения. Принципиальная схема строения зон качения такая: внутри шарообразные и эллипсоидальные ядра, сложенные гранитными породами, по краям окаймляющие их гнейсо-сланцевые оболочки. На этой основе составлены схемы тектонического и металлогенического районирования Украинского щита.

Фанерозойская тектоника УССР обусловлена динамикой дифференциально дфигающихся блоков земной коры и реагирующего на эти движения осадочного чехла. Зоны глубинных разломов, среди которых для каждого геологического периода выделяются четыре основных направления (две диагональные и две ортогональные), определили разломно-блоковую структуру территории и закономерности развития на ней процессов геоморфогенеза, седиментогенеза, тектоно-магмогенеза, орогенеза, рифтогенеза и рудогенеза.

Начиная с рифея развитие геологической структуры УССР шло по двум основным направлениям: на юге по линии расширения докембрийской платформы за счет причленения к ней новых консолидированных участков байкальского, каледонского и герцинского орогенов, на севере по схеме дробления платформы и образования зон вторичной (субгеосинклинальной) активизации (авлакогены, рифтогены, синеклизы, синклинории и др.). На этой основе составлены схема тектонического районирования УССР и карты распространения зон глубинных разломов, тектоно-магматических структур и прогнозных площадей.

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A MODEL FOR TECTONIC EVOLUTION OF CONTINENTAL MARGINS IN THE USSR NORTH-EAST

1. The formation of mature continental crust in the North-Eastern mesozoides as indicated by such characteristic features of this process as granitoidal magmatism and the Okhotsk-Chukchi continent-marginal volcanic belt was a one-act process that terminated in the Albian-Cenomanian. During the Preriphean time only a nonuniform granitic-metamorphic layer was formed with patches of continental crust. Its further repeated accretion accompanied by destructive manifestations underlied the geosynclinal process and determined its complicated and contradictory features.

2. Similarly constructive and complicated by destructions was the development of the Koryak-Kamchatka region adjoining the mesozoides, i.e. a part of the modern zone of transition from the Asiatic continent to the Pacific ocean. It occurs at a late geosynclinal stage of development featuring the initiation of continent-marginal volcanic belt. With its lay-out completed it would be logical to expect a consolidation of this geosynclinal-fold system conjugated to the continent as well as a separation of it from the adjacent Pacific areas by newly-formed insular arcs thus isolating the emergent granitic-metamorphic layer entering an early geosynclinal stage of development.

3. Within the North-East of Asia a lateral row of geosynclinal-fold

structures is thus recognized occurring at various developmental stages the totality of which may be envisaged as an evolutionary model for continental margins of Western Pacific type. On the whole, the evolution was accretional in character which is particularly reflected in "re-entrant angle" structures (Verkhoyansk, Chersky, Polousny, Talovka-Pekul'nei, Kurile-Kamchatka) that serve as boundaries between the successfully emerging granitic-metamorphic layers. However, the fact that destructive processes which may be vigorous enough to form peculiar riftogenic zones of the Alazeya-Oloy type (e.g. the Chersky-Polousny structure) are also manifestated suggests a dual and antagonistic character of tectonic processes occurring at continental margins.

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МОДЕЛЬ ТЕКТОНИЧЕСКОЙ ЭВОЛЮЦИИ КОНТИНЕНТАЛЬНЫХ ОКРАИН СЕВЕРО-ВОСТОКА СССР

I. Формирование зрелой континентальной коры в мезозоидах Северо-Востока, судя по характерным индикаторам этого процесса - гранитоидному магматизму и окраинно-континентальному Охотско-Чукотскому вулканическому поясу, было одноактным, завершившимся в альб-сеномане. В дорифейское время был образован лишь неравномерный (с островками континентальной коры) гранитно-метаморфический слой. Дальнейшее неоднократное наращивание его, с одновременным проявлением деструкции, и составило суть геосинклинального процесса и определило его сложность и противоречивость.
2. Таким же конструктивным, осложнявшимся деструкцией, было развитие смежного с мезозоидами Корякско-Камчатского региона - участка современной зоны перехода от Азиатского континента к Тихому океану. Он находится на позднегеосинклинальной стадии развития, когда окраинно-континентальный вулканический пояс лишь начинает формироваться. С завершением его становления логично ожидать консолидации, причленения к континенту и этой геосинклинально-складчатой системы, а также "отшнурования" от смежной акватории Тихого океана новообразованными островными дугами участков вновь сформированного гранитно-метаморфического слоя, вступающих в раннегеосинклинальное развитие.
3. В пределах Северо-Востока Азии намечается, таким образом, латеральный ряд геосинклинально-складчатых структур, находящихся на различных стадиях развития и в совокупности представляющих модель эволюции континентальных окраин западнотихоокеанского типа. В целом эволюция имела направленно аккреционный характер, что отражено, в частности, структурами "входящего угла" - Верхоянской, Черско-Полоусной, Таловско-Пекульнейской, Курило-Камчатской, представляющими

собой границы последовательно формирующихся гранитно-метаморфических слоев. Однако проявление в них деструктивных процессов, иногда вплоть до возникновения, как в Черско-Полоусной, своеобразных рифтогенных зон типа Алазейско-Олойской,- свидетельство двойственности и антагонизма в протекании тектонических процессов на континентальных окраинах.

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TECTONIC OUTLINE AND EVOLUTION OF THE HENGDUANSHAN REGION

This paper deals with five main aspects about the tectonics of the Hengduanshan (Transverse Mountains) Region, i.e. the division of the tectonic units, the division of the tectonic cycles, the deep fractures and subduction zones, the evolution of the Tethys Ocean and tectonic development.

On the basis of a lot of recent geological and geophysical data, the authors have compiled a new tectonic map of Transverse Mountains and attempt to briefly describe the various tectonic units, deep fracture and subduction zones with necessary revisions and supplements as compared with previous articles.

In part of the tectonic cycles, the authors would like to emphasize the great significance of the Variscan and Indosinian Cycles in the evolution of the Tethys Ocean.

Finally this paper has summarized three major stages of tectonic development, i.e. the geosyncline-platform stage in Paleozoic and Pre-Paleozoic, the evolutional stage of the Tethys Ocean, the stage of the intensive compression from south or the formation and development stage of the Qinghai-Xizang (Tibet) Plateau.

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SOUTH HIMALAYA DIWA (GEODEPRESSION) REGION

The Himalayan Mts. area has been referred to Cenozoic geosyncline region. According to new data and from the writer's viewpoint, only its

N. margin along the R. Yarlung Zangbo has geosynclinal nature, while its main part including High Himalaya Mts. Lower Himalaya Mts. and Siwalik fault-depressed zone is in fact a diwa region. Chrystalline basement composed of Qomolangma Group (metamorphosed in 640-660 ma), and Rouqie Group (U. Sinian) represents the geosyncline and older stages. On the basement are overlain unconformably Ordovician to Cretaceous sediments with typical platformal features, mainly of marine and partly continental with Gondwana flora Glossopteris. Apparently the S.Himalaya Diwa Region was a part of the ancient pre-Cambrian India Platform before Tertiary. In Neogene, resulting from platformal activation, the diwa stage was coming with serious folding, faulting and magmatic activities. Sharp structural-topographical contrast began to appear as zones of geodomes and diwa basins. Besides, collision and compression between Indian and Euasian crust bodies strengthened the deformation with repeated thrusts. The High Himalaya Mts. including the Peak Qomolangma which was fragments of the N. edge of the ancient India Platform has been rising in this way and has become a geodome series so lofty seen today.

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GEOTECTONIC NATURE OF THE FEN-WEI GRABEN - A RIFT-TYPE DIWA (GEODEPRESSION)

Fen-Wei graben is situated on the W. Margin of N. China diwa Region, stretching zigzag, NNE-SSW, 1400 km long, 10-100 km wide. It cuts the Shanxi Plateau (av. altitude 2 km) with great depth (5-6 km), filled up with Cenozoic sediments (thickness 3-4 km, at Taiyuan 6 km). Associating with the mainly vertical displacements of the marginal fault zones, the graben extended laterally up to 7 km (S. part). Earthquakes with foci 10-30 km deep were frequent, $M \leq 8$. Twenty-four times of eruptions mainly of alkaline basalts happened locally (at N. part) in Cenozoic. Heat flow looks rather high as marked by 17 hot springs. Negative Bouguer anomalies are dominant, max. - 200 mgal. The crust is av. 38 km (at Xian 27 km) thick, 2-4 km thinner than that of the marginal uplift zones (40 km, at W. of Taiyuan 45 km). Apparently a mantle arched belt exists below. In the upper mantle, V_p=7.95 km/sec. Originally here was a part of the broad ancient China Platform. In early Jurassic, it was activated and entered the diwa stage. Since Eocene, the Fen-Wei rift-type diwa began to exist, produced mainly by the creeping of the asthenospheric materials. It may be referred to the crevice type of post-platformal continental rift-zones in E.E. Milanovsky's classification.

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THE PRELIMINARY STUDY OF THE MESOZOIC DEFORMATION STRUCTURE IN THE CENTRAL PART OF XIZANG (TIBET) PLATEAU

The Mesozoic deformation structures in the central part of Xizang (Tibet) Plateau could be divided into five stages: 1) The compression in N-S direction: The tight folds with E-W axial trending of the Late Triassic Series were formed during this period; 2) The compression in E-W direction and the expansion in N-S direction: The cleavage planes formed previously in the Late Triassic strata were folded, the Olistostrome melanges were formed, and the Ophiolite materials occurred along the rifts and trenches; 3) The compression in N-S direction: The N-S lineations in Ophiolitic rocks were folded, the Ophiolites were emplaced, the Ophiolitic melanges were formed, and the Jurassic-Early Cretaceous strata were folded; 4) The intense compression again in N-S direction: The Late Cretaceous and Eocene strata were folded, and the regional cleavage planes trending near E-W direction or the Nappe structures occurred; 5) The compression in E-W direction and the shear in N-S direction: The cleavage planes in N-S direction and the normal faults occurred in both the volcanic breccia beds of the Island-Arc area and the Molasse conglomerate beds.

The five period deformations mentioned above took place separately in Mid-Late Jurassic, Early Cretaceous, Late Cretaceous, Eogene, and Neogene. Owing to these deformations, three major tectonic lineations (E-W, NE and NW, near by N-S) for their marks were preserved.

These deformation, particularly the ductile deformation, reflect the Crustal movement in the depth or Upper Mantle. They are closely related to the separation or closing of the plates.

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STRUCTURE AND EVOLUTION OF SOME CONTINENTAL RIFTS CONSEQUENCE FOR THEIR THERMO-MECHANICAL EVOLUTION

Numerous continental rifts of Mesozoic and Cenozoic ages are characterized by an extensional structure with horst, grabens and tilted blocks bounded by listric normal faults.

In the case of pure extensional rifts, where the minimum stress σ_3 is perpendicular to the mains axis of the rifts, the main nor-

mal faults often display a general curvature toward the central through (Gulf of Suez, Bay of Biscay continental margin).
The amount of extension, that may be deduced from field, seismic and well data appears to be relatively low (less than 50%) in the case of rifts where volcanic activity is rare.
The subsidence ratios during rifting in these extensional rifts vary in time and space. Short term variations (less than 2 my) may appear, associated with the isostactic response of the lithosphere, where densities repartition may be rapidly modified.
These observations on rift evolution suggest that the rifting is not only related to the simple stretching at constant rate of the lithosphere. The extension of the upper crust is much less important than the thinning of the lower crust and the lithospheric mantle. These constraints are included in a thermo-mechanical model of lithospheric extension.

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TRIASSIC AND JURASSIC TECTONIC MOVEMENTS IN CENTRAL JAPAN

In Central Honshu Arc, Japan, the zonal arrangement of tectonic belts, from Japan Sea side to Pacific side, is:

Hida gneiss complex terrane — gneiss (1493Ma, 679Ma); Funatsu-type granite (180Ma)

(thrust)

Unazuki Metamorphic Belt — Intermediate P-T type (240Ma)

(thrust)

Hida Marginal Structural Belt
- Tetori Group (Late Jurassic)
- Kuruma Group (Early Jurassic) — shallow sea, Coniopteris-Ptilophyllum flora
- Okutone Group (Late Triassic)
- Inner melange zone — Weak- or unmetamorphosed Paleozoic (olistostrome)
- Outer serpentinite melange zone — high-pressure type schist as tectonic block (410-310Ma)
- Omi Limestone block overlying basic volcanics (Early Carb.- Up. Permian)
- Serpentinite nappe zone
- Meta-ophiolite zone

(thrust)

Mino terrane (Permian to Jurassic)

Middle to Late Triassic tectonic movement: Hida Marginal Structural

Belt consists of the metamorphic complex formed in a subduction zone and sedimentary piles formed in a fore arc basin during Early Carboniferous to Early Triassic ages. They as a whole were compressed and the original structure disappeared, associated with the serpentinite melange protrusion during Middle to Late Triassic tectonic movement.
Jurassic tectonic movement: Those complexes were overlain unconformably by the Kuruma Group during Early Jurassic age. Eastward thrusting took place again just after the sedimentation of the Kuruma Group, associated with the secondary protrusion of serpentinite melange.

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NUMERICAL MODELLING OF MANTLE CONVECTION AND PLATE MOTION

The recent advances in modelling mantle convection are reviewed with special emphasis put on the implications for the constitution and movement of lithospheric plates. An important aspect in reconciling fluid models of mantle convection with rigid plate kinematics seems to be the non-Newtonian character of mantle rheology, i.e. the dependence of effective viscosity on stress. Other aspects of mantle convection are also influenced by non-Newtonian rheology.
An unsettled issue for over a decade is the ultimate fate of the subducted lithosphere, especially whether it penetrates the lower mantle or not. Translated into the picture of fluid convection, this became the question of whole mantle flow is layered convection. Numerical models have been used to determine the characteristics and the premises of layered convection. Regarding the other end of the plate tectonic cycle, numerical calculations indicate that it is unlikely that spreading ridges are connected with a rising branch of a convection cell. Localized upwellings may exist in the mantle in form of axisymmetric plumes which cause mid-plate volcanism. The instability of a hot low-viscosity boundary layer of the large-scale convection is a very likely source for such plumes. Another kind of secondary convection - i.e. convection unrelated to the plate tectonic cycle - might be triggered by an instability of the lower lithosphere and take the form of small-scale convection in the upper mantle. This could provide an explanation for the flattening of the age dependence of ocean depth at old ages and determine the maximum thickness and thermal structure of continental lithosphere. The sublithospheric convection has no direct surface expression; topography and gravity anomalies may

provide indirect evidence for its existence and structure. Recent work shows that the gravity signal of convection depends critically on the viscosity stratification.
Finally a couple of open problems and possible steps towards their solution are discussed.

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POSICION DE CUBA ORIENTAL EN LA GEOLOGIA DEL CARIBE

En el trabajo, sobre la base de un extenso estudio bibliográfico y los resultados de sus propias investigaciones, los autores realizan un análisis de la posición de Cuba Oriental en la geología caribena. En los últimos 15 años, la geología de Cuba Oriental ha sido tema de gran interés para los investigadores de la geología regional del Caribe, área clave en cualquier reconstrucción paleogeográfica, en especial aquellas basadas en la teoría de las placas. Particular interés reviste el territorio ubicado entre la llamada falla Cauto y la falla Oriente, el cual ha ocupado diversas posiciones en distintas reconstrucciones paleogeográficas y paleotectónicas. Muchos especialistas suponen que la corteza terrestre entre ambas fallas se originó y desarrolló lejos de Cuba, uniéndose a ella en una etapa tardía de su evolución geológica. Sin embargo, los rasgos fundamentale de la estratigrafía, tectónica y magmatismo del Cretácico y Cenosoico a un lado y otro de la "falla" Cauto son similares o complementarios, lo cual evidencia que, al menos desde el Cretácico, la corteza terrestre a un lado y otro de la supuesta dislocación ha tenido una historia similar y estrechamente vinculada, sin desplaza mientos horizontales de consideración según la hipotética falla.
Al norte de la "falla" Cauto, las ofiolitas, junto con las vulcanitas y clastitas cretácicas, están sobrecorridas yaciendo sobre los cortes miogeosinclinales (zona Remedios). Los datos geológicos y geofisícos muestran que la corteza terrestre en el noroeste de Cuba Oriental es continental (o subcontinental ?), yaciendo sobre ella un pequeño espesor de ofiolitas y rocas supracorticales cretácicas.
Varios geólogos y geofísicos, entre ellos uno de los autores, sostienen que la corteza terrestre entre las fallas Cauto y Oriente es suboceánica, fundamentados en la interpretación de los datos geofisicos, aunque las similitudes geológicas a ambos lados de la "falla" Cauto obligan a considerar que, al menos desde el Cretácico, la evolución geológica de toda la región esta estrechamente vincu-

lada y que, por tanto, pudiera no existir ningún cambio sustancial en la composición cortical en el territirio.
Las reconstrucciones paleogeográficas cenozoicas de Cuba Oriental muestran que la fosa de Bartlett (Cayman) no se originó hasta el Mioceno y que el desplazamiento horizontal, a lo largo de la falla Oriente, no debe sobrepasar los 175-200 km.
En el trabajo se estudian tambien algunos aspectos relacioados con la geología de Cuba Oriental poco conocidos como son: interrelación entre las propiedades físicas de las rocas y la geología, características petroquímicas de las ultrabasitas y presencia de estructuras circulares vinculadas a la mineralización endógena.

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CRUSTAL STRUCTURE AND TECTONICS OF THE BERING SEA REGION

The Bering Sea comprises a multitude of tectonostratigraphic terranes, structural elements, and in-place sedimentary and igneous rock masses that include: 1. a continental shelf and margin underlain by a basement framework of Mesozoic island arcs and accreted terranes overlain by thick basinal sequences that accumulated in younger Cenozoic rift basins and crustal sags; 2. belts of deformed rocks associated with Mesozoic and Cenozoic subduction zones and transform faults located along the Alaska-Siberia margins; 3. a fragment of Mesozoic oceanic crust, Aleutia, beneath the Aleutian Basin that was trapped there in early Tertiary time and subsequently deeply buried by Cenozoic sediment; 4. crustal massifs, oceanic plateaus or remnant arcs that cordon and flank the deep-water Bering Sea basins; and 5. an active volcanic island arc guarding the southern border of the basin.

The various process that formed the disparate basement structures of the region were largely initiated in Mesozoic time as the consequence of northwestward movement of Pacific crust, Aleutia, and its piggy-back terranes of thicker crust against and laterally along the Siberian-Alaska margin. Subduction, transform faulting, and accretion of the approaching oceanic crust significantly deformed the Alaskan and Siberian margins and created regional basement structures. The uplifted and eroded remnants of the resultant fold belts, the interior basins, the implaced tectonstratigraphic terranes, and the arc massifs are the foundation of the present inner Beringian and Alaskan shelves.

Large structural basins, filled with Cenozoic sediment, are rifted into predominately sedimentary terranes beneath the outer Beringian shelf. These basins, which juxtapose the interior shelf massifs, subsided initially in early Tertiary time along the pre-existing transform margin. Vertical uplift and subsidence of the continental shelf, formation of the Aleutian arc, and voluminous sedimentation in the back-arc Bering Sea basin and outer shelf basins have characterized the Cenozoic evolution of the Bering Sea Region.

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CALEDONIAN AND TERTIARY STRUCTURES IN WEST SPITSBERGEN

The coastal mountains of west Spitsbergen south of Bellsund expose a thick Proterozoic mainly sedimentary sequence, the Hecla Hoek (HH), unconformably overlain by a Carboniferous-Tertiary sedimentary platform sequence (PS). The HH terrane is complexly deformed, and three groups of structures are recognized - probably all of Caledonian age. The oldest group (D_1) includes a NNW-trending ridge-groove lineation within a layer-parallel dynamic foliation, small isoclinal folds with axes parallel to the lineation and axial planes parallel to the foliation, and probably some large recumbent folds. The second group (D_2) includes NW-trending asymmetric folds with a strong transverse foliation that dips moderately to the SW. The youngest group includes NNW-trending open folds with a weak vertical foliation, horizontal crinkles, some cross folds, and kink bands. In contrast, during early Tertiary deformation in a zone of transpression the coastal HH behaved mainly as rigid blocks which rose along steep faults above the PS to the east. A narrow fold-and-thrust belt (10-20 km wide) developed in the tilted PS from eastward down-dip translation of PS beds and the upward propagation of faults from the HH. Later in Tertiary time an extensional phase, probably following the separation of Spitsbergen and Greenland, formed local NNW-trending graben.

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THE SPACING OF RIFT AXIS MORPHOLOGICAL DOMES: DEPENDENCE UPON DIAPIRIC PROCESSES IN THE UNDERLYING ASTHENOSPHERE?

The near periodic distribution of morphologic domes on slow to fast spreading centers may be an indication of deep seated magma dynamics within the asthenosphere underlying the ridge axis where a linear region of instability may develop at the onset of partial melting. This fluid instability may be similar to the Raleigh-Taylor instability model. Less dense fluid at depths of 40-80 km may penetrate the overlying fluid at discrete and ideally evenly-spaced points. This periodic upwelling should generate excess magma at discrete points on the ridge axis creating volcanic domes. The spacing between domes will depend upon the continuity and thickness of the deep axial instability layer, the temperature and viscosity ratios of the subjacent magma, and the distance between transform faults. Non-ideal geometry may stimulate the migration of the domes through time.

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TECTONIC MODELS AND COMPARATIVE STUDIES OF ANCIENT FORE-ARC TERRAINS

Conceptual models, which relate observed rock associations and relationships to formative processes, are widely used in sedimentology and tectonics. Some are

specific to particular regions: no general applicability is claimed. Others, derived from studies in several regions, claim a more general applicability. They usually include variants of some common theme, thereby accommodating observed differences between regions.

In tectonics, unlike sedimentology, the development and application of models is unsystematic. Procedures for their construction and criteria for their application and validation are needed.

A general tectonic model must summarise the essential features of several particular cases. It must serve as a norm for comparative purposes; be a guide for future observations; have potential as a predictor for new geological situations; and provide a basis for process-interpretation of the system it represents.

Tabulation of observed tectonic attributes, followed by systematic comparison of regions, provides a systematic basis for constructing a general model. Its validity or relevance to any region may be assessed by comparing tabulations of model attributes and observed regional tectonic attributes. Useful working hypotheses may result. Process aspects remain conjectural.

This procedure is exemplified using a fore-arc model of crustal evolution and regions in Newfoundland, Scotland, Egypt and Australia.

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EVOLUTION OF THE PALEOZOIC TASMAN FOLD BELT, EASTERN AUSTRALIA: SUBDUCTIVE ARC COLLISIONS, POST-SUBDUCTION SEDIMENTATION AND ANATECTIC MAGMATISM

The Late Proterozoic to Triassic Tasman Fold Belt of eastern Australia is a region of 35 to 50 km-thick continental crust. It has been variously interpreted as having developed on a sialic substrate (evidence principally from the widespread Paleozoic granitoids) or on a simatic substrate (evidence principally from sedimentary and mafic volcanic rocks).

These conflicting hypotheses can be reconciled by invoking widespread subductive emplacement of sediments, derived from a Proterozoic sialic source (?Antarctica), to depths of 10 - 20 km, beneath the presently exposed Paleozoic supracrustal rocks. Emplacement was followed by anatexis, due to thermal equilibrium or a mantle thermal anomaly. The resultant magmatism and deformation contributed to cratonization of the fold belt.

Salient evidence invoked in support of each hypothesis, and a tectonic model which reconciles them, will be reviewed. The model implies that the fold belt represents a rather systematic collage of West Pacific-type island arc terrains which have been juxtaposed by subductive collisions and subsequently buried to varying extents by post-subduction sediments. A Siluro-Devonian extensional phase, marked by acid volcanism, complicates the history of the fold belt. It has been attributed to a trans-tensional convergent regime. This regime may have been triggered by ridge subduction in the Early Silurian.

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SOME NOTES ON KARROO-CRETACEOUS AND CENOZOIC RIFTS IN CENTRAL AND EASTERN AFRICA

The patterns of rifting, sedimentation and igneous activity at the Karroo-Cretaceous lower Zambezi triple junction are described and compared with similar patterns at the Cenozoic triple junction in Ethiopia.
The Cenozoic Malawi rift and its southward continuation through Mozambique are examined. Recent seismic and aeromagnetic surveys have revealed something of the character of faulting, deformation and sediment thickness in the floor of the Malawi rift basin. Associated igneous activity includes the well-known, mainly undersaturated, volcanics of the Rungwe volcanic field at the north end of the Malawi rift. Attention is also drawn to a little-known group of olivine-nephelinite and limburgite intrusions or cones, of Tertiary age, 1000 km farther south along the rift. Comparison is made with the Kenya rift in terms of structure, igneous activity, sedimentation and evolution.

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THE DEFORMATION OF ULTRABASIC ROCKS IN THE YALUZANGBU RIVER FAULT

Through a detailed study of the deformation of the ultrabasic and adjoining rocks in the eastern sector of the Yaluzangbu River fault, the author has distinguished three kinds of deformation (viscous flow, the plastic flow and brittle fracture and 13 subfabric types, approached the problems of deformation processes and mechanism, inferred the deformation depth range from the gliding systems of olivine, the relation between strain and fractionation of solid solution of pyroxene and the serpentinization features, but indicated the vertical deformation zoning of the Yaluzangbu River fault and its texture uniform. According to the relation between foliation, extension lineation and direction of the faults, the author infers that the laminar differential flow planes during the viscosity flow deformation run parallel to the surface of the lithosphere, which have great tendency to be decoupled, but flaser planes (XY plane) during the plastic and brittle deformation run parallel to the main rault plane of the Yaluzangbu River fault, inclined steeply to the south. It is considered that the ultraba-

sic rock has suffered nearly horizontal intense E-W compression during the formation of the Himalayan fold belt (the mountain range).

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ON THE YANSHANIAN MOVEMENT OF PERI-PACIFIC TECTONIC BELT IN CHINA AND ITS ADJACENT AREAS

In 1927, Weng Wenhao, a Chinese geologist, named the term "Yanshanian Movement" for the first time. In recent years, the Yanshanian Tectonism has been recognized as a very important event in the evolution of the circumpacific tectonic belt.

In this paper the Yanshanian Movement and tectonic evolution of the middle part in western peri-Pacific belt (East China, Korean peninsula, East Mongolia, Far East of Soviet Union, Japan Islands and related sea areas) are discussed. The present paper consists of the following three parts: (1) Tectonics and formation of Yanshanian stage; (2) Subdivision and characteristics of Yanshanian Movement; (3) Tectonic evolution and regional background of the Yanshanian stage. According to the palaeogeographic and palaeotectonic development of the Yanshanian Tectonic Cycle in Eastern China and its adjacent areas may be divided into early Yanshanian stage and late Yanshanian stage with some regional orogenic episodes.

About the characteristics of the Yanshanian Movement, we have discussed: the relationship between Yanshanian and Indosinian Movements; the relationship between the syndepositional tectonic disturbances and synorogenic structural deformation of Yanshanian stage; the relationship between the eruptive and intrusive magmatism; the relationship between tectonic activity and tectonic setting; the relationship between Yanshanian Movement and metallogenesis. Some maps have been compiled showing the formational types and tectonic movements, the palaeotectonic evolution of the early and late Yanshanian stage.

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SIMPLIFIED CLASSIFICATION OF PLATFORM ANTICLINES

The synsedimentary character of tectonic deformations is a common feature of the platform covers. It is caused both by the differentiated vertical movements of basement blocks and by the horizontal displacements of rock salts, frequently occuring in the epicontinental environments of platforms. These synsedimentary processes result in local changes of thickness which may be either gradual or - across the growth faults - more abrupt. These changes in turn cause the final form of platform anticlines to be variable in various planes of their vertical and horizontal sections.

Platform anticlines have been divided into two major classes depending on their tectogenetic agent. Salt anticlines originated as a result of active salt flowage, non-salt anticlines - as a result of passive differential subsidence of basement blocks.

Salt anticlines are of non-piercement and piercement types. The former are characterized by thickness reductions in the otherwise complete sequences, the latter - by numerous stratigraphic gaps and/or unconformities. Both types of salt anticlines may be either elongated or isometric, the limit value between them being the length to width ratio = 2:1. Elongated non-piercement anticlines have been called salt swells, isometric ones - salt pillows; piercement anticlines respectively: salt crests or salt plugs.

Non-salt anticlines have been called placanticlines, after Shatskiy's original term, and divided into three groups. The height of cryptomorphic (reflected) placanticlines decreases upwards due to thickness reductions in their crestal parts. They may even completely disappear in the younger structural surfaces. On the contrary, the height of phaneromorphic (superficial) placanticlines increases upwards since they have originated on the sites of the earlier down-faulted blocks. Finally, the height of isomorphic placanticlines remains constant in various structural surfaces because a single tectonic event was responsible for their origin.

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GEOTECTONIC INTERPRETATION OF THE CHOOGARYONG RIFT VALLEY, KOREA PENINSULA

Volcanic episode in the Choogaryong valley which runs in NNE-SSW from Wonsan of the east coast to Seoul, can be classified into four stages: firstly constructions of Precambrian complex, Jurassic

granodiorite and Cretaceous breccia; secondly, Cretaceous volcanic activities of green tuff, andesite dike, early old basalt, tuff braccia and late old basalt; thirdly, erosion of preexisting rocks from Late Cretaceous to Late Quaternary and accumulation of unconsolidated gravel-sand deposits along old rivers; fourthly, central eruptions of alkali basalt of Holocene age forming basalt plateaus. The major mineral constituents of old basalts are labradarite and clinopyroxene, and additionally the young basalt contains magnesian olivine. Petro-chemical plottings of 74 basalts on SiO_2-(Na_2O + K_2O), K_2O-MgO and Normative Or-Ab-An indicate that the younger is higher in alkalinity.

Paleomagnetic values of two old basalts show reversed different polarities, while the young indicates Brunhes normal epoch.

Highly eroded small outcrops of old basalts arranged rather symmetrically to a high angle fault which was recognized as an axis of the valley suggest that the valley was formed by occasional riftings.

The geological results obtained from the SW part would be extended northeastward to Wonsan Bay. The author proposes use of aulocogen system in this area to interprete opening of East Sea considering three-armed rifts: the Choogaryong valley as a failed one and two proto-coastal zones along NE and SE coasts of Wonsan Bay are active ones so as to develop proto-East Sea.

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THE ROLE OF THE ASTHENOSPHERE IN ISOSTATIC COMPENSATION DURING CONTINENTAL UPLIFT AT A CONVERGENT MARGIN

Western North America includes an extensive area of uplift which is second only to the Tibetan Plateau. The area of uplift is greatest opposite the San Andreas fault where a trench-spreading center collision had taken place. The area of uplift decreases with distance to the currently active spreading centers. The Tibetan Plateau is the result of a continent-continent collision whereas the uplift of western North America is a result of an ocean ridge-continent collision.

As a continent converges on an ocean ridge, it over-rides an increasingly thin and hot subducting plate. In order to maintain the earth's surface as a close approximation to an isopotential surface, the subducted plate must be compensated isostatically by transfer of asthenosphere to the base of the continental lithosphere towards the convergent margin. As a consequence, the leading edge of the continent is uplifted and the uplift progresses away from the convergent margin until the convergent margin assumes the physiography of the over-ridden ocean ridge at the time of trench-spreading center collision. The area of maximum uplift becomes more extensive as the trailing edge of the subducted plate continues to be over-ridden by the continent. This model is in accord with the physiography of North America and the geologic record.

The role of the asthenosphere is to provide compensation by flow of this viscous medium. At the time of trench-spreading center collision, a pressure gradient shunts the asthenospheric current from the quenched spreading center to the channel between the continental lithosphere and the subducted plate. Sinking of the subducted plate causes upwelling of asthenosphere feeding the laminar flow between the two plates.

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НЕКОТОРЫЕ ЧЕРТЫ НОВЕЙШЕЙ ТЕКТОНИКИ ВЬЕТНАМА

I. Анализируя кайнозойские отложения в прогибах Вьетнама, сравнивая их с циклами рельефообразования, автор считает, что новейшие тектонические движения, создавшие основные черты современного рельефа, начались с олигоцена после длительного времени выравнивания, происходившего в палеоцене и эоцене.
2. По характерам новейших тектонических движений Вьетнам является областью умеренного эпиплатформенного горообразования (градиент поднятия 40–50 м/км, амплитуда поднятия 2000–3000 м).
3. Система новейших разломов активно действует во время новейшей тектоники. Кайнозойские отложения относятся к молассовой формации и по общему характеру их разрез является микрокластогенным. Проявление новейшего вулканизма начинается с миоплиоцена и продолжается до настоящего времени. По петрохимическим особенностям эти вулканиты имеют много общего с аналогичными сериями Байкальского рифта и грабена Осло, относившимися к типу рифтовых базальтоидов. Отмечается активная сейсмичность, особенно в зонах новейших разломов. Все это свидетельствует о тектоническом режиме континентального рифта, существовавшегося во время новейшей тектоники во Вьетнаме на фоне общего поднятия.

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ON THE GELOGICAL STRUCTURE AND DEVELOPMENT OF THE TRANSITION ZONE BETWEEN THE MOESIAN PLATFORM AND THE BLACK SEA DEPRESSION

The Moesian platform and the Black sea depression are tectonic structures of the "inner sea" type generated by uniform mechanism through spreading and destruction of the continental crust, but in different geological time (during Early Palaeozoic and Late Mesozoic-Cenozoic accordingly). These structures have similar geophysical characteristics: positive gravity field, thin crust, high velocity of the fundament under the sedimentary cover, specific seismicity and heat flow. The magnetic field reflects the distribution of the island arc and rift magmatism within the limits and in

the vicinity of these structures. The transition zone between the Moesian platform and the Black sea depression is a mobile zone with considerable deformation within the Palaeozoic and Triassic sediments and with the presence of Hercynian and possibly Kimmerian volcanism, deep Prejurassic-Late-Cretaceous erosion, rapid change of the character of sedimentation during the Cretaceous period and considerable submeridional faulting during Neogene. Direct contact between the Cenozoic sediments of the Black sea depression and the eroded surface of the Palaeozoic and Mesozoic sediments of the submarine margin of the Moesian platform in the area of the modern continental slope is supposed to exist. The study of the transition zone has an important theoretical and practical significance for the prospection of the industrial oil and gas concentration.

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TECTONIC EVOLUTION OF THE GARHWAL HIMALAYA - A MICROCONTINENT MODEL

Recent data from the Central Himalaya of Garhwal have revealed the existence of undoubted pre-Himalayan metamorphism, migmatisation and deformation in the Bhatwari Group between the Main Central Thrust and Joti-Bhandali Thrust. This unit shows NE/SW plunging reclined isoclinal to very tight folds with S_1 as axial plane foliation dipping NE. All the typical Himalayan deformations have developed upon the aforesaid S_1 foliation. The Bhatwari Group has undergone regional metamorphism up to garnet grade. In contrast, the units with characteristic Himalayan deformation has gone metamorphism up to sillimanite grade. The conclusions emerging out of the analysis in terms of space and time are summarised as follows: (i) The Central Himalaya comprises at least three chronologic units which provide dates of 1900-2300 my, 1200-1400 my and 500-600 my, the oldest one being the extension of the Bhatwari Group; (ii) The Himalayan Orogeny is not a simple subduction phenomenon since Continental blocks have not gone too far northwards below the other; (iii) The involved Precambrian Basement as the Bhatwari Group has undergone at least one phase of metamorphism and migmatization before the collision; (iv) The Himalayan region consisted of one or more microcontinents or there may be intercontinental subduction; (v) The younger formations rid over the older ones along the narrow obducted zones giving rise to thermal domes; (vi) The late stage movements have brought one block relatively upwards and against the other due to northerly moving Indian Plate.
The proposed microcontinent model also considers the Precambrian and Paleo-Mesozoic geological history of the Himalaya.

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NAPPE-FOLDED STRUCTURES OF THE POLAR URAL AND THE PIE-HOY

The Polar Ural and the Pie-Hoy were considered as a system of linear folds (the Polar Ural Megaanticlinorium and the Pie-Hoy Synclinorium). Geological and geophysical materials of the last years prove a nappe-folded structure of the Polar Ural as A.V.Peive and others (1977) supposed earlier. After new data the Pie-Hoy has also the same structure. The modern Uralian folded belt was formed in the framework of the East European Platform. The belt consists of a dislocated Paleozoic shelf complex covered by some allochtonous layers of Paleozoic bathyal and paleooceanic complexes. Outcrops of the Baikalian folded basement were usually regarded as the Central Uralian Rise, but as a matter of fact they represent a system of layers and ledges which were formed in the warping zone of the East European Platform margin. According to geophysical data the Baikalian basement is traced far inside the West Siberian Plate. The South Novaya Zemlya-Pie-Hoy anticlinal structure composes of a Paleozoic shelf complex. In the Pie-Hoy the complex is almost completely covered by an allochtonous layer of the Pie-Hoy Paleozoic deep-water complex. Rocks of the Baikalian basement take part in the formation of this layer also. The present-day structure of the Polar Ural was formed in consequence of the tectonic compression release in the direction from the East to the West, while the Pie-Hoy structure underwent the stress from the North-East where the Bidarazky deep-seated fault is now situated. The origin of the nappe-folded structures of the Polar Ural and the Pie-Hoy were caused by the tectonic decollement and differential shifting of lithosphere layers. The amplitude of the shifting reaches at least hundred kilometres as can see from structural reconstructions carried out the base of examination of the Paleozoic complexes formational characteristics.

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ПОКРОВНО-СКЛАДЧАТЫЕ СТРУКТУРЫ ПОЛЯРНОГО УРАЛА И ПАЙ-ХОЯ

Считалось, что Полярный Урал и Пай-Хой представляют собой системы линейных складок (Полярноуральский мегантиклинорий и Пайхойский синклинорий). Геолого-геофизические материалы последних лет уверенно говорят о покровно-складчатом строении Полярного Урала, ранее предложенным А.В.Пейве и др. (1977). Покровное строение, по данным последних лет, имеет и Пай-Хой. Современное Уральское складчатое

сооружение сформировано в пределах Восточно-Европейской платформы. Оно состоит из дислоцированного шельфового комплекса палеозоя, перекрытого рядом аллохтонных пластин, сложенных палеозойскими формациями батиального комплекса и палеоокеанического сектора. Выходы байкальского складчатого фундамента, обычно выделяемые в Центрально-Уральское поднятие, представляют собой систему пластин и выступов, образовавшихся в зоне коробления края Восточно-Европейской платформы. По геофизическим данным, байкальский фундамент далеко прослеживается в пределы Западно-Сибирской плиты. Южноновоземельско-Вайгачско-Пайхойская антиклинальная структура сложена шельфовым комплексом палеозоя. На Пай-Хое шельфовый комплекс почти полностью перекрыт аллохтонной пластиной, сложенной глубоководным (Пайхойским) комплексом палеозоя. В строении пластины участвуют также и породы байкальского фундамента.

Современная структура Полярного Урала образовалась в результате разрешения тектонических напряжений, направленных с востока на запад. Структуры же Пай-Хоя сформированы тангенциальным давлением, направленным с северо-востока от зоны Байдарацкого глубинного разлома.

Покровно-складчатые структуры Полярного Урала и Пай-Хоя образовались в результате тектонического отслоения и дифференцированного перемещения литопластин. Рассмотрение формационной принадлежности комплексов палеозоя, слагающих литопластины, и вытекающие из него структурные реконструкции указывают на значительную амплитуду перемещения пластин, достигающую по крайней мере ста километров.

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EXPERIMENTS ON "BRITTLE" FOLDING

At relatively shallow depth, folds do not form as a result of viscous instability and hence the laws of buckle folding in viscous media (Ramberg, 1963) do not apply. Because it is probably not possible to establish a quantitative theory of such "brittle" folding, we have carried out a number of model experiments to help us understand empirically the folding process in the brittle regime.

Single and triple layers of different brittle model materials were embedded in a matrix of modeling clay, and compressed in a squeeze box. Preliminary results, which will be illustrated, show that (1) these folds form serially, rather than simultaneously, and (2) failure by thrusting is inhibited in favor of folding if deformation of an encasing yielding material guides the buckling process.

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POLYPHASE FOLDING DEFORMATION IN DELHI SUPERGROUP OF ROCKS IN SOUTHERN HARYANA, INDIA

The Delhi metamorphites of southern Haryana, India, bear imprints of three sets of mutually interferring folds. The earliest recognisable folds (F_1) are sharp-hinged, isoclinal with high amplitude/wave length ratio. These folds are characterised by disharmony at fold hinges, and sometimes assume rootless and intrafolial nature. Attitudes of F_1 axial planes and axes depend on their disposition in F_2 fold geometry. Strong regional foliation (S_1), which often obliterates bedding (S_o) in schistose rocks, accompanies F_1 folding and a set of lineation L_1 (mineral lineation, striping lineation and mullions) has developed. F_1-folds are co-axially superposed by F_2-folds - open, upright, round-hinged - which trend in NNE-SSW direction and plunge both towards north and south. F_2 is the most dominating folding phase and governs the outcrop pattern. The accompanying axial plane cleavage (S_2) is a strain-slip cleavage in metapelites and a fracture cleavage in meta-psammites, and a set of lineation L_2 (puckers, intersection of S_2 with S_0/S_1, some mineral lineation) has developed. Longitudinal faults and shears accompany co-axial F_1/F_2 folding. These folds are overprinted by a later cross-fold (F_3) - open, broad-hinged, small-amplitude folds - which caused culminations and depressions of earlier fold axes. F_3-folds show variable plunge amount and direction depending on the limb disposition of earlier folds. Incipient development of S_3 planar surface is noted locally. Interference structures are manifest in striping lineation, hook-shaped folds and eyed interference. Folds widely varying in style and geometry have been formed in a simple plan of superposed deformation comprising sub-horizontal compressions at high angles to each other.

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STRUCTURAL MODEL OF THE PALEOGENE-NEOGENE FORMATION OF THE WESTERN PART OF THE GETIC DEPRESSION AND EVOLUTION OF THE RELATIONS BETWEEN THE GETIC DEPRESSION AND THE MOESIC PLATFORM

The Paleogene-Neogene formations of the Getic Depression were folded and displaced during the Savian, Styrian, Attican and Wallachian phases, as it is proved by angular unconformities and erosion or non-deposition stratigraphic breaks. Each phase resumed and accentuated the major structural elements of the preceding ones and, at

the same time, is characterized by structural elements that differ from those of preceding or following phases. In the Bibesti-Matasari-Ciovirnasani area, a depression with platform basement develops, filled with Neogene, non-displaced molasse. The platform presents several steps of sinking under the Lower Miocene molasse, that played an important part in the molasse structural configuration. Lower Miocene molasse thrusts over the Lower Sarmatian one of the outer flank of the depression with platform basement, the encroaching line passing to the north of the Bibesti-Bulbuceni and the south of the Balteni-Ticleni structures. In the Balteni-Ticleni area the fault loses its thrust character and becomes a normal one that, in the northern compartment, includes Paleogene formations as well. Northward, in the Paleogene-Miocene molasse domain an uplifted zone develops, with Paleogene in its axis, that can be traced eastward, up to the Dimbovita Valley.
The mentioned elements are well drawn on the seismic sections registered in recent years, and it is their geological interpretation that makes the support of our paper.

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FRACTURE ANISOTROPY IN LAYERED ROCKS UNDER UNIAXIAL COMPRESSION AND TENSION

The nature of observation, in the course of present work is confined to influence of various families of weaknesses on fracture pattern of rock specimens of gondites, schists and gneisses under uniaxial compression and Brazilian tension. The specimens were, therefore, spacially examined prior to failure, with special attention to various families of weak planes and fracture patterns were interpreted in terms of the response of attitudes of such weak planes.
In several specimens of the present rocks, failure takes place along a direction other than the prominent planes of weaknesses and in some specimens failure takes place throughout the body of specimen when orientations are not favourable for fracture propogation along either set of the weakness planes. But when a weak plane is oriented at 30° to 45° with respect to compression axis, the specimens fail along the weakness plane itself. It is concluded that the failure becomes a compromise between the ideal fracture pattern and the pattern of the plane of weakness where more significant is the intensity and orientation of the compressive stress with respect to the planes of

weaknesses. The failure of the specimens under Brazilian tension is always along the loading diameter of the specimens. Thus the fracture mechanism under tensional forces can be described to be simple; though a few specimens sheared off along the layers or cleavages and fracture could not occur along the loading axis.
The authors find out in their experiments on layered gondites, made up of alternating compliant and stiffer layers, that the effect of layered fabric on the final fracture pattern can't be defined as the rock has a number of other flows also; and because the greater the difference between the strength of compositional layers and that of matrix, the more effective anisotropy is to the final fracture pattern. This study of failure characteristics is useful in predicting the nature of strata failure and in planning support requirements in underground openings.

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THE RIPHEAN-EARLY PALEOZOIC OPHIOLITES OF THE NORTH EUROPA-ASIA CONTINENT

The ophiolites present the relics of the perioceanic or island-arc crust, included into the orogenic structures during the process of the obduction. They are abundant in the baikalides and caledonides of Ural-Mongolian belt. Judging by the age of the upper members of the ophiolite associations, they were being formed in Early-Middle Riphean, Vend-Early Cambrian and Ordovisian-Silurian. Their formation and the following tectonic history are connected with the pulsations of the central and perioceanic (in the marginal seas) of spreading and the stage increment of the segments of the Early orogenesis in the periphery of the Paleoasiatic ocean. In the structure of the orogens the allochthones of the full or dismembered sections of the ophiolites are metamorphosed in the different facies (from greenschist to eclogite) in the dependence of the combination of the processes of the obduction and subduction. The upper ophiolite magmatites are presented by the tholeiites, calc-alkaline or mixed series. The marianite-boninite series is a typical member of many ophiolite complexes. Associating sedimentary formations characterize the conditions of the marginal sea and island arc. The relations of the ophiolites with the island-arc differen-

tiated volcanics and ultramafite-mafite intrusions were developed. The lower ophiolite gabbros and peridotites form the comagmatic series, reflecting the processes of the depletition of the upper mantle, accumulation and flow of the melts in the zones of the differential movements of the upper mantle and following cumulate processes. The composition of the ophiolites, products of their secondary alterations, $^{87}Sr/^{86}Sr$ and $^{18}O/^{16}O$ reflect the wide role of the mantle transvaporization in their genesis with the participation of the sea waters.

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РИФЕЙСКО-НИЖНЕПАЛЕОЗОЙСКИЕ ОФИОЛИТЫ СЕВЕРНОЙ ЕВРАЗИИ

Офиолиты представляют реликты периокеанической или островодужной коры, впаянные в ткань орогенных структур в процессе обдукции. Наиболее широко они распространены в байкалидах и каледонидах Урало-Монгольского пояса. Судя по возрасту верхних членов офиолитовых ассоциаций, они формировались в раннем - среднем рифее, венде - раннем кембрии и ордовике-силуре. Их формирование и последующая тектоническая история связаны с пульсациями центрального и периокеанического (в краевых морях) спрединга и стадиального приращения сегментов раннего орогенеза на периферии Палеоазиатского океана. В чешуйчато-складчатой структуре орогенов аллохтоны полных и разрозненных разрезов офиолитов метаморфизованы в разных фациях (от зеленосланцевой до эклогитовой) в зависимости от сочетания процессов обдукции и субдукции.

Верхние офиолитовые магматиты представлены разнотипными толеитами, известково-щелочными или смешанными сериями. Характерным членом многих офиолитовых комплексов является *марианит-бонинитовая серия*. Ассоциирующие осадочные формации также характеризуют условия краевого моря и островной дуги. Соотношения офиолитов с островодужным дифференцированным вулканизмом и ультрамафит-мафитовыми интрузиями разнообразные. Нижние офиолитовые габбро и перидотиты составляют комагматичный ряд, отражающий процессы деплетирования верхней мантии, накопления и перемещения расплавов в зонах дифференциальных движений верхней мантии и кумулятивных процессов. Состав офиолитов, продуктов их вторичных изменений, $^{87}Sr/^{86}Sr$, $^{18}O/^{16}O$ отражают широкую роль верхнемантийной и коровой трансвапоризации в их генезисе с участием морских вод.

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PRELIMINARY STUDY OF RELATIONSHIP BETWEEN STRESS FIELD AND MATERIAL FIELD WITHIN A BRUSH STRUCTURE IN THE AREA OF SHAXI PORPHYRY COPPER DEPOSIT IN ANHUI PROV., CHINA

This paper studies mainly the relationship between the stress field and material field within a brush structure (a brush type) in the area of Shanxi copper deposit of the middle-lower Yantze River metallogenetic belt. I also discuss the effect of the stress field that gave rise to the brush structure upon the formation of igneous rock and ore. The results indicate that there seems to be some material adjustment when the rising magma and active ore solution reached such a stress field.

1. Elements of heavier atomic weight and greater density were accumulated in the area where the stress was high while elements of lighter atomic weight and lower density gathered where stress was relatively low.
2. Elements of shorter radius tended to be concentrated in the high stress area, and those of the longer radius in lower stress area.
3. Heavier isotopes of sulphure (S^{34}) occurred in high stress area whereas the light ones in lower stress area.
4. Cu, Mo, Ag always appear in the medium stress domain, while the Cu, An, Pb in the lower stress domain.

In addition, reformation and recollection of copper ores during subsequent rejuvenation of the brush structure were also involved.

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STRUCTURAL-FORMATION UNITS AND TECTONIC MAPS

The main tectonic objects of the formation level of organization are the structural-formation stages (SFS) - geological bodies characterized in substance respect by formation series which form them, and in morphological respect by peculiarities of dislocations. The parageneses of SFS form the structural - formation zones, complexes, systems, The substance - morphological principle of establishment of tectonic objects allows to systematize SFS according to a) sets of species of formations which form formation series, b) types of dislocations. These features determine the taxons of SFS of various rank - types..., families, genera, species. The types of SFS are characterized by the morphology of the tecto-

nic structures formed by them. The families of SFS in substance aspect are characterized by the appurtenance of formations which form them to one of supergroups (sedimentary, sedimentary - volcanogenic, volcanogenic and intrusive, metamorphic) and in morphologic aspect by appurtenance of tectonic forms which form formation series to one of the classes. More fractional division of substance and morphological features of SFS, gives the possibility ef to seperate genera and species according to their groupings.
The fields of distribution of SFS belonging to the definite taxa of species and generic rank are shown on maps and and by their combinations represent recent tectonic structure and history of evolution of the territory. The tectonic maps based on the SFS representation correspond to the geological maps of the same scale. The maps are accompanied by various schemes which illustrate the tectonic zonation of the territory according to the age of SFS and their associations, regimes of formation etc.

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СТРУКТУРНО-ФОРМАЦИОННЫЕ ПОДРАЗДЕЛЕНИЯ И ТЕКТОНИЧЕСКИЕ КАРТЫ

Основными тектоническими объектами формационного уровня организации являются структурно-формационные яруса (СФЯ)-геологические тела, характеризующиеся в вещественном отношении слагающими их формационными рядами, а в морфологическом - особенностями дислокаций. Парагенезисы СФЯ образуют структурно-формационные зоны, комплексы, системы. Вещественно-морфологический принцип выделения тектонических объектов позволяет систематизировать СФЯ по:а) наборам видов формаций, образующих формационные ряды; б) типам дислокаций. Эти признаки определяют таксоны СФЯ разного ранга - типы... семейства, рода, виды. Типы СФЯ различаются морфологией образуемых ими тектонических структур. Семейства СФЯ в вещественном аспекте характеризуются принадлежностью слагающих их формаций к одной из надгрупп (осадочных, осадочно-вулканогенных, вулканогенных и интрузивных, метаморфических), а в морфологическом - принадлежностью образуемых формационными рядами тектонических форм к одному из классов. Более дробное разделение вещественных и морфологических признаков СФЯ дает возможность по их группировкам обособлять рода и виды.
Поля распространения СФЯ, принадлежащих определенному таксону видового или родового ранга, изображаются на картах; своими сочетаниями они передают современное тектоническое строение и историю развития территорий. Тектонические карты, основанные на изображениях СФЯ, равноточны геологическим картам того же масштаба. Карты со-

провождаются различными схемами, иллюстрирующими тектоническое районирование территорий по возрасту СФЯ и их тех или иных ассоциаций, режимам образования и т.д.

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GRANITE-GNEISSIC DOMES IN THE STRUCTURE OF CONTINENTAL FOLD BELTS (THE CENTRAL PAMIR)

Accretion of the granite-metamorphic layer of the earth's crust takes place at the orogenic stage of the geosynclinal development when granite-gneissic domes (swells) form. Chains of them stretch along the strike of main structural elements of fold belts. On their origin and location they are bound up with the most large-scale anticlinal structures.

The alpine zone of the Central Pamir disposed at northern outskirts of the Karakorum fold belt is the typical province of such domes. They are here in limits of the Easternpamir and the Vanch-Yazgulem anticlinoriums.

At outlying parts of domes metamorphic series mainly of kyanite-sillimanite type can be seen. In central parts of domes metamorphic rocks are changed by migmatites, gneissic granites and pegmatites, which are formed by means of the ultrametamorphism and the anatexis with the SiO_2-Na metasomatism. Bodies of allochtonous granites are also disposed here.

The formation of domes was accompanied by different fold and fracture deformations, mainly overthrusts. The structural and metamorphic development of rock series happened in central and marginal parts of domes at the same manner and answered regularities of the united deformation-metamorphic cycle. Domes were forming from the end of the Paleogene to the Miocene during the orogenic stage of the alpine tectonic cycle at the expense of rocks of Vendian to Jurassic and probably to Paleogene age, which had almost uninterrupted succession in the Central Pamir.

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ГРАНИТО-ГНЕЙСОВЫЕ КУПОЛА В СТРУКТУРЕ ФАНЕРОЗОЙСКИХ СКЛАДЧАТЫХ ПОЯСОВ КОНТИНЕНТОВ (НА ПРИМЕРЕ ЦЕНТРАЛЬНОГО ПАМИРА)

Наращивание гранитно-метаморфического слоя земной коры происходит на орогенной стадии развития геосинклиналей и проявляется в форме образования гранито-гнейсовых куполов (валов), цепочки которых вытянуты в соответствии с простиранием основных структурных элементов складчатых поясов. Пространственно и генетически они связаны с крупнейшими антиклинальными структурами. Типичным примером развития гранито-гнейсовых куполов служит альпийская зона Центрального Памира на северной окраине Каракорумской складчатой системы. Они приурочены здесь к Восточно-Памирскому и Ванч-Язгулемскому антиклинориям. По периферии куполов наблюдается метаморфическая зональность преимущественно кианит-силлиманитового типа с переходом от зеленосланцевой к амфиболитовой фации. К центральной части приурочены мигматиты, гнейсо-граниты и пегматиты, образовавшиеся в результате ультраметаморфизма и анатексиса, протекавших в условиях интенсивного кремнекислотно-натриевого метасоматоза, а также аллохтонные граниты. Формирование куполов сопровождалось разнообразными складчатыми и разрывными деформациями, в первую очередь образованием тектонических покровов. Исследование последовательности сопряженного развития эндогенных процессов показало, что структурно-метаморфическая эволюция толщ в пределах осевых и периферических частей куполов протекала по единому плану и подчинена закономерностям одного деформационно-метаморфического цикла. Образование куполов происходило в конце палеогена и в миоцене на орогенной стадии альпийского тектонического цикла по породам от вендского до юрского и, возможно, палеогенового возраста, образующим в пределах Центрального Памира почти непрерывный разрез.

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TERTIARY BASINS OF THE COASTAL ZONE OF ANDES IN SOUTHWESTERN ECUADOR: RESULT OF A BLOCK-FAULTING WITH SLUMPING

The coastal area of Ecuador represents an emerged accretion prism constituted by a middle Cretaceous oceanic basement with upper Turonian to Quaternary sediments.

During Tertiary times a block-faulting associated with an early slumping occurred as follows: first, in the Paleocene, flexuration of the southern flank of the Chongon Colonche hills initiated slumping of the Cayo Formation towards the south. Next, in the middle Eocene, the Ancon Basin was formed by block-faulting with slumping of the Chanduy Formation, forming olistoliths or klippes which migrated down slope from southeast to northwest. Next, in the upper Oligocene, the Progreso, Guayas and Gulf of Guayaquil Basins were formed by down faulting and additional slumping. Olistoliths of the Cayo Formation were produced by the sliding of blocks from the Chongon Colonche hills let on the north to south slopes. Finally, in the upper Miocene, slices of the Bellavista Member migrated from the southern Chongon Colonche hills to the northern border of the Progreso Basin due to a new block-faulting of the Guayas and the Gulf of Guayaquil Basins.

Two kinds of sediments filled the different basins. One of them was a flysch type which was accumulated before the Oligocene. The other, a molasse type, was deposited since this age, with a general emersion in Quaternary time.

This study of block-faulting and slumping events provides a genetical explanation of the Santa Elena Olistostrome Complex.

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STRUCTURAL FRAMEWORK AND TECTONIC HISTORY OF THE SOUTHEASTERN EDGE OF CARIBBEAN PLATE

Recent investigations of tectonics and vulcanism in Central America, conducted in conjunction with geothermal exploration shed new light on the structural evolution of the area. The scope of the investigations includes detailed trend analysis of structural elements along the southwestern edge of the Caribbean Plate, between the Motagua Fault Zone in Guatemala and the Panama Fracture Zone. The analysis was complemented by geophysical surveys conducted in Nicaragua and Honduras, which included gravimetry and various electromagnetic electric resistivity methods.

The results indicate a three-phase tectonic evolution of the southwestern edge of the Caribbean Plate. A N38°E compression phase during the Miocene was associated with an accelerated descent of the Pacific lithosphere along the Middle America Trench, following fragmentation of the East Pacific Plate into the Cocos and Nazca plates.

This compression resulted in uplift, tilting, and folding of early Tertiary formations, along a N52°W axial trend. An important set of N5°W-trending dextral wrench faults is mostly obscured by younger sediments, but is very prominent on Bouguer anomaly maps. The next tectonic phase was a Pliocene extension, which resulted in a markedly increased intensity of volcanic activity and the development of the Nicaraguan and Hondurean depressions. The extensional phase was triggered by an ENE differential drift of the bulk of the Caribbean Plate relative to its southwestern stationary wedge-shape part, locked in the acute angle between the Cocos Plate, along the Middle America subduction zone, and the North American Plate, along the Motagua Fault Zone. The last tectonic phase involved Quaternary shearing, which evolved as a consequence of the differential stresses within the Caribbean Plate, and led to fragmentation and counterclockwise rotation of the Central American Volcanic Axis.

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GEOPHYSICAL CHARACTERISTIC OF CONTINENTAL LITHOSPHERE AND PRINCIPLES OF ITS REGIONALIZATION

A characterization of lithosphere and principles of ist regionalization for continental structures are presented using the new results of complex deep seismic, seismologial and regional measurements. The principles under theoretical development are founded on the condition that there is no conformity between the depth and the structure of the Earth crust and upper mantle (the depth and the structure of the Earth crust and the upper mantle are different). The distribution into regions is to analyse the geologico -geophysical data that characterize structure inhomogeneities of the rock as well as specific states of the strained medium. The ways for the lithosphere regionalization are put forward in accordance with velocity characteristics and an imagination of a multesign information. The first way consist in the study of timedependent anomalies to be determined with the deviation of the P-wave propagation time from the average statistical godograph of the region researched. The depth distribution for the timedependent anomalies of the Earth's crust and the upper mantle is sugggested. The series of nine anomalies is found to be due to the combination of velocity parameters of the Earth crust and the upper mantle. The second way involves in the simultaneous mapping of a few parameters. The extreme values of the parameters are taken in consideration to be depend on the

strained medium in conditions of the modern tectonic activity. These parameters assumed the following: 1) the thickness of the Earth crust to point out the geostatic pressure; 2) the heat flow on the Mohorovicic discontinuity to show the heating of the upper mantle; and 3) the boundary velocity for the Mohorovicic discontinuity to give indirect evidence for the medium density. Relations between the parameters above give some information concerned the TP-conditions, the densification and the rarefaction of the upper mantle. The future development of the regionalization principles for the lithosphere has to use complex of geophysical parameters given with the spatial picture.

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ГЕОФИЗИЧЕСКАЯ ХАРАКТЕРИСТИКА И ПРИНЦИПЫ РАЙОНИРОВАНИЯ КОНТИНЕНТОВ

По результатам глубинных сейсмических, сейсмологических и региональных комплексных исследований производится характеристика литосферы континентальных структур и разработаны принципы их районирования. Теоретической основой развиваемых принципов является положение о разноэтажности и несоответствии строения земной коры и верхней мантии. Задачей районирования является разделение геолого-геофизической информации, характеризующей структурно-вещественные неоднородности и особенности напряженного состояния среды. Предложены методы районирования литосферы по типам скоростных характеристик и на основе изображения многопризнаковой информации. Существо первого метода составляют вычисления временных аномалий, определяемых по отклонениям времен пробега продольных волн по отношению к среднестатистическому годографу исследованного региона. В последующем предполагается разложение временных аномалий по уровням в земной коре и верхней мантии. По сочетанию скоростных параметров земной коры и верхней мантии установлено девять типов. Второй метод преследует цель картирования нескольких параметров одновременно. Во внимание принимаются экстремальные значения параметров, являющиеся свидетельствами напряженного состояния среды в условиях современной тектонической активности. Приняты следующие параметры: мощность земной коры как показатель геостатического давления, тепловой поток на поверхности Мохоровичича (М) как свидетельство разогретости мантии и граничные скорости на М как косвенное указание на плотность среды. Соотношения указанных параметров дают информацию о термобарических условиях, уплотнении и разуплотнении верхней мантии. Будущее в развитии принципов районирования литосферы связывается с комплексным и объемным представлением геофизических параметров.

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GEOLOGICAL STRUCTURES OF HIGHLY METAMORPHOSED ARCHEAN COMPLEXES

Composition and geological structure of the Archean highly metamorphosed complexes are determined by very deep and complicated transformations of substances which have come mostly from the mantle. These transformations were caused by tectonic deformations and metamorphism and resulted in the obliteration of the original relations between primary geological bodies. The ancient complexes consist now mostly of secondary bodies composed of the rocks which did not exist before. The boundaries between these bodies reflect their relations originated due to deformation and metamorphism.

The results of very big deformations were flattening of geological bodies of various shapes, so they became converted almost into plates, and folding of flattened and layered bodies into folds so tightly compressed that they might be taken for undisturbed layers. Concentration of big deformations along many narrow zones led to the formation of many parallel deformational boundaries and ruptures, of new foliation and new plane-parallel bodies that resulted in the new deformational-metamorphic stratification.

Buckling folds are prevailing in these complexes. The recumbent folds were formed in the rocks with subvertical planar fabric undergoing vertical shortening and horizontal elongation perpendicular to this fabric.

Impossibility of big deformations homogeneous through the whole thickness of the crust permits to suppose that there were convection-like movements inside the Earth crust. The cause of these movements might be the decrease of rock's density due to granitization. Succession of deformations of different directions, regularities of metamorphic evolution from the lower to the higher temperature gradient, abundance of granitized rocks on the surface of the crust and other features are in a good agreement with the supposition about convection-like movements.

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ГЕОЛОГИЧЕСКИЕ СТРУКТУРЫ ГЛУБОКО МЕТАМОРФИЗОВАННОГО АРХЕЯ

Состав и структура древних глубокометаморфизованных комплексов определяются сложной вещественной и структурной переработкой материала, в основном поступившего из мантии. Эта переработка, вызванная тектоническими деформациями и метаморфизмом, привела к уничто-

жению первичных соотношений между исходными геологическими телами. Сейчас эти комплексы состоят преимущественно из новообразованных тел, сложенных ранее не существовавшими породами, характер и положение границ которых отражает взаимоотношения, сложившиеся в ходе тектоно-метаморфической переработки комплексов.

Следствием очень больших деформаций было сплющивание тел различной исходной формы почти до состояния пластин и смятие пластообразных и слоистых тел в складки, иногда настолько тесно сжатые, что их можно принять за ненарушенные слои. Концентрация больших деформаций в частых узких параллельных зонах привела к возникновению множества параллельных деформационных и разрывных границ, новых плоскостных текстур и новых плоскопараллельных тел, создавая этим новую, деформационно-метаморфическую расслоенность.

Преобладающим типом складок этих комплексов являются складки продольного укорочения. Широко распространенные лежачие складки формировались, в отличие от прямых, в условиях вертикального укорочения толщ с субвертикальными текстурами при возможности соответствующего удлинения по горизонтали перпендикулярно этим текстурам.

Невозможность однородного по всей мощности коры протекания больших деформаций заставляет предположить внутри коры движения, подобные конвективным, причиной которых могло быть, например, снижение плотности коры при гранитизации. С такими движениями хорошо согласуются также последовательность наложения деформаций разного плана, закономерная эволюция метаморфических комплексов от низкоградиентных к высокоградиентным, выход гранитизированных образований на поверхность на больших площадях.

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REGIONAL GRAVITY STUDY OF THE WEST AND CENTRAL AFRICAN RIFT SYSTEM

The West and Central African Rift System is a complex set of rift structures with two main branches extending from the Benue rift (Nigeria) via Lake Chad to northern Niger and via Cameroon, Chad and Central African Republic into Sudan. These rifts initially developed in lower Cretaceous to Tertiary times and have had generally continuous histories of subsidence. This compares markedly to the contrasting evolution of neighbouring domal uplifts (Adamaoua, Darfur, Tibesti & Hoggar) and to the uplift history of the East African Rift System.

Compilations of existing and new gravity data for the West and Central African Rift System are presented and reveal that rifting associated with tensional and shear tectonics are associated with negative Bouguer gravity anomalies superimposed on broader positive Bouguer gravity anomalies. Hydrocarbon exploration clearly indicates that the negative anomalies are caused by large thicknesses of low density Cretaceous and Tertiary sediments infilling and overlapping the sides of the elongate rift basins, while the broader positive anomalies are interpreted as being caused by thinner crust beneath the rifted regions. The isostatic response of this crustal model is consistent with the subsidence history of these rifts and closely follows the McKenzie model (McKenzie 1968) of rift basin development. Using gravity derived estimates of crustal extension a regional tectonic model is presented.

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SOME GEOLOGICAL FEATURES OF THE NEIGHBOURING SEAS OF EAST CHINA

I. The seismic activity in the neighbouring seas of east China possesses a feature of "macroseism in the eastern part but microseism in the western part".
We divided the east seas into 6 major zones of seismic activity, calculated the release energy of earthquakes that occurred in history of each seismic activity zone and worked out the corresponding strain curves of the seismic activity.
II. The geodynamic status of the neighbouring seas of east China possesses a feature of "compression in the east part but tension in the west part".
These data show that the Cainozoic (especially the post-Neogene) geodynamic status of the continental shelf zone of China coast is controlled by the environmental mechanism of tensional stress.
III. Studies indicated that the seabed land form and sediment distribution possess a feature of "antiquity on the outerside but youthfulness on the innerside", and are of obvious circum-continental zoning.
The inner zone of the continental shelf of China coast is post-glacial erosion-accumulative seabed, while the outer zone is the residual topography and residual depositional zone formed in the Pleistocene during a period when the sealevel was relatively low.

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CONDITIONS FOR FORMING POSITIONS OF ORE FIELDS AND ORE DEPOSITS

On basis of extensive actual and experimental material were carefully reviewed tectonic conditions for formation of the most disseminated types of ore-bearing structures in the Central Asia effects of morphology of structural elements as well as their kinematics were investigated in respect of their distribution of tectonic stresses and specific peculiarities of morphogenesis of ore bodies associated with it. On basis of simulating of ore-bearing structures upon optically active materials, causes and configurations of their developments in localized plan of deformations were ascertained and principles of systemat-

ized positions of ore-deposit locations and fields and a possibility of making use of simulation methods for large and medium scale predictions of endogenous mineralization were shown. Investigation of tectonophysical conditions for formation and morphologokinematic analysis of structural geological positions of majority of ore-bearing fields and districts with industrial deposits of hydrothermal genesis showed, that in course of minerals forming in them, as a rule, expansion of a local nature prevailed among them on a background of regional tectonic compression.

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ТЕКТОНОФИЗИЧЕСКИЕ УСЛОВИЯ ФОРМИРОВАНИЯ ПОЗИЦИЙ РУДНЫХ ПОЛЕЙ И МЕСТОРОЖДЕНИЙ

На большом фактическом и экспериментальном материале рассмотрены тектонофизические условия формирования наиболее распространенных типов рудоносных структур Средней Азии; исследовано влияние морфологии структурных элементов и их кинематики на распределение тектонических напряжений и связанных с этим особенностей морфогенеза рудных тел. На основе моделирования рудоносных структур на оптически активных материалах выяснены причины и формы проявления локальных планов деформаций. Сформулированы принципы систематики позиций месторождений и рудных полей, показана возможность использования моделирования для целей крупно- и среднемасштабного прогнозирования эндогенного оруденения.

Исследование тектонофизических условий формирования и морфолого-кинематический анализ структурно-геологических позиций большинства рудных полей и районов с промышленными месторождениями гидротермального генезиса показал, что во время минералообразования в них, как правило, преобладало докальное растяжение на фоне регионального тектонического сжатия.

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THE INDOSINIAN MOVEMENT AND TECTONIC OF ANCIENT CHINESE CONTINENT

The Ancient Chinese Continent was located at juncture of Paleotethys and Paleopacific Ocean in Permo-Triassic. Indosinian plate movements occurred along paleocontinental boundary. It led to the following events: paleotethys was closed, the whole paleocontinent was involved, especially the tectonic framework of its southern

part was reformed. There was a complete system of Trench-Arc-Basin from Jingsha River B-subduction boundary to Longmensha A-subduction boundary in Indosinian stage. There were three tectonic episodes: 1. Jingsha River movement (Ladinic) occurred at first along parisuture. 2. Noric movement (pre-Noric) migrated to Red River parisuture. 3. Longmenshan movement (Rhaetic), paleotethys was closed at last. By ten the primary form of Qinghai-Xizang (Tibet) plateau was formed. Major contact relation was probably some sinistral-rotating transform faults between paleocontinent and Paleo-Pacific Ocean in Indosinian stage. Only Double Metamorphism Zone of Western Japan might be considered as a B-subduction (T3/T2). As a result of united effect, system of NE-trend's pressure-torsion structure occured in Southern China. Indosinian paleotectonic comprises three units from margins to interior: 1. paleocontinental margin mobile belts, 2. active parts of paleocontinental interiors (craton border). 3. most stable part of paleocontinent were upper Yangzi platform and Sino-Korean platform, the strain of which was the slightest. Major movement types showed subsidence forming some large basins, which developed on the basement of paleocontinental Indosinian tectonic.

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TECTONIC SIGNIFICANCE OF STRUCTURAL-MAGNETIC LINEAMENTS OF THE SOUTHERN BRAZIL

Based on aeromagnetic survey carried out in Southern Brazil, it was possible to define four great NW-SE structural-magnetic lineaments, longer than 600 kilometers and 20-50 kilometers wide.

These lineaments belong to the Ponta Grossa Arch - a transversal megastructure to the Parana Basin. Based on lithological characteristics of the basin stratigraphy a model of the tectonic evolution of such structures is proposed. The mainly uplift of the arch occurred during the late Jurassic and the Cretaceous, when swarms of diabase dikes intruded faults and tension fractures and supplied tholeiitic basaltic flows. Alkaline and ultrabasic alkaline rocks and carbonatites were also intruded. The lineaments are considered as deep structures that reached the upper mantle, related to the tectonic evolution of the continental margin of southern Brazil. It is reasonable that some similar structures may occur in southern Africa, where identical rocks of comparable ages and evolution are know.

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DESARROLLO GEOTECTONICO, PETROLOGIA Y MINERALIZACION DE LA ASOCIACION OFIOLITICA DE CUBA

La asociación ofiolítica representa en el desarrollo geológico de Cuba a la antigua corteza oceánica y se encuentra en la actualidad - tangencialmente emplazada entre el arco volcánico y el margen continental septentrional, con los que se relaciona espacialmente a lo largo del territorio. El cinturón ofiolítico se prolonga en un extensión de 1000 km^2 y presenta un ancho que varia desde 3 hasta 30 km, siendo característicos en él los contactos tectónicos con las estructuras circundantes, aunque en algunas regiones parecen ser transsicionales con las secuencias volcánicas del Cretácico Inferior. Se definen claramente los cuatro complejos representados por las ultramafitas serpentinizadas, los cúmulos máficos, diques de diabasas, y basaltoides toleíticos con sus sedimentos pelágicos asociados. Se han determinado variaciones estructurales y petrológicas desde Occidente hacia la parte oriental del territorio, con una marcada tendencia a la disminuación del espesor de los complejos superiores y el de los inferiores, lo que no está relacionado directamente con las intensas alteraciones hidrotermales y tectónicas que afectan a las rocas de la asociación.
La mineralización de las ofiolitas se limita en su mayor parte el complejo de cúmulos máficos donde aparecen considerables acumulaciones de cromita y al complejo de basaltoides donde es características la mineralización de cobre, principalmente calcopirítica.

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NEW ASPECTS TO THE TECTONIC EVOLUTION OF THE EXTERNAL HELLENIDES DURING THE UPPER PALEOZOIC AND TRIASSIC

Abundant fossil discoveries in the HP/LT-metamorphic Phyllite group and in the lower parts of the nearly unmetamorphic Tripolitza nappe on Crete Island lead to new aspects of the tectonic evolution of the External Hellenides in the Upper Paleozoic and Triassic.
In the central part of the Phyllite group a fully marine environment is indicated by conodonts for the Middle/Upper Carboniferous to Lower Permian and for the Upper Permian to Upper Scythian. However, the Upper Triassic shows shallow water environment (ostracodes

and bivalves) in the lower part and a pelagic facies (conodonts and radiolarians) in the upper part of the Phyllite group. All available biostratigraphic data give rise to the assumption that the Phyllite group forms a huge recumbent isoclinal fold.
Recently further carboniferous conodonts have been found below the lower Norian limestones of the Tripolitza nappe. The tectonic significance of these paleozoic limestones is still investigated; possibly they are a first indication for a further nappe or nappe fragments between the Phyllite group and the Tripolitza nappe.
The preliminary results indicate a pelagic environment in the southern Tethys for several times from the Middle Carboniferous to the Upper Triassic, maybe implied by several openings and closings of troughs during that time.

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THE COMPLEX OF GEODYNAMIC INVESTIGATIONS OF THE SIBERIAN LITHOSPHERE

In order to find out the mechanism of forming the modern structure of Siberian lithosphere the following is used: a)combined interpretation of geological and geophysical data on the structure and dynamics of the lithosphere with the construction of principal models for the mechanisms of producing its main structures, b)mathematical modelling the chief geodinamic processes in these mechanisms.
The interpretation is based on the ascertaining the relationships between the structural and geodynamic characteristics, such as the structure of the Earth crust and mantle, the distribution of density inhomogeneities, elastic and thermal properties, viscosity, modern crustal movements, isostasy, thermal regime, the stress-strain states parameters and seismicity. The hypotheses on possible mechanisms of forming the lithosphere of various neotectonic elements are formed by excluding those processes which are not consistent with found relationships.
Based on the complex of data above, the model for interaction of horisonthal movements of large lithosphere masses by upper-mantle small -scale thermal convection is preverable model for the mechanism of formation of modern structure of lithosphere in Siberia.
Mathematical modelling for the upper-mantle convection with the isostatic rebounding in the lithosphere had shown that the convection explains the regularities in the distribution of most geodynamic characteristics and their relationships - inharitance of the latest and modern vertical crust movements and their antiisostatic direction,

greater differentiation (for the main structural and geodynamic parameters) of the active regions having thick asthenosphere over with the stable regions, direct dependence of the intensity of geodynamic processes upon geothermal regime. However some features of lithosphere manifested in the border zones of the Siberian Platform may be explained only by the suggestion of interaction of the convection with horisontal movements of Verkhoyask-Kolym and Altay-Sayan mountain belts toward the Platform , that leads to the compression of the Siberian Platform and, as possible, to the local extension of the lithosphere in the Baykal rift zone.

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КОМПЛЕКС ГЕОДИНАМИЧЕСКИХ ИССЛЕДОВАНИЙ ЛИТОСФЕРЫ СИБИРИ

Для выяснения механизмов формирования современной структуры литосферы Сибири используются: а) комплексная интерпретация геолого-геофизических данных о структуре и динамике литосферы с построением принципиальных моделей механизмов образования основных ее структур; б) математическое моделирование ведущих геодинамических процессов в рамках этих механизмов.

Основой интерпретации является выяснение соотношений между структурными и геодинамическими характеристиками: строением коры и мантии, распределением неоднородностей плотности, упругих и тепловых свойств, вязкости, современными движениями земной коры, изостазией, геотермическим режимом, напряженно-деформированным состоянием и сейсмичностью. Гипотезы о возможных механизмах формирования литосферы различных неотектонических структур строятся путем исключения тех процессов, которые не удовлетворяют выявленным соотношениям.

По совокупности геодинамических данных предпочтительной моделью механизма формирования современной структуры литосферы Сибири является модель взаимодействия горизонтальных движений крупных литосферных масс с движениями деформируемых блоков литосферы под действием верхнемантийной мелкомасштабной тепловой конвекции.

Математическое моделирование верхнемантийной конвекции с изостатическим регулированием в литосфере показало, что конвекция объясняет закономерности распределения большинства геодинамических характеристик и их соотношений – унаследованность новейших и современных вертикальных движений и их антиизостатическую направленность, более силь-

ную дифференциацию (по основным структурным и геодинамическим параметрам) активных областей с мощной астеносферой по сравнению со стабильными регионами, прямую зависимость интенсивности геодинамических процессов от геотермического режима. Однако некоторые особенности литосферы в зонах ограничения Сибирской платформы объясняются только при взаимодействии конвекции с горизонтальными движениями Верхояно-Колымского и Алтае-Саянского горных поясов, приводящими к сжатию Сибирской платформы и, возможно, вызывающими местное растяжение литосферы в Байкальской рифтовой зоне.

Предложенная модель имеет термодинамическое и петрологическое обоснование.

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CRUSTAL DYNAMICS CAUSED BY LITHOSPHERIC HETEROGENEITIES

Lateral density variations constitute the cause of the Earth's internal dynamics. These density heterogeneities may be of thermal or chemical origin. They can, in principle, be mapped by seismological studies. For simplicity one may separate the large scale dynamics expressed at the surface by plate tectonics from smaller scale deformations within or at the border of a given plate. A good illustration of the smaller scale dynamics is given by mountain building or by basin formation, where the lithosphere either thickens or thins.

Mechanically, the stresses generating lithospheric deformations are known to be proportional to the moment M of the density distribution $\rho(z)$, where z is the vertical direction:

$$\bar{\tau}_{xx} - \bar{\tau}_{zz} = \frac{g}{L} \int_0^L \rho(z)\, z\, dz$$

This was shown by Artuyshkov (J. Geophys. Res. 78, 7675, 1973) and reformulated by Fleitout and Froidevaux (Tectonics, 1, 21, 1982). The above relationship applies to density sources varying laterally with wavelength large compared to the lithospheric thickness L. The geoid, also, is proportional to the moment M represented by the above integral. One expects therefore some correlation between tectonic style and geoid.

For an oceanic ridge the density variations are essentially given by the progressive cooling of the plate. The extensional tectonics at young ages and the compressive character increasing with age is easily explained by the above argument. So is the roof-shaped geoid over ridges.

The distribution of stresses within Western North America, with the known contrast between the Basin and Range and the Colorado plateau, will equally be analysed in terms of laterally varying lithospheric density structures.

Finally the complex double root underneith the Central Alps will be discussed. The lithospheric dense root will be shown to drive the present day collision process.

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GEOTECTONIC DEVELOPMENT OF THE NORTH-WESTERN PART OF THE PACIFIC OCEAN

Island-arc systems of the region have much analogy to ancient eugeosynclines, liminar, or andesitic in particular, according to the composition of sedimentary and magmatic rocks, petrochemical characteristics and geoformations. Besides predominance of calc-alkali series of volcanites, absence of ophiolites they are characterized by interruption in volcanism, which alternate with flysh formations. Greate age range of geosynclinal formations of Kamchatka and Japan Islands including the whole Phanerozoic attests to a long polycyclic development of transitional zones and also attests indirectly to antiquity of the western part of the Pacific Ocean. Contemporary island arc stage, which started in Miocene, has stopped the mesocenozoic geosynclinic cycle, and it remained incompleted. Superposition of this new stage is revealed by unconformity of structures and in its destructive development with respect to continental crust. A new volcanic zone located not along the line continent-ocean but in the rear of non-volcanic microcontinent (The Small Kuril arc, the Eastern part of Japan). Neotectonic movements with amplitude of more than 11 km together with volcanism created a sharply relief of island-arc system marking by insular volcanic and deep-water colluvial-flysh formations. Occurence of numerous pebbles and boulders of granites, gneisses, amphibolites, metamorphic slates, quartzites, jaspers suggest an ancient sialic foundation of the islands and the community of structure and history with Kamchatka and Japan. Thus the transitional zones are the region of a long interaction of continent and ocean, developing according to geosynclinal type with predominance of the tendency to destruction of the continental crust at least in the last stage. The degree of this destruction is greater in the central part of the Large Kuril Arc.

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ГЕОТЕКТОНИЧЕСКОЕ РАЗВИТИЕ СЕВЕРО-ЗАПАДНОЙ ОКРАИНЫ ТИХОГО ОКЕАНА

Островодужные системы региона по вещественному составу осадочных и магматических пород, петрохимическим особенностям и геоформациям во многом аналогичны древним эвгеосинклиналям, особенно лиминарным, или андезитовым, типа Анд. Помимо преобладания известково-щелочных серий

вулканитов, отсутствия офиолитов они характеризуются прерывистостью вулканизма, более длительными авулканическими, в основном флишевыми этапами. Большой возрастной диапазон геосинклинальных образований, на Камчатке и Японских островах включающий весь фанерозой, свидетельствует о длительном полициклическом развитии переходной зоны и косвенно о древности западной части Тихого океана. Современный островодужный этап, начавшийся в миоцене, прервал мезо-кайнозойский геосинклинальный цикл, который остался незавершенным (нет моласс). Наложенность этого этапа видна и в несогласных взаимоотношениях структур и в его деструктивном по отношению к континетальной коре развитии. Новый вулканический пояс заложился не по границе континент-океан, а в тылу авулканичного микроконтинента(Малая Курильская гряда, восточная часть Японии). Неотектонические движения амплитудой более II км совместно с вулканизмом создали резко расчлененную островодужную систему, маркируемую островными вулканическими и глубоководными колловиально-флишевыми формациями. Помимо основного синхронного вулканитового и седиментокластового материала они включают гальки и валуны гранитов, гнейсов, амфиболитов, метаморфических сланцев, кварцитов, яшм, указывающих на древний сиалический фундамент островов и на общность строения и истории с Камчаткой и Японией. Зона перехода от континента к океану,таким образом, является областью длительного взаимодействия этих структур первого порядка. Она развивалась и развивается по геосинклинальному типу, с преобладанием тенденции к деструкции континентальной коры, по крайней мере в последнем этапе. Степень деструкции континентальной коры наибольшая в средней части Курил, состоящей из малых островов.

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STRUCTURE AND DYNAMICS OF THE RHENISH MASSIF

Plateau uplift of the Rhenish Massif in the Federal Republic of Germany and its causes were studied intensively during a six years multi-disciplinary research programme. Evidence for recent uplift was deduced from geodetic precision levelling and studies of river terraces. These findings correlate with the regional seismicity and stress distributions derived from fault plane solutions of local earthquakes and from in-situ stress determinations. The orientation of the stress fields can also be observed in the distribution of young volcanic activity. The structure of the lithosphere was investigated by explosion seismic surveys, by the analysis of teleseismic travel time anomalies and magnetotelluric depth-soundings. Strong lateral heterogeneities became apparent in the crust and upper mantle. Of special relevance is the discovery of a large low velocity body in the subcrustal lithosphere from teleseismic travel time anomalies. This body is located in the area of strongest present uplift and young volcanic activity. It possibly forms the primary driving agent.

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TECTONIC ZONATION OF THE CAUCASUS AND ADJACENT PARTS OF THE ANATOLIAN-IRANIAN SEGMENT OF THE ALPIAN FOLDED BELT

1. The geodynamics of contemporary aspect formation of the tectonic structure of the Caucasus and adjacent parts of the Anatolian-Iranian segment of the Alpian belt is interpreted Earth's expansion and compression phases. The Earth's pulsation development was caused by the periodical discharge of heat provoked by the substance gravitational differentiation on the mantle-core boundary as well as by the radioactive decay.

2. The formation of geosyncline troughs and their closure i.e. the continental crust formation in the Mediterranean folded belt, the part of which is the Caucasus, has taken place as a result of permanent divergence and convergence of earlier consolidated continental blocks of Eurasia and Gondwana, which is stipulated by the Earth's expansion and compression phases interchange.

In extension and attention epochs of crust and divergence of cratons the different types of eugeosyncline zones (ophiolitic troughs) have been formed. The Gondwana northward movements were accompanied by breaking up of its northern peripheric part with the broken up and torn away blocks turned into medial massifs by alpine tectogenesis and located between them seam zones became miogeosynclines or parageosynclines (Central Iran, Elburs, near-Caspian zone of Transcaucasus, Central Anatolia, Taurides, Zagros). In the northern near-Eurasian part of the seam zone the geosyncline zones have formed (Eastern Pontian-Adjarian-Trialetian, Somkheto-Kaphanian, Sevano-Akerian). In the Earth's compression and crust huddling phases the convergence of those cratons has taken place stipulating folding, metamorphism, granitization i.e. the granite-metamorphic layer formation.

3. The considered segment is divided into tectonic elements taking into account the structural-formational pecularities, the age of general folding phase, the time of geosyncline troughs formation and other hystorico-geological indications.

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ТЕКТОНИЧЕСКОЕ РАЙОНИРОВАНИЕ КАВКАЗА И СОПРЕДЕЛЬНЫХ ЧАСТЕЙ АНАТОЛИЙСКО-ИРАНСКОГО СЕГМЕНТА АЛЬПИЙСКОГО СКЛАДЧАТОГО ПОЯСА

I. Геодинамика формирования современного облика тектонической структуры Кавказа и сопредельных частей Анатолийско-Иранского сегмента альпийского складчатого пояса нами интерпретируется в свете пульсационной гипотезы, т.е. чередования фаз расширения и сжатия Земли. Причиной пульсационного развития Земли могло служить периодическое выделение тепла, вызванное гравитационной дифференциацией вещества на границе мантии и ядра, а также распадом радиоактивных элементов.
2. Заложение геосинклинальных прогибов и их замыкание, т.е. формирование континентальной коры в Средиземноморском складчатом поясе, часть которого составляет Кавказ, происходило в результате перманентного раздвижения и сближения обрамляющих его ранее консолидированных континентальных блоков - Евразии и Гондваны, обусловленных чередованием фаз расширения и сжатия Земли.
В эпохах растяжения и утонения коры и раздвижения кратонов между ними формировались различного типа эвгеосинклинальные зоны (офиолитовые троги). Движения Гондваны на север сопровождались раздроблением ее северной периферической части, откололившиеся и оттороженные обломки которой превратились в переработанные затем альпийским тектогенезом срединные массивы, а расположенные между ними рубцовые зоны - миогеосинклинальные или парагеосинклинальные прогибы (Центральный Иран, Эльбурс, Приараксинская зона Закавказья, Центральная Анатолия, Тавриды, Загросы). В северной, Приевразийской части рубцовой зоны формировались эвгеосинклинальные зоны (Восточно-Понтийско-Аджаро-Триалетская, Сомхето-Кафанская, Севано-Акеринская). В фазах же сжатия Земли и скучивания коры имело место сближение указанных древних кратонов, обусловившее складчатость, метаморфизм, гранитизацию, т.е. формирование гранитно-метаморфического слоя.
3. Рассматриваемый сегмент расчленяется на тектонические элементы, учитывая структурно-формационные особенности, возраст главной складчатости, время заложения геосинклинальных прогибов и др. историко-геологические признаки.

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ALPINE GEODYNAMICS OF THE CAUCASUS

Actual and analytical material suggests the necessity of admitting the predominance of horizontally directed tectonic forces and move-

ments in the Earth's Crust of the Caucasus and consequently of adopting the idea of Mobilism for the interpretation of its geodynamic evolution.

The geodynamic evolution of the Caucasus is considered in the work against the background of the entire central segment of the Mediterranean belt and adjacent areas. Palinspatic schemes of the tectonic development of this belt from the Late Paleozoic to the Late Eocene, based on a complex of geological, paleobiogeographical and paleomagnetic data, are presented.

An attempt has been made to show, that horizontal displacements of ancient East European and African platforms, as well as of separate blocks (or small plates) of Lithosphere within the Mediterranean belt during the Late Pre-Cambrian - Early Mesozoic, alternately gave rise to oceanic basins. The latters are marked in modern structures by the rocks of ophiolitic association. On the margins (or on one of the margins) of these basins processes of subduction of Oceanic Crust are admitted, with the formation of volcanic island arcs and granitoid magmatism related to them. A dynamic unity of extention and compression is observed within the Mediterranean belt. The closure of the oceanic basin of Paleotethys roughly coincides in time with the opening of Mesotethys, thus ensuring maintenance of the gap between the Afro-Arabian and Eurasian continents required by paleomagnetic and other data. At the same time, the closure of Mesozoic ocean of Tethys on the whole is most likely synchronous with the opening of the modern Atlantic ocean.

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АЛЬПИЙСКАЯ ГЕОДИНАМИКА КАВКАЗА

Фактический и аналитический материал указывает на необходимость допущения господства в земной коре Кавказа горизонтально направленных тектонических сил и движений и, следовательно, привлечения идей мобилизма к интерпретации его геодинамической эволюции.

Геодинамическая эволюция Кавказа рассматривается в докладе на фоне развития всего центрального сегмента Средиземноморского пояса и смежных с ним областей. Представлены палинспастические схемы тектонического развития этого пояса с позднего палеозоя до позднего эоцена, обоснованные комплексом геологических, палеобиогеографических и палеомагнитных данных.

Сделана попытка показать, что в результате горизонтального перемещения древних Восточно-Европейской и Африканской платформ, а также от-

дельных глыб (или малых плит) литосферы внутри Средиземноморского пояса в течение позднего докембрия- раннего мезозоя происходило попеременное заложение океанических бассейнов, которые в современной структуре маркируются породами офиолитовой ассоциации. По краям (или на одном краю) этих бассейнов допускается развитие процессов субдукции океанической коры, с которыми связаны образования вулканических островных дуг и гранитоидный магматизм. Отмечается динамическое единство процессов растяжения и сжатия в пределах Средиземноморского пояса. Закрытие океанического бассейна Палеотетиса в общем совпадает по времени с раскрытием Мезотетиса, что и обеспечивает сохранение необходимого по палеомагнитным и другим данным зияния между Афро-Аравией и Евразией. Наряду с этим очевидно, что закрытие мезозойского океана Тетис в целом синхронно с раскрытием современного Атлантического океана.

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TECTONIC AND PALEOTECTONIC ZONATION ACCORDING TO THE TIME OF PLATFORM STRUCTURE FORMATION

Middle-scale and large-scale tectonic and paleotectonic maps based on the method of zonation according to the time of the main stage of platform structure formation can be used for the purposes of regional synthesis (Garetsky, Aizberg, 1973, 1975; Aizberg, Garetsky, Suveyzdis, 1982). Middle-scale and general tectonic maps of Byelorussia (1974), of the Baltic republics (1979), of the USSR oil-bearing areas (Dikenschtejn et al., 1978) and paleotectonic maps of the western part of the Eastern-European platform (1982) were made according to this method. This method consists in presentation of spatial relations of the cover structural subdivisions (complexes, stages, substages) with distinguishing of that dominating by thickness. Areas of extent of complexes, stages, substages dominating by thickness are shown by a definite colour in every type of geotectonic subdivision combination, which reflects in essence the main stage of the platform structure evolution. The amount of information given by maps is increased by traditional presentation of different structural and formation features. Paleotectonic maps made up on this basis are subdivided into two principal types: 1) stage-time (interval) maps, 2) maps of tectonic (geochronological) boundaries. Regional paleotectonics of a definite time interval (stage, substage or period, epoch) is reflected on the first maps by presen-

tation of relation of structural stages and substages formed during the time under consideration only, with distinguishing that dominating by thickness. The latters correspond to the main stages (substages. phases) of evolution of given cover section and are shown by a definite colour, as well as on tectonic maps. Paleotectonic maps of the second type reflect the principal features of regional tectonics which were formed by any definite geochronological boundary of the platform evolution. The method of their making is analogous to that stated above.

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ТЕКТОНИЧЕСКОЕ И ПАЛЕОТЕКТОНИЧЕСКОЕ РАЙОНИРОВАНИЕ ПО ВРЕМЕНИ ФОРМИРОВАНИЯ ПЛАТФОРМЕННЫХ СТРУКТУР

Для целей регионального синтеза можно использовать тектонические и палеотектонические карты среднего и крупного масштаба, в основу которых положен метод районирования по времени основного этапа формирования платформенных структур (Гарецкий, Айзберг, 1973, 1975; Айзберг, Гарецкий, Сувейздис, 1982). В соответствии с этим методом созданы среднемасштабные и обзорные тектонические карты Белоруссии (1974), Прибалтики (1979), нефтеносных областей СССР (Дикенштейн и др., 1978), палеотектонические карты запада Восточно-Европейской платформы (1982). Основа этого метода районирования - показ пространственного соотношения подразделений чехла (комплексов, этажей, подэтажей) с выделением из них доминирующего по мощности. В каждом типе сочетания структурных подразделений определенным цветом показываются площади распространения доминирующего по мощности комплекса, этажа, подэтажа, что по существу отражает главный этап развития платформенной структуры. Информативность карт увеличивается традиционным показом различных структурных и формационных признаков. Созданные на этой же основе палеотектонические карты подразделяются на два основных типа: 1) стадийно-временные (поинтервальные); 2)тектонических (геохронологических) рубежей. На первом палеотектоника региона определенного временного интервала (этапа, стадии или периода, эпохи) отражается показом соотношения образованных только в рассматриваемое время структурных этажей и подэтажей с выделением доминирующего по мощности. Последние соответствуют основным стадиям (подстадиям, фазам) формирования данной секции чехла и показываются, как и на тектонических картах, определенным цветом. Палеотектонические карты второго типа отражают основные черты тектоники региона, сформированные к любому определенному геохронологическому рубежу платформенного развития. Метод их создания аналогичен описанному выше.

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INTERNATIONAL TECTONIC MAP OF THE EASTERN-EUROPEAN PLATFORM SOUTH-WESTERN BORDER

As a result of investigations for the IGCP project № 86 "Eastern-European platform, S.-W. border", International tectonic map on a scale of 1:1,5 million covering the territory of Middle and Eastern Europe from Great Britain and the southern part of Scandinavia to the Black Sea was compiled. It is based on the principle of reflection of the final folding age. The map is supplemented with schemes on a scale of 1:10 million representing tectonic zonation of basement and cover, as well as the Mohorovičič discontinuty and heat flow. The Teisseyre-Tornquist line (TT) forms a part of more extensive Dobruja-North Sea lineament and separates the pre-Baikalian basement of the Eastern-European platform (EEP) from a more recent one of the Western-European platform (WEP). TT line is a fault zone having scaly-thrust character in a number of areas. In paleotectonic plan, since the Riphean, this line is the most distinct one among all possible WEP boundaries. It divides Europe into areas with different thickness of earth's crust (thin-within WEP and thick-within EEP), with different heat flow (high and contrast on WEP, lower and calm on EEP). A wide enough mobile zone distinctly reflected in the platform cover evolution is noted along the EEP border.

The EEP border is marked sometimes by magmatism. The Rygen-Vislian caledonian geocyncline elongated for over 900 km was observed along the TT line. The Pomorsko-Kujavsky trough had been formed over its northern part during the late-Permian and Mesozoic, which had endergone the inversion at the very end of the Mesozoic and had been transformed in a uplift zone of the same name. In connection with the evolution of the Caledonian and late-Permian-Mesozoic trough, the marginal part of EEP was sharply subsided forming respectively the Baltic-Pridniester system of pericratonnal subsidences and Polish-Byelorussian monocline . The Dobruja-North Sea lineament represents a constituent part of a global tectonic element stretching from Greenland and Iceland, through the Faeroes Islands, along the south-western border of EEP and continuing on the other side of the Black Sea up to Zagross.

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МЕЖДУНАРОДНАЯ ТЕКТОНИЧЕСКАЯ КАРТА ЮГО-ЗАПАДНОГО КРАЯ ВОСТОЧНО-ЕВРОПЕЙСКОЙ ПЛАТФОРМЫ

В результате работ по проекту №86 МПГК "Восточно-Европейская платформа (юго-западный край)" составлена Международная тектоническая карта масштаба I:I,5 млн., охватывающая территорию Средней и Восточной Европы от Великобритании и юга Скандинавии до Черного моря. В ее основу положен принцип отображения возраста заключительной складчатости. Карту дополняют схемы масштаба I:I0 млн. тектонического районирования фундамента и чехла, а также поверхности Мохо и теплового потока. Линия Тейссера-Торнквиста (ТТ) входит в состав более протяженного Добруджско-Североморского линеамента и разделяет добайкальский фундамент Восточно-Европейской платформы (ВЕП) от более молодого Западно-Европейской платформы (ЗЕП). Линия ТТ - это зона разломов, которая в ряде участков имеет чешуйчато-надвиговый характер. В палеотектоническом плане, начиная с рифея, эта линия наиболее отчетливая из всех возможных границ ВЕП. Она делит Европу на территории с разной мощностью земной коры (тонкой в пределах ЗЕП и толстой ВЕП), различным тепловым потоком (высоким и контрастным на ЗЕП, более низким и спокойным на ВЕП). Вдоль края ВЕП намечается достаточно широкая мобильная зона, отчетливо отражающаяся в развитии платформенного чехла. В отдельных случаях край ВЕП маркирует магматизм. Вдоль линии ТТ прослежена вытянутая более чем на 900 км Рюгенско-Вислянская каледонская геосинклиналь. Над ее северной частью в поздней перми и мезозое сформировался глубокий Поморско-Куявский прогиб, который в самом конце мезозоя претерпел инверсию и превратился в одноименную зону поднятий. В связи с развитием вдоль линии ТТ каледонского и позднепермско-мезозойского прогибов краевая часть ВЕП претерпела резкое опускание с образованием соответственно Балтийско-Приднестровской системы перикратонных опусканий и Польско-Белорусской моноклинали. Добруджско-Североморский линеамент представляет собой составную часть глобального тектонического элемента, который прослежен от Гренландии и Исландии через Фарерские острова, по юго-западному краю ВЕП и продолжается по другую сторону Черного моря вплоть до Загроса.

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DEEP STRUCTURE AND EVOLUTION OF PRIPJAT-DNIEPER-DONETS AND KENYAN RIFTS

These rifts belong to intracontinental, had been forming correspondingly in Late Devonian and Late Paleogene. Therefore, joint examination promote to studying of both rifts evolution, that set in the limits of oval Pre-Middle-Devonian and modern archs of Pre-Cambrian basement with altitude of 4-5 km. Rifts are limited by marginal subcrustal fructures, that consist of regional faults system with length 30-300 km, summary amplitude 3-5 km. The volcanic formation filling in rifts have alkali-ultrabasic and alkali-basaltiform composition. Pre-Cambrian deep fractures play an essential role in accumulation of volcanite, tectono-volcanic structures, salt and indiametrical tectonic zonation.

Rifts, apparently, had been formed as a result of introduction in lithosphere of warmed up pulsate widen asthenosphere diapir fold according to regmatic, sometimes, crossing het of superdeep fructures. The asthenosphere diapir, enriched by melt down diabase fraction, reached Mocho surface, promoted by formation of earth crust oval arch, newformed arch fractures and outpouring of magma, and future pulsate run to 300-700 km of asthenosphere matter in the foot of earth crust - its insignificant stretching and rifts formation with depth to 3-5 km. Accumulation of coarse-grained and variagated rocks simultaneously with outpouring of magma near fractures was pulsate.

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ГЛУБИННОЕ СТРОЕНИЕ И ЭВОЛЮЦИЯ ПРИПЯТСКО-ДНЕПРОВСКО-ДОНЕЦКОГО И КЕНИЙСКОГО РИФТОВ

Эти рифты принадлежат к внутриматериковым, формировавшимся соответственно в позднедевонское и позднепалеогеновое время. Поэтому совместное рассмотрение их способствует познанию эволюции обоих рифтов, которые располагаются в пределах овальных досреднедевонского и современного сводов докембрийского фундамента высотой 4-5 км. Рифты ограничены краевыми подкоровыми разломами, состоящими из системы региональных сбросов длиной 30-300 км и суммарной амплитудой 3-5 км. Мощность земной коры в их приосевой части уменьшается. Выполняющие рифты вулканические образования имеют щелочно-ультраосновной и щелочно-базальтовый состав. В накоплении вулканитов и тектоно-вулканических структур, отложении соли, поперечном тектоническом райони-

ровании существенную роль играли докембрийские глубинные разломы. Формировались рифты, очевидно, в результате внедрения в литосферу разогретого пульсационно расширяющегося астеносферного диапира по регматической, иногда пересекающейся сетке сверхглубинных разломов. Обогащенный расплавленной диабазовой фракцией астеносферный диапир, достигнув поверхности Мохо, способствовал формированию овального свода земной коры, новообразованных сводовых разломов и излиянию магмы, а дальнейшее пульсационное растекание до 300-700 км астеносферного вещества в подошве земной коры - ее незначительному растяжению и образованию рифтов глубиной до 3-5 км. Накопление грубозернистых и пестроцветных пород одновременно с излиянием магмы у разломов было пульсационным.

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PETROLOGO -GEOCHEMICAL PROCESSES OF PHANEROZOIC CONTINENTAL CRUST FORMATION OF ARMENIA (LESSER CAUCASUS)

Petrologo -geochemical effects and mechanisms of melts evolution have been revealed, as well as ore elements behaviour under permanent convergence of African-Arabian and East European paleocontinents. Phanerozoic continental crust formation of Armenia (Lesser Caucasus) was complex, with several stages of development:

1. The oceanic stage (Jurassic-Early Cretaceous) is represented by ophiolite rock association developed in narrow Sevan, Zangezur and Vedi zones. Mantle ultramafics of dunite-harzburgite, lherzolite, gabbro-peridotite formation (a layered complex) and mafites of diabase-tholeiite formation were involved in tectonic squeezing out and formation of nappes and olistostrome complexes.

2. The transitional stage (Middle Jurassic-Miocene) had two substages: formation of the Tauro-Caucasian marginal sea and the Somkhet-Karabakh-Kafan island arc. At an early phase (Late Jurassic-Neocomian), the indicator complex of the granite-metamorphic layer was calc-alkaline series of an andesite-basalt formation, typical of active margins and penetrated by rocks of the plagiogranite and gabbro-diorite-tonalite formations. At a later phase (Upper Cretaceous-Miocene), tholeiitic basalts, andesites and liparites were extruded, associated with thick allochthonous ophiolitoclastic flysch-olistostrome series (Senomanian-Lower Coniacian). This phase is characterized by growing island arc and Na and K dominated "immature" crustal magmatism. Later, there appeared a tendency towards potassic

metasomatosis, and Tertiary palingenetic formations of the banatite, alkali-syenite and granosyenite-granite type (Bazum-Pambak-Zangezur). 3. The continental stage (Upper Miocene-Anthropogene) was marked by liparite-dacite, trachyliparite, trachyandesite and andesite-basalt formations (Gegam Upland, Aragats, Ayotsdzor, Ararat).

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ПЕТРОЛОГО-ГЕОХИМИЧЕСКИЕ ПРОЦЕССЫ ФОРМИРОВАНИЯ КОНТИНЕНТАЛЬНОЙ КОРЫ ФАНЕРОЗОЯ АРМЕНИИ (МАЛЫЙ КАВКАЗ)

I.Океаническая стадия (юра-ранний мел) представлена комплексом пород офиолитовой ассоциации, развитым по узким зонам (Присеванская, Зангезурская, Вединская). Мантийные ультрамафиты дунит-гарцбургитовой, лерцолитовой, габбро-перидотитовой (расслоенный комплекс) и мафиты диабаз-толеитовой формации подверглись тектоническому выдавливанию, растаскиванию их чешуй, пластин и накоплению олистостромовых толщ.

2. Переходная стадия (средняя юра-миоцен) представлена двумя этапами: образованием окраинного моря (Тавро-Кавказское) и островной дуги (Сомхето-Карабах-Кафанская). На раннем этапе (поздняя юра-неоком) комплексом-показателем гранитно-метаморфического слоя являются характерные для активных окраин известково-щелочные серии андезитобазальтоидной формации, прорванные породами плагиогранитной и габбро-диорит-тоналитовой формаций. На позднем этапе (верхний мел-миоцен) происходили излияния толеитовых базальтов, андезитов и липаритов, ассоциированные с мощными аллохтонными флишево-олистостромовыми сериями (сеноман-нижний коньяк) офиолитовой ассоциации. Для этого этапа свойственно наращивание островной дуги и становление "незрелого" корового магматизма с преобладанием в его составе Na над K. Позднее возникают тенденция калиевого метасоматоза и развитие третичных палингенных формаций типа банатитовой, щелочно-сиенитовой и граносиенит-гранитной (Базумо-Памбак, Зангезур).

Прослежены петролого-геохимические эффекты и механизмы эволюции расплавов, а также поведение рудных элементов в условиях перманентного сближения Африкано-Аравийского и Восточно-Европейского палеоконтинентов. Процесс становления континентальной коры фанерозоя Армении (Малый Кавказ) является сложным и многостадийным:

3. Континентальная стадия(верхний миоцен-антропоген)выражена образованием липарито-дацитовой, трахилипаритовой,трахиандезитовой и андезито-базальтовой формаций (Гегамское нагорье,Арагац, Айоцдзор, Арарат).

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ON THE NATURE OF TECTONIC STAGES IN THE EVOLUTION OF FOLD BELTS IN THE WESTERN HIMALAYA

The tectonic trend and the development of the continental crust in the western part of the Himalayan Tectogene could be better visualised by the concept of tectonic stages differing in their structural style and sedimentary-magmatic-metamorphic history. The important tectonic stages distinguished are (i) basement, (ii) late Proterozoic-early Palaeozoic fold belt, (iii) upper Palaeozoic-Mesozoic folded cover and localised fold belts, and (iv) Meso-Cainozoic fold belt, folded covers and marginal fold belts.

The basement comprising deformed cores of ancient crustal rocks of probably mid-Proterozoic age (1620±90 Ma to 1830 Ma) was, however, partly involved in the deformational events during the later tectonic stages. The overlying fold belt comprises metasedimentary and volcano-sedimentary sequences of late Proterozoic-early Palaeozoic cycle, characterized by intense folding of isoclinal to reclined types, with associated metamorphism from greenschist to amphibolite facies and granitoid emplacement during 456±50 Ma to 612±100 Ma.

The next tectonic stage of late Palaeozoic-Mesozoic cycle constitutes folded cover of sedimentary sequence in epiplatform basins. Meso-Cainozoic cycle comprises fold belt and folded covers of the main Himalayan cycle with the development of Indus Ophiolite along the northern fringe of the Tethys Himalayan. This cycle is also represented by reactivation of the earlier fold belts with associated thermal reconstitution/regeneration of the earlier rock sequences during mid-Eocene (45 Ma) and early Miocene (20 Ma).

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CHARACTER OF THE SILICIC LIQUIDS OF THE WICHITA MOUNTAINS - A CAMBRIAN RIFT ENVIRONMENT

The Wichita Mountains of southwestern Oklahoma, U.S.A. are part of the Southern Oklahoma aulacogen and expose a basement sequence unusual in age for the continental interior of the U.S. The rift, which was active from at least the Cambrian to the Permian, apparently was initiated with emplacement of a strongly bimodal igneous suite. Rise and consolidation of hydrous tholeiitic liquid (~550my) was followed after an erosional interval by rhyolite-granite (~525my). The N60°-70°W structural trend of the rift transects earlier 1200-1500my basement.

While subordinate in volume to the rhyolites, the granites are the most extensively exposed igneous units. These rocks were emplaced as thin sheets rather than the more common bulbous masses of batholithic terranes. One granitic sheet has a horizontal extent of 55 km and is about 0.5 km thick. Overall, the granites are A-type: anorogenic, mildly alkaline (metaluminous), relatively anhydrous, high temperature (900°-1000°C) and hypersolvus, barren of ore deposits, and enriched in light rare-earths with a distinct Eu anomaly.

Three chemical classes are recognized on the basis of major element chemistry:

Oxide wt%-Class	*Mt. Scott*	*Reformatory*	*Mountain Park*
SiO_2	71.0-73.6	73.8-74.7	75.0-77.6
TiO_2	>0.4	0.2- 0.3	0.1- 0.25
Fe_2O_3 (total Fe)	>3.5	1.8- 2.7	1.2- 2.6
MnO	>.07	0.02- 0.05	0.00- 0.04
CaO	1.0- 1.5	0.3- 0.7	0.1- 0.6
K_2O	~4.3	4.2- 5.3	4.1- 5.5
P_2O_5	0.08	0.00- 0.02	.00- 0.01
Rb (ppm)	127 (116-135)	127 (101-158)	174 (119-231)
Sr (ppm)	91 (84-100)	41 (8-59)	22 (3-63)

Mt. Scott is more primitive, has a very uniform composition, and must have been well-equilibrated with its source rock. The three classes show a gross spatial control with Mt. Scott prominent in the eastern outcrop area, Reformatory prominent in the western area, and Mountain Park occurring over the whole region. These classes may represent distinct liquids and presumably exist in the co-magmatic rhyolites.

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INVESTIGATION OF PHYSICAL AND MECHANICAL PROPERTIES OF ROCKS

The properties of homogeneous intact rocks are compared with those of rock in mass where much more attention must be paid to discontinuities such as joints, faults and bedding planes. Strength, porosity and permeability, stability and weathering resistance are major physical properties affecting behaviour. These properties in turn are affected by shape of grains since this affects interlock and internal friction and hence mechanical behaviour; grain-shape also affects porosity and

permeability so weathering resistance and durability are affected. These physical properties interact and are of concern to engineering geologists in foundation engineering, reservoir engineering and materials engineering.

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THERMAL INHOMOGENETIES IN THE CONTINENTAL UPPER MANTLE AND NEOTECTONICS

Many regions of recent tectonic activity are characterized by the existence of mantle inhomogeneties, which are revealed by various geophysical methods. It is found that the lithosphere beneath the continental rifts and many recent uplifts (high platoes) is abnormally thin. The thinning of the lithosphere is connected with the process of intensive convective heating. The study of the thermal regime of the lithosphere, when the convective heat flow is supplied to its base, is performed in the frame of Stephan's type problem. The solutions giving the possibility to state a relation between the evolution of the thickness of the lithosphere and the value of the heat flow at the base of the lithosphere at neotectonic stage are derived. The results of computations show that the thickness of the lithosphere can be reduced to one half of its initial value for the time interval of an order of several millions years when the value of convective heat flow from the anomalous mantle is of an order of I - 3 HFU. The evaluation of Nusselt number leads to the conclusion on the important role of intensive small-scale convection as a mechanism of heat and mass transfer in the anomalous mantle. The crustal movements are caused by a number of physical processes (the heat expansion of the lithosphere, the forces of the isostatic nature having the greatest importance in the case of density inversion at the base of the lithosphere, the tension produced by the flow of heated material and, finally the regional tectonic stress field). The role of these factors and their interactions in the tectonic processes are discussed.

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ТЕРМИЧЕСКИЕ НЕОДНОРОДНОСТИ КОНТИНЕНТАЛЬНОЙ ВЕРХНЕЙ МАНТИИ И НЕОТЕКТОНИКА

Области современной тектонической активности, как правило, характеризуются наличием значительных неоднородностей в верхних слоях мантии, выявляемых различными геофизическими методами.

В частности, для областей континентального рифтогенеза и целого ряда новейших поднятий установлено существенное сокращение мощности литосферы, отражающее процесс интенсивного разогрева подкоровых слоев. Исследование термического режима литосферы в условиях конвективного нагрева снизу выполнено в рамках задачи стефановского типа с заданным тепловым потоком на подвижной границе. Полученные решения позволяют установить связь между изменением мощности литосферы и величиной глубинного теплового потока на неотектоническом этапе. Результаты вычислений указывают на возможность сокращения мощности литосферы вдвое за несколько миллионов лет при подводе к ее подошве теплового потока порядка первых единиц HFU . На основании оценок числа Нуссельта делается вывод о важной роли интенсивной мелкомасштабной конвекции как механизма теплопереноса в аномальной мантии. Наблюдаемые движения земной коры определяются целым рядом физических процессов: тепловым расширением литосферы при ее прогреве, изостатическими силами, особенно сильно проявляющимися в случае создания инверсии плотности на нижней границе литосферы, растягивающими напряжениями, возникающими при течении разогретого подкорового вещества, а также региональным полем тектонических напряжений. Обсуждается вклад этих факторов и их взаимодействие в процессе формирования основных тектонических структур на континенте.

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ON THE STRUCTURE OF THE ALPINE OROGENE ON THE BALKAN PENINSULA

The Alpine belt on the Balkan Peninsula is a megastructure of divergent orogenic and palinspastic symmetry but today it is veiled since the evolution of Northern branch terminated here during the Oligocene while the Southern continued to develop until present time. The Alpine median massif on the Balkans was not the Rhodope Massif but the Pelagonian-Menderes triassic submarine "ridge" (today - "Pelagonian marbles", "Pelagonian shelf" of Macedonia and Greece and the "carbonate upper series" of Menderes , etc.). It was also

an important barrier between the Northern and Southern Tethys, borderet on the two sides by two couples of "internal zones" (with oceanic and continental floor) as the Subpelagonian-Shar Planina + the Pindus trough (s.l.) and the Muresh-Vardar-Strandza + the Trojan - Nish trough (s.l.) which terminated their pre-orogenic development until the end of the Lower Cretaceous. In front of them two "external zones" developed in different time intervals - the Ionian (s.l.) and the Stara Planina + the Fore Balkan. They grade in composition and structure to the basins of the foreland - the Moesian and Apulian platforms. In structural aspect the Serbo-Macedonian "massif" is the basement of the internal zones from the Northern branch (Ograzhden, Sakar, Dervent ecc) while the Rhodopes (s.s.) are today fragments of the Alpine "external massif" including initially also the marble "Rhodope complex" and its ultrametamorphic basement. Together with the basement of the Inner Carpatho-Balkanides the Rhodopicum forms a very thick and layered allochthone, in places burried (?) up to 4-8 km blow the surface (Rila Mt etc.).

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FOLDING DEFORMATION AND TEXTURAL EVOLUTION OF ALPINE ULTRAMAFIC ROCKS IN SOUTHERN SIBERIA

Massifs of ultramafic rocks of Southern Siberia consist of banding dunite-harzburgite complexes; they are unique folded systems having originated as a result of the consistent stages of deformation. The dynamics of the first stage was being created under subhorizontal flow and resulted in the development of isoclinal folding. The flow direction can be seen from the position of Ng-maximum of olivine concentration and from the lineation connected with it. During the second stage of deformation the flow prevails in the subvertical plane coinciding with axial planes of large folded forms of conical type. Changes in the dynamics resulted in the destruction of early olivine petrofabric and in changes in lineation orientations, the lineation approaching Nm-maximum. The third of the deformation process reflects the flow in gently sloping planes and the formation of isoclinal fold-faults. Under these conditions olivine Np-maximum orientation is normal to the flow plane and lineation is between Ng and Nm. Textural development of ultramafic rocks after folding deformation finds its expression in regressive changes in the systems of intracrystal slip in olivine from (OIO) [IOO] trough {OKL} [IOO]

to (I00) [00I] accompanied by syntectonic recrystallization. Deformation of ultramafic rocks at its first stage took place in the boundary between the crust and the upper mantle. The resulted internal texture of the massifs is a reflection of the common tectonic layering of lithosphere. The second stage of the deformation was controlled by deep-seated breaks and found its expression in vertical synkinematic flow of ultramafic substance accompanied by massifs movement to the area of their consolidation. The subsequent changes in the ultramafic substance is conditioned by metapepsis and they took place simultaneously with the changes in the wall rocks under horizontal flow.

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СКЛАДЧАТЫЕ ДЕФОРМАЦИИ И ТЕКСТУРНАЯ ЭВОЛЮЦИЯ АЛЬПИНОТИПНЫХ ОСНОВНЫХ ПОРОД В ЮЖНОЙ СИБИРИ

Массивы альпинотипных гипербазитов юга Сибири сложены полосчатыми дунит-гарцбургитовыми комплексами и представляют собой уникальные складчатые системы, возникшие как результат последовательно проявившихся трех этапов деформации. Динамическая обстановка первого этапа создавалась в условиях субгоризонтального течения и нашла выражение в развитии изоклинальной складчатости. Направление течения фиксируется положением N_g -максимума концентрации оливина и связанной с ним линейности. На втором этапе деформации течение доминировало в субвертикальной плоскости, совпадающей с осевыми поверхностями крупных складчатых форм конического типа. Изменение динамической обстановки привело к разрушению ранних петроструктурных узоров оливина и переориентации линейности в положение, близкое к N_m -максимуму. Третий этап деформационного процесса отражает течение в полого наклонной плоскости и формирование изоклинальных опрокинутых складок. В этих условиях N_p -максимум оливина ориентирован нормально к плоскости течения, а линейность располагается между N_g и N_m. Структурная эволюция складчато деформированных гипербазитов находит отражение в регрессивной направленности смены систем внутрикристаллического скольжения в оливине от (0I0)[I00] через {0KL}[I00] к (I00)[00I], сопровождавшегося синтектонической рекристаллизацией. Деформация гипербазитов на первом этапе осуществлялась в области границы коры и верхней мантии. Создаваемая при этом внутренняя структура массивов отражает общую тектоническую расслоенность литосферы. Второй этап деформации контролировался глубинными разломами и проявился в вертикальном синкинематическом течении гипербазитового субстрата при движении массивов в области их консолидации. Последующее преобразование вещества гипербазитов связано с региональным метаморфизмом и осуществлялось с вмещающими породами в обстановке горизонтального течения.

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REVIEW OF THE RED SEA RIFT GEOLOGICAL HISTORY AND ASSOCIATED MINERALIZATIONS

The Red Sea presents the opportunity to study numerous problems related to the evolution from a continental rift to a young ocean. A review of a great amount of geological and geophysical data enables to outline the main geological events linked to the four main phases of the Red Sea history.

1. The pre-rifting phase, Upper Cretaceous to Eocene, is marked by different sequences between a southern part (Ethiopia, Yemen, SW Arabia) and a central-northern part.

2. The rifting phase, approximately Oligocene, witnesses a continuous line of weakness independent of Arabo-Nubian Precambrian shield structure.

3. The first stage of Red Sea opening during Miocene is characterized by very thick evaporites deposits over a basement whose structure has been the subject of vigorous debate. In agreement with some authors, a mixed nature of the basement is proposed in order to explain the first opening by continental extension and massive mafic intrusions.

4. The recent stage of opening, Pliocene to Recent, was accomplished by clearly recognized accretion of oceanic crust. A remarkable progression of this oceanic opening from South towards North exists in the central and northern parts as it is examplified by characteristic morphostructures.

Along with this dynamic scheme, different types of mineralization can be associated with each stage of evolution forming a sequence that can be found in older rifts.

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ON THE FORMATION AND EVOLUTION OF THE NORTHERN HIMALAYAN AND GANDISE GEOSYNCLINES

Both the Northern Himalayan and Gandise Geosynclines were formed as intracontinental troughs by depression in Triassic and Early Cretaceous respectively on the Centro-Southern Tibetan Massif, which was part of the Gondwanaland with its foundation formed by

the Jingning Folding and the Paleozoic as platform cover. They were then succeedingly closed respectively in middle Late Cretaceous and by the end of Eocene, and turned into two folded belts of different ages, which are separated by the great Yarlung Zangbo fault with south-depping fault-plane. This great fault belongs to type A downthrust formed within the continental crust. Within the two folded belts there commonly developed ultra-ferro-magnesian rocks, basic to intermediate-acidic rocks, radiolarian-bearing chert, and flyschs. Ultra-ferro-magnesian rocks are mantle rocks, being emplaced in various rock associations and structures at different ages, so they are distinctly multicyclic in nature, formed under complicated conditions, and mostly not representing the remants of oceanic crust. It is held here that the formation of the geosynclines under discussion and the ophiolites associated with them are directly connected with the structural state within the deep mantle.

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STRUCTOGENETIC SIGNIFICANCE OF THE MICROTECTONIC DATA IN REGIONS WITH SUPERPOSED METAMORPHISM (EXAMPLES FROM THE SOUTH CARPATHIANS)

The microtectonic structural elements imprinted in the crystalline schists are the result of the geodynamic movements during which the rocks developed in different orogenic phases.
The paper deals with a methodologic problem concerning the possibility to separate the various metamorphic phases which have superposed in a region, the depth at which the microtectonic structural elements were generated, the geodynamic causes of formation and deformation, and their dispersion according to depth, movement ampleness and metamorphic intensity following the origin and the character of the structural elements distribution (foliations, lineations, fissures). The researches carried out in different crystalline massifs of the South Carpathians proved that the mineral metamorphic foliations and lineations are the result of the plastic flow movements in deep-seated zones at lower structural levels; they point out tangential movements with a definite direction. At the upper structural levels of the overthrust nappes conjugated disjunctive structural elements - subhorizontal and inclined - develop as a result of the tangential movements. Likewise, the orthorhombic symmetry of the dispersion of foliations and lineations is typical of the deep-seated zones, whereas the triclinic symmetry is specific to the upper structural levels.

In certain cases one can observe that the last superposed metamorphism, accompanied by plicative foldings with concentrical bent, wiped out almost completely the synmetamorphic elements (foliations and lineations) generated by an older metamorphism (Hercynian metamorphism of the Baikalian Leaota crystalline series or the pre-Baikalian Cumpăna series).

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PRECAMBRIAN AND PALEOZOIC RIFTING IN NORTHEASTERN ASIA

The Siberian Platform and the Verkhoyano-Chukotsk area repeatedly suffered continental rifting in the Riphean-Vendian and Late Silurian-Early Carboniferous. The Udza, Yudoma-Maya, Prykolymsk and other paleorifts refer to the Riphean-Vendian. In the Middle Paleozoic, the Vilyui, West-Verchoyansk, and Arga-Tass rift systems were developed. Rift structures are represented by narrow linear and branching graben-shaped troughs surrounded by dike belts, sill chains, and massifs of alkaline ultrabasic rocks with carbonatites. Rifting is related to pulses of arching and stretching of the sialic crust megablocks. The arching stages are identified on the basis of thining out of rock masses, development of rudaceous terrigenous rocks and largely deep-seated magmatic complexes of alkaline, alkaline-ultrabasic, alkaline-basic composition. In the periods of intensive stretching and spreading, basic complexes of normal and subalkaline composition, as well as volcanoterrigenous-carbonaceous strata were formed. The pulsing mechanism of tectono-magmatic processes provided the complexity of rift systems including both arch-volcanic and slit elements. Late Precambrian sedimentary formations filling the thickest (to 10 m) paleorifts are characterized by tele-pyroclastic-carbonaceous composition with a significant admixture of carbonaceous material. In narrow trough branches abundant are volcanoterrigenous-carbostromatolithic rocks of the formation with great amounts of volcanoclastic components (to 60%), the thickness of the strata assumes 2-4 km. In Middle Paleozoic paleorift depressions, volcanogenic, halogenic and argillo-carbonaceous associations are recognised, with the total thickness of 5-6 km.

Analysis of ancient rift systems makes is possible to trace the evolution of rifting processes in time. The interval between alkaline magmatism outbursts was found to be 160-180 Ma, with alternating manifestation of basic volcanism of normal alkalinity.

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ДОКЕМБРИЙСКИЙ И ПАЛЕОЗОЙСКИЙ РИФТОГЕНЕЗ СЕВЕРО-ВОСТОКА АЗИИ

Сибирская платформа и Верхояно-Чукотская область в рифее-венде, позднем силуре-раннем карбоне периодически охватывались процессами континентального рифтогенеза. Рифей-вендский возраст имеют Уджинский, Юдомо-Майский, Прикольмский и другие палеорифты. В среднем палеозое формировались Вилюйская, Западно-Верхоянская и Арга-Тасская рифтовые системы. Рифтовые структуры представлены узкими линейно вытянутыми и ветвящимися грабенообразными прогибами, обрамленными дайковыми поясами, цепочками пластовых интрузий, массивами щелочных ультраосновных пород с карбонатитами.

Формирование рифтовых структур было связано с импульсами сводообразования и растяжения мегаблоков сиалической коры. Этапы сводообразования фиксируются по сокращению мощностей толщ, развитию грубообломочных терригенных пород и существенно глубинных магматических комплексов щелочного, щелочно-ультраосновного, щелочно-основного состава. В периоды интенсивного растяжения и раздвигов формировались базитовые комплексы нормального и субщелочного состава, вулканотерригенно-карбонатные толщи. Пульсирующий механизм тектоно-магматических процессов обуславливал сложное строение рифтовых систем, сочетающих элементы сводово-вулканического и щелевого типов. Позднедокембрийским осадочным формациям, заполняющим наиболее мощные (до 10 км) палеорифты, свойственен телепирокласто-карбонатный состав с заметной примесью углеродистого вещества.

В узких троговых ответвлениях распространены породы вулканотерригенно-карбостромовой группы формации с высоким (до 60%) содержанием вулкано-кластических компонентов; мощность толщ составляет 2-4 км. Среди формаций среднепалеозойских палеорифтовых депрессий выделяются вулканогенные, галогенные и глинисто-карбонатные ассоциации суммарной мощностью 5-6 км.

Анализ древних рифтовых систем позволяет проследить эволюцию процессов рифтогенеза во времени. Устанавливается периодичность в 160-180 млн.лет вспышек щелочного магматизма, чередующихся с проявлениями базитового вулканизма нормальной щелочности.

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GEODYNAMICS AND THE MECHANISM RESPONSIBLE FOR THE FORMATION OF TECTONIC DISLOCATIONS IN THE GARM TEST AREA, TADJIKISTAN

It is thought that the boundary between the Eurasian and Indian lithospheric plates traverses the test area in question. The area includes adjacent portions of Tien-Shan and Pamirs and the Tajik depression between these. Available geological, geodetic, seismological and magnetometric data provide evidence supporting the hypothesis that tectonic structure, seismicity and recent movements in the area are associated with mutual relative sliding motion of two or three tectonic plates that constitute the upper crust there.
This can be explained by convergence of the plates mentioned (Tien-Shan and Pamirs). The same result can be obtained by a supposed increase in the volume of sedimentary rocks within the Tadjik depression which is located between the immobile Tien-Shan and Pamirs massifs. The possibility of such processes has been pointed out by E.Og and S.Bubnov (in a general form). This hypothesis is being developed by S.A.Zakharov for this particular region.
There are geological, geochemical, lithological data (not for the study area) that point to deep genesis of most of material constituting carbonate, siliceous, clayey, evaporite and some other rocks. Part of the deep material may free some space for itself in the upper crust owing to crytallization pressure of deposited material. This may result considerable increase in the volume of layered masses. Repeated geodimeter measurements and a comparative analysis of seismotectonic deformations and earthquake numbers as a time series for different seismically active crustal volumes in the study area cast some doubt on the possibility of a simple explanation for the geodynamics and the formation mechanism of tectonic dislocations there by a mere convergence of the Eurasian and Indian lithospheric plates.

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ГЕОДИНАМИКА И МЕХАНИЗМ ФОРМИРОВАНИЯ ТЕКТОНИЧЕСКИХ ДИСЛОКАЦИЙ РАЙОНА ГАРМСКОГО ПОЛИГОНА В ТАДЖИКИСТАНЕ

Существуют представления, что через район полигона, включающий смежные части Тянь-Шаня, Памира и разделяющей их Таджикской депрессии проходит раздел Евразиатской и Индийской плит литосферы. Имеющиеся геологические, геодезические, сейсмологические и магни-

тометрические данные свидетельствуют о том, что тектоническое строение, сейсмичность и современные движения района связаны со взаимным относительным проскальзыванием двух-трех тектонических пластин, на которые расслаивается здесь верхняя часть коры.

Это можно объяснить сближением упомянутых плит (Тянь-Шаня и Памира). Тот же результат может быть получен за счет предполагаемого увеличения объема осадочных пород Таджикской депрессии, располагающейся между неподвижными упорами Тянь-Шаня и Памира. На возможность таких процессов (в общей форме) указывали Э.Ог и С.Бубнов. Применительно к рассматриваемому региону эту гипотезу разрабатывает С.А.Захаров.

Существуют геологические, геохимические, литологические данные (безотносительно к рассматриваемому району), свидетельствующие о том, что значительная часть материала карбонатных, кремнистых, глинистых, эвапоритовых и некоторых других пород имеет глубинное происхождение. В верхней части коры часть глубинного вещества может активно освобождать себе пространство за счет кристаллизационного давления выпадающего из раствора вещества. В результате объем пород слоистых толщ может существенно увеличиться.

Повторные светодальномерные измерения и сравнительный анализ сейсмотектонической деформации и временных рядов чисел землетрясений различных сейсмоактивных объемов коры рассматриваемого района ставят под сомнение возможность простого объяснения геодинамики и механизма формирования тектонических дислокаций региона одним сближением Евразиатской и Индийской литосферных плит.

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TECTONOSTRATIGRAPHIC UNITS AND LARGE-SCALE DETACHMENTS: KEYS TO ACCOUNT FOR THE APPARENT WESTERN TERMINATION OF THE NORTH PYRENEAN FAULT, IBERIAN AND EUROPEAN PLATES, SOUTHERN FRANCE

The North Pyrenean fault (NPF) is a transform along which the Iberian and European plates were juxtaposed. However, there is a question as to the through-going nature of the NPF and thus the geologic history of the Pyrenees and development of the Bay of Biscay. Based on the recognition of tectonostratigraphic units in the Pyrenees, a model is proposed to account for the history of the North Pyrenean fault zone (NPFZ) and the apparent termination of the NPF near Lourdes. The tectonostratigraphic units (lanières) are coherent stratigraphic sequences recognized by marked differences in stratigraphy, thickness, and depositional histories; and separated from one another by regional faults. The model includes: (1) The NPF was reactivated during the Late Cretaceous. (2) Juxtaposition of normal continental Iberian plate crust against the thinner transitional crust of the European continental margin. (3) Tectonic loading and subsidence along basins within the NPFZ. (4) Strong N-S compression during the early Cenozoic, causing the European plate to be thrust beneath the Iberian plate and attendant intense metamorphism along the NPF plate suture zone. (5) Oligocene uplift of the Pyrenees associated with northward transport of detachment sheets, obscuring the NPF. Detachment generally occurs at stratigraphic boundaries associated with Triassic-Lias non-marine and volcanic rocks. Six tectonostratigraphic units are recognized: Aquitaine, Oloron, Irati, Escot, Bigorre, and Basque.

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MAFIC DYKE SWARMS: USEFUL MANIFESTATIONS OF RIFTING IN TECTONIC STUDIES

Mafic dyke swarms, 100's to 1000's of kilometres in length criss-cross all Precambrian Shields and are generally little altered or deformed. Most of these swarms are themselves of Precambrian age and testify to a long history of repeated rifting in continental interiors that has continued into the late Phanerozoic especially in Africa and South America. Precambrian dyke swarms are likely to be particularly useful in studies of early global dynamics because they constitute datable, paleomagnetically accessible paleostress indicators that are of sufficient regional extent to provide constraints on past continental movements and configurations.

Mafic dykes, particularly from North America are used to highlight certain structural features that may provide insight into their origin and geodynamic significance. Structural aspects of interest include regional variations in dyke attitude and paleomagnetic direction that provide data on the nature of deformation affecting Shield areas, radiating dyke patterns that suggest central magma feeder zones, and an orthogonality of late Archean dyke trends with the structural grain of Archean host rocks that may indicate intrusion into a crust pre-stressed by the Kenoran orogeny.

Geological observations suggest that a sub-horizontal to inclined trajectory of magma flow is a common feature in dykes. Longitudinal changes in petrology, geochemistry and the orientation of flow-induced fabric might thus be expected that would have important bearing on problems concerning the location of magma sources and the process of dyke injection.

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BASALTIC "DIPPING REFLECTORS" AND THE OPENING OF THE NE ATLANTIC

The rifted passive margin of the southwest Rockall Plateau is characterised by oceanward-dipping seismic reflectors. Penetration of these by DSDP Leg 81 and subsequent petrological work has identified these reflectors as a series of basaltic flow units and related pyroclastic deposits of Late Palaeocene age. The basalt flows are typically sub-alkaline and from four sites across the margin are consanguineous with a limited evolution along the tholeiitic trend. Immobile trace elements indicate limited fractionation. Some flow units show the effects of subaerial weathering, with development of hematite and nontronite, but with increasing subsidence of the margin there was prolonged interaction between seawater and warm basalt at below 200°C. At Site 555 on the Plateau, higher temperatures (250-300°C) occurred during greenschist alteration of the deepest rocks (olivine-dolerites and basalts) penetrated. The significance of this magmatism in terms of subsidence and early spreading is discussed.

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EARLY TERTIARY MAGMATISM AND THE OPENING OF THE NORTH-EAST ATLANTIC

Drilling during DSDP Legs 48 and 81 has revealed that substantial igneous activity accompanied the separation of Rockall Plateau and Greenland during the early Tertiary. Volcanism began during the late Palaeocene with the extrusion of a thick basalt pile which gives rise to the series of oceanward-dipping seismic reflectors characteristic of this and several other rifted passive continental margins. The basalt flows are typically sub-alkaline with limited fractionation and evolution along the tholeiitic trend. Flow units show the effects of early subaerial weathering, with the development of hematite and sporadic nontronite, but with increasing subsidence of the margin there followed prolonged interaction between seawater and basalt at relatively low temperatures (below 200°C). A short period of relative quiescence followed cessation of basalt extrusion. When volcanism recommenced, its character was markedly different, being highly explosive and of more variable chemistry. A series of air-fall tuffs and lapilli-tuffs were then deposited, mainly tholeiitic with with subsidiary intermediate and alkali basalt types. Pyroclastic activity declined later in the early Eocene with a major transgression over the South West Rockall Plateau area. Subsequently, only thin sporadic tholeiitic tuffs were deposited, with a renewal of basalt extrusion.

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MODEL FOR THE CRETACEOUS GEOTECTONIC EVOLUTION OF CENTRAL CUBA

Central Cuba is built up by three geotectonic units: the Bahamas platform to the North, the Cretaceous island arc to the South and the ancient oceanic crust in between them. The zones Camajuani and Placetas, formed in deep water conditions, are tectonically joined with the platform.

The ancient oceanic crust is represented by a typical ophiolite association. The volcanics of this association are low-K_2O, abyssal, tholeiites.

The Cretaceous (Lower Cretaceous to Lower Campanian) volcanics are calc-alkaline assamblage, differing clearly by their compositional and geochemical features from the ophiolites. For these volcanics the typical features of the volcanic arc magmatites are characteristic.

For the geological structure of Central Cuba a clear obduction is typical - disposition of the oceanic crust together with the island arc over the platform. The obduction is a follow up of the subduction of the oceanic crust in front of the North American continent under the Caribbean plate. In connection with this subduction the Cretaceous island arc was created. In the zone of subduction predominantely blocks of Placetas and Camajuani were enveloped and intensely metamorphosed. The ophiolites over them were altered even more intensely from high pressure metamorphism as well.
The subduction is caused by a spreading center in the Caribbean plate. The troctolite dyke swarms of the ancient oceanic crust of the island were formed probably at the "roots" of this center.
The presence of such a center could be assumed also by the geological structure of the Venezuelan Coast of Southern America which is analogous to the described above.

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TECTONIC ZONATION OF CENTRAL CUBA

The present investigation represents an attempt for clarifying the rank and the genetic nature of the geotectonic units of Central Cuba.
Three main geotectonic units - the Bahamas platform to the North, the island arc to the South and the ancient oceanic crust in between them - remained from the Pre-Upper Campanian stage of development.
The zones Camajuani and Placetas, formed in deep water conditions, are tectonically joined to the platform from the scope of the continental margin.
The ancient oceanic lithosphere is represented by an ophiolite association. Serpentinized peridotites, gabbro cumulates, basic volcanites and sedimentary-volcanic complex are distinguished in this association.
Two complexes are presented in the Cretaceous island arc association: lower - volcanic flisch interlayered with submarine basic volcanites with sub-alcalic affinities and upper-volcanic molassa in which an evolution from andesites to acid (subaereal) volcanites is to be found.
A platform type of development is characteristic for the Post Upper Campanian stage, during which an unification of the southern two geotectonic units with the North American continent took place.

This development was executed during two substages: Early - subplatformic (Upper Campanian-Middle Eocene) and Late - platformic (including Recent).

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ON THE LATE VARISCIAN TECTONIC EVOLUTION OF THE NORTHERN PERIPHERY OF THE SINO-KOREAN PLATE

Since 1.7 b.y.B.P. the Sino-Korean plate has created several times to the north (present direction), the largest dimenision had been reached to the end of the Variscian cycle, the Hegenshan-Suolunshan is the northern boundary of them. The main goal of this paper is to give an explanation of the tectono-magmatic reactivation at the northern periphery of the Sino-Korean plate. Four tectono-magmatic activated zones have been set up. The average content of K_2O and other related petro-chemical indexes of the late Variscian volcano-plutonic complexes show regular changes from north to south. These regularities indicate that the tectono-magmatic reactivation considered here are controlled by the subduction and crowaing of the palaeomongolian oceanic plate towards the Sino-Korean plate; the differences between the four zones are shown by the different basements, which suffered reactivation.

The similar zones for the south-western periphery of the Siberian plate has been established by Soviet geologists. A comparative study of these zones can provide a possible model of evolution of the northern Asian lithosphere.

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THE CRETACEOUS-TERTIARY FLYSCH OF THE EAST ALPS AND CARPATHIANS - EVIDENCE FOR SUBDUCTION, COLLISION AND TRANSFORM FAULTING BETWEEN THE ALPINE-CARPATHIAN ARC AND THE EUROPEAN PLATE

The continuity between the flysch zones of the East Alps and Carpathians is the key for treating the geodynamic evolution of the Alpine Carpathian Arc as a loop-arc structure consisting of a westward dipping subduction zone in the East Carpathians and a left-lateral transform fault zone in the West Carpathian and East Alpine flysch zones.

Subduction-related volcanism in the East Carpathians is of Neogene age. Diachronism of the East Carpathian flysch troughs which become progressively younger towards east suggests, however, that the sub-

duction zone was active at least since the late Early Cretaceous. This is in line with a Vranconian age of the oldest reported tuffs whereas other volcanics older than Miocene have been lost from the surface. According to STEFANESCU (1980) the imbricated nappes of the East Carpathians comprise 3 groups: those in the west (Bucovinian and related nappes) with a continental basement representing the former inner, active margin of the arc, those in the middle (Black Flysch Nappe, Bratocea Digitation of the Ceahlau Nappe) with an oceanic basement, and those in the east (remainder of the Ceahlau Nappe, Tarcau Nappe, etc.) resting on a continental basement of a former passive margin. Successive westward subduction finally lead to the elimination of the central oceanic area and collision between the active and passive margins, i.e. between the Penninic-Pannonian and European plates possibly as early as in the Senonian. The original width of the intervening oceanic area between these two plates is unknown. Some authors consider it a wide ocean ("Siret Ocean" of HERZ & SAVU, 1974), but a limited width of perhaps a few 100 km is more likely. Very little of it is preserved in the central group of nappes.

Rigidity of the European plate requires that the westward collisional approach of the passive margin in the East Carpathians (which was a southern promontory of the European plate) is changing to left-lateral transform motion as the plate boundary turns east-west in the West-Carpathians. This is in accordance with the lack of diachronism in the flysch troughs of the West Carpathians and East Alps. In part (Silesian Nappe, Rhenodanubian Flysch) these represent true deep-sea trench deposits. In this scheme the Skole Nappe and the Prätigau Flysch correspond to passive margin basins on the southern slope of Europe, in other words to the outer digitations of the Ceahlau Nappe and the Tarcau Nappe etc. in Roumania. When the deep-sea trenches in the East Alps and West Carpathians were eliminated by a final collisional event in Eocene and Miocene times, respectively, in the West Carpathians this event was accompanied by a pulse of subduction which produced the andesitic Miocene volcanics of the Inner West Carpathians.

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RIFT PROPAGATION - NEW RESULTS

Plate tectonics and its predecessor, seafloor spreading, were so successful in revolutionizing the Earth sciences that only very few modifications have been necessary. One of these modifications is the suggestion that lithospheric plates break apart progressively rather than simultaneously, gradually reorganizing the Earth's plate boundary geometry. This idea, known as the propagating rift hypothesis, provides an explanation for many seafloor and continental margin features oblique to relative and "absolute" plate motions which were inexplicable with previous plate tectonic theory and had been used by some scientists to argue that plate tectonics was invalid.

We have just completed two cruises to test and investigate the fine-scale and large-scale implications of the propagating rift hypothesis. The fine-scale investigation involved the new Scripps Seabeam multi-narrow beam sonar contour imaging system and the Deep-Tow system of the Marine Physical Lab at Scripps, as well as routine geophysical techniques, and was conducted at the "type-example" propagating rift system at 95.5°W along the Galapagos spreading center. We discovered clear evidence that propagation exists and has been continuous although the preempted spreading center appears to have died discontinuously. There is a well-defined sheared zone between the propagating and dying rifts where most of the seismicity in the area is occurring. The propagating rift curves toward the dying rift and individual en

echelon failed rift segments curve toward the propagator tip, although the overall failed rift system bends away from the propagator tip, as predicted. There is a geologically brief period of time during which both spreading centers are active and overlap. We hope to have new results from planned ALVIN submersible work here to present as well.

Our other cruise involved a large-scale Seabeam, magnetics and gravity survey of the anomalous Easter "plate" or "microplate" area, which appears to be the site of the fastest propagation across the longest transform offset causing the largest spreading center jumps and transferring the most lithosphere from one plate to another of any known active propagating rift system. We also may have discovered a new type of seafloor spreading on this cruise, seemingly diffuse spreading ahead of the propagator tip where there is no well-defined spreading center, possibly analogous to an anomalous area near the Galapagos triple junction where the Cocos-Nazca spreading center is propagating west into crust created on the EPR.

The nested-V geometry of pseudofaults produced by rift propagation is best visualized with animation and our latest computer graphics movie of plate tectonic evolution will be shown. The propagating rift idea also has important implications for continental rifting and indicates that previous reconstructions such as the Bullard fit are in error because continental margins are pseudofaults rather than isochrons.

Our quantitative tests indicate that the propagating rift hypothesis can be confidently added to plate tectonic theory. One of the most pleasing aspects of this idea is that it provides a simple explanation for seemingly complex areas such as the Juan de Fuca area where even the scientists who discovered plate tectonics thought their model couldn't work in detail, thus indicating that plate tectonic theory is even more successful than previously thought.

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MYLONITIC ROCKS IN THE DISTURBED ZONE OF THE MEDIAN TECTONIC LINE, CENTRAL JAPAN

The MTL has a disturbed zone which is about 1.0 km wide and many geological bodies include in the zone. Mylonitic rocks in the disturbed zone are derived from Ryoke granitic rocks. Cataclasite is widely distributed and mylonite is intercalated in it. Thus, mylonitic rocks in the disturbed zone are heterogeneously developed. Grain size of quartz of mylonitic rocks generally decreasses toward the main fault of the MTL. But sometimes it changes locally in the disturbed zone. The crystallinity index (CI) of quartz of mylonitic rocks seems to reflect the feature such as grain size reduction and recrystallization in brittle to ductile deformation, and the post deformational annealing. The measurement of CI across the disturbed zone indicates that CI values decrease toward the main fault of the MTL. But they do not uniformly change as in the case of the grain size distribution of quartz. The observation of mylonitic rocks by means of SEM reveals that grain boundaries of quartz tend to be more complicated in accordance with grain size reduction and decrease of CI of quartz.

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THE QUARTZ SUBFABRIC (C-AXES ORIENTATION) OF METAMORPHIC TECTONITES - AN INDICATOR OF DEFORMATION CONDITIONS

A systematization of quartz c-axes orientation in low- to high-grade metamorphic rock complexes (R-, b-, and S-tectonites), mainly from the Saxothuringian Zone of the Central European Hercynides, based on morphological features of c-axes diagrams is presented. Diagram morphology and geometry (specific angles in crossgirdles and pseudotwogirdles) reflect the relationships between distinct orientation types and structural stages stockworks) of metamorphic complexes. Small circle orientation parallel (ac), widely distributed in blastomylonites and R-tectonites, is considered in detail. Comparisons between quartz orientation in metamorphic rocks and results of experimental deformation show that c-axes orientation is mainly controlled by "fracture hypothesis" - and translation-mechanisms in the deformation models of simple shear and pure shear. Destinating factors for the behaviour of quartz are temperature, confining pressure, differential stress, and rate of deformation. In migmatites and anatexites c-axes orientation reflects monoaxial stressconditions under varying confining pressure, characteristic for quasiviscous mediums.
In accordance with the facies diagram of regional metamorphism, a deformation-facies diagram of quartz orientation types is proposed.

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CENOZOIC HISTORY OF THE BONIN ARC

The Bonin Arc is consist of several dominant N-S trending morphologic features of the Bonin Trench, the Bonin Ridge (forearc basement high), the Bonin Trough, the Shichito Ridge (volcanic chain), the backarc knolls zone, the Izu Ridge and the Shikoku Basin from east to west.
The first stage of the Bonin Arc is formed in middle to late Eocene. There was an arc with a volcanic chain in the Bonin Ridge. During this period, a forearc basement high lay east of the volcanic chain, which cannot be seen in the modern Bonin Arc. The final stage is accompanied by the appearance of a new volcanic chain, the west of the older stage volcanism. In the modern Bonin Arc, backarc spreading is taking place immediately westside of the volcanic chain.

The Bonin Trough opened in a quite period of intermittent volcanism during early to middle Oligocene and ceased opening during late Oligocene when the second stage volcanism occurred in the same ridge. This interpretation is based on the hypothesis of alternating occurrence of arc volcanism and marginal sea spreading and also the activity related to the subduction complex in the trench.

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EXPERIMENTAL ANALYSIS ON THE DEVELOPMENT OF PRESSURE SHADOWS AND PRESSURE FRINGES

A lozenge-shaped irrotational strain box and a simple shear box have been designed to produce inhomogeneous strain around rigid porphyroblasts simulating pressure shadows and pressure fringes. Local deformation in the matrix around such object has been evaluated using displacement vectors and strain analysis from distorted grids. Displacement vectors show variations in magnitude and orientation around included object and it is observed that relatively less deformed areas marked by low magnitude of vectors are likely zones for the development of pressure shadows and pressure fringes. A computer programme has been developed to determine and produce automatic plot of magnitude and orientation of principal strain axes from the distorted grids. Strain analysis using a computer demonstrates that the low strain areas are the potential regions for the development of such inhomogeneities. The shapes of the shadow and fringe areas are found to be dependent on the shape of the included object. The orientation of the recrystallized fibrous minerals that might grow in the fringe zones will be straight in case of irrotational strain deformation and curved in simple shear deformation.

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THE STRUCTURAL CHARACTERISTICS IN ALTYN BELT

1. The Altyn structural belt, NEE in trend, is composed of an uplifted anticlinorium belt with the upper Proterozoic strata as the axis, and pounded by a large fault.Rocks of all ages with the The Altyn system, 1700km long, is distributed in northwest China, bordering Xinjiang, Qinghai and Gansu Provinces. The structural characteristics in Altyn system can be included briefly as below:

exception of Triassic are present and associated with magma activities. 2. Besides the dominant NEE-trending Altyn structural belt, there are two other structural parts; EW trending structural slices composed of Lower Proterozoic high grade metamorphic rocks and the NW-trending structures distorted by the Altyn fault. 3. The Altyna System was upheaved in the Indosinian Period separating the two big oil-gas-bearing basins -- Tarim and Tsaidam. 4. The boundary fault Zone, composed of many sinistral compresso-shear faults was repeatedly active, controlling the distribution of Jurassic-Cretaceous early and late Tertiary and Quaternary troughs and the recent lakes and swamps.

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GEOLOGICAL FEATURES OF THE JIANGNAN REGION IN EARLY JURASSIC TO EARLY PERIOD OF EARLY CRETACEOUS TIMES AND THEIR INTERPRETATION IN TERMS OF PLATE TECTONICS

From Jurassic to early Cretaceous, the Jiangnan region, covering a vast area from the coastal district of Zhejiang to the middle and lower Yangtze valley, together with the southeastern "China" made up an active continental margin of the paleo-south China type. It was separated from the Oceanic Plate by a minor plate, and acted upon only by the Oceanic Plate through the trasmission of the minor plate. This accounts for the following characteristics of the Jiangnan region:

The continental margin can be structurally divided from east to west into the eastern Zhejiang volcanic arc belt, the western Zhejiang-southern Anhui thrust-folded belt and the lower Yangtze retroarc basin belt with the second belt characterized by the thrusts and folds and the other two belts by faulted blocks.

Magmatic activities were rather intense. The eastern Zhejiang volcanic belt was dominated by volcanics of calc-alkaline series (mostly rhyolite) and "I" type granitoids; the thrust-fold belt by volcanics of calc-alkaline series comprising mainly andesite-rhyolite and "S" type granites consisted chiefly of biotitegranites-two-mica granites the retroarc basin belt by volcanics of alkaline-calc series made up predominatly of trachyte-andesite and "I" type granites composed in the main of diorite and quartz monzonite.

The sedimentary basins of these three belts, are composed unexceptionally of volcanic and terrigenous clastic accumulations.

Paired metamorphic zones are well developed.

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STUDY OF SEISMIC CONDITIONS OF THE 1976 TANGSHAN EARTHQUAKE BY THE AID OF THREE-DIMENSIONAL PHOTO-ELASTIC FAULT ANALYSIS

Based on the study of seismic geology in Tangshan and from the basic viewpoint of linear-elastic fracture mechanics and the experiment by photo-elastic method, this paper deals with the seismic model of the Tangshan earthquake. A frozen artificially-made fracture model of three-dimensional photo-elastic is used to imitate the main faults in the earthquake area (including Tangshan fault, Baodi fault and Cangdong fault), and the photo-elastic slice technique is used to obtain the photo-elastic data for a group of slices. The stress strength factors (K_I, K_{II}, ox) and stress field at the ends of faults at different depths in the earthquake area have been calculated. In addition, a three-dimensional photo-elastic analysis of the fractures has been extended to the adjacent parts of the Tangshan earthquake area.

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STRUCTURAL-GEOPHYSICAL MODEL FOR VOLCANO-SEDIMENTARY COVER AND BASEMENT OF THE ADEN-RED SEA REGION

Recent geophysical studies undertaken within the Aden-Red Sea region resulted in compilation of review gravity and magnetic anomaly maps for the sea area and the adjacent continental part. The integrated interpretation of the geological and geophysical material has made it possible to construct isopach maps of the sedimentary cover, relief maps of the consolidated basement, magnetic and density models, as well as to perform a geodynamic analysis of the evolution of the region. The obtained interpretation results point to:
- the presence of two interfaces that approximate the tops of the magnetic masses; the depth difference between these interfaces within the axial rise of the Red Sea makes up 2-3 km;
- the difference in orientation of the "linear" magnetic masses relative to the axial trough in the Red Sea and in the Gulf of Aden;
- a predominance of the total magnetization of rocks in a direction corresponding to the intensity vector T of the present-day magnetic field;
- concentration of earthquake foci within the zones of intensive magnetic anomalies;

- density contrasts corresponding to the major troughs of the Red Sea and Gulf of Aden are typical of the shelf and coastal plain; the continental boundary of the subduction zones corresponds to the piedmont and to slopes of the mountain ranges that surround the Red Sea and Gulf of Aden;
- morphometric parameters of the buried median rise are close to those of the mid-oceanic ridge of the Indian Ocean;
- the presence at the piedmont of the continental slope of the trench-like basins of the consolidated basement showing depth of up to 10 km; the presence of the pre-Jurassic-Cenozoic rises, subparallel to the rift axes, in the continental region;
- the presence of areas of abrupt thining of the crustal thickness and associated subsidence of the basement within the surrounding continental territories. These areas advance inland for hundreds of kilometres;
- a sedimentation rate at the piedmont of the continental slope of the Gulf of Aden and Red Sea is by one order less than the rate of movement of the lithospheric plates.

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СТРУКТУРНО-ГЕОФИЗИЧЕСКАЯ МОДЕЛЬ СТРОЕНИЯ ВУЛКАНОГЕННО-ОСАДОЧНОГО ЧЕХЛА И ФУНДАМЕНТА АДЕНСКО-КРАСНОМОРСКОГО РЕГИОНА

Геофизические исследования последних лет в пределах Аденско-Красноморского региона позволили составить сводные карты полей ΔT и ΔG на акваторию и прилегающий к ней континент. Комплексная интерпретация геолого-геофизических данных позволила построить схемы мощности осадочного чехла и рельефа консолидированного основания, магнитную и плотностные модели и выполнить геодинамический анализ эволюции региона. Результаты комплексной интерпретации показывают:
- наличие двух поверхностей, аппроксимирующих верхние кромки магнитных масс; в пределах осевого вала Красного моря различие в глубинах этих поверхностей составляет 2-3 км;
- различие ориентации "линейных" магнитных масс по отношению к осевому трогу в Красном море и Аденском заливе;
- доминирование суммарной намагниченности горных пород в направлении современного вектора T;
- концентрацию очагов землетрясений в зонах интенсивных магнитных аномалий;
- плотностные неоднородности, соответствующие главным трогам Красного моря и Аденского залива охватывают шельф и приморскую равнину; континентальная граница зон субдукции соответствует подножью и склонам горных гряд, обрамляющих Красное море и Аденский залив;

- морфометрические параметры погребенного срединного вала близки к параметрам индоокеанского срединного хребта;
- наличие у подножья континентального склона желобообразных прогибов консолидированного основания глубиной до 10 км; в континентальной области докрско-кайнозойских валов, субпараллельных рифтовым осям;
- наличие в пределах континентального обрамления участков резкого утонения земной коры и связанного с ним погружения фундамента, протягивающихся на сотни километров вглубь континента;
- скорость осадконакопления у подножья континентального склона Аденского залива и Красного моря на порядок меньше скорости движения литосферных плит.

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LAS OFIOLITAS DE CAMAGUEY, CUBA: NATURALEZA, POSICION TECTONICA Y SEDIMENTOS DERIVADOS

En la porción centro norte de la Provincia de Camagüey, aflora un cuerpo de ofiolitas en un área de unos 1200 km^2. Lo componen principalmente el complejo dunito-peridotítico, en menor grado el complejo acumulativo gabroide, y relictos del complejo de diques y demetasilicitas. En la actualidad el cuerpo está minuciosamente tectonizado, con fábrica brechosa, triturada y foliada, en clara correspondencia con las zonas de distinta deformación del cuerpo. En Cuba se considera en general que las ofiolitas constituyen el substrato del arco volcánico cretácico, pero una interpretación alternativa es que las mismas sean los relictos de la litósfera oceánica de un mar marginal.

Las ofiolitas yacen en posición alóctona sobre el paleomargen continental mesozóico de las Bahamas, a consecuencia de la obducción que concluyó en el Eoceno Medio tardío, determinada por desplazamientos dirigidos relativamente de sur a norte.

El cabalgamiento de las ofiolitas sobre el paleomargen continental provocó la sedimentación de un olistostroma, que yace imbricado entre el autóctono, pequenas escamas parautóctonas arrancadas de éste, y el alóctono procedente del sur. En la composición de la masa basica del olistostroma entran brechas serpentiníticas, serpentinito gabroicas, arenicas y gravelitas serpentiníticas, brecha-conglomerados vulcanomícticas principalmente.

Los olistolitos tienen dimensiones entre decenas de centímetros y un kilómetro, y se componen de serpentinita triturada, gabroides, vulcanitas, calizas jurásicas e infracretácicas, y calciruditas del Maestrichtiano y Eoceno Inferior.

Tanto el olistostroma como las secuencias antes mencionadas están cubiertas discordantemente por sedimentos del Eoceno Superior y màs jóvener del neoautóctono.

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GEOTECTONOGENESIS AND THE EARTH'S EVOLUTION AS A CONSEQUENCE OF ITS MASS AND DIMENSION INCREASE IN TIME

The 7 times increase of mass and the 1,8 times increase of dimensions of Earth during $4,5 \cdot 10^9$ years is based on geological data. The Earth's evolution has been governed by the increase in gravitational acceleration (approximately twice), the decrease of rotation velocity (approximately on the order of 1,5), the change of its form from flattened out to globe-shaped and the considerable decrease of its distance from the Sun. Energy resources of geotectogenesis are connected with the exothermic reaction of substance synthesis in the entrails of Earth. The earth's crust and mantle have the rheological properties of Bingham substance and therefore tectonic movements are changed step-by-step followed by earthquakes of various intensity. The changes of the Earth's form and the rising of lithospherical blocks are accompanied by the super-giant earthquakes with intensive endogeneous effects. Benioff-Zavaritski zones are the ones with static substance displacement stress of diminished value that ensures maximum confining of insignificant earthquakes. The mechanism of forming the continental and oceanic earth's crust, geosynclines and rift zones, arising of orogenes, forming the faults and ridges on the ocean floor and trap blocks on continents is based on the above-mentioned effects. The earth's evolution is accompanied by the distribution of hypsometric levels on its surface depending on the time of forming the earth's crust, the volume increase of the Ocean and the transgressive and regressive phenomena. The relief of Mid-ocean rift systems reflects the discontinuous rising of lithospherical blocks and the Earth's seismic history has been reflected in it for the last 150-200 million years. The earthquakes connected with the rising of lithospherical blocks are the most considerable phenomena of such type with globe-shaped form of the Earth. Their power is 1000 times greater than power of the most destructive earthquakes known in the world and the prediction of these phenomena is of extremely urgent problem for mankind. The influence of planet mass change on the geological characteristics of their and Solar system evolution is analysed.

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ГЕОТЕКТОНОГЕНЕЗ И ЭВОЛЮЦИЯ ЗЕМЛИ КАК СЛЕДСТВИЕ УВЕЛИЧЕНИЯ ЕЕ МАССЫ И РАЗМЕРОВ ВО ВРЕМЕНИ

На базе геологических материалов обосновано увеличение массы и размеров Земли за 4,5 млрд.лет соответственно в 7 и I,8 раз . Развитие Земли определялось увеличением ускорения земного тяготения (примерно в 2 раза), уменьшением скорости осевого вращения (примерно на I,5 порядка), изменением ее формы от сплюснутой до шарообразной и значительным уменьшением расстояния от Солнца. Энергетические ресурсы геотектогенеза связаны с экзотермической реакцией синтеза вещества в недрах Земли. Земная кора и мантия обладают реологическими свойствами тел бингамовского типа и поэтому тектонические движения происходят скачкообразно, что сопровождается землетрясениями различного масштаба. Изменения формы Земли и воздымания литосферных блоков сопровождаются сверхгигантскими землетрясениями с интенсивными эндогенными проявлениями. Зоны Заварицкого-Беньофа являются зонами с пониженным значением статистического напряжения сдвига вещества, что обеспечивает максимальную приуроченность к ним значительных землетрясений. На базе указанных представлений обоснованы закономерности образования земной коры континентального и океанического типов, развития геосинклиналей и рифтовых зон, возникновения орогенов, образования разломов и хребтов на океаническом дне и трапповых толщ на континентах. Развитие Земли сопровождается расчленением ее поверхности по гипсометрическим уровням в зависимости от времени образования земной коры, ростом объема Мирового океана и чередованием трансгрессивных явлений.

Рельеф срединно-океанических рифтовых систем отражает скачкообразное воздымание литосферных блоков и в нем зафиксирована сейсмическая история Земли за последние I50-200 млн.лет. Землетрясения, связанные с воздыманием литосферных блоков, являются наиболее крупными явлениями подобного рода при шарообразной форме Земли, их мощности в тысячи раз превосходят мощности известных самых разрушительных землетрясений, и прогнозирование этих явлений представляет собой исключительно актуальную проблему для человечества. Анализируется влияние изменения массы планет на геологические особенности их развития и эволюции Солнечной системы.

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MIDDLE MASSIFS AS A RESULT OF TECTONIC LAYERING OF THE LITHOSPHERE

Pregeosynclinal blocks in the Phanerozoic mobile belts are usually considered as middle massifs - relics of the consolidation zones of the preceeding cycles of geosynclinal development (Janshin, 1965 et al.). From the viewpoint of a new global tectonics, small middle massifs are considered as fragments (microcontinents) of the continental plates, which originated, while the latter were breaking-up and pulling apart. A mechanism of their formation on breaking-up the plates could not be explained by truncation of escarpments, while a strike shift was originating along an irregular primary fracture on rupturing the plate. The microcontinents do not expose the features of these shifts also on the passive margins of the present-day continents. Fragments of the continental plates originate as a result of tectonic layering of the lithosphere, due to the significant variation of its rheological properties upwards the lithosphere. The upper 8-12 km of the crust, the viscosity of which is about 10^{24}-10^{30} poises, are breaking up on its extension as a brittle body, displaying seismic effects. The open fractures, which are hydrodynamically related to the surface, could not develop at the deeper levels, due to increase of the confining pressure. The viscosity of rocks at the depth of 30 km decreases to 10^{19}-10^{20} poises, i.e. no less then by a factor of ten thousands. At stress of any sign there take place plastic deformations, not accompanied by seismic effects, rather than brittle ones. As a result of the total extension of a such heterogenous system at the margin between the rigid and plastic-deformed parts of the earth crust, the shift zone is inevitably originating there. When the upper brittle part of the crust is rather thin, this shift results in its rupture into great blocks, much like the cracking crust on stretched dry rubber. When the continental crust is thick, which is usual for the present-day continents, separation of blocks is difficult and a high gradient of deformation arises in the plastic layer. The probable evidence of this situation is banded (pseudo-stratified) gneissic and gabbro-ultramafic complexes of the lower parts of the crust and upper mantle.

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СРЕДИННЫЕ МАССИВЫ КАК РЕЗУЛЬТАТ ТЕКТОНИЧЕСКОГО РАССЛОЕНИЯ ЛИТОСФЕРЫ

Догеосинклинальные блоки в фанерозойских подвижных поясах обычно рассматриваются как срединные массивы - остатки зон консолидации предшествующих циклов геосинклинального развития (Яншин, 1965). С позиции новой глобальной тектоники небольшие срединные массивы рассматриваются как обломки (микроконтиненты) континентальных плит, возникшие при разрыве и раздвижении последних. Механизм их образования при разрыве плит не может быть объяснен срезанием выступов при возникновении продольного сдвига вдоль неровной первоначальной трещины разрыва плиты. Признаков таких сдвигов нет у микроконтинентов и на пассивных границах современных материков. Обломки континентальных плит возникают в результате тектонического расслоения литосферы вследствие сильного изменения ее реологических свойств по вертикали. Верхние 8-12 км коры с вязкостью порядка 10^{24}-10^{30} пуаз при растяжении рвутся как хрупкое тело с сейсмическими эффектами. Глубже вследствие увеличения всестороннего давления и температуры открытые трещины, гидродинамически связанные с древней поверхностью, возникать не могут. Вязкость пород на глубине 30 км уменьшается до 10^{19}- 10^{20} пуаз, т.е. не менее, чем в 10000 раз. При стрессе любого знака здесь вместо хрупких деформаций происходят пластические без сейсмических явлений. В результате общего горизонтального растяжения такой неоднородной по вертикали системы на границе жесткой и пластически деформируемой частей земной коры неизбежно возникает зона сдвига. Этот сдвиг при недостаточно мощной верхней, хрупкой части коры приводит к ее разрыву на крупные глыбы наподобие трескающейся корки на растягиваемой усохшей резине. При мощной континентальной коре, обычной для современных материков, отрыв глыб затруднен и возникает высокий градиент деформации в самом пластичном слое. Возможным свидетельством такой ситуации служат полосчатые (ложно стратифицированные) гнейсовые и габбро-гипербазитовые комплексы нижних частей коры и верхней мантии.

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MODEL OF DEVELOPMENT OF THE LINEAR FOLDED BELTS IN THE CONTINENTS

The model of development of the linear folded belts constructed initially for the Urals, as an example, is proposed there:

I. The formation of the vast zone of the deconsolidated mantle

under the continental lithosphere. Uplift of the earth crust, regular diashysis (tectono-magmatic activity) and rifting, followed by depression; block tectonics, alkali magmatites and those with an alkali trend, pseudo-stratified intrusions, carbonatites. Erosion, formation of rifted molasse. In the Urals this stage covers period I.400-500 Ma.

2. The earth crust spreading followed by brittle fructures of the upper IO km of the lithosphere and plastic extension of its deeper parts, the resulted dynamometamorphism has taken place with formation of blastomylonites at different temperatures. In the upper part of the earth crust there are intrusions of granitoids, suffered mainly zonal low-pressure metamorphism, and formation of separate blocks (microkontinents). Eruptions of the platform and then oceanic basalts between them, followed by their associated sediments. The full break-up of the lithosphere, followed by formation of ophiolites in the oceanic crust; the greenstone metamorphism. In the Urals it is the Ordovician and partly Silurian times.

3. The closing of the oceanic basin, formation of the island arcs, thrust of the hydrated oceanic crust under the oceanic and continental ones, partial obduction and glaucophane metamorphism. The onset of remelting of the underthrust crust. Formation of plagiogranitoid intrusions; the zonal moderate-pressure metamorphism. Formation of zones of secondary spreading, exposed prefuse sub-oceanic basaltic magmatism. In the Urals it is the end of the Silurian-Devonian times.

4. The complete closing of the sub-oceanic basins. Reconstruction of the tectonic structure. Development of liparite-trachyte volcanism. Sudden emergences of rifting on the young crust of the intermediate type. In the Urals it is the early Carbonian time.

5. Folding (clustering), increase of the crust thickness, granite magmatism, zonal low-pressure metamorphism, development of linear zones of K-blastomylonites. Formation of mountain structures, overthrusts and foredeep depressions, and upper molasse. Termination of formation of the continental crust. In the Urals it is the late Paleozoic.

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МОДЕЛЬ РАЗВИТИЯ ЛИНЕЙНЫХ СКЛАДЧАТЫХ ПОЯСОВ НА МАТЕРИКАХ

Предлагается нижеследующая модель развития, первоначально построенная на примере Урала.

I. Формирование под континентальной литосферой обширной зоны разуплотненной мантии. Подъем земной коры, периодический диасхизис (тек-

тоно-магматическая активизация) и рифтогенез, сопровождающиеся депрессией; глыбовая тектоника, щелочные и со щелочным уклоном магматиты, псевдостратифицированные интрузии, карбонаты. Размыв, формирование рифтогенных моласс. На Урале это этап от 1400 до 500 млн. лет.
2. Раздвижение земной коры с хрупкими разрывами верхних (приблизительно 10 км)и с пластическим растягиванием более глубоких частей литосферы, где вследствие этого происходит динамометаморфизм с образованием разнотемпературных бластомилонитов. В верхней части земной коры интрузии гранитоидов, зональный метаморфизм преимущественно низких давлений и образование изолированных глыб (микроконтинентов). Излияния между последними платформенных, а затем океанических базальтов, сопровождаемых соответствующими осадками. При полном разрыве литосферы формирование офиолитов океанической коры; зеленокаменный метаморфизм. На Урале это ордовик и часть силура.
3. Замыкание океанического бассейна, формирование островных дуг. Пододвигание гидратированной океанической коры под океаническую и континентальную, частично обдукция и глаукофановый метаморфизм. Начало переплавления пододвинутой коры. Формирование плагиогранитоидных интрузий; зональный метаморфизм умеренных давлений. В тыловых морях островных дуг образование зон вторичного спрединга с обильным субокеаническим базальтовым магматизмом.На Урале это конец силура, девон.
4. Полное замыкание субокеанических бассейнов. Перестройка тектонического плана. Развитие липарит-трахитового вулканизма. Вспышки рифтогенеза на молодой коре промежуточного типа. На Урале это ранний карбон.
5. Складчатость (скучивание), увеличение мощности коры, гранитный магматизм, зональный метаморфизм низких давлений, развитие линейных зон калиевых бластомилонитов. Формирование горных сооружений, шарьяжей и предгорного прогиба, образование верхней молассы. Завершение формирования континентальной коры. На Урале это поздний палеозой.

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THE ACTIVE RIFTING PROCESS IN NORTHERN ICELAND

The Krafla rifting episode has provided the unique opportunity to observe the interaction of rifting and magma injection.The observed surface deformation and gravity changes accompanying the rifting can be better understood by modelling. Additional evidence as the time-space behaviour of inflation-deflation, seismicity, volcanism and "absolute" strain/stress (also with depth) have to be taken into account. The picture which we believe best describes the observations is one of simultaneous magma accumulation in the crust-mantle transition region and the release of compression

generated during the previous rifting and injection episode. This stress release follows from the retreat of the plate-kinematic frame and the cooling of the crust that was heated during the previous injection of magma. This is e.g. indicated by the pre-rifting geodetic observation of contraction toward the fissure swarm between 1965 and 1975. The relaxation of compressive stress with depth may also be explained this way. The model should, however, also involve a decrease of the elastic moduli with depth, so that the effective compression of the lithosphere adjacent to the axis of injection will be taken up by an increase of "hydrostatic" pressure at some depth. This would be accompanied by a broad uplift and such an uplift seems indeed to be observed to the east of Krafla, that is in the axial neovolcanic zone. Small-scale vigorous convection in a deep reservoir of magma or, more likely, crystal mush will help explaining the observations. It seems that there is no need for general tension normal to the rift axis in spite of the divergent tectonics of spreading as long as there is a sufficient and easily available supply of magma, which driven by buoyancy will invade any potential void. The supply of magma varies, however, along the rift axis. This factor seems to control the amount of graben subsidence, to a lesser degree that of lateral widening, and of volcanism.

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KINEMATICS OF THE NEOGENE FRACTURE SYSTEM IN THE GARHWAL HIMALAYA

Satellite imagery and extensive aerial photogeological coverage of various morphotectonic units of the Garhwal Himalaya and the Indogangetic Plains reveal four important sets of lineaments and fracture traces; all of them revealing strike-slip sense movements. Whereas horizontally displaced lithologic and tectonic boundaries clearly depict the sense of movement along certain lineaments, e.g. the Ganga and Yamuna Lineaments, small-scale straight fracture traces, revealed from topographic features, are generally associated with major fracture traces in the sense of Riedels (R), Conjugate Riedels (R'), Displacement Shears (D) and Thrust Shears (P) indicating the sense of movement along major zones.

L_1 lineaments trend N5°-N10° and show dextral sense of displacement, while its conjugate sinistral set (L_2) trends N50°. The other strike-slip fracture traces and lineaments trend N25° with the dextral sense (L_3) and N90° (L_4) with the sinistral sense of displacement. Morphotectonically, L_2 and L_4 lineaments and fracture traces are rarely seen in the very Late Cenozoic Siwalik Sub-Himalayan Belt and the Indogangetic Plains, while all of the sets are widely developed throughout.

Kinematically, it seems that the orientation of maximum principal horizontal stress σ_1, has changed from N60° to N25° in space and time anticlockwise by an amount of 35° due to the rotation of northerly drifting Indian Plate in Holocene and Recent.

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RETROGRADE AND PROGRADE METAMORPHISM IN THE ST. ANTHONY COMPLEX, NEWFOUNDLAND, AND ITS SIGNIFICANCE FOR OPHIOLITE EMPLACEMENT

Thin, strongly deformed sequences of metamorphic rocks underlying western Newfoundland ophiolites have been interpreted in terms of progressive metamorphism resulting from the subduction of oceanic crust and adjacent continental margin beneath a young, overriding oceanic plate. However, recent work on the St. Anthony Complex suggests that the importance of retrograde metamorphism has been overlooked, particularly in the higher grade parts of the sequence. The metamorphic "aureoles" can be considered large shear zones in which rocks of diverse origins and metamorphic grades have been juxtaposed under lower amphibolite facies conditions. In the upper aureole (Green Ridge Amphibolite), oceanic rocks brought up from depth preserve high grade metamorphic assemblages that have been re-equilibrated to lower grades within shear zones. In the lower aureole (Goose Cove Schist), prograde greenschist to amphibolite facies metamorphism affected all the downgoing continental margin rocks, but the mineral assemblages are fully developed only in high strain zones. Since complete re-equilibration occurs only where deformation is particularly intense, an apparently continuous sequence from low to high grade assamblages is preserved, with the ambient lower amphibolite facies conditions pervasive only in the central part of the shear zone. This model explains some of the problems inherent in viewing the aureoles as simple prograde sequences, including the steep thermal gradients, the apparent pressure increase towards the peridotite contact, and the assembly mechanism for the aureole. The model implies that the present configuration of the St. Anthony Complex (and similar aureoles beneath other ophiolites in the Appalachian, Caledonian, and Tethyan systems) is the result of fortuitous preservation of relict high grade assemblages within an amphibolite facies shear zone, and that, in effect, no single prograde sequence exists.

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TYPES OF THE STRUCTURAL RECORDS OF OROGENY

The structural record of orogeny may be characterized by various types of tectonic styles associations and may serve for the reconstruction of the respective orogenetic regimes and for testing geodynamic models. In the plate tectonics model, orogeny is regarded as a tectogenetic and morphotectonic process associated with the individual stages of plate convergence. In the Mesozoic - Cenozoic orogenic belts, structural records of orogeny in several type areas have been analyzed.

In the Andean Cordilleras the structural record of the orogeny associated with oceanic subduction is expressed in various fold and fault styles. The record of the initial collision stage is well preserved in the Zagros suture in the form of ophiolite nappes. The record of the mature collision stage characterized mainly by the superficial nappes of the miogeosynclinal sequences is discussed on the example of the Krizna nappe development in the West Carpathians. The structural record of the culminating collision stage is described in the Mt Everest-Makalu section of the East Nepal Himalayas, being represented mainly by the relief basement nappes.

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OKINAWA TROUGH - A EMBRYONIC MARGINAL BASIN

The depth to MOHO in Okinawa Trough ranges from 15 to 28 km, and the depth to MOHO is 15-20 km in southern part of Trough, more 20 km in northern, the nature of crust beneath Okinawa Trough is in transformation from continental to oceanic. In the Okinawa Trough are deposited thick sedimentary strata, mainly of Neogene and Pleistocene age, and divided into three layers, the upper horizontal layer, the middle layer lightly folded and the lower deformed layer. They are resent to Pliocene, Miocene and Paleogene and older respectively. On both slopes of the Trough, are developed many normal faults, along which interrupt the intrusive igneous rocks into the sedimentary strata, and volcanic activity made some seamounts appearing on the bottom of the Trough. The tectonic movement in southern of Trough is stronger than in northern. The formation of Okinawa Trough started after the Miocene. The Okinawa Trough is a arc-back basin and a embryonic marginal basin in rifting and spreading. However, the true Trough in tectonic sense is the southern part of Trough only.

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ACCRETIONARY TECTONICS AND THE GROWTH OF WESTERN NORTH AMERICA

The Pacific margin of North America is composed of many allochthonous terranes that accreted to a cratonal nucleus during Mesozoic and early Cenozoic time. More than 150 terranes have now been recognized, each of which is characterized by distinctive rock assemblages and geologic histories that differ markedly from those of their neighbors. These terranes are composed of scraps of island arcs, disrupted oceanic basins with abundant radiolarian chert, parts of seamounts, continental-rise prisms, and continental fragments, some of which seem to be of North American affinity. Combined paleomagnetic, paleobiogeographic, and lithologic data substantiate that some terranes have moved northward as much as several thousand kilometers; some terranes now at high latitudes may have been situated in the Southern Hemisphere during Triassic time. Tectonic effects during accretion include polyphase isoclinal folding, large-scale thrust and strike-slip faulting, development of penetrative metamorphic fabrics on a regional scale, and recrystallization in both blueschist and greenschist metamorphic facies.

The net effect of this tectonic activity was to extend the west margin of North America westward by as much as 800 km.

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GEOLOGICAL MAP OF THE OPHIOLITE BELT OF NAGA HILLS, INDIA

An IGCP project in India included geological studies of the known Indian ophiolites particularly of the Himalayan region, Indo-Burmese arc, and the oceanic region of Andaman-Niccobar. The Geological Survey of India and other Indian universities have been actively engaged in mapping and geological evaluation of the Himalayan and Andaman-Niccobar ophiolites. But within the limits of Indian Sector of the Indo-Burman Ranges, the geological mapping of the Naga Hills ophiolite (90 km x 1-15 km) was undertaken both by the State Directorate of Geology and Mining, Nagaland (DGMN) and the Geological Survey of India. The DGMN completed the geological mapping of this ophiolite belt on 1:50,000 scale in 1981 and is continuing mapping on larger scales (1:5000, 1:2000, 1:1000) in different potential mineral-bearing areas.

Mapping of this ophiolite belt was beset with several constraints due to rugged and remote terrain, extreme tectonic dismembering, obscure contact relationships, and near-constant vegetation, soil and scree-material covers. Size, shape and trend of individual lithobodies are often inconsistent. The boundaries of lithobodies are fractured, sheared, brecciated or mylonitised. Remote sensing and photogeology had been useful only to the extent of tracing the main boundaries of the ophiolite belt, major lineaments and general tectonic setting. These specialized techniques did not serve much for the purpose in this melange-type terrain as far as the tracing of actual outcrop pattern of individual lithomembers, which are so large in number and varied in characters, are concerned. The photogeological tracing of lithoboundaries, in most cases, did not corroborate with field observations and often gave erroneous impression about the actual contact relationship, spatial disposition and identity of various lithounits except for major serpentinite bodies and the overlying clastic sedimentary cover. Results of best possible approximation or nearest to the reality in mapping were obtained only by arduous physical tracing of the field characters without any bias. Field guides and criteria were established for reasonably precise mapping after a close correlation of the field observations with the

laboratory studies in the initial stages and feed-back supplement from time to time. The soil characteristic, type and density of vegetation, and topographic relief were very useful in this terrain for field mapping.
A complete geological map was produced on 1:50 000 scale with imprints of lithological layouts, structural elements, and mineral occurrences. A special emphasis was given to the metallogenic developments and exploration-significant features which make it thoughtful for the exploration geologist as well.

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LES TRACEURS MAGMATIQUES DE L'EVOLUTION D'UNE DISTENSION DEPUIS LE REGIME INTRACONTINENTAL JUSQU'A UNE RIDE MEDIO-OCEANIQUE : EXEMPLE DE L'EST DE LA PLAQUE AFRICAINE

Les résultats des travaux réalisés par le laboratoire de Pétrologie de Lubumbashi sur le volcanisme associé au Rift de l'Afrique Centrale permettent, en les intégrant dans l'ensemble des données relatives au Rift Est-Africain, de proposer un modèle d'évolution du volcanisme en relation avec les déformations lithosphériques, depuis un régime distensif intracontinental jusqu'à une marge inactive de type A.T.L.

Les premières laves épanchées caractérisant les stades pré-rifts continentaux, sont des émissions fissurales de basaltes tholéiitiques et transitionnels (trapps) mises en place essentiellement pendant la phase de gonflement crustal.

Elles sont relayées par des laves alcalines sodiques, tout au moins au niveau des termes basiques qui marquent l'individualisation du rift continental limité par des failles normales.

Sur les fractures transverses (failles transformantes naissantes en domaine continental ?), le volcanisme est alcalin potassique à hyperpotassique. Le taux de saturation des magmas primogéniques diminue dans le temps et dans l'espace (de l'extérieur vers le centre du rift).

Les laves émises dans la partie axiale du rift continental à un stade relativement avancé dans son évolution sont des basaltes transitionnels d'abord de tendance alcaline puis tholéiitiques. Ces magmas transitionnels initialement enrichis en terres rares légères (exemple : rift continental de type Kivu), vont évoluer progressivement vers les termes caractérisés par un spectre franchement tholéiitique qui sera atteint dans un régime tectonique transitoire marquant le début de "l'océanisation" de la croûte (exemple : rift proto-océanique de type Afar) ; le dernier stade évolutif étant une ride médio-océanique classique de type Atlantique.

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EURASIAN AND NORTH AMERICAN STRUCTURAL EVOLUTION CIRCUM MODEL

Analysis of spatial-temporal links of Post-Riphean ophiolite belts in Eurasia and North America revealed eight age groupes, stratching parallelly to the edges of the Siberian platform and succeeding

each other across the strike forming regular lateral rows. The southmost, the most complete row (the Altai - Sayan - Tien Shan- Pamirs - Afghano-Himalayan area) is presented by the age groupes of Vendian - Middle Cambrian, Middle Cambrian - Late Ordivician, Late Ordivician - Early Devonian, Early Devonian- Early Carboniferous, Early Carboniferous - Late Permian, Late Permian - Late Triassic, Late Triassic - Cretaceous. In the westerm lateral row (the Urals- - Scandinavia - Appalachian - Cordilleras) from the number of the mentioned structures only the Late Ordovician-Early Devonian are not known. From the eastern row (Verkhoyanie- Kamtchatka) the first three belt groupes are absent, all the rest, beginning with Early Devonian - Early Carboniferous preserve the general succesioon. The ophiolitic belts of one and the same age groupe are spatially co-relationned, often they transfer one into the other along the strike (Iran - Afghanistan- the Pamirs- China- Sikhote-Alyn) as if forming eight structural circles around the Siberian platform. They mark former intercontinental basins with oceanic crust, which in sequence opened on the margins of Gondwana. Their separated continental blocks (the Riphean greenshist belts and Early PreCambrian blocks) nowadays border the ophiolite circles. The essence of the Post Riphean structural evolution of Eurasia and North America is the regular migration of geosynclinal process from the Siberian platform to the present day Pacific ocean and the Indian ocean leaving in the back the younger fold zones with the succeeding transfer into continental margins of Laurasia.

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КОЛЬЦЕВАЯ МОДЕЛЬ СТРУКТУРНОЙ ЭВОЛЮЦИИ ЕВРАЗИИ И СЕВЕРНОЙ АМЕРИКИ

При анализе пространственно-временных связей послерифейских офиолитовых поясов Евразии и Северной Америки установлено, что все они укладываются в восемь разновозрастных групп, которые простираются параллельно краям Сибирской платформы и, последовательно сменяя друг друга вкрест простирания, образуют закономерные латеральные ряды.

Южный, наиболее полный ряд (Алтае-Саяны - Тянь-Шань -Памир - Афгано-Гималайская область) составляют пояса возрастных групп венда - среднего кембрия, среднего кембрия-позднего ордовика, позднего ордовика-раннего девона, раннего девона-раннего карбона, раннего карбона-поздней перми, поздней перми-позднего триаса, позднего триаса-мела. В западном латеральном ряду (Урал - Скандинавия - Аппалачи - Кордильеры) из перечисленных структур остаются неизвестными только позднеордовикско-раннедевонские. Из восточного ряда

(Верхоянье – Камчатка) выпадают первые три группы поясов, остальные, начиная с раннедевонско-раннекаменноугольной, сохраняют последовательность.

Офиолитовые пояса одной возрастной группы пространственно увязываются между собой, нередко переходят друг в друга по простиранию (Иран – Афганистан – Памир –Китай – Сихотэ-Алинь), намечая вокруг Сибирской платформы восемь структурных колец. Они маркируют прежние внутриконтинентальные бассейны с океанической корой, поочередно раскрывавшиеся по периферии Гондваны, чьи оторженные материковые области (раннекембрийские континентальные глыбы и рифейские зеленосланцевые пояса) ныне разделяют офиолитовые кольца. Сущность послерифеской структурной эволюции Евразии и Северной Америки заключается в закономерной миграции геосинклинального процесса от Сибирской платформы к современным Тихому и Индийскому океанам с оставлением в тылу все более молодых складчатых областей и их последовательным превращением в континентальные окраины Лавразии.

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STRUCTURE OF OBRUCHEV AND SHATSKY RISES ON SEISMIC DATA

During 1979-1981 seismic measurements on Obruchev and Shatsky rises by the Pacific Oceanological Institute have been done. The structure of the upper part of the crust was studied by following methods: continuous seismic profiling (CSP), sono-bupyo refraction measurements (SB) and deep seismic sounding (DSS) with bottom seismograph (BS). From results of CSP the total thickness of sedimentary cover varies from 0.1 to 2.0 km on the Obruchev rise. It consists of four acoustic units, they were identified by the cross-section of the site 192. Near the south-east extremity of the seamount Detroit the characteristics of sediments are different from characteris of sediments on the rise. Between the North-Western Pacific Basin and the rise tectonic zone is situated as a fault system. The Obruchev rise is an independent structure, it doesn't continue the Imperor seamount chaine. From the results of reflection measurements the sediment layer has mean velocities from 1.62 to 1.91 km/s. On the south part of the Shatsky rise sedimentary thickness consists of four acoustic units, they were identified by cross-sections of the sites 305 and 306. Thickness of the sediments varies from 0.6 to 1.5 km. Some places where the sediments are eroded up to surface of the low acoustic unit. The refraction method data on the Shatsky rise measured layers with velocities 4.0; 5.0 and 6.8 km/s, they are si-

tuated under sedimentary rocks. The records of BS show converted waves and was computed velocites of shear waves and Poisson ratio. The Obruchev rise was investigated by DSS method. These measurements demonstrate the presence of layers 2A, 2B and oceanic layer.

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СТРОЕНИЕ ВОЗВЫШЕННОСТЕЙ ОБРУЧЕВА И ШАТСКОГО ПО СЕЙСМИЧЕСКИМ ДАННЫМ

В течение 1979-1981 годов Тихоокеанским океанологическим институтом ДВНЦ АН СССР проведены сейсмические исследования на возвышенностях Обручева и Шатского. Изучалось строение верхней части земной коры методами непрерывного сейсмопрофилирования (НСП), глубинного сейсмического зондирования (ГСЗ) с донными сейсмографами и отраженных волн (МОВ)с сейсмоакустическими радиобурями.По данным НСП,мощность осадков на возвышенности Обручева изменяется от 0,1 до 2,0 км. Осадочный слой сложен четырмя акустическими комплексами, индентифицированными по разрезу скв. 192. Характеристики осадочного слоя, примыкающего к юго-восточной оконечности возвышенности горы Детройт, отличаются от характеристик осадков на возвышенности. От ложа Северо-Западной котловины возвышенность отделяется зоной тектонических нарушений, представленной системой сбросов. Возвышенность Обручева является самостоятельным структурным образованием, а не продолжением Императорских гор. Средняя скорость в осадках, определенная здесь МОВ в 4 точках, изменяется от 1,62 до 1,91 км/с. Осадочный слой на южном поднятии возвышенности Шатского сложен четырьмя акустическими комплексами, индентифицированными по разрезам скв. 305 и 306. Мощность слоя изменяется от 0,6 до 1,5 км. Местами осадки эродированы вплоть до кровли нижнего акустического комплекса. По данным ГСЗ,на возвышенности Шатского ниже осадков выделяются слои со скоростями 4,0; 5,0 и 6,8 км/с. На записях выделены обменные волны, по временам их вступлений оценена скорость поперечных волн в осадках и значение коэффициента Пуассона. На возвышенности Обручева ГСЗ выявлено двухслойное строение второго слоя и определена скорость в третьем слое.

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THE PREURAL TECTONICS

1. The Preural foredeep is the main tectonic form in the Preurals; its tectonic evolution is distinctly seen here in the emplacement of formations various in composition. The outer part of the foredeep is marked by the zone of barrier reefs (in case of their absence, the borderline of platform and depression deposits change), the inner part is marked by the marine and continental molasse zone which is generally overlapped by nappes of orogenic regions.
2. The foredeep deposites are dissected with thrusts into a number of tectonic sheets which can be traced in a plan as belts parrallel to the adjacent folded zone, locally the belts are shifted transcurrently. The main tectonic elements of the foredeep are tectonic sheets, thrusts and nappes; they are folded into linear and dome-like folds.
3. The intensity of the allochtons dislocation and amplitude of their displacement are consequently ascending from the platform to the geosyncline.
4. A distinct genetic relation in the disjunctive and plicated dislocations exists in their setting: folds are always secondary structures derived from thrusts.
5. The modern tectonic pattern of the foredeep depends on the main evolutionary process - horizontal compression.
6. The process of the foredeep formation has taken several stages which is evidenced in ante-Ordovician, -Eifelian, -Kynovian, -Visean, -Verean, -Postcarboniferous, -Early Permian and -Postpermian, -Middle Triassic and other time intervals.
7. The increasing intensity of the foredeep dislocation towards the adjacent orogenic zones and the strike conformity of its main structures suggest a genetic relation of the Preural foredeep with the Ural geosynclinal energetic resources; This fact is emphacised by the coincidence of the main thrusting and folding stages with the tectonic cycles of the geosyncline evolution.

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ТЕКТОНИКА ПРЕДУРАЛЬЯ

I. Главной тектонической формой Предуралья является Предуральский краевой прогиб, тектоническое развитие которого четко зафиксировано в размещении на его территории различных по составу формаций. Внеш-

ние контуры прогиба определяются зоной распространения барьерных рифовых массивов (или границей смены платформенных и депрессионных отложений там, где рифы отсутствуют), внутренние - зоной морских и континентальных моласс, как правило, перекрытых надвигами орогенных областей.

2.Ложе и выполнение прогиба расчленено надвигами на множество тектонических чешуй, выходы которых в плане прослеживаются полосами параллельно сопредельной складчатой области, иногда смещаясь друг относительно друга сдвигами поперечного направления. Главными структурами краевого прогиба являются тектонические чешуи, пластины и покровы (шарьяжи), смятые в линейные и куполовидные складки.

3.Интенсивность дислоцированности аллохтонов, а также амплитуд их перемещения последовательно возрастает в направлении от платформы к геосинклинали.

4.В размещении дизъюнктивных и пликативных дислокаций устанавливается четкая генетическая связь: складки всегда являются вторичными структурами, производными от надвигов.

5.Ведущим процессом эволюции структуры краевого прогиба является горизонтальное сжатие, обусловливающее его современный тектонический рисунок.

6.Формирование структуры краевого прогиба было многоэтапным, что зафиксировано в предордовикское, предэйфельское, предкыновское, предвизейское, предверейское, предпозднекаменноугольное, предранне- и позднепермское, предсреднетриасовое и другие интервалы времени.

7.Увеличение степени дислоцированности краевого прогиба в направлении смежных орогенов, согласованность простираний его основных структур свидетельствуют о генетической зависимости Предуральского прогиба от энергетического источника Уральской геосинклинали, что подчеркивается совпадением основных этапов надвигообразования и складчатости с тектоническими циклами развития геосинклинальной области.

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THE ORIGIN AND EVOLUTION OF THE URAL GEOSYNCLINE

On the basis of the tectonic relationships of the sedimentation process and development of magmatism, metamorphism and tectonic structure a model of geological evolution in the Urals is suggested; the authors tried to show that the geosynclinal process depends on the active thrusting of oceanic masses on the continental margin resulted in tectonic and geochemical interactions of sialic (continental) and basic (oceanic) crust. The main issues of the model are as follows: Ultramaphic belts in the Urals are the exposed on the

present surface frontal parts of large allochtonous thrust sheets of oceanic crust overthrusting the East-European platform. There were three main stages of thrusting: Late Ordovician, Middle Devonian and Lower Carboniferous evidenced by glaucophane-bearing metamorphic complexes. The older belts are all in the West, and the younger ones are in the East.

The main characteristic features of the geosynclinal magmatism are the evolution of its chemical composition in time and lateral migration of volcanism in space; geosynclinal magmatism develops with cyclic recurrence of vertical formation series in three time intervals: Ordovician - Middle Devonian, Middle Devonian - Early Tournaisian, Late Tournaisian - Visean. Every new tectonic cycle starts after thrusting of an ultramaphic belt and develops in environment of lateral compression. First comes into being the volcanic part of the formation with composition evolutioning from basic rocks to acid more alkalic, and then forms sedimentary part represented with flysch. So lateral migration existing in the eugeosyncline zone of the Urals both for volcanics and flysch is caused by the subsequent rock masses thrusting from the Ural paleoocean onto the East-European platform; and the thrusting created the geosyncline formation series changing one another in time and space.

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ПРОИСХОЖДЕНИЕ И РАЗВИТИЕ УРАЛЬСКОЙ ГЕОСИНКЛИНАЛИ

На основе выявленных закономерностей в осадконакоплении, развитии магматизма, метаморфизма и структуры предложена модель геологического развития Урала, в которой предпринята попытка показать, что геосинклинальный процесс обусловлен активным шарьированием океанических масс на край континента, приведшим к тектоническому и геохимическому взаимодействию сиалистической (континентальной) и базитовой (океанической) кор. Основные положения этой модели сводятся к следующему: гипербазитовые пояса Урала являются выведенными на поверхность фронтальными зонами крупных аллохтонных пластин океанической коры, шарьированных на Восточно-Европейскую платформу в три крупных этапа: позднеордовикский, среднедевонский и нижнекаменноугольный, что зафиксировано глаукофанизацией метаморфических комплексов. Омоложение поясов происходит в восточном направлении.

Геосинклинальный магматизм, основными характерными чертами которого являются эволюция химического состава во времени и латераль-

ная миграция вулканизма в пространстве, развивается циклично, с повторяющимися вертикальными формационными рядами в интервалах времени: ордовик - средний девон; средний девон - раннее турне; позднее турне - визе. Каждый тектонический цикл начинается после шарьирования очередного гипербазитового пояса и протекает в условиях тангенциального сжатия земной коры. При этом вначале возникла вулканическая часть формационного ряда, состав которой эволюционировал от основного к кислому при увеличении роли щелочей, затем осадочная, представленная флишем. Таким образом, наблюдаемая в эвгеосинклинальной зоне Урала латеральная миграция как вулканизма, так и флишенакопления обязана механизму последовательного шарьирования горных масс со стороны Уральского праокеана на Восточно-Европейскую платформу, создавшего закономерно сменяющие друг друга во времени и в пространстве ряды геосинклинальных формаций.

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TECTONIC RELATIONS BETWEEN THE GAVROVO AND PINDUS ZONE, VARDOUSSIA SUBZONE AND PARNASSUS ZONE, IN SOUTHWEST STEREA HELLAS, GREECE

Between the Nafpactos and Giona areas occur various allochthonous units of Pindus, Vardoussia (subzone) and Parnassus zones (middle isopic zones of Hellenides) overthrusted on the autochthonous flysch of Gavrovo ridge (internal zone of the external Hellenides).

Some of them are independent and resulted from the dilaceration of the Pindus zone and Vardoussia subzone during their displacement from their initial position for many kilometers towards west into the autochthonous flysch at the post Upper Eocene age.

Detailed mapping of the study area proved that the real tectonic relations between the autochthonous zone and the allochthonous zones are :

- The four units which represent the Pindus zone are independent and constitute huge typical klippes synsedimentary of the autochthonous flysch.
- The two units which consist of the Vardoussia subzone are independent. The northen of them constitutes one huge, fractionated into three segments, klippe synsedimendary of the autochthonous flysch and the meridian of them is overthrusted on the autochthonous flysch and is upthrusted by the meridian unit of the Parnassus zone.
- The five units which represent the front of the Parnassus zone are deformed and contracted into a whole, by the influence of many faults of different nature. The western part of the meridian unit is overthrusted on the autochthonous flysch and its eastern part is upthrusted on the meridian unit of the Vardoussia subzone. The four other units float or are slightly submerged in the autochthonous flysch.

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GEOLOGICAL STRUCTURE OF CENTRAL GREECE AND OF THE CYCLADES ISLANDS

The area of Central Greece (Central and Western Macedonia, Thessaly, Eastern Sterea Ellas, Attici and Euboea) and of the Cyclades islands (leaving out the post-alpine formations), constitutes a system of overlapping tectonic units, which follow from top to base :

1. Olympos-Ossa-Almyropotamos unit : consisting of a continuous series of carbonaceous rocks, of great thickness, of triassic up to upper-eocenic age, that ends up with flysch sediments. The formations of this unit are slightly metamorphic and occur in the area in the form of tectonic windows.

2. Ambelakia-Okhi units : consisting of various series of metasediments, with intercalations of metabasites and serpentinite bodies characterized by High Pressure - Low Temperature (HP-LT) metamorphism. These units have been overthrust, after Middle Eocene on the Olympos-Ossa-Almyropotamos unit.

3. Pelagonian zone unit : Its formations occupy the greatest part of this area and are overthrust on the Ambelakia-Okhi units and furthermore all of them together on the Olympos-Ossa-Almyropotamos unit. This unit consists of a mesozoic formations series lying on a paleozoic basement usually metamorphic. Between Upper Jurassic and Upper Cretaceous in this series, a volcanosedimentary series, of triassic-jurassic age, is tectonically intercalated, accompanied by ophiolitic rocks.

4. Almopia zone unit : consisting of non-metamorphic formations and occurs only on the eastern margin of this area in the form of an intensely weathered tectonic nappe.

5. Plutonic intrusions : they are mainly granitic and granodioritic intrusions of postuppercretaceous-preupereocenic age.

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TERTIARY TO RECENT GEOCHEMICAL EVOLUTION OF THE ALEUTIAN ARC: IMPLICATIONS FOR REGIONAL TECTONICS

Two distinct geochemical (isotopes, major and trace element chemistry, mineralogy) and metamorphic terrains have been found in Tertiary age strata of the Aleutian Arc basement. The first terrain, which consists of the central and eastern Aleutians, is characterized by the Finger Bay Volcanics (submarine volcanics, pyroclastics, and volcanogenic sedimentary rocks) and the Tertiary plutons on Adak Island. A greenschist metamorphic overprint on the early Tertiary Finger Bay Volcanics and the Finger Bay pluton is due to circulation of hot, meteoric water associated with the intrusion of the later Teritary plutons. These Tertiary igneous rocks have essentially the same geochemical signature as the magmas of the active, oceanic segment of the arc and suggest little

change in tectonic configuration of this region since the Tertiary. In contrast, the early Tertiary volcanic rocks of Attu Island in the inactive western Aleutians have a geochemical signature suggesting formation in a back-arc or ocean-ridge setting. Metamorphism in these rocks is probably related to circulation of seawater through the cooling magmas. Later arc-related magmas are limited in extent on Attu suggesting that this region has had a different history than the central Aleutians.

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RELATION OF THE CHEMISTRY OF THE PLIO-PLEISTOCENE TO RECENT VOLCANOES OF THE ALEUTIAN ISLAND ARC, ALASKA, TO THEIR TECTONIC SETTING

The chemistry of volcanoes in the western and central Aleutian arc can be related to four generalized segments defined by the alignment of the volcanoes. Volcanoes at the ends and between segments tend to be dominantly basaltic and have magmas which show an Fe-enrichment trend. The andesites are largely vitropyric, may contain groundmass pigeonite, and lack amphibole. Volcanoes between segments have a higher proportion of andesite and show no Fe-enrichment trend. Andesite phenocryst assemblages are complex, and may include amphibole, Cr-rich clinopyroxene, and Ni-rich olivine. These lavas contain abundant evidence for mixing of more evolved magmas with less evolved magmas. In general, the volcanoes at the ends and between segments have lavas that crystallized at higher-T and lower-P than volcanoes between segments consistent with tectonic controlls on ascent paths related to volcanic position. The parent lava for all these magmas is a basalt (> 9% MgO) that is in equilibrium with a high FO, Ni-rich olivine. The available samples from the Four Mountain Segment, which sits closer to the trench than the other segments, are distinct in that they lack amphibole and are the least K_2O-rich in the arc.

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PALEOGEN HISTORY OF THE PERIADRIATIC LINEAMENT - A HUNGARIAN POINT OF VIEW

The zone separating the Eastern and Southern Alps /Periadriatic Lineament = PAL/ bifurcates at the western end of the Lienz Dolomites. The northern branch /Defereggental--Anterselva--Valles Lineament/ has a continuation in the Rába and Margecany--Lubenik Lineaments /AHRENDT, 1980; KOVACS, 1983/. It separates Alpine metamorphism to the north and Variscan metamorphism to the south. The southern branch /Pusteria, Gailtal, Karavanka and Balaton Lineaments/ is defined by the occurrence of Late Variscan granitoids and Alpine tonalites.

The northern and southern branches of the PAL intercept a separate unit of the Alpine edifice, the Bakony--Drauzug Unit. Paleogeographic reconstructions based on Permian to Paleogene isopic zones have shown that before the Paleogene the whole unit was between the Eastern and Southern Alps. Its present-day position is the result of an eastward directed continental escape.

After Mesozoic inactivity, large-scale transcurrent faulting began during the Eocene, along the two branches of the PAL, connected with the continental escape of the Bakony--Drauzug Unit. The escape continued during the Oligocene. The 450--500 km long displacement of the unit resulted in the formation of a thousand km long and some metres to several tens of kilometres wide melange zone along the lineament. Tonalite magma intruded into zones of transtension forming lamellar bodies. Larger acidic plutonic bodies formed in transtensional segments of continental triple junctions /Bergell, Adamello/. Andesite volcanism accompanied the lateral displacements.

The ultimate cause of the behavious of the PAL as a strike-slip belt and of the continental escape of the Bakony--Drauzug Unit was the northward motion of the Apulian microplate.

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DEPENDENCE OF THE TYPE OF RIFTING ON THE CONDITIONS OF EXTENSION

The continental break up occurs in two ways. 1) As a consequence of rapid thinning of the lithosphere (L) accompanied by sinking at first due to loss of buyoancy and then due to thicknening of the L. in the course of cooling. 2) As a result of slow extension in a series of impulses accompanied by uplifts of various scale. The first type is examplefied by the Triassic - Early Jurassic fragmen-

tation of Pangea with "free" dispersion of continental blocks, the second - by Cainozoic rifting (the Baikal, Rhina, Afro-Arabian rift systems), when rifts were formed in the course of continental collision.

In the first case rapid thining of the L. either continuous or in a series of closely spaced impulses leads directly to formation of the ocean. In the second - rifting is hampered by external obstacles and goes in rare impulses separated by wide time-gaps. Initial extension causes slight thinning of the L., rising of the astenosphere, increase of partial melting in the uplifted part, ascending and accumulation of light material (a lense of the anomalous mantle) at the bottom of the crust, isostatic uplift, eruption of magma through re-opened fissures. The astenospheric uplift and the area of assending anomalous mantle are registered by geophysical methods as "mantle inhomogenities" below the rift zones. Successive extensional impulses result as in the first case in the opening of the ocean. In both cases rifting is not related to local mantle features (plume, astenolith, etc.) but reflects regional extension.

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ЗАВИСИМОСТЬ ТИПА РИФТОГЕНЕЗА ОТ УСЛОВИЙ РАСТЯЖЕНИЯ

Процесс раскола континента осуществляется двумя способами. I. Путем быстрого утонения литосферы (Л), сопровождающегося погружением сначала вследствие "потери плавучести", затем по мере оставания Л за счет нарастания и утяжеления ее мантийной части. 2. В результате медленного, импульсного растяжения, сопровождающегося поднятиями разного масштаба. Первый тип развития характерен для рифтов (Р) триасового - раннемелового времени, формировавшихся в условиях фрагментации Пангеи и "свободного" расхождения образовавшихся континентов, второй - для кайнозойских рифтов, большинство из которых (Байкал, Рейнский Р , Африкано-Аравийская Р система) образовались в результате напряжений, возникших в теле плит при их столкновениях. Рифтогенез первого типа определяется быстрым растяжением континентальной Л (непрерывным или в виде частых последовательных импульсов), завершающимся образованием океана. Во втором случае растяжение осуществляется редкими импульсами (раздвижение затруднено внешними препятствиями). Начальное растяжение приводит к небольшому утонению Л , образованию выступа астеносферы,повышению степени плавления мантийного вещества в образовавшемся выступе, всплыванию легкого материала и накоплению его в подошве коры, изостатическому поднятию, поступлению магм на поверхность из подкоровой линзы. Область всплывания легкого материала, размеры которой зависят от ширины и протяженности участка Л , подвергшегося растяжению, регист-

рируется сейсмологическими методами как "мантийная неоднородность" под Р зонами. Последующие импульсы растяжения приводят, как и в первом случае, к образованию океана. В обоих случаях образование и развитие Р не автономны, отражают процессы регионального растяжения.

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STYLE AND TIMING OF RIFTING IN THE NORTH AMERICAN CRATON

Recent studies have shown that the North American craton has been extensively rifted during the past 2 billion years, and that these rifts are important because of their propensity for reactivation, their relation to natural resources, and their utility as indicators of tectonic regimes. Despite many uncertainties in detailed geological and geophysical interpretations of these features, several episodes of rifting are clearly evident. The first occurred in the Late Proterozoic, and resulted in the development of several aulacogens along the western margin of the craton and extensive rifting in the midcontinent area. The next event was Eocambrian in age and involved the break-up of the continent to form the proto-Atlantic ocean. Aulacogens along the southern margin of the craton related to this event are the dominant tectonic elements in this area, and the Paleozoic basins related to these features contain much of the hydrocarbon reserves of the United States. Another major continental break-up began in the Triassic as the Atlantic Ocean and Gulf of Mexico opened. This event formed the passive continental margin that exists today, and marked the end of tectonic activity in most of the North American craton. Tertiary rifting has been confined to the western portion of the craton, and includes such features as the Rio Grande rift and eastern Basin and Range province, where extension has been occurring during the last 30 m.y.

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PERICONTINENTAL AND INTERCONTINENTAL GEOSYNCLINAL BELTS: A COMPARISON OF DEVELOPMENT FEATURES

The two main types of geosynclinal belts are: pericontinental geosynclinal belts developed along the Pacific periphery and intercontinental geosynclinal belts which include the Late Precambrian and Phanerozoic Mediterranean, Ural-Okhotsk, North Atlantic and Arctic belts. The former (PCG) developed in the transitional continent-ocean zone, much owing to the involvement of ocean crust into the geosynclinal process; the initiation of the latter (ICG) took place on the old Precambrian continental crust as a result of rifting. That is the reason why the ensimatic island arcs are characteristic of the PCG, while microcontinents are typical of the ICG. Continuity of geosynclinal development with a shift to the ocean is peculiar to the PCG; as for the ICG, their history was an alternation of expansion and complete or almost complete closure, followed by a new splitting of continental crust. Simultaneously, the active geosynclinal process shifted to the centr of the belt or to one of the continen-

tal frames. The ICG riftogenous origin conditioned a wide and prolonged development of their margins as typical passive margins, while the Pacific margins developed as predominantly active ones since Riphean - the beginning of Phanerozoic. The folded mountain edifices emerging within the PCG have as a rule an accretionary (subductional) origin; as for the ICG, they are of collision origin. The old continental crust in the second case often experiences a considerable remobilization with the formation of the Penninic type nappes; ophiolite nappes are obductioned to continental margins (in case of the PCG - to the old island arcs or accretion wedges). A large scale transcurrent fault tectonics is most characteristic of the PCG and has a more limited development in the ICG. The PCG volcano-plutonic belts belong to the "liminar" type and emerge in the Andean type margins, while intercontinental, collisional belts prevail in the ICG. A continental crust, but not mantle component is of importance in granitoids and volcanics. Paired metamorphic belts are most typical of the PCG. In the ICG hemipelagic sediments prevail over the pelagic ones, as well as detrital over chemobiogenous; quartz material predominates in flysch and molasse clastic rocks.

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ОКРАИННО-КОНТИНЕНТАЛЬНЫЕ И МЕЖКОНТИНЕНТАЛЬНЫЕ ГЕОСИНКЛИНАЛЬНЫЕ ПОЯСА:СОПОСТАВЛЕНИЕ ОСОБЕННОСТЕЙ РАЗВИТИЯ

Двумя основными типами геосинклинальных поясов являются окраинно-континентальные, развитые по периферии Тихого океана и межконтинентальные, к которым относятся Средиземноморский, Урало-Охотский, Северо-Атлантический, Арктический пояса позднего докембрия и фанерозоя.Первые (ОКГ) развивались в зоне перехода от океана к континентам во многом за счет вовлечения океанской коры в геосинклинальный процесс, заложение вторых (МКГ) происходило на древней, докембрийской континентальной коре в результате рифтообразования. Поэтому для ОКГ характерно присутствие эншматических островных дуг, для МКГ - микроконтинентов. ОКГ свойственна непрерывность геосинклинального развития со смещением в сторону океана; в истории МКГ этапы расширения пространства с океанской корой чередовались с этапами полного или почти полного их замыкания, за которыми следовало новое дробление континентальной коры, новый рифтинг. При этом активный геосинклинальный процесс смещался к центру пояса или к одному из континентальных ограничений. Рифтогенное происхождение МКГ обусловило широкое и длительное развитие их окраин в качестве пассивных, в то время как окраины Тихого океана с конца рифея - начала палеозоя развивались преимущественно

как активные. Складчатые горные сооружения, возникающие в пределах ОКГ, имеют в основном субдукционное, а МКГ - коллизионное происхождение. Древняя континентальная кора во вторых из них часто испытывает существенную ремобилизацию с образованием покровов пеннинского типа, а офиолитовые покровы обдуцируются на края континентов (в ОКГ на древние островные дуги или аккреционные клинья). Сдвиговая тектоника крупного масштаба наиболее характерна для ОКГ и более ограниченно развита в МКГ. Вулкано-плутонические пояса в ОКГ принадлежат к типу краевых, возникающих на окраинах андского типа, в МКГ преобладают внутриконтинентальные, коллизионные пояса. В гранитоидах и вулканитах существенна компонента не мантийного, а континентально-корового происхождения. Парные метаморфические пояса наиболее типичны для ОКГ. В МКГ гемипелагические осадки преобладают над пелагическими, обломочные - над хемобиогенными; в составе обломочных пород флиша и моласс велика роль кварцевого материала.

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THE INTERNATIONAL TECTONIC MAP OF THE WORLD AND SOME CONCLUSIONS

In 1981 compilation of the first International Tectonic Map of the World on a scale of 1:15 000 000 was finished. Many authors from various countries and continents took part in the work. The basic principle of the legend of the map is division into tectonic regions according to the age of folding for the continents (and shelves) and according to the time of formation of the oceanic crust for the oceans and structures of marginal and inland seas of a suboceanic type. Besides that, the legend provides for the representation of other features of tectonic structures. Subdivision of land areas according to the age of folding seems customary today; in this respect the map does not contain any basically new methodology elaboration, except subdivision of zones that originated on the oceanic, continental, transitional and unspecified crust. Consistent application of this method throughout the land area of the Earth permits to draw some general conclusions. One of them, mainly dealt with in the report, pertains to the problem of global epochs of folding. As regards major events, their single sequence throughout the Earth has to be admitted. In any case, this conclusion holds for the Phanerozoic and apparently for the main Precambrian boundaries. From this point of view there are no essential differences in the development of the Atlantic and Pacific "segments" of the Earth. However, intensity of the events and their role in tectonic history of different areas and, even, of the continents

or their large regions are most variable. At the same time, there are much more main epochs of deformation, regional metamorphism and granite magmatism, than those traditionally recognized in Europe: the Baikalian (Cadomian), Caledonian, Hercynian, Cimmerian and Alpine epochs. Therefore, the authors gave up these denominations and use purely geochronological ones instead.

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МЕЖДУНАРОДНАЯ ТЕКТОНИЧЕСКАЯ КАРТА МИРА И НЕКОТОРЫЕ ВЫТЕКАЮЩИЕ ИЗ НЕЕ ВЫВОДЫ

В 1981 г. было завершено составление первой Международной тектонической карты мира в масштабе 1:15 000 000. В ее создании принимал участие большой интернациональный коллектив авторов, состоящий из ученых разных стран и континентов. В основу легенды карты положен принцип районирования по возрасту складчатости для континентов (включая шельфы) и по времени формирования океанической коры для океанов и структур окраинных и внутренних морей субокеанического типа. Эти главные характеристики дополняются изображением также ряда других особенностей тектонического строения. Районирование континентальных площадей по возрасту складчатости теперь уже можно считать традиционным; карта в этом отношении не содержит принципиально новых методических разработок, за исключением выделения зон, возникших на океанической, *континентальной, переходной или невыясненого типа коре. Однако* последовательное применение этого подхода ко всей континентальной поверхности земного шара позволяет сделать ряд выводов общего характера. *Один из них - который в основном и рассматривается в докладе* - относится к проблеме глобальных эпох складчатости. Если иметь в виду достаточно крупные события, то приходится признать, что их последовательность *является единой для Земли в целом. Этот вывод во всяком* случае справедлив для фанерозоя, но также, по-видимому, и для главных рубежей в докембрии. С этой точки зрения нет, в частности, существенных различий в развитии так называемых *атлантического и тихо*океанского "сегментов" земного шара. Однако интенсивность проявления рассматриваемых событий и их значения в тектонической истории разных областей, а иногда даже и целых континентов или их крупных частей, могут сильно варьировать. Вместе с тем число основных эпох деформаций, регионального метаморфизма и гранитоидного магматизма оказывается большим, чем традиционно выделяемые в Европе байкальская (кадомская), каледонская, герцинская, киммерийская и альпийская эпохи, что заставило авторов отказаться от этих наименований и заменить их чисто геохронологическими.

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VOLCANISM OF THE BAIKAL RIFT ZONE

Volcanism and rifting are usually interrelated in space and time. However, the continental rift zones are not equally impregnated with magmatic derivatives with their individual parts being generally amagmatic. Regions of volcanism are often displaced to the rift basins and can expend far away from their bounds. In this respect, the most significant is the south-west flank of the Baikal rift zone with basalt fields representing only a small part of the volcanic province of Central Asia.

Lava fields and volcanoes are found both on uplifts and in basins and also in areas (Vitim plateau, Dariganga) unaffected by noticeable vertical movements in the Cenozoic. First volcanic outbursts began in the Paleogene, the major volcanic activity was in the Miocene-Pliocene and it sharply decreased in the Pleistocene and Holocene. Since the Paleogene, there was the expansion of areas of volcanic activity and the transition of volcanic centers from the regions of early eruptions to the margins of volcanic area. Moreover, individual parts of the system of rift basins are the examples of local multiple volcanism (Tunka basin).

The relationship between the degree of lithosphere tension and the lava volumes and their chemistry are established. The stage of maximum productivity of volcanism (Miocene-Pliocene) is characterized by fissure eruptions of mildly alkaline rocks up to tholeiitic ones in the areas of most possible tension. Alkaline and strongly alkaline basaltic rocks are typical of the stage of decreased volcanic activity. This petrochemical variation of basalts from mildly alkaline to alkaline may indirectly suggest deeper levels of magma formation due to the cooler lithothermal system under the Baikal rift zone and lower tension in lithosphere.

Volcanism in the Baikal rift zone and in other areas of Central and East Asia resulted not only from regional deep processes under volcanic regions due to the presence of the high temperature anomal mantle and its uprise, but also from global ones associated with the change of kinematics of lithospheric plates.

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ВУЛКАНИЗМ БАЙКАЛЬСКОЙ РИФТОВОЙ ЗОНЫ

Вулканизм и рифтогенез обычно обнаруживают пространственно-временную сопряженность. Однако насыщенность континентальных рифтовых зон магматическими производными не везде одинакова, отдельные их звенья вообще амагматичны. Ареалы вулканизма нередко смещены относительно рифтовых впадин и могут распространяться далеко за их пределы. Особенно показательным в этом отношении является юго-западный фланг Байкальской рифтовой зоны (БРЗ), базальтовые поля которого составляют лишь небольшую часть центральноазиатской вулканической провинции.

По отношению к неотектоническим структурам лавовые поля и вулканы расположены как на сводовых поднятиях, так и во впадинах, а также встречаются в районах (Витимское плато, Дариганга), не испытавших в кайнозое заметных вертикальных перемещений. Первые вспышки вулканизма начались в палеогене. Максимум вулканической активности приходится на миоцен-плиоцен, а в плейстоцене и голоцене произошел ее резкий спад. Начиная с палеогена имело место расширение площадей вулканической активности и перемещение центров вулканизма из районов ранних извержений к окраинам вулканических областей. При этом отдельные рифтовые впадины являются примером локально выраженного многоэтапного вулканизма (Тункинская впадина).

Установлена зависимость между степенью растяжения литосферы, объемом излившихся лав и их химизмом. Для этапа максимальной продуктивности вулканизма характерны трещинные излияния умереннощелочных пород вплоть до толеитовых в областях максимального растяжения. Щелочные и сильнощелочные базальтовые породы типичны для этапа резкого уменьшения вулканической активности. Эта петрохимическая направленность базальтов от умереннощелочных к щелочным может косвенно указывать на углубление уровней магмообразования в связи с охлаждением литотермальной системы под БРЗ и уменьшением растягивающих напряжений в литосфере.

Вулканизм БРЗ и других внутренних районов Центральной и Восточной Азии является следствием не только региональных глубинных процессов под вулканическими ареалами, обусловленных появлением высоконагретой аномальной мантии и ее подъемом, но и глобальных, связанных с изменением кинематики литосферных плит.

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DEFORMATION IN SALT TECTONIC AND THEIR ORIGIN

Buckle folding, forced folding and faults are developed in salt tectonic structures. Lineation, vergence, form variety as well as irregularity of distribution of folds contraction degree along deposit area and absence of tectonic shortening are characteristic features of the buckle folding in Upper-Kamian, Kalush-Golinsk, Verra-Fulda and other deposits. According to the amount of annual layers cut by an angular unconformity surface, the duration of microfolds formation is less than 3-4 years and for larger ones 20-25 years. Buckle folds do not include flow textures of mineral grains with clay interlayers boundinage. They are formed at the present of elastic deformations taking place at the stage of diagenesis. This folding is called as condiagenetic one. Plastic deformations are common in salt thick series and plugs. The amplitude of flow folds is measured in tens and hundreds of metres. These folds consist of salt rock flow texture. Initial petrostatic loads causing plastic deformation equal to 15 kg/cm^2 (Solikamsk depression) and 100-150 kg/cm^2 (Pripiat fault trough). Faults crossing salt rock layers tell about fracture deformations of salt rock (Starobinsk deposit). Buckle folding and faults are formed under the influence of regional tectonic stresses which are relatively "momentary" while long gravitational stresses determine forced folding.

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ДЕФОРМАЦИИ В СОЛЯНОЙ ТЕКТОНИКЕ И ИХ ПРОИСХОЖДЕНИЕ

В соляных тектонических структурах развита складчатость продольного сжатия, складчатость нагнетания и разрывные нарушения. На Верхнекамском, Калуш-Голынском, Верра-Фульда и других месторождениях складчатость характеризуется линейностью, вергентностью и разнообразием форм, а также неравномерностью распределения степени сжатия складок по площади месторождений и отсутствием складчатого сокращения. По количеству годовых слоев, срезанных поверхностью углового несогласия, длительность образования микроскладок составляет менее 3-4 лет, а более крупных -20-25 лет. Складки продольного сжатия не содержат структур течения зерен минералов при явном будинаже глинистых прослоев. Они образуются при упругих деформациях, протекающих в стадию диагенеза. Такая складчатость называется кондиагенетической.

В соляных массивах и штоках распространены пластические деформации. Амплитуда складок течения измеряется десятками и сотнями метров. Эти складки сложены каменной солью флюидальной структуры. Начальные петростатические нагрузки, вызывающие пластическую деформацию, составляют 15 кг/см^2 (Соликамская впадина) и 100-150 кг/см^2 (Припятский прогиб).
Разрывные нарушения, пересекающие пласты каменной соли, свидетельствуют о хрупких деформациях каменной соли (Старобинское месторождение). Складчатость продольного сжатия и разрывные нарушения формируются под воздействием региональных относительно "мгновенных" тектонических напряжений, а складчатость нагнетания - длительных гравитационных напряжений.

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HORIZONTAL SQUEEZING-OUT AT FOLDED BELTS COMPRESSION

At horizontal compression of the folded orogenic belts, the deformed substance may be squeezed out not only vertically up (vertical squeezing-out succeeded by deep-seated thrusts, the "main" longitudinal folded structures and orogen as it is) but also horizontally along the belt (horizontal squeezing-out). The necessary condition for stimulation of the latter process is irregular distribution along folded belt of horizontal compression, which reaches its maximum in the forehead part of provoking deformation block-presses, and its minimum in the intervals between them. Significant role in the choice of this or that squeezing-out direction is also played by lythostatic load, which gradually grows in the orogenesis, and that is why it slows down mountain growth.
The tectonic accumulation of rock masses in the least compression places ("geodynamic shelters") resultes in specific structural paragenesis, represented by deep - seated wrench faults, cross folded zones, widenings of orogenic belts and structural arcs, related to them. These structural elements are rather various, but have the following obligatory peculiarities: location in the intervals between syntaxises, paragenetic connection of the compression structures with wrench faults, arc-line form of folded zones and comparatively late time of formation (orogenic stage, especially its late phase).
The classical area of horizontal squeezing-out processes is the eastern part of the Mediterranean orogenic belt formed as a result of collision between Eurasia and some isolated microcontinents. Horizontal squeezing-out of deposits from the places of maximum compression (Caucasian, Kopetdagian, Pamirian syntaxises) led to formation of East-Black-sea, South-Caspian and Afghanian-Tadjik submeridional

cross fold zones. They are gradually curved in the direction of the substance flow. One can suppose that a horizontal squeezing-out of a larger scale determined the advancing of the Zagros - Sulejmanian structural arc towards the Indian ocean in the "gap" between Aravian and Indostan microcontinents.

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ГОРИЗОНТАЛЬНОЕ ВЫДАВЛИВАНИЕ ПРИ СЖАТИИ СКЛАДЧАТЫХ ПОЯСОВ

При горизонтальном сжатии складчатых орогенических поясов деформируемый материал может выжиматься не только по вертикали вверх (вертикальное выдавливание, сопровождающееся формированием глубинных надвигов,"главной" продольной складчатости и самого орогена), но и по горизонтали вдоль пояса (горизонтальное выдавливание). Необходимое условие для возникновения последнего процесса - неравномерность распределения вдоль складчатого пояса горизонтального сжатия, наибольшего в лобовой части вызывающих деформацию изолированных блоков-штампов и наименьшего в промежутках между ними. Существенную роль в выборе того или иного направления выдавливания играет и литостатическая нагрузка, постепенно возрастающая в процессе орогенеза и поэтому затормаживающая рост гор.

В результате тектонической аккумуляции горных масс в местах наименьшего сжатия ("геодинамических убежищах") формируется своеобразный структурный парагенезис, представленный глубинными сдвигами, зонами поперечных к общему структурному плану складок, а также раздувами орогенических поясов и связанными с ними структурными дугами. Эти структурные элементы весьма разнообразны, но имеют следующие непременные особенности: расположение в промежутках между синтаксисами, парагенетическая связь структур сжатия со сдвигами и дугообразная форма складчатых зон, относительно позднее время формирования (орогенный этап, особенно его поздняя стадия).

Классический район проявления процессов горизонтального выдавливания - восточная часть Средиземноморского орогенического пояса, сформированная в результате столкновения Евразии с несколькими изолированными микроконтинентами. Горизонтальное выдавливание осадков из мест наибольшего сжатия (Кавказский, Копетдагский, Памирский синтаксисы) привело к формированию Восточно-Черноморской, Южно-Каспийской и Афгано-Таджикской зон поперечных субмеридиональных складок, плавно изогнутых в сторону течения материала. Можно полагать, что горизонтальным выдавливанием более крупного масштаба вызвано выдвигание Загросско-Сулеймановой структурной дуги к Индийскому океану, в "проем" между Аравийским и Индостанским микроконтинентами.

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SHEETED COMPLEX AND PILLOW LAVAS OF OPHIOLITES AND THEIR STRUCTURAL-MORPHOLOGICAL INTERRELATION IN THE BAYAN-KHONGOR ZONE OF MONGOLIA

The Vend-Cambrian (?) ophiolitic association of the Bayan-Khongor zone of Mongolia stands comparison with typical ophiolites in the set of its rocks and their interrelation, as well as in the petrochemical evidence. The section of ophiolites shows the zone of pillows underlain by a zone of a continuous 0,5 km thick sheeted complex. Dykes of the set cease tobe parallel where screen pillow appear up-section and screen gabbro down-section. The dyke set has two types of dykes, plagiophyric and aphyric dolerites. The dykes are feeders of the basalts which also feature two types of pillow, plagiophyric and aphyric. Geological evidence and petrochemical parameters prove complete identity of lavas and dykes within each type of rocks. Hyaloclastic breccias formed near the mouth of dykes, as well as their extensive accumulations (up to 50 m) in lower parts of lava sheets, point to powerful gas release during submarine eruptions. The structure of hyaloclastic interlayers, their structural-morphological relations and transitions from dykes to pillow suggest they resulted from recurrent submarine "pulverization". Together with aphyric dolerites and basalts with typically tholeitic trend, the dykes and pillow of plagiophyric type were also recorded there which are enriched in plagioclase. This may be attributed to crystallization differentiation which must have taken place under the long-term opening of the upper cover of the magmatic chamber and caused by a certain "retention" of magmatic melt in it as a result of the changed rate of spreading.

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ПАРАЛЛЕЛЬНЫЕ ДАЙКИ И ПОДУШЕЧНЫЕ ЛАВЫ ОФИОЛИТОВ И ИХ СТРУКТУРНО-МОРФОЛОГИЧЕСКИЕ ВЗАИМООТНОШЕНИЯ В БАЯН-ХОНГОРСКОЙ ЗОНЕ МОНГОЛИИ

Венд-кембрийская (?) офиолитовая ассоциация Баян-Хонгорской зоны Монголии по набору слагающих ее пород и их взаимоотношениям, а также по петрохимическим данным хорошо сопоставима с типичными офиолитами. В разрезе офиолитов под зоной подушечных базальтов расположена зона сплошных параллельных даек мощностью 0,5 км. Их параллельность утрачивается выше с появлением междайковых лав и ниже , с появлением междайкового габбро. Комплекс даек сложен дайками двух типов - плагиофировых и афировых долеритов, где последние всегда позднее. Дайки являются подводящими каналами для базальтов, среди

которых также выделяются два типа подушечных лав - плагиофировых и афировых. Геологические особенности и петрохимические параметры подтверждают полную идентичность лав и даек внутри каждого типа пород. Гиалокластитовые брекчии, образованные в приустьевых частях даек, и их мощные (до 50 м) скопления в нижних частях покровов лав свидетельствуют о значительном выделении газов при подводных извержениях. Строение гиалокластитовых прослоев и их структурно-морфологические соотношения и взаимные переходы от даек к подушечным лавам позволяют предполагать их образование в результате неоднократно повторяющейся подводной "пульверизации". Появление кроме афировых долеритов и базальтов, характеризующихся типичным толеитовым трендом, еще даек и лав плагиофировых, обогащенных плагиоклазом, может быть объяснено процессом кристаллизационной дифференциации. Последний протекал, вероятно, в условиях длительного раскрытия верхней оболочки очага и был вызван некоторой "задержкой" магматического расплава в нем в результате изменения скорости спрединга.

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THE OPHIOLITES OF THE EASTERN SLOPE OF THE SOUTH URALS

It was established that in the Paleozoic period the oceanic crust in the Urals began to build up in the Lateordovician as the continental blocks were moving apart (Peive, Ivanov et al., 1977). It was formed during the Silurian-Earlydevonian period (the oceanic basalts of the Poljakovskaja formations and the base of the Karamalitaschskaja one).

As in the other eugeosynclines of the world the oceanic crust has here the trinominal construction: ultramafites and the products of metamorphism, gabbro and amphibolites, the tholeitic basalts with the complex of parallel dykes at the base and the layers of siliceous and siliceous-argillaceous sediments at the top. There is a specific feature of the ophiolites of the eastern slope of the Urals: the section of the oceanic crust is here locally completed by sodium rhyolites and dacites in association with sodium basalts forming the contrasting Baimak-Buribaiskaja and Karamalitaschskaja formations, that is not observed in the modern oceans.

The main problem of the ultramafites is that there is no common view about the age and place in the history of the Earth's crust formation. We suggest to consider the nature of ultramafites as the component of ophiolite section. The ultramafites are observed usually at the base of the ophiolite association. As the rocks they can be moved into the higher horizons of the formed Earth's

crust by different processes including protrusions. Therefore the geological correlations of ultramafites with other complexes mean very little about their age. And the time of appearance of tholeiitic basalts is the time of origion of rostite of ultramafic composition, therefore the dating of siliceous sediments according the organism relics allow to judge about the age of not only the tholeiitic pillow lavas but also of the ultramafites, that are combined with them spatially, that is about the age of the whole ophiolitic association. The necessity of taking into account charriers and other possible tectonic manifestations that often disturb the relations of the considered complexes is quite natural.

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ОФИОЛИТЫ ВОСТОЧНОГО СКЛОНА ЮЖНОГО УРАЛА

Установлено, что на Урале в палеозойское время океаническая кора начала формироваться в позднем ордовике по мере раздвигания палеоконтинентальных блоков (Пейве, Иванов и др., 1977) и образовалась в течение силурийско-раннедевонского времени (океанические базальты поляковской и низов карамалыташской формаций).

Как и в других эвгеосинклиналях мира, океаническая кора здесь имеет трехчленное строение: гипербазиты и продукты метаморфизма, габбро и амфиболиты, толеитовые базальты с комплексом параллельных даек в основании и прослоями кремнистых и кремнисто-глинистых осадков вверху. Есть и специфика офиолитов на восточном склоне Урала, заключающаяся в том, что разрез океанической коры здесь местами завершается натриевыми риолитами и дацитами в ассоциации с натриевыми базальтами, образующими контрастные баймак-бурибайскую и карамалыташскую формации, чего не наблюдается в современных океанах.

Основная проблема гипербазитов состоит в том, что нет единого взгляда на их возраст и место в истории формирования земной коры. Предлагаем рассматривать природу гипербазитов как составную часть офиолитового разреза. Гипербазиты обычно находятся в основании офиолитовой ассоциации и в более высокие горизонты сформировавшейся земной коры могут как породы выводиться различными процессами, в том числе и в виде протрузий. Поэтому геологические соотношения гипербазитов с другими комплексами мало что говорят об их возрасте. Вместе с тем время появления толеитовых базальтов является и временем рождения рестита гипербазитового состава, поэтому датировка кремнистых осадков по остаткам организмов позволяет судить о возрасте не только толеитовых подушечных лав, но и гипербазитов, которые пространственно с ними совмещены, т.е. о возрасте всей офиолитовой ассоциации. При

этом естественна необходимость учета шарьяжей и других возможных проявлений тектоники, которые часто нарушают взаимоотношения рассматриваемых комплексов.

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LATERAL ZONALITY OF PERMIAN SEDIMENTARY AND VOLCANIC FORMATIONS OF CENTRAL KAZAKHSTAN

Lateral zonality of Permian geological formations of Central Kazakhstan testifies the geodynamic situation of active continental margin districts. The following tectonic stages stand out: the first - heritable geodynamic zones of carbon completed in early Permian formation, and the second characterized by further development of the first early Permian beginning of trias. The succession of geodynamic zones and the formations occur from preoceanic parts in Northern Djungary towards the rear parts in the West and North-East Central Kazakhstan. For the first stage the following zones are alloted: 1. North Djungarian - terrigeno-flinty formation of the continental declivity; 2. North Balkhash - molasse of external nonvulcanic arc; 3. Sajak - greycoloured sea molasse inter-arc trough; 4. Balkhash-Jli district volcanic belt - orogeny vulcano-plutonic formation of lime-alkali composition; 5. Djezkazghan, Teniz and Jrtysh neighbouring rear depressions with redcoloured terrigenous formations including evaporators - in the first, terrigenous redcoloured series - in the second and greycoloured terrigenous and coal-bearing - in the third. In the second stage occurs a tectonic "pilling-up" in the sea basins of inter-arc trough and the continental declivity with their subsequent inclusion into the vulcanic belt, but with a weak magmatic activity of the natric row. The magmatic processes intensify, alkalinity and potash increase in the zone of the vulcanic belt of the previous stage. In the rear zone heritage the stipulations of the first stage, but the following specific peculiarities were manifested: replacement of terrigenous redcoloured formation by greycoloured clay-carbonate with preservation of evaporators in the bottoms of the pit with the absence of connections of the lake basin with the sea - in the Djezkazghan depression; continuation of accumulation of redcoloured terrigenous thicknesses but with the thinning of disintegrated rock formations in the pit and intensification of particoloured rocks - in the Teniz depression and the replacement of the greycoloured terrigenous and coal-bearing formations by the redcoloured terrigenous one - in the Irtysh neighbouring depression.

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ЛАТЕРАЛЬНАЯ ЗОНАЛЬНОСТЬ ПЕРМСКИХ ОСАДОЧНЫХ И ВУЛКАНОГЕННЫХ ОБРАЗОВАНИЙ ЦЕНТРАЛЬНОГО КАЗАХСТАНА

Латеральная зональность пермских геологических формаций Центрального Казахстана свидетельствует о геодинамической обстановке активной континентальной окраины. Выделяются тектонические этапы: первый, наследующий геодинамические зоны карбона, окончившийся в ранней перми, и второй, характеризующийся дальнейшим развитием первого - ранняя пермь - начало триаса. Смена геодинамических зон и формаций происходит от приокеанической части в Северной Джунгарии к тыловым частям на западе и северо-востоке Центрального Казахстана. Для первого выделяются зоны: I) Северо-Джунгарская - терригенно-кремнистая формация континентального склона; 2) Северо-Балхашская - молассовая внешней вулканической дуги; 3) Саякская - сероцветная морская моласса междугового прогиба; 4) Балхаш-Илийский краевой вулканический пояс - орогенная вулкано-плутоническая формация известково-щелочного состава; 5) Джезказганская, Тенизская и Прирташская тыловые впадины с красноцветной терригенной формацией, включающей эвапориты, в первой, терригенными красноцветными толщами во второй и сероцветными терригенными и угленосными в третьей. Во втором этапе происходит тектоническое"скучивание" в морских бассейнах междугового прогиба и континентального склона с последующим включением их в вулканический пояс, но со слабой магматической активностью натрового ряда.

В зоне вулканического пояса предыдущего этапа усиливаются магматические процессы, возрастает щелочность и калиевость. В тыловой зоне наследуются условия первого этапа, но проявляются специфические особенности: смена терригенной красноцветной формации сероцветной глинисто-карбонатной с сохранением в низах разреза эвапоритов при отсутствии связей озерного бассейна с морем в Джезказганской впадине; продолжение накопления красноцветных терригенных толщ, но с утонением обломочного материала в разрезе и усилением пестроцветности пород в Тенизской впадине и смена сероцветных терригенных и угленосных формаций красноцветной терригенной в Прирртышской впадине.

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PRESENCE OF A NEOAUTOCHTHONOUS SUPERSTRUCTURE IN A PART OF CENTRAL CUBA (CIEGO DE AVILA - CAMAGUEY)

During the Campanian, as a result of an intensive tectogenesis, the pre-existing structural-facial zones lost their individuality. After obduction and thrusting of the former island arc over the continental margin of the Bahama microplate towards north, they were welded together into an unique mass with complicated internal structure. Over the allochthone of the former island arc (zone Zaza) a number of new tectofacial environments with neoautochthone character have been created in situ from the Campanian to recent times. An early (Upper Campanian - Eocene) and a late (Oligocene - Quaternary) neoautochthones are distinguished. They correspond to two stages of structure formation, respectively transitional-continental and continental. The chronostratigraphic range of the formations building the early neoautochthone is different in the separate localities. The basins had a subequatorial strike, and a character of shelf and continental slope. The structures during this stage were formed as a result of the Laramide, Illyrian and Pyrenean phases, and were relatively independent on the earlier structural plans. The folds are mainly brachyform and with a northern vergence. Some faults were synkinematically formed with them. Low-amplitude thrusting took place again along the faults Cubitas and Camajuani during the Illyrian phase. The crust shortening was unimportant. The transversal faults La Trocha and Camaguey had caused the formation of megablocks which behaved in a different manner during the sedimentation and structure forming processes. The late neoautochthone is characterized by formation of superimposed depressions with irregular orientation and different filling.

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PRINCIPLES OF TECTONIC ZONATION AND DESCRIPTION OF STRUCTURAL ELEMENTS ON THE TECTONIC MAPS

1. Tectonic mapping includes two procedures: a) tectonic zonation (apportionment of structural elements) and b) description of structural elements.
2. Tectonic zonation consists of the breaking up of mapped space. Mapped space as a whole is divided into structural elements of the

first rank. Perhaps, tectonic zonation of all or some structural elements of the first rank with apportionment of structural elements of the second rank can be conducted. In the tectonic maps structural elements are apportioned up to four ranks; however, zonation is more often limited to two or three ranks.

3. In tectonic zonation the principles of specialization and proportionality are observed. In accordance with the principle of specialization the apportionment of structural elements in the limits of the entire map, but of structural elements 2(3,4) rank in the limits of the structural element 1(2,3) rank is carried out according to one and the same indication or according to a fixed list of indications. By observing the principle of specialization a tectonic map is a model, containing the basis for a comparative analysis and prognosis. If the principle of specialization is not observed, such possibilities are excluded, and the effectiveness of the map is diminished. The principle of proportionality is expressed in the apportionment of elements within the bounds of a limited scale of its sizes, selected so that the structural elements are comparable in sizes. In the event of an excessively large scale of sizes (e.g. geosyncline system and intrusive body or saline plug) a comparative analysis makes little sense.

4. A description of structural elements can be realized by depicting the form of geological bodies as iso-pachous line or structure contour, by introduction of outermodel signs for the bodies (intrusions) lying beyond the lower limit of the scale of sizes; by depiction of the geophysical anomalies, volcanoes etc. The principle of homogeneous description should be observed, because it is necessary for comparative analysis of structure elements.

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ПРИНЦИПЫ ТЕКТОНИЧЕСКОГО РАЙОНИРОВАНИЯ И ОПИСАНИЕ СТРУКТУРНЫХ ЭЛЕМЕНТОВ НА ТЕКТОНИЧЕСКИХ КАРТАХ

I. Тектоническое картирование включает в себя две процедуры: а) тектоническое районирование (выделение структурных элементов) и б) описание структурных элементов.

2. Тектоническое районирование представляет разбиение картируемого пространства. Картируемое пространство в целом разделяется на структурные элементы I ранга. Может быть проведено тектоническое районирование всех или нескольких структурных элементов I ранга с выделением структурных элементов II ранга. На тектонических картах выделяется до четырех рангов структурных элементов, однако чаще районирование ограничивается двумя или тремя рангами.

3. При тектоническом районировании соблюдаются принципы специализации и соразмерности. В соответствии с принципом специализации выделение структурных элементов в пределах всей карты, а структурных элементов 2(3,4) ранга в пределах структурного элемента I(2,3) ранга проводится по одному и тому же признаку или по фиксированному списку признаков. При соблюдении принципа специализации тектоническая карта представляет модель, содержащую основу для сравнительного анализа и прогнозов. При несоблюдении принципа специализации такие возможности исключаются, а эффективность карты снижается. Принцип соразмерности выражается в выделении структурных элементов в пределах ограниченного диапазона их размеров, выбранного так, чтобы структурные элементы были бы сравнимы по размерам. При слишком большом диапазоне размеров (например, геосинклинальная система и интрузивное тело или соляной купол) сравнительный анализ теряет смысл.
4. Описание структурных элементов может осуществляться путем изображения форм геологических тел изопахитами или стратоизогипсами, введения внемодельных знаков для тел (включений), лежащих за нижним пределом принятого диапазона размеров, изображения геофизических аномалий, вулканов и т.д. Должен соблюдаться принцип однородности описания, что необходимо для сравнительного анализа структурных элементов.

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SHALLOW, NEAR-SURFACE AND INDUCED STYLES OF TECTONICS IN SOME ALPINE FOLD MOUNTAINS FORMED ON THE PASSIVE MARGIN OF EUROPEAN CONTINENT

In many Alpine fold mountains (Carpathians, external Alps, Provence, Languedoc) a special type of fold and nappe structures has been observed, suggesting a shallow, near surface conditions of deformations. Shear surfaces of overthrusts become shallower in direction of thrusting and finally they appear on the tectonic-paleorelief surfaces. This is a free-style folding and thrusting, developed close to the surface. Independently of this, the loading under the partial nappes was considerable, resulting several induced deformations, such as large uptorn synclinal folds and stretch folds. These last deformations permit to recognise the vergence of folding and thrusting. The tectonic transport in individual tectonic-facies zones has been caused by basement movement and tangential stresses. The gravitational factor could have been

of some importance in the case of basement depressions and slopes of elevations. All these deformations developed on the passive margin of European continent and are directed toward the continent.

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GLOBAL SYSTEM OF GEOBLOCKS

The regularities of distribution of deep and surface hererogeneities of the Earth are revealed when analyzing the whole planet. From a position of geoblock conception of the lithosphere structure there are established the individual peculiarities of geoblocks and interblocks joints and also their combinations forming the recent block (cell) pattern of the Earth. The geoblocks are the large regional structures having the typical features of lithogenesis, magmatism and metamorphism and type set of mineragenic zones (Krasny, 1967).

There are distinguished the following geoblocks: 1. Cratonic: a) high standing -Greenlandia, Superior, Central-Brazilia, Dnieper, South-Africa, Hindustan, West-Australia etc.-in all 23; b) lower standing -Mississippi, Moscow-Mezen, Sahara etc. -in all 13; c) trap -Tungusska and Parana; 2. Sedimentogenic (plates of young platforms)-Turanian, West-Siberian, Sverdrup, Chako etc.-in all 18; 3. Geosynclinal-block -Iberian, Kazakchstan, Altai-Sayany, Alaska etc.-in all 11; 4. High-mobile, differentiated marginal and inter-continental -Okhotsk, Nippon, Philippin, Caribbean etc.-in all 13; 5. Ocean: a) with the fragments of the continental crust -Amerasia, Rokoll, Aguľyas, South-Western (Pacific ocean) etc.-in all 5; b) with the ocean lands (olends) -North-Western and Karolina (Pacific ocean); c) proper ocean basaltoid -South (Pacific ocean), Central-Indoocean etc. -in all 14; d) spreding - North-Eastern (Pacific ocean), Euroasia, Tasmanov, Galapagoss, etc.-in all 7.

There are usually established lateral boundary intergeoblock systems: A) Metamorphogenic, magmatogenic and magmatogenic-sedimentogenic -Albani-Frazer, Dagomea-Carussian, Mongolia-Okhotsk, Zagros, Himalaya etc. B) Sedimentogenic -Adelaida, Sette-Daban, Mackenzie -the Rocky Mountains etc. C) Regmatogenic "andesite-riolite" Okhotsk-Chukotka, "andesite" Kuril-Kamchatka, Marian, "basaltic" Imperial mountains etc. In the stabilization of geoblocks the leading role belongs to the following events: a) which took place during the formation of the Earth as geological body (accretion and meteorite bombarding), b) which completed nuclear formation of structure in the Early Proterozoic; c) which created neogenetic young platforms, areas of marginal seas and autonomic mantle-crust cells or ocean.

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ГЛОБАЛЬНАЯ СИСТЕМА ГЕОБЛОКОВ

Закономерности распределения глубинных и повеохностных неоднородностей Земли раскрываются при анализе всей планеты. С позиций геоблоковой концепции строения литосферы устанавливаются как индивидуальные особенности геоблоков и межгеоблоковых сочленений,так и их сочетания, образующие современный глыбовый(ячеистый) узор Земли. Геоблоки -крупные региональные структуры,обладающие характерными чертами литогенеза, магматизма и метаморфизма и набором минерагенических зон (Красный, 1967).

Различаются геоблоки:1.Кратонные:а)высокого стояния-Гренландский, Сьюпериор,Центрально-Бразильский,Днепровский,Южно-Африканский,Индостанский,Западно-Австралийский и др.-всего 23; б)низкого стояния-Миссисипский,Московско-Мезенский,Сахарский и др.-всего 13;в)трапповые Тунгусский и Парана,2.Седиментогенные(плиты молодых платформ)-Туранский,Западно-Сибирский,Свердрупа,Чако и др.-всего18.3.Геосинклинально-глыбовые - Иберийский,Казахстанский,Алтае-Саянский,Аляскинский и др.-всего 11, 4.Высокоподвижные дифференцированные окраинно-и межматериковые- Охотский,Ниппонский,Филиппинский,Карибский и др.-всего 13 5.Океанские:а)с фрагментами континентальной коры -Амеразийский,Рокколл,Агульяс,Юго-Западный(Тихий океан) и др.-всего 5; б)с океанскими землями(олендами)- Северо-Западный и Каролинский(Тихий океан),Саргассов и др.-всего 7; в) собственно океанские базальтоидные -Южный (Тихий океан),Центрально-Индоокеанский и др.-всего 14;г)спрединговые Северо-Восточный (Тихий Океан), Евразийский,Тасманов,Галапагосский и др.-всего 7.

Выделяются обычно полигенетические латеральные граничные межгеоблоковые системы: А.Метаморфогенные,магматогенные и магматогенно-седиментогенные- Албани-Фрэзер,Дагомейско-Фарузианская,Монголо-Охотская, Загрос,Гималайская и др. Б.Седиментогенные -Аделаида,Сетте-Дабан, Маккензи-Скалистых гор и др. В.Регматогенные андезито-риолитовые - Охотско-Чукотская; андезитовые - Курило-Камчатская,Марианская;"базальтовые" -Императорских гор и др.

В становлении геоблоков первенствующую роль играли события:а) происходившие на заре становления Земли как геологического тела(аккреция и метеоритная бомбардировка);б)завершающие нуклеарное структурообразование в раннем протерозое;в)создавшие новообразованные молодые платформы,области краевых морей и автономные мантийно-коровые ячейки океана.

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GEOLOGY AND GEOPHYSICS OF THE KURIL-KAMCHATKA ISLAND SYSTEM

The results of geological and geophysical studies that were carried out by scientists of the Sakhalin Complex Research Institute, FESC, USSR AS, for over a quarter of century and most intensively during the last 10 years have been systematised in the "Geologo-Geophysical Atlas of the Kuril-Kamchatka Island System". These results have been complemented with geologo-geophysical data obtained in different years by other USSR institutions and by foreign (USA, Japan) scientists. In addition to the Kuril and Komandorsky island arc areas proper, the mapped area involves a vast area of the sea of Okhotsk, part of the Bering Sea and the Pacific Ocean. It involves such large morphostructures as the Kuril Deep-Sea Basin, the USSR Academy of Sciences and the Institute of Oceanology Rises, the West Kamchatka, Sakhalin and Hokkaido shelves, the Kuril-Kamchatka trench and the western part of the Aleutian Trench, the Zenkevich Marginal Oceanic Swell, the Obruchev Undersea Rise and a part of the Pacific Ocean bed.

The Atlas consists of a number of chapters that summarise the results of the main trends of modern geological science such as geomorphology and geologic structure, natural geophysical fields, crustal structure from seismic data, island arc dynamic features such as recent crustal movements, volcanism, seismicity, tsunamis. The data presented in the Atlas do not make it possible to support the idea of subduction of oceanic lithospheric plates under island arcs as is strongly suggested by the "new global tectonics" concept, although there can hardly by any doubt as to the existence of the phenomen of horizontal compression of the oceanic and continental lithospheric plates in island system areas.

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ГЕОЛОГИЯ И ГЕОФИЗИКА КУРИЛО-КАМЧАТСКОЙ ОСТРОВНОЙ СИСТЕМЫ

Результаты геолого-геофизических исследований, которые выполнялись учеными СахКНИИ ДВНЦ АН СССР на протяжении более четверти века и наиболее интенсивно в течение последних IO лет, систематизированы в "Геолого-геофизическом Атласе Курило-Камчатской островной системы". Они дополнены геолого-геофизическими материалами, в разные годы полученными другими организациями и учреждениями СССР, а также зарубежных стран (США, Япония). В рамки картосоставительных работ, кроме непосредственно островной суши Курильской и Командорской островных гряд, включены обширные акватории Охотского, частично Берингова моря и Тихого океана. Сюда вошли такие крупные морфоструктуры, как Курильская глубоководная котловина, подводные возвышенности Академии наук СССР, Океанологии, шельфы Западной Камчатки, Сахалина и Хоккайдо, Курило-Камчатский и западная часть Алеутского глубоководных желобов, краевой океанический вал Зенкевича, подводная возвышенность Обручева и частично ложе Тихого океана. Атлас представлен серией разделов, обобщающих результаты основных направлений в области современной геологической науки: геоморфология и геологическое строение, естественные геофизические поля, строение земной коры по сейсмическим данным, динамические особенности островной системы, такие, как современные движения земной коры, вулканизм, сейсмичность, явления цунами. Изложенные в Атласе материалы не позволяют поддержать идею субдукции океанических литосферных плит под островные дуги, как это с большой определенностью предполагает концепция "новой глобальной тектоники", хотя наличие явления горизонтального сдавливания океанической и континентальной литосферных плит в районах островных систем вряд ли может ставиться под сомнение.

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MAIN FEATURES OF DENSITY MODELS FOR TECTONIC UNITS OF CONTINENTAL TYPE

Gravitational modelling and analysis of the main features of density models are completed for various tectonic units of the continental type in different regions of the globe. The main features are the following. The earth crust, including the crust-to-mantle transition zone, is characterized by density increase with depth, the gradient varying both from layer to layer and with depth. Density mo-

dels of large tectonic units meet the requirement of isostatic compensation due to variations of both crustal thickness and density of rocks; isostatic equilibrium is achieved in layers of low viscosity both in the upper mantle (the asthenosphere) and in the earth crust (but not at the M discontinuity). In platforms, crustal thickness is generally large, whereas densities of consolidated rocks are generally low. Depressions always have the consolidated crust of a smaller thickness, often with concomitant density increase and uplift of the M discontinuity. The vaulted parts of riftogenic structures and areas of tectonic activation are characterized by a decrease of the consolidated crust thickness; here, the existence of the "crust-mantle mix", uplift of the asthenosphere, graben structure and magmatic bodies are established. Orogenes have low average densities of the consolidated crust with the M surface sinking; "mountain roots" are displaced towards the density blocks. Analysis of the features of density models shows that formation and evolution of tectonic units are strongly influenced by physical and chemical transformations due to processes of gravitational fractionation of the matter in the gravity field of the Earth, with separate structure units tending to the state of isostatic equilibrium.

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ОСНОВНЫЕ ЗАКОНОМЕРНОСТИ ПЛОТНОСТНЫХ МОДЕЛЕЙ ТЕКТОНИЧЕСКИХ СТРУКТУР КОНТИНЕНТАЛЬНОГО ТИПА

Выполнено гравитационное моделирование, проведен анализ и рассмотрены основные закономерности плотностных моделей различных тектонических структур континентов разных регионов Земли. Закономерности сводятся к следующему. Земная кора, в том числе и зона перехода к верхней мантии, характеризуется градиентно-слоистым нарастанием плотности с глубиной. Плотностные модели крупных тектонических структур хорошо удовлетворяют требованиям изостатической компенсации, осуществляемой изменениями мощности коры и плотности пород; изостатическое равновесие устанавливается на слоях пониженной вязкости как в верхней мантии (астеносфера), так и в земной коре, но не на разделе Мохоровичича. Платформы характеризуются увеличением мощности земной коры при уменьшении средней плотности. Впадинам всегда соответствует сокращение мощности консолидированной коры, часто сопровождаемое ее уплотнением и подъемом раздела Мохо. Сводовые поднятия рифтогенных структур и областей тектонической активизации также характеризуются уменьшением мощности консолидированной коры, но здесь отмечаются "коро-мантийная" смесь, подъем астеносферы, грабеновые структуры и

магматические тела. Орогены обладают пониженной средней плотностью коры при погружении раздела Мохо; "корни гор" смещаются под блоки наибольшей плотности. Анализ закономерностей плотностных моделей свидетельствует, что на образование и развитие тектонических структур решающее влияние оказывают физико-химические преобразования вследствие процессов гравитационной дифференциации вещества в поле силы тяжести Земли при стремлении отдельных структур к состоянию изостатического равновесия.

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IMPORTANCE OF BOUDINAGE IN THE ANALYSIS OF FOLDED STRUCTURES AND RUPTURE DISPLACEMENTS

Boudinage bears significant imformation concerning conditions of deformation of stratified formations. It originates in the environment with a differential movement of the substance and obtains asymmetrical forms. A close spatial connection of these forms with folds and rupture displacements, in which boudinage comes into being, permits to reconstruct stratigraphy of bedded formations as well as to define the type of folds, their position in space, direction of displacement of wings of rupture displacements and spatial position of displacement surface. Twenty eight forms of asymmetrical boudinage are analysed along with their particular features and genesis. Recommendations are given for mapping of barren strata. Particular attention has been given to new genetic types of boudinage and its relations with cleavage and drag folds.
The importance of boudinage is that it is associated with a great number of different deposits of useful minerals. It affects a distribution and forms of individual ore bodies, deposits and ore fields.
Data from studies of some regions of the Soviet Union and in particular Siberia are given in the work.

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ЗНАЧЕНИЕ БУДИНАЖА ПРИ АНАЛИЗЕ СКЛАДЧАТЫХ СТРУКТУР И РАЗРЫВНЫХ СМЕЩЕНИЙ

Будинаж несет большую информацию об условиях деформации слоистых толщ. Возникая в среде с дифференциальным движением вещества, будинаж приобретает асимметричные формы. Тесная пространст-

венная связь этих форм со складками и разрывными смещениями, в которых будинаж образуется, позволяет восстанавливать стратиграфию слоистых толщ, определить тип складок, их положение в пространстве, направление перемещения крыльев разрывных смещений и пространственное положение сместителя.
В докладе анализируются 28 форм асимметричного будинажа, подчеркиваются их отличительные особенности и генезис, даются практические рекомендации по их использованию при картировании немых толщ. Особое внимание уделено новым генетическим типам будинажа и его связи с кливажем и складками волочения. Значение будинажа заключается еще и в том, что с ним связано большое количество разнообразных месторождений полезных ископаемых. Будинаж влияет на распределение и форму не только отдельных рудных тел, но и целых месторождений и даже рудных полей.
Сведения приводятся по результатам изучения нескольких регионов Советского Союза и особенно Сибири.

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IAPETAN RIFTS IN THE CANADIAN SHIELD

The surface of the southeastern part of the Canadian Shield is transected by two well-defined rifts: the Ottawa and Saguenay grabens. They are interpreted as remnants of the multibranched rift system which formed in the late Precambrian/early Cambrian times as a prelude to the formation of the Iapetus ocean. These rifts are deeply eroded except at their ends where they merge with the Appalachian foldbelt.

There is now a considerable body of evidence that the Ottawa graben is the failed arm which radiated from an ore triple junction, but the precise relationship of the Saguenay graben to the ancient rift system is not clear.

The shield surface in this general area is also characterized by numerous lineaments which are probably fracture controlled. The trends of these lineaments, like those of the rifts, meet the Iapetan continental margin at large angles. Together they form a distinctive pattern which probably represents a system of lateral dislocations related to the principal Iapetan rifts. At least in the case of the Ottawa graben, later reactivation has occurred.

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GEOTECTONIC MODEL OF THE DEVELOPMENT OF THE MIDDLE EUROPEAN VARISCIDES

For the Middle European variscides the model of the development of matter and structural differentiation of crust is suitable. On the example of the Czech Massif the variscides may be interpreted as the system of depressions and domes, having been developed for a long period in the Cadomian and Variscian tectonomagmatic stage in the form of paired tectonometamorphic systems. They are typical of regular space arrangement of lithological, magmatic, metamorphic, structural-tectonic and depositional-geologic phenomena. As the cause of the mobile development the long-term, in space and time irregular thermal energy output may be considered, which already in the upper Proterozoic had intruded the heterogeneous crust and in conclusion of the Variscian development the intense growth of granitic layer, crust expansion and total uplift of variscides had taken place. Brunnia is the only block of massif being concolidated by Cadomian and partly pre-Cadomian orogenesis. The tectogenic processes in the core of variscides activated it at the margins only. Due to the interaction between the accretion zones and the extensive continent the remarkable geotectonic zones in the eastern part of variscides originated. The linearly oriented zone is here involved being subparallel with the margin of the ancient continent. It gradually desintegrated along the deep faults into a mosaic of blocks which had been differentially regenerated and activized. Its Variscian, magmatic, metamorphic and structural-tectonic development, inclusive of the origin of overthrust structure with many antivergent zones is very complex.

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TECTONIC ZONING ACCORDING TO TYPES OF CRUSTAL STRUCTURE BY THE EXAMPLE OF WESTERN EURASIA

1. The study of deep structure of Western Eurasia by seismic methods was carried out in greater detail as compared to other regions thus providing favourable conditions for tectonic zoning with allowance for peculiar features of crustal structure. The schemes of topography of the base of the Earth crust (HM), of the basement surface (HF), of the thickness of the crust (M=HM-HF), the maps of boundary velocities of the named surfaces and of other geophysical parameters were compiled. The age range of sedimentary rocks fil-

ling the basement depressions was evaluated on the basis of seismic stratigraphy.
2. The geological-geophysical-geochemical (geonomical) multi-parameter space is the decisive factor for tectonic zoning. The informative value of each parameter is discussed. Two-dimensional models of the Earth crust were compiled for the basic tectonic structures of Western Eurasia which are specifically and clearly reflected in the field of some of the parameters. Three parameters describing the composition of the Earth crust, HM and HF are sufficient for the zoning of the largest tectonic structures. The values and variability of these parameters provide a contrasting characteristic of the most important tectonic types of the structures.
3. The analysis of the materials showed the necessity of introducing several corrections into modern perceptions. The boundaries of East European craton were redefined and, in particular, the classification of the Caspian depression as the young platform was justified. The contrasting difference between the paleozoids of Western Europe and of the USSR is demonstrated as also the differences between deep depressions of the Alpine region and of the young platforms. A sharp difference is established between the Earth crust of the inner regions of the West Siberian plate and that of its marginal cones and outer framing. The extensive development of the zones of mafic crust with homogeneous composition on continents is described as regularly lying at the base of depressions of the basement which were called deprogens.

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ТЕКТОНИЧЕСКОЕ РАЙОНИРОВАНИЕ ПО ТИПАМ СТРОЕНИЯ ЗЕМНОЙ КОРЫ НА ПРИМЕРЕ ЗАПАДНОЙ ЕВРАЗИИ

I. Глубинное строение Западной Евразии сейсмическими методами изучено наиболее детально по сравнению с другими регионами, что создает благоприятные предпосылки для проведения тектонического районирования с учетом особенностей строения земной коры. Составлены схемы рельефа подошвы земной коры НМ, поверхности фундамента НФ, мощностей коры М=НМ-НФ, карты граничных скоростей названных поверхностей и других геофизических параметров. На основе сейсмической стратиграфии оценен возрастной диапазон осадочных пород, выполняющих депрессии фундамента.
2. Решающее правило при выполнении тектонического районирования необходимо находить в геолого-геофизико-геохимическом геономическом многопризнаковом пространстве. Обсуждается информативность различных признаков. Построены двумерные модели земной коры для основных тектонических сооружений Западной Евразии, которые нахо-

дят отчетливое специфическое отображение в поле ряда параметров. Для районирования крупнейших тектонических структур достаточно использовать три параметра, описывающих состав земной коры, НМ и НФ. Величины и изменчивость этих параметров контрастно характеризуют важнейшие тектонотипы структур.

3. Анализ материалов показал необходимость внесения ряда корректив в существующие представления. Уточнены границы Восточно-Европейского кратона, в частности обосновано отнесение Прикаспийской впадины к молодой платформе. Показано контрастное различие палеозоид Западной Европы и СССР. Выявлены различия глубоких впадин альпийской области и молодых платформ. Установлено резкое отличие земной коры внутренних районов Западно-Сибирской плиты от ее бортовых зон и внешнего обрамления. Обосновано широкое развитие на континентах зон мафической земной коры однородного состава, закономерно располагающихся в основании депрессий фундамента и названных депрогенами.

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THE GEOCHEMISTRY OF PALEOZOIC OPHIOLITES AND THEIR PRIMARY NATURE

The sections of the Lower Paleozoic ophiolite complexes (Khantaishir and Bayankhagor) in Mongolia and the Upper Paleozoic complex (Mugodzhar) in the South Ural have been studied. The former two fix the remnants of the Asian paleoocean, the Mugodzhar complex - those of the Ural paleoocean. The ophiolite complexes occur as a series of allochthone slabs underlain by serpentinite melange. Some slabs preserved the rock blocks from which the initial ratios of the ophiolite members can be restored. In all the complexes the lower and middle parts are represented by ultrabasic and basic intrusive rocks, the upper parts by diabases. Among the latter the horizons of parallel dykes, sometimes explosive breccia and pillow lavas are distinguished. As a whole, the section is comparable with that observed in natural outcrops of recent ocean, for example, in the Hess trough (the Pacific ocean) or in the transform fracture zones. A distinctive feature of the ophiolite complex sections is the presence of explosive breccia indicating the enrichment of the parent magmas with volatiles uncommon to magmas of the recent seafloor spreading zones. The chemical compositions of ophiolites and oceanic rocks are better to compare in the example of lavas and dykes since it is rocks of the oceanic crust second layer that provide the most representative data (Wedepohl, 1981). Besides, the intrusive rocks of layered com-

plexes i.e., the third oceanic crustal layer of cumulating nature may be geochemically similar independently of the geodynamical environments of their formation. Ophiolite complex diabases are usually represented by low-potassium tholeiites. Sometimes, varieties enriched with SiO_2, K_2O and rare lithophilic elements are met. For some complexes calc-alkaline differentiation trends of diabase series are outlined. The ophiolite upper member associations are chemically most similar to the rocks of the neogenic troughs of marginal seas. The analysis undertaken shows that the ophiolite complexes preserve preferrably the remnants of former marginal seas rather than open oceanic space.

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ГЕОХИМИЯ ПАЛЕОЗОЙСКИХ ОФИОЛИТОВ И ИХ ПЕРВИЧНАЯ ПРИРОДА

Изучены разрезы нижнепалеозойских офиолитовых комплексов (хантайширский и баянхангорский) Монголии и верхнепалеозойского (мугоджарского) Южного Урала. Первые два фиксируют остатки Азиатского, а мугоджарский - Уральского палеоокеанов. Офиолитовые комплексы залегают в виде серии аллохтонных пластин, подстилаемых серпентинитовым меланжем. В некоторых пластинах сохраняются блоки пород, по которым можно восстановить первичные соотношения членов офиолитовых ассоциаций. Во всех комплексах низы и средние части разрезов представлены ультраосновными и основными интрузивными породами, а верхи - диабазами. Среди последних выделяются горизонты параллельных даек, иногда эксплозивных брекчий, а также подушечных лав. В целом разрез сопоставим с тем, который мы наблюдаем в естественных обнажениях современного океана, например во впадине Хесса (Тихий океан) или в зонах трансформных разломов. Отличительной особенностью разрезов офиолитовых комплексов является наличие эксплозивных брекчий, указывающих на обогащенность первичных магм летучими, что не свойственно магмам спрединговых зон современных океанов.

Сравнение химического состава пород офиолитов с породами океана лучше всего проводить на примере лав и даек, так как именно по породам второго слоя океанической коры имеется наиболее представительный материал (Wedepohl , 1981). Кроме того, интрузивные породы расслоенных комплексов (III слой океанической коры), имеющие комулятивную природу, могут иметь близкий геохимический состав независимо от геодинамических условий их образования. Диабазы офиолитовых комплексов обычно представлены низкокалиевыми примитивными толеитами. Иногда среди них отмечаются разности, обогащенные SiO_2, K_2O и редкими литофильными элементами. Для некоторых комплексов намечаются известково-

щелочные тренды дифференциации диабазовых серий. По химическому составу ассоциации верхних членов офиолитов наиболее близки к породам глубоководных новообразованных впадин окраинных морей. Проведенный анализ показывает, что в офиолитовых комплексах предпочтительнее сохраняются остатки прежних окраинных морей, чем открытых океанических пространств.

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GEOTECTONICS OF THE EASTERN SEA AREA OFF CHEJU ISLAND

Marine geologic structure and mechanics of faults are studies by using the results of an offshore seismic reflection survey conducted in an area between Cheju and Tsushima Islands 1970. These show the area is consisted of four middle Miocene to Pleistocene sedimentary layers overlying upper Cretaceous or Paleogene acoustic basement, and could be divided geotectonically into two regions by a boundary of 33°33' north latitude. The sediments become thicker toward Fukue basin and contain normal faults, graben structure and widespread unconformity, with interruption by tectonic activity and erosion.

Petrofabric analysis separates fault system into two groups. One has a strike of N 40°-50°E and a dip of 60°-70° SE or 60°-70° NW, which is developed throughout two regions. Another has a strike of N 10°-20°E and a dip of 60°-70° NW, which is developed only in the northern region. The former delineates stress pattern at the time of deformation such that σ_1 is compressive and vertical, σ_2 also compressive but in horizontal direction of N 40°-50°E parallel to the strike, and σ_3 tensile and in horizontal direction of N 40°-50°W normal to the strike. The latter indicates σ_1 is compressive and vertical, σ_2 compressive and in horizontal direction of N 10°-20°E, and σ_3 tensile and in horizontal direction of N 70°-80°W. Inferences from geotectonic studies suggest there were two stages of deformation, one of which covered all the area and the other only the northern region. These can be attributed to subduction of Nankai trench to yield graben structural pattern in a back-arc area.

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STRUCTURES INDICATING PREDOMINANTLY REVERSE-SLIP ON BILLEFJORDEN FAULT ZONE, NORTHERN DICKSONLAND, SPITSBERGEN

The Billefjorden fault zone is a 0.5 to 1.0 km wide zone of parallel and branching faults trending N4°W. The Balliolbreen fault, the principal strand, has reverse separation on the order of 2000 m and displaces Hecla Hock metamorphic rocks on the east against Devonian Old Red Sandstone on the west. Prior to being overlain by carboniferous rocks, the Balliolbreen fault dipped 52 to 63 degrees east. Folds in Old Red Sandstone are tight and overturned adjacent to the fault zone and become open and upright to the west. Fold axes and thrusts with separations not exceeding a few hundred meters have sinuous patterns and trends ranging from N40°E to N45°W; they do not intersect the fault zone with the consistent trend characteristic of strike-slip faults. The gentle dip of the Balliolbreen fault and the pattern of folds and thrusts suggest east-west compression and predominantly reverse-slip. Moreover, areas of fault gouge and breccia within the fault zone vary in width from 30 to 100 m in contrast with the 1-2 km previously reported for major strike-slip faults. Our results do not support earlier suggestions of post Old Red Sandstone strike-slip of 200 to 1000 km on the Billefjorden fault zone.

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THE TECTONIC POSITION AND FORMATION SERIES OF THE YOUNGER CONTINENTAL AND OCEANIC PROVINCES

The global system of Later Mezozoic-Cainozoic age spatially corresponds with the world system of young riftogenic and geosyncline structures. The series of alkaline formations of the sodium type have a manifest trend to be closely connected with the Earth's rift system, as to the alkaline formations of a potassium type are predominantly connected with the geosynclinal system. The most complete and contrasted series of alkaline formations and those related with them possess the intercontinental and pericontinental rifts (from the oldest to the youngest ones): the basalt, alkaline-basalt, rhyolite (alkaline-rhyolite) - tranchyte - alkaline basalt, phonolite - tranchyte - alkaline basalt, phonolite - nephelinite with carbonatites, kimberlite, phonolite, trachyte, alkaline rhyolite, leicitite ones. A number of block range alkaline formations (basalt, alkaline-basalt, rhyolite (alkaline rhyolite) - trachyte - alkaline - basalt) is akine to the earlier members of continent formation series and, as well as the latter one, is characterized by the potassium type of geochemical specialization. In other words, the formation series of oceanic tectonic structures are only distinctly contracted primary parts of long and contrasting series of platform formations.

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ТЕКТОНИЧЕСКОЕ ПОЛОЖЕНИЕ И ФОРМАЦИОННЫЕ РЯДЫ МОЛОДЫХ ЩЕЛОЧНЫХ ПРОВИНЦИЙ КОНТИНЕНТОВ И ОКЕАНОВ

Глобальная система щелочных провинций позднемезозойско-кайнозойского возраста пространственно совпадает с мировой системой молодых рифтогенных и геосинклинальных структур. Ряды щелочных формаций натриевого типа обладают отчетливой тенденцией связи с рифтовой системой Земли, а ряды щелочных формаций калиевого типа - преимущественно с геосинклинальной системой. Среди рифтовых зон наиболее полным и контрастным рядом щелочных и родственных им формаций обладают внутриконтинентальные и периконтинентальные рифты (от древних к молодым): базальтовая, щелочнобазальтовая, риолит-(щелочнориолит)-трахит-щелочнобазальтовая, фонолит-трахит-щелочнобазальтовая, фонолит-нефелитовая с карбонатитами, кимберлитовая, фонолитовая, трахитовая, щелочнориолитовая, лейцititовая. Ряд щелочных формаций глыбовых хребтов (базальтовая, щелочнобазальтовая, риолит (щелочнориолит)-трахит-щелочнобазальтовая, фонолит-трахит-щелочнобазальтовая, базанит-фонолит-нефелинитовая) и срединно-океанических рифтов (базальтовая, щелочнобазальтовая, риолит-(щелочнориолит)-трахит-щелочнобазальтовая) близок ранним членам ряда континентальных формаций и, также как и последний, характеризуется натриевым типом геохимической специализации. Другими словами, формационные ряды тектонических структур океанов - это всего лишь резко сокращенные начальные части длинных и контрастных рядов щелочных платформенных формаций.

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ULTRA-ALKALINE MAGMATISM WITH OR WITHOUT RIFTING

Examination of the relationship between rifting and the types of alkaline magmatism reveals features at present overlooked by current theories of plate tectonics. For example, in East Africa the majority of ultra-alkaline igneous rocks (carbonatites, kimberlites, melilitites, nephelinites, ijolites) lie west of the site of the Gregory Rift Valley and pre-date it by tens of millions of years. The mildly alkaline volcanic rocks (basalts, basanites, tephrites, trachytes) occur closely along the site of the Rift Valley but began erupting about 10 Ma before the first signs of any rift fracturing. Rift fracturing on a big scale in East Africa has occurred only in the last 5 Ma, while the magmatism there began about 50 Ma ago. Clearly in East Africa at least, it cannot be said

that alkaline magmatism is controlled by the rifting, but the converse could be true. Ultra-alkaline magmatism is not even related to the rifting in either space or time except for a small number of examples in the last few million years. Similar relations hold in many other parts of the world. It is concluded that rifting is a necessary accompanying feature of ultra-alkaline magmatism in the continents or oceans.

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DEEP STRUCTURE OF WESTERN MEDITERRANEAN BASIN: CROC 2 LARGE APERTURE SEISMIC SURVEY

Data from thirty Expanding-Spread Profiles carried out in Gulf of Lions and Ligurian Sea in September 1981 were used to study deep structure of Western Mediterranean Basin.
P-refractions and precritical reflections were observed even from the Mohorovicic discontinuity despite presence of hallocinetic Messinian salt Layer, and have been used in the x-t domain to derive velocity structure of both sedimentary cover and crust.
Three different geological domains are distinguished: a thick continental domain, with a velocity of 6.2 km/s and a thickness of 20 km, continued seawards by a thinned continental domain with a thickness of 5 to 7 km only, and then in the center of the basin, a double-layered crust, with velocities of 5.8 and 6.9 km/s and total thickness of about 5 km, interpreted as an oceanic domain, with basement at about 10 km below sea-level.
The thinned continental domain is very wide in the Gulf of Lions (100 km) and considerably reduced in the Ligurian Sea.
Contribution of these data for Late-Oligocene rifting and early Miocene rotation of Corsica-Sardinia is discussed.

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ТЕКТОНИКА ВЬЕТНАМА И СОПРЕДЕЛЬНЫХ СТАН ЮГО-ВОСТОЧНОЙ АЗИИ

Территория Вьетнама и сопредельных стран Юго-Восточной Азии представляет собой сложное гетерогенное складчатое сооружение, которое состоит из разновозрастных континентальных кор, сформировавшихся на месте сочленения крупнейших подвижных поясов мира - Тихоокеанского и Средиземноморского. В истории тектонического развития региона про-

цессы становления коры континентального типа происходили поэтапно, отражая сложную эволюцию геосинклинальных поясов, длительно развивающихся с докембрия до настоящего времени на этом глобальном структурном узле.

Докембрийские этапы развития региона отмечаются тремя главными событиями - формированием протоконтинентальной коры в архее, становлением впервые континентальной земной коры фанерозойского типа в конце среднего рифея и заложением новых эвгеосинклинальных систем в позднем рифее. В результате в конце докембрия на данном регионе была создана структурная картина, включающая раннеконсолидированные блоки (докембрийские складчатые комплексы) и заключающиеся между ними геосинклинальные системы (или области).

На протяжении фанерозоя процессы формирования коры континентального типа, складчатости и стабилизации подвижных поясов происходили здесь на рубеже силура и девона, в позднем палеозое, в позднем триасе, в мелу, в миоцене и продолжаются на переходной зоне между Азиатским континентом и обрамляющими его океанами.

Анализ совокупности геологических данных и особенностей тектонического развития земной коры рассматриваемой территории позволяет выявить основные закономерности стадийности и направленности конструктивных и деструктивных процессов в континентальной земной коре. Проявления обоих процессов здесь обнаруживают закономерные вертикальные и латеральные связи друг с другом. Вертикальные связи заключаются в наблюдаемой последовательности эволюционных событий, сначала свойственных деструктивному процессу, а затем - конструктивному в каждой геосинклинальной системе. Что касается латеральных связей, то отмечена отчетливая сопряженность и относительная взаимная компенсация этих процессов в пространстве.

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TECTONIC STRUCTURE OF KAMCHATKA AT KONTINENT OCEAN TRANSITION ZONE

The evolution of the geosynclinal systems of Kamchatka peninsula, beginning from Early Precambrian developed step by step from the North-West to the South-East.This is evidenced by rejuvenation of the same-type geological formations oceanward.In the same direction oceanic crust was involved progressivelyinto the geosynclinal process and was transformed into continental crust.The initiation and the development of regional structures within the paleosystems(volcanik arc-trench-Benioff zone-ocean ridge) was controlled by the deep-seated faults,apearing at the joint of the oceanic and the con-

tinental lithosphere plates. The geological processes of geosynclinal stage/volcanism, magmatism, metamorphism, hydrotermal activity/caused the release of endogenic energy. The heat flows of this energy were connected with the crustal zones of penetration at the intersection of deep_seated faults. This led to the formation of linear and circular metallogenic zones and magmatogenic ore systems/volcanogenic ore centres/. The discovery and study of paleogeosynclinal systems similiar to the contemporary Kuril-Kamchatka system has great importance for the comprehension of the geological history of mobil belts, their structure and metallogenic specialization.

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ТЕКТОНИЧЕСКОЕ СТРОЕНИЕ КАМЧАТКИ В ЗОНЕ ПЕРЕХОДА КОНТИНЕНТ - ОКЕАН

Развитие геосинклинальных систем начиная от раннего докембрия на полуострове Камчатка происходило последовательно в юго-восточном направлении, что подтверждается последовательным омоложением однотипных геологических формаций от континента к океану. В этом же направлении происходило поступательное вовлечение земной коры в геосинклинальный процесс и переработка ее в кору континентального типа. Заложение и развитие региональных геологических структур в палеосистемах (вулканическая дуга-глубоководный желоб-зона Беньофа - океанический хребет) обусловлены глубинными разломами, возникающими на стыке океанической и континентальной литосферных плит. Геологические процессы геосинклинальной стадии развития (вулканизм, магматизм, метаморфизм, гидротермальная деятельность) обусловили высвобождение эндогенной энергии, тепловые потоки которой приурочены к глубинным проницаемым зонам в узлах пересечений глубинных разломов. Это привело к формированию линейных и кольцевых металлогенических зон и магматогенно-рудных систем (вулканогенно-рудных центров). Выявление и изучение палеогеосинклинальных систем, аналогичных современной Курило-Камчатской, весьма важно для понимания истории геологического развития и строения регионов, выявления их металлогенической специализации.

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PREURALIDES OF THE JOINT ZONE OF THE EAST-EUROPEAN PLATFORM AND URALS

The joint zone is the Urals axial zone situated to the west from the Main Urals Ophiolitic Belt. Pre-Upper Cambrian formations (preuralides) with relics of sub-latitudinal structures related to the platform ones are developed there. To the north from the Ufimsky projection of the platform (approximately the middle of the zone) these structures are extending to the north-west and to the south they have the south-western trends. By its geological structure the joint zone is heterogeneous. In its middle part the crust is of the continental type. The blocks of the Archean granulitic and Lower Proterozoic gneissic basements are exposed there. Riphean formations show the platform character. The destruction zones similar to the continental rifts are distinguished there, their ages are 1600-1500, 1350, 800 m.y. In the Polar, Circum-Polar Urals and in the south of the South Urals the crust is of the transitional type. The Pre-Paleozoic ophiolitic basement is exposed in places there. Where the paired metamorphic belts, asymmetrical distribution of sedimentary, volcanic, magmatic formations in grenvillides (1100-1000m.y.) and baikalides (670-550) of these regions are available, one may distinguish fragments of environments corresponding to the island arcs, marginal seas, active continental margins, Benioff zones. The basement of the marginal seas are mainly composed of ophiolites of preuralides. They are metamorphosed in a complicated manner and differ from ophiolites of the uralides by their lesser depletion: ultramafites are rich in lherzolites, mafites are more alkaline and ferruginous. A series of massives of the Main Ophiolitic Belt (Voikarsky, Nuraly and etc.) presents "ophiolite in ophiolite". Structures and blocks of the preuralides in the east of the Urals influence the distribution and specific character of the Paleozoic formations in the whole Urals.

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ДОУРАЛИДЫ ЗОНЫ СОЧЛЕНЕНИЯ ВОСТОЧНО-ЕВРОПЕЙСКОЙ ПЛАТФОРМЫ И УРАЛА

Зона сочленения - это осевая зона Урала, расположенная к западу от Главного Уральского офиолитового пояса. Здесь развиты доверхнекембрийские образования (доуралиды) с реликтами субширотных структур,

связанных со структурами платформы. К северу от Уфимского выступа платформы (примерно середина зоны) простирания этих структур северо-западные, к югу - юго-западные.
По геологическому строению зона сочленения неоднородна. В ее средней части с платформенной корой обнажены блоки архейского гранулитового и нижнепротерозойского гнейсового фундамента. Рифейские формации имеют платформенный характер, выделены зоны деструкции, близкие континентальным рифтам, с возрастом 1600-1550, 1350, 800 млн. лет. На Полярном, Приполярном Урале и на юге Южного Урала мощность сиаля в осевой зоне сокращена, местами обнажен допалеозойский офиолитовый фундамент. По наличию парных метаморфических поясов, ассиметричному размещению осадочных, вулканических, магматических формаций в гренвилидах (1100-1000 млн.лет) и байкалидах (670-550 млн. лет) этих районов выделяются фрагменты обстановок, соответствующих островным дугам, окраинным морям, активным континентальным окраинам, зонам Беньофа.
Офиолиты доуралид в основном являются фундаментом окраинных морей. Они сложнометаморфизованы и от офиолитов уралид отличаются меньшей истощенностью - в ультрамафитах много лерцолитов, мафиты более щелочные и железистые. Ряд массивов Главного офиолитового пояса (Войкарский, Нурали и др.) представляет "офиолит в офиолите". Структуры доуралид и блоки доуралид в восточной области Урала влияют на размещение и специфику палеозойских формаций всего Урала.

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TECTONICS AND QUANTITIVE PARAMETERS OF THE TRANSITIONAL ZONE SEDIMENTARY BASINS

In recent structure of the upper part of the Earth cover transitional zones represent large sedimentary basin belts of five major genetic types. The belt of the recent passive margin compose about 40% or 200,7 m.km^3; transitional zones and ancient margins, so-called Mezogea - 6,5% or 33 m.km^3; the zone transitional from passive to recent active margin - 7,5% or 38 m.km^3; the colombian and recent active margin summarized- about 4,8% or 24,3 m.km^3 of the cover of all Earth sedimentary basins excluding miogeosyncline (510 m.km^3).

All the belts are characterised by riftogenic nature, considerable thickness of the sedimentary cover (up to 10-18 km), increased influence of volcanism on sedimentation, descending of crust'blocks on the late evolutionary stages, initial formation time, unequal for individual links of each belt. The formation of recent passive margin belt and belt transitional to ancient oceanic margin began

150 m.y. with rejuvenation in individual links up to 130, 100, 80-60 and 30 m.y., colombian belts and in those of recent active margins in individual links 80-60 m.y. and in the rest 50-32, 20 and 10 m.y. In quantitive parameters of the structure heterogeneity are reflected: unequal values of volume cover and sedimentation intensity; redistribution of sedimentation rate in time and space, caused by migration of spreding axes and growth velocity change of oceanic crust in time. The low sedimentation rates correspond to this growth and high ones to vertical movements, sometimes of the avalanche rate.

Along this, in the structure of the deep-water areas of the passive margin belts take part the regions of occurence of abnormal consolidated rocks of different genesis, including deep-water ones, formed on the early and intermediate stages of the ocean formation along with the destruction of former continental crust.

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ТЕКТОНИКА И КОЛИЧЕСТВЕННЫЕ ПАРАМЕТРЫ СЕДИМЕНТАЦИОННЫХ БАССЕЙНОВ ПЕРЕХОДНЫХ ЗОН

В современной структуре Земли переходные зоны представляют крупнейшие пояса седиментационных бассейнов пяти основных генетических типов. На долю поясов современной пассивной окраины приходится около 40% или 200,7 млн. км^3; переходной зоны к древней окраине, т.н. Мезогеи - 6,5% или 33 млн. км^3; переходной зоны от пассивной к современной активной окраине - 7,5% или 38 млн. км^3; колумбийского и современной активной окраины совместно-порядка 4,8% или 24,3 млн. км^3, чехла всех седиментационных бассейнов Земли (без миогеосинклиналей)-510 млн.км^3.

Все пояса характеризуются рифтогенной природой, значительной до 10-18 км)мощностью чехла, повышенным влиянием вулканизма на седиментацию, интенсивными нисходящими движениями блоков на поздней стадии эволюции. Различие определяется тектонической позицией, направленностью изменения геодинамической обстановки, временем начала формирования, неоднозначными и для отдельных звеньев каждого из поясов. Формирование поясов современных пассивных окраин и переходного к древней океанической окраине началось на рубеже 150 млн.лет с омоложением в отдельных звеньях до 130, 100, 80-60 и 30 млн.лет; пояса переходного к современной активной окраине преимущественно - на рубеже 80 млн.лет с омоложением в звеньях до 50, 32 и 20 млн.лет; поясов колумбийского и современной активной окраины в отдельных звеньях - на рубеже 80-60 млн.лет, а в остальных - на рубежах 50-32,20 и 10 млн.лет.

В количественных параметрах различие отражено неравнозначными значениями объема чехла и интенсивности седиментации; перераспределением темпа седиментации во времени и пространстве, обусловленном миграцией осей спрединга и изменением скорости разрастания океанической коры во времени. Этому разрастанию отвечают низкие скорости седиментации, а вертикальным движениям поздней стадии эволюции - высокие, порой уровня лавинной.
В строении глубоководных частей поясов пассивных окраин принимают участие "аномальные" ареалы консолидированных пород различного генезиса, возникшие на ранней и промежуточной стадиях океанообразования при деструкции былой континентальной коры.

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TECTONIC EVOLUTION OF ASIA

From the newly compiled "Tectonic Map of Asia" it can be clearly seen that the whole continent was not originally a single landmass, but a result of long time evolution from separated paleoplates. Asia and its adjacent regions can be divided into 12 plates during Phanerozoic. These plates did not coexist at the same time. Those, which made up the northern part of Asia were separated from each other by oceans in early Paleozoic time and situated in low latitude territories on both sides of the equator. The Gondwanaland, on the hand, remained integrated. Owing to the convergent movements of the plates, the geosynclines along the continental margins folded and/or subducted forming the early Paleozoic (Caledonian) and subsequently the late Paleozoic (Variscan) fold belts. The said plates joined together to form the Paleo-Eurasia Plate. In early Mesozoic the Paleo-Eurasia Plate shifted dextrally and the South China-Southeast Asia Plate moved northward to combine with the former along the suture of Kunlun and Western Qinling Mountains. This enlarged landmass may be called the Meso-Eurasia Plate. Meanwhile the Gondwanaland began to disintegrate. A number of microcontinents constituded the Turkey-Central Iran-Gondise median plate which joined the Meso-Eurasia Plate to forn the Neo-Eurasia Plate. The Indian Plate drifted from south to collide with Neo-Eurasia Plate in early and middle Tertiary along the Taurus-Zagros-Yarlung Zangbo suture line. The configuration of the modern Eurasia continent was then accomplished. In late Cenozoic the Indian Plate still moved northward. The Main Boundary Fault came to exist along the pidemont of Siwalick Ranges.

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ON TECTONIC SYSTEM SERIES WITH AN EMPHASIS ON THE STRUCTURES OF CATHAYSIAN TYPE IN EASTERN CHINA

Tectonic system series is a concept drawn from a thorough research on the characteristics and evolution of the tectonic systems in China. The Cathaysian system, Early-Neocathaysian system, Late-Neoca thaysian system, latest-Neocathaysian system and Cathaysoid system of the X-type structure in eastern China may be collectively called Cathaysian tectonic system series, which are formed in various structural zones trending from NNE to NE respectively. These X -type structures control the distribution of geological formations and mineral resources. Each of them has its own characteristic formations, mineral resources as well as deformation. Furthermore, they also exist some genetic and evolutional relations between them. The other well known major gigantic tectonic systems of China also reflect similar regularities. Therefore, it is to be considered that a tectonic system series in a specified region refers composed to a number of tectonic systems of the same type which were formed in different periods under the same manner of external forces. To study the tectonic system series has both practical and theoretical significance for explorating mineral resources of different geologic periods and studying the genetic and evolutional relation between different tectonic systems.

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ON THE PERIPACIFIC STRUCTURAL-MAGMATIC DOMAIN OF ASIAN CONTINENT

Discussed in this paper is a huge structural-magmatic domain developed since Mesozoic, which is regarded as one of the significant features of the continental margin of "Pacific type". Its western boundary is close to longitude 105°E. As the result of the multiple subductions in different positions of the Pacific Plate beneath the Eurasian Plate and of the variation in the natures of different continental tectonic units, the structural-magmatic domain is distinctly zoned both longitudinally and latitudinally. It can be divided longitudinally into four structural-magmatic zones: intracontinental zone, interior faulted zone, epicontinental sea basin zone, and island arc zone, and latitudinally into four structural-magmatic rock regions: the Eastern Siberian Region, Xingan-Xihuote Re-

gion, North China Region, and South China Region. The whole structural-magmatic domain is represented by a huge magmatic cycle consisting of the Indosinian, Yanshanian, and Himalayan cycle, each of which represents a magmatism of specific nature. In the structural-magmatic domain, the Mesozoic magmatic activities were characterized by the regular variation: from the continent outwards to the Pacific magmatism became gradually more intensity and younger, and submarine eruptions and basic and ultrabasic magmatic activities increased.

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A STUDY ON THE CRUSTAL STRUCTURE OF SOUTH CHINA SEA

The crustal structure of South China Sea is obviously zoned from the north to the south, and blocked from the west to the east. The crust of the upper northern margin (water depth less than 1.0 km) is composed of:

Sediment	Vp=1.6-4.9 (km/s)	max.thk. 8.0(km)	ave.thk. 3.0(km)
Granitic	Vp=5.0-6.3 (km/s)	max.thk. 4.5(km)	ave.thk. 2.5(km)
Basaltic	Vp=6.5-7.2 (km/s)		

In the deep sea plain the average thickness of the crust is 6.3 km, and the crust is composed of:

Sediment	Vp=1.55-3.9 (km/s)	max.thk. 3.5(km)	ave.thk. 1.0(km)
Layer 2	Vp=4.1-6.3 (km/s)	max.thk. 3.1(km)	ave.thk. 2.1(km)
Layer 3	Vp=6.5-7.7 (km/s)	max.thk. 4.1(km)	ave.thk. 2.9(km)
Upper mantle	Vp=7.9-8.75(km/s)		

South China Sea could be divided into two parts if a line was drawn from Dongsha Island to Shuangzhi Shoal. In the eastern part of the upper northern margin, there are three unconformities in the Tertiary system and the Miocene series is folded, but in the western part these phenomena are not very obvious.

On the lower northern margin (water depth more than 2.0 km) the crustal structure is similar to the deep sea plain. Although there are many sea mountains and hills in the eastern part, the nature of the crust is continental crust.

In the northwestern part of the deep sea plain the thickness of the crust and the layer 3 are thinnest, while in the southwestern part, they are thickest.

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EVOLUTION OF THE MORPHOSTRUCTURE OF THE OCEAN RIFT ZONES IN THE PROCESS OF SPREADING OF LITHOSPHERIC PLATES

Geologo -geophysical investigations for last time including the direct observations from diving apparatus enable to reveal the regularity of the rift zone morphostructure of different areas of the World Ocean and to trace the evolution line of its development. At the first stage the graben surrounded by stepped sinking continental margins arises along the spreading axis after the break of the continental crust. Active volcanic processes, fissures, and faults are observed on the graben floor. This stage is found in the Red Sea. Then the rift zone is extending under the lithospheric plate spreading, and its axis section is standing at the definite bathymetric level owing to isostatic equilibrium of the rising mantle matter and the accretion ocean crust. The rift ranges are formed along the rift valley boundaries as a result of the vertical movements and faults. The lithospheric plates are isostatically sinking owing to the cooling, crystallization,and density rise of its matter as moving away from the spreading axis. As a result the primary ridge with block--range dissection arises that is the rift zone without the flanks. This stage is observed on the Kolbeinsey Ridge or in the Gulf of Aden. Then the inclined surface of the flank zones are formed owing to the spreading and sinking of the lithospheric plates and the mid--oceanic ridge arises as the planetary form of the submarine relief. It occupies almost the whole area between the continental margins. This stage is observed in the Arctic Basin or on the Reykjanes Ridge. The calculations show that the minimum width of the primary rift ridge must be about 150 to 200 km, and the minimum width of the mid--oceanic ridge must be about 800 to 900 km.

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ЭВОЛЮЦИЯ МОРФОСТРУКТУРЫ РИФТОВЫХ ЗОН ОКЕАНОВ В ПРОЦЕССЕ РАЗДВИЖЕНИЯ ЛИТОСФЕРНЫХ ПЛИТ

Геолого-геофизические исследования последних лет, включая непосредственные наблюдения из подводных аппаратов, позволили выявить закономерности морфоструктуры рифтовых зон различных районов Мирового океана и наметить эволюционный ряд их развития. На первом этапе после развыва континентальной коры вдоль оси раздвижения возникают грабен или система грабенов, окаймленные ступенчато погружающимися

континентальными окраинами. На дне грабена, являющегося зародышем рифтовой долины, происходят активные вулканические процессы и образуются трещины растяжения и сбросы. Такая стадия наблюдается в Красном море. В дальнейшем по мере раздвижения литосферных плит рифтовая зона расширяется, а ее осевая часть устанавливается на определенном батиметрическом уровне, обусловленном изостатическим равновесием поднимающегося мантийного вещества и генерируемой океанической коры. В зависимости от соотношений плотностей коры и подстилающего вещества здесь формируются либо рифтовые долины, либо осевые поднятые блоки. По периферии рифтовых долин в результате взбросов и сопровождающих сбросов образуются рифтовые гряды. Литосферные плиты в связи с остыванием, кристаллизацией и уплотнением вещества по мере удаления от оси раздвижения изостатически погружаются. В результате появляется первичный валообразный хребет с характерным блоково-грядовым расчленением, представляющий собой рифтовую зону полной ширины без флангов. Такая стадия наблюдается, например, на хребте Колнбейнсей или в Аденском заливе. При дальнейшем раздвижении и последовательном погружении литосферных плит формируются наклонные поверхности фланговых зон и возникает срединно-океанический хребет как планетарная форма подводного рельефа, которая занимает почти все пространство дна океана между континентальными окраинами. Эту стадию можно видеть в Арктическом бассейне или на хребте Рейкьянес. Расчеты показывают, что для формирования первичного рифтового хребта необходима минимальная ширина около 150-200 км, а для появления срединно-океанического хребта полного профиля - ширина порядка 800-900 км, причем возрастание скоростей раздвижения ведет к увеличению этих цифр.

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ON ACTIVE FAULT

First, this paper is related to implications of active fault and its significance of research. There are different opinions on two categories, one is the problem of time interval and the other is the degree of activity. According to the author's opinion, its time interval is much better from the beginning of Q to recent, its creep 0.1 mm/year is said to be active. Second, its identified mark is enumerated in the paper. Third, its mode and degree of activity are described: one is creep, the other adapts earthquake to release the elastic strain forming abrupt slip. Fourth, it mentions its mechanical formation, the central point being stress field, a great number of them rejuvenate, while a small part originate primarily, being conpressive, extension and shear. Fifth, the

relation of it to the structural system, the structural system is active due to its stress field, if the latter is the some or similaras its original. Finally, some Chinese principal active faults are mapped and recent stress field is mentioned, the former is brief and the latter adopting the "Plate" theory referring to the stress origin and direction, we derived the stress field of the inner land of China.

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EVOLUTION AND STRUCTURAL ANALYSIS OF MESOZOIC AND CENOZOIC CONTINENTAL RIFT SYSTEMS IN ASIA

With the disintegration of Pangaea, there were widely developed continental rift systems in Asia during Mesozoic and Cenozoic. Among them the Cathaysian rift system in East Asia and the Red Sea rift system in West Asia are the most prominent; the Baikal rift system and the Shansi rift system are S-shaped, spreading in mid-Asia; the Sumatra rift system came into being in association with Indonesia Island-Arc.

According to the reflection seimic studies, the evolutional process for the Cathaysian rift system may be divided into four stages: doming, spreading, regional subsiding and aborting. During these taphrogenic stages, tilted blocks and listric faults developed, sometimes with widespread volcanic rocks, and deltaic and marine sediments occurred.

Rifting was chiefly controlled by the pre-existing linements of basement, mantle upwelling, regional stress condition and strike-slip faults. Those rifts in development of which strike-slip faults played an important role may be called strike-slip rifts. In light of the formation, the rift systems in Asia may be classified as: continental rupture rifts, failed rifts (aulacogens), collisional rifts (impactogen), and convergent boundary rifts.

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THE OLD VOLCANIC STRUCTURES OF THE YISHU RIFT IN THE MIDDLE SECTOR OF THE TANLU FRACTURE ZONE

During Cretaceous, developed in the middle sector of the Tanlu Fracture Zone was a continental rift system, the Yishu Rift System, which covered an area including most part of Shandong Province and some parts of Bohai Sea and Yellow Sea. More than 10 large old volcanic structures have been preliminary identified in this rift system. They are commonly characterized by the following features: 1) They are mostly round or elliptical with diameters generally ranging from 10-30 kilometers and occur in a chain along the fracture; 2) They are well reflected in satellite images, aeropholographs, and geophysical data; 3) Ring-like and radiating fractures are well developed and partially filled with dykes and veins; 4) Most of them are composed of several craters and cones; 5) Chiefly consist of complex in the centers with subvolcanics surrounded; 6) From the axis to both sides of the rift, the volcanics become younger and grade from basic to acid; 7) The volcanism was chiefly characterized by basic eruption in the early stage, central alkaline explosion in the middle stage, and acid eruption in the late stage, with an intensity variation as weak-strong-weak; 8) The evolution of magma is of both island arc and subbenioff zone type. Consequently, it can be concluded that the formation and consumption of the rift system was obviously controlled by the interaction between the Pacific Plate and the Eurasian Plate.

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ON FORMING MECHANISM OF THE RIFTS AND THE MESOZOIC-CENOZOIC BASINS FROM THE DEEP STRUCTURES AND THE STRESS DISTRIBUTIONS

This paper gives the crustal structures of rifts and basins both in China and abroad. From this paper we find that upper mantle uplifts correspond to rifts or basins and the thickness of lithosphere of these regions is thinner. It means that upper mantle in these regions is upwarded. The paper also presents the stress distribution caused by the mantle current under the lithosphere. It is obvious that the big basins, especially the Mesozoic-Cenozoic basins, are located in the tensile regions. By means of these data we obtained that

there may be a small scale divergent mantle current under the lithosphere in rift and basin regions. It can make some rising of upper mantle. Due to the uplift, we suppose the lower interface of the lithosphere rises with 0.5, 1.0, or 2.0 km in the central part. The distributions of principal stress are calculated by using the finite element method. It shows that in the central portion of upwarding is the tensile stress region with a magnitude approximate 10^2-10^3 kg/cm^2. These tensile stress gives rise to the forming of tension fractures. If such a procedure goes on, the tensile fractures are gradually expanded. Owing to the gravity effect, in some place they can make the gravitational slippage and the normal faults which produce the rifts or depression basin.

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TECTONICS OF THE SOUTH CHINA SEA AND CONTINENTAL MARGIN SPREADING

The South China Sea possesses the general features occurring in marginal seas of the West Pacific Ocean, but is different from the latter on account of the Taiwan and North Luzon arcs face the marginal sea, the Manila Trench is situated on the side of the marginal sea, where an opposing subduction zone exist, as well as that the main lineaments in the central sea basin are perpendicular and not parallel to the island arc. Based on the study of the main geologic structural features of the South China Sea, we suggest the following: the mantle wriggled and spread out towards the ocean; the continental margin became dismembered by faulting; seafloor spreadings took place along the axes in various directions during different periods; and the continental(island) blocks spread out only towards the ocean. Besides, the graben system of the continental margin formed by continental margin spreading and the model of the cycle of its development have also been proposed. By using the viewpoint and model, the geologic structural features of the South China Sea and the mechanism of its formation are interpreted.

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STRUCTURAL ZONING OF LARGE FAULTS

Large faults are complex features with specific peculiarities of de-development and internal structure. During faulting sizable volumes of the Earth crust surrounding future fault plane, are drawn into processes of rupturing. In this near-fault space accessory ruptures of different ranks, length and distribution density are developing. Analysis of accessory ruptures from geological and observational data indicates synonymously increase in their density according to the exponential law. Density is maximum in the central parts of a zone and near lateral boundaries it is minimum. It enables to define location of a main rupture and boundaries of a zone of its dynamic influence quite exactly.

Lengths (l) of accessory ruptures are maximum at the lateral boundaries and minimum - at the axial parts of zones (d). This dependence may be described by equation: $l = kd+c \pm \Delta$, where coefficients k and c are equal to 0.8-2.5 and 0.7-12.0 accordingly. The structure of influence zones of faults with different size testifies to uniform-discrete change in rupture density not only across but also along the strike of the influence zone. It is expressed by alternation of fields with heightened density (destructive fields) and segments of minimum density. Discrete destructive fields forestall the formation of a main rupture and reflect the character of processes of crustal destruction. Isolated portions with maximum deformation are formed from the moment of beginning of fault formation. The pattern of distribution of feather ruptures is a peculiar indicator for kinematic type of faults and dynamics of its formation. It also conditions natural location of magmatic and ore concentrations in the zones of influence of large faults.

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СТРУКТУРНАЯ ЗОНАЛЬНОСТЬ КРУПНЫХ РАЗЛОМОВ

Крупные разломы представляют собой сложные структуры со специфическими чертами развития и внутреннего строения. При формировании разломов в процессы разрывообразования вовлекаются значительные объемы земной коры, окружающие будущий сместитель. В этом приразломном пространстве развиваются сопутствующие разрывы разного ранга, длины и плотности. Анализ сопутствующих дизъюнктивов по геологическим и экспериментальным данным однозначно указывает на возрастание их плот-

ностей, согласно экспоненциальному закону, по мере удаления от латеральных границ к центральным частям зон, что позволяет достаточно точно определять местоположение магистрального разрыва и границ зоны его динамического влияния. Фиксируется постепенное увеличение длин (ℓ) сопутствующих разрывов по мере удаления от осевых частей зон (d). Зависимость описывается уравнением вида $\ell = kd + c \pm \Delta$, где коэффициенты k и c имеют значения 0,8 - 2,5 и 0,7 - 12,0 соответственно.

Анализ зон влияния разномасштабных разломов свидетельствует о равномерно-дискретном изменении плотностей разрывов не только вкрест, но и по простиранию зон влияния. Оно выражается в чередовании полей повышенной плотности (деструктивные поля) с участками минимальной плотности. Дискретные деструктивные поля предваряют формирование магистрального разрыва и отражают специфику процессов разрушения земной коры, связанную с локализацией участков максимальной деформации с момента начала формирования разлома.

Характер распределения разрывов оперения является своеобразным индикатором кинематического типа разлома, динамики его формирования, обуславливает закономерное размещение магматических и рудных концентраций в зонах влияния крупных разломов.

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STRUCTURE AND EVOLUTIONARY STAGES OF THE BAIKAL RIFT

The structure of the crust indicates that the depressions of the Baikal rift zone have been formed due to extension which manifested itself irregularly along its strike. The general pattern of this zone is controlled by heterogeneities of the crust. The asthenospheric upwelling because of mechanical replacing of the lithosphere by the asthenosphere is evidently a cause of the extension of the crust, as well as of the formation of the Sayan-Baikal domal uplift.

The study of Cenozoic sediments from the depressions permits us to distinguish two stages of the Baikal rift zone evolution. At the first stage (from 35 to 3 or 5 m.y. ago) the rift basins subsided rather slowly and the Sayan-Baikal domal uplift was not high. At the second stage (from 3 or 5 m.y. ago to Present) the rate of the subsidence of the basins have increased nearly by an order and the altitudes of the domal uplift have reached the values close to the Recent ones.

We suggest that the first stage of the rifting was connected with

growth of the asthenospheric upwelling. The second stage began when the asthenosphere reached the Moho. The upward movement of the asthenospheric material ceased at that time, as its density is higher than the density of the crust. Spreading of the upwelling began that resulted in increase of rates of the extension and rifting. This hypothesis permits us to reproduce theoretically the recent value of the regional heat flow and the Curie depth using the numerical model of the transient thermal field of the rift zone lithosphere.

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СТРОЕНИЕ И СТАДИИ РАЗВИТИЯ БАЙКАЛЬСКОГО РИФТА

Строение земной коры указывает на образование рифтовых впадин Байкальской зоны в результате растяжения, неравномерно проявившегося по ее простиранию. Общий структурный рисунок рифтовой зоны в значительной мере определяется неоднородностями земной коры. Причиной растяжения коры и образования Саяно-Байкальского сводового поднятия, по-видимому, является формирование астеносферного выступа путем механического замещения литосферы астеносферой.

Изучение кайнозойских осадков во впадинах делает возможным выделить две стадии развития Байкальской рифтовой зоны. На первой стадии (с 35 до 3-5 млн.лет тому назад) рифтовые впадины прогибались сравнительно медленно, а высоты Саяно-Байкальского сводового поднятия были невелики. На второй стадии (с 3-5 млн.лет тому назад до настоящего времени) почти на порядок увеличились скорости опускания днищ впадин, а высоты сводового поднятия достигли значений, близких к современным.

Можно полагать, что первая стадия развития рифта связана с ростом высоты астеносферного выступа. Начало второй стадии соответствует времени подхода астеносферы к разделу Мохо. Движение астеносферы вверх при этом прекратилось из-за того, что ее плотность превышает плотность земной коры. Началось растекание выступа в стороны, что привело к увеличению скорости растяжения коры и скорости формирования впадин. Эта гипотеза позволяет теоретически воспроизвести современное значение регионального теплового потока и глубину точки Кюри путем численного моделирования нестационарного термического поля литосферы рифтовой зоны.

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TECTONIC EROSION, ACCRETION AND STABILITY IN THE EVOLUTION OF LIMINAL SYSTEMS

Liminal systems (continental arcs, marginal arcs), both modern and ancient, are various in structure and tectonic regime. Andean type is the most known but its importance shouldn't be exaggerated. Even in the Andes such a pattern came into being only 12-13 m.y.b.p., while it had been different during 200 m.y., until the upwarping and arching began. In Mesozoic Andes there appeared a few back-arc extension episodes, evidenced by tholeiite basalts of Bolivia and NW Argentina. Extension is likely existing now in Guatemala-Costa Rica liminal system, where it is thought to be governed by trench-continent relative motion. The dip and the length of Benioff Zones under liminal systems are also various.

The evolution of liminal systems may be accompanied both by tectonic erosion (Peru-Chile) and by subduction-accretion (Sumatra, Mexico, Alaska); stability state is possible as well (Guatemala-Costa Rica). For liminal systems of the past the kind of regime may be recognized according to existance of either accretion prisms or subduction-trancated marginal structures. Tectonic erosion and accretion (together with other factors) are likely to cause lateral migration of volcanic arcs and the composition of vilcanites, especially their isotope characterictics. Compression stresses are the most usual in liminal systems, and are connected with the global orientation of the systems (mostly west-facing), with active overriding of continental plate, and with young age of the crust being subducted. But still there is no direct correspondence between erosion-accretion regime and the stress. Compression seems to be necessary but not sufficient condition for the tectonic erosion. As to the accretion, it occures in any stress field: compressional, neutral and even extensional, as far as back-arc extension may couple with fore-arc compression. Sediment supply to the trench is accepted to be of great importance, and in its turn depends of tectonics.

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ТЕКТОНИЧЕСКАЯ ЭРОЗИЯ, АККРЕЦИЯ И СТАБИЛЬНОЕ СОСТОЯНИЕ В РАЗВИТИИ ЛИМИНАРНЫХ СИСТЕМ

Лиминарные системы (continental arcs, marginal arcs),как современные,так и древние,разнообразны по строению и тектоническому режиму. Широко известен андский тип, но его значение не следует переоценивать. В самих Андах соответствующая обстановка определилась лишь

12-13 млн.лет назад,а раньше (до воздымания и аркообразного изгиба), почти 200 млн.лет,условия были иными.В тылу вулканического пояса мезозойских Анд проявлялись даже растяжения, отмеченные толеитовыми оазальтами Боливии и Северо-Западной Аргентины. В настоящее время растяжения проявляются в Гватемальско-Костариканской системе,что обусловлено балансом относительного перемещения желоба и континента.Наклон зоны Беньофа лиминарных систем и ее длина также разнообразны. Развитие лиминарной системы может сопровождаться как тектонической эрозией края континента (Перу-Чили), так и субдукционной аккрецией (Суматра, Мексика, Аляска); возможно и стабильное состояние (Гватемала - Коста-Рика). Для древних систем режим реконструируется по наличию аккреционных комплексов или срезанных субдукцией окраинно-материковых структур. Тектоническая эрозия и аккреция, наряду с другими факторами, влияли на латеральную миграцию вулканических поясов прошлого, а также на состав вулканитов, особенно на их изотопную характеристику.

Для лиминарных систем наиболее обычны сжимающие напряжения, что увязывается с их глобальной ориентировкой (обращены главным образом на запад), активным надвиганием континентальной плиты и молодостью субдуцирующей плиты. Однако прямая зависимость режима от напряженного состояния отсутствует.Для тектонической эрозии сжимающие напряжения - необходимое, но недостаточное условие. Аккреция развивается как при сжатии, так и при нейтральном поле и даже при растяжении: проявляясь в тылу вулканического пояса оно нередко сочетается со сжатием во фронтальной полосе. Важны условия седиментации в желобе, которые, в свою очередь, зависят от тектонических факторов.

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EL PAPEL DE LOS MOVIMIENTOS VERTICALES DE LA ETAPA OROGENICA, EN LA DISTRIBUCION DE LOS ESPESORES DE LAS SECUENCIAS ALOCTONAS EN CUBA-OCCIDENTAL

En la etapa orogenica de desarrollo en Cuba Occidental, que abarca desde el Campaniano hasta la parte baia del Eoceno Inferior, se produjeron movimientos horizontales intensos, con la formacion de mantos de corrimiento. Gran importancia, en la distribucion de los espesores de los mantos de corrimiento formados, tuvieron los movimientos verticales que se produjeron en esa etapa, lo que dio lugar al desarrollo de fosas tectonicas largas y estrechas, de direccion-sublatitudinal, separadas por zonas relativamente levantadas, lascuales se rellenaron fundamentalmente, por secuencias miogeosinclinales y eugeosinclinales cabalgadas desde el sur.

La amplitud de los movimientos verticales alcanzo 5 km y mas, loque localmente se expresa en la existencia de sectores con grandes diferencias en los espesores de los mantos de corrimiento.
Se lograron establecer ciertas regularidades (zonaciones), en la distribucion de los espesores de dichos mantos y sus caracteristicas. Los eventos geologicos senalados, no estudiados anteriormente en Cuba, se detectaron gracias a los trabajos geofisicos, de perforacion y a los levantamientos geologicos realizados en los ultimos anos, cuestion que reviste gran importancia para la proyeccion argumentada de los trabajos de prospeccion para minerales utiles, especialmente para petroleo y gas.

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NAPPE TECTONIQUE DE HINBOUN SUR LE TERRITOIRE DU LAOS MOYEN

Travaux terminés des géologues soviétiques et lao ont établi une nappe tectonique dite Hinboun à la limite du Massif Indosinias mitoyen et de la zone plissée lao-vietnamienne. Son autochtone est constitué de hercynien de la partie mariginale du Massif Indosinias. Les formation sédimentaires de platforme (complexe Indosinias supérieur de l'âge probablement triasique) les recouvrent transgressivement en formant un parautochtone charrié, plissé, écailleux (puissance de l'ordre 300 m). L'allochtone est présenté avant tout par des formations carbonatées, miogéosynclinales dislioquées d'une manière compliquée dans la zone lao-vietnamienne (calcaire ouralo-permiens, puissance de l'ordre de 700 m). Le plan principal est présenté par des corps subhorizontaux de mylonites et R-tectonites.
Un front de 200 km de nappe en arc saillant vers le sud-ouest est marqué dans la vallée du Mécong par une série de klippes.
Un arrière-front est situé dans la région de la crête d'Annam et est marqué par des affleurements de roches profondément métamorphisées distants de 60 km.
La correspondance en temps de la formation de la nappe de Hinboun (fin du Trias -debut du Crétacé) aux charriages du Tétis connus ainsi que la présence de structures similaires symétriquement par rapport aux massifs consolidés auparavant serait la conséquence de la compression de l'écorce terrestre durant cette période. Les zones subhorizontales du plan de la nappe ont servi d'encaissants favorables à des intrusions subvolcaniques de formation andésito-rhyolitiques et à une minéralisation stannifère associée avec ces intrusions.

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ХИНБУНСКИЙ ТЕКТОНИЧЕСКИЙ ПОКРОВ НА ТЕРРИТОРИИ СРЕДНЕГО ЛАОСА

Работами советских и лаосских геологов установлен тектонический покров на границе Индосинийского срединного массива и Лаосско-Вьетнамской складчатой зоны, получившей название Хинбунский. Автохтон его сложен герцинидами краевой части Индосинийского массива. Трансгрессивно перекрывающие их платформенные осадочные формации (верхний Индосинийский комплекс предположительно триасового возраста) образуют чешуйчатый, шарьяжно-складчатый параавтохтон (мощность около 300 м). Аллохтон представлен сложнодислоцированными миогеосинклинальными, преимущественно карбонатными образованиями Лаосско-Вьентнамской зоны (Урало-Пермские известняки, мощность около 700м). Главный сместитель представлен близгоризонтальными телами милонитов и R-тектонитов. Фронт покрова дугой, выпуклой к юго-западу, обозначен рядом клиппов в долине Меконга и имеет протяженность около 200 км. Тыловая часть расположена в районе Аннамского хребта и обозначена выходами глубокометаморфизованных пород, Расстояние между ними 60 км. Соответствие времени формирования Хинбунского покрова (поздний триас - ранний мел) известным шарьяжам Тетиса, а также наличие симметрично расположенных подобных структур относительно ранее консолидированных массивов, вероятно, является следствием общего сжатия земной коры в это время.
Близгоризонтальные зоны сместителя тектонического покрова явились благоприятными вместителями субвулканических интрузий андезит-риолитовой формации и оловянного оруденения, связанного с этими интрузиями.

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PROBLEMS OF TECTONIC FLOW OF ROCKS

Tectonic flow of rocks is inhomogeneous, and this heterogeneity causes the formation of structure patterns of various size. In order to understand the mechanism of structure formation it is necessary to study the tectonic flow quantitatively.Some problems are most significant on this way: 1) description and quantitative analysis of structure patterns, 2)quantitative evaluation of strain and rotation, 3) study of stress-metamorphism for evaluation of deformation. The tectonic flow consists of translation and displacement gradient. The

gradient (strain and rotation) can be measured in natural geological objects. Special investigations in many regions of Asia and Europe as well as structure pattern modelling shows that it is possible to obtain the quantitative data defining the deformation and displacement almost everywhere. These data enable to ascertain the formation mechanism of such features as tectonic overthrusts, refolded folds, lythosphere layering, discordance of deformation style, alternation of parallel zones of compression and tension, and others. Analysing the structure patterns it is necessary to take into account specific effects of heterogeneous deformation (cline-, reverse-, press-, and tectonic-suturing-effects). These effects link together the translation and heterogeneities of deformation.Quantitative analysis of structure parageneses and evaluation of strain and rotation is carried out with natural strain gauges in rocks (deformed inclusions, folds, boudinage, cleavage,"tectonofacies", and others) as well as by means of stress-metamorphism study.The stress-metamorphism plays particular role in the evaluation of strain and rotation as it is coursed by deformation and defines it on mini- and micro-levels. Stress-metamorphism is wide-spread and provides the possibility to measure the deformation with satisfactory accuracy. Quantitative study of tectonic flow is an actual problem of modern structure geology, and has a practical application also. In ore regions the structure patterns control the localization of mineral deposits, and stress-metamorphism control the character and morphology of mineralization.

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ПРОБЛЕМЫ ТЕКТОНИЧЕСКОГО ТЕЧЕНИЯ ГОРНЫХ ПОРОД

Тектоническое течение тектоносферы неоднородно, и эта неоднородность определяет возникновение структурных рисунков разных порядков величины. Выяснение механизмов структурообразования требует количественного изучения тектонического течения и ставит следующие основные проблемы: I) описание и количественный анализ структурных рисунков; 2) количественная оценка деформации и ротации; 3) изучение стресс-метаморфизма для оценки деформации. Тектоническое течение состоит из параллельного переноса и градиента перемещения масс. Параллельный перенос не поддается измерению, но может быть вычислен путем анализа структурного рисунка, если известно распределение градиента. Градиент (деформация и ротация) может быть непосредственно измерен в геологических объектах. Специальные исследования во многих районах Азии и Европы и моделирование структурных рисунков показали, что количес-

твенные данные о деформациях и перемещениях можно получить почти повсеместно и с их помощью можно расшифровать механизм таких явлений, как тектонические покровы, наложенные складки, расслоенность литосферы, дискордантность деформаций, чередование параллельных зон сжатия и растяжения и др. При анализе структурных рисунков необходимо использовать закономерности неоднородной деформации (эффекты клина, пресса, смены знака, тектонического сшивания), связывающие параллельный перенос с неоднородностями деформации. Количественное исследование парагенезов структур и оценка деформации и ротации осуществляется с использованием тензодатчиков, заключенных в породе (деформированные объекты, складки, будинаж, кливаж, тектонофации и др.), и проявлений стресс-метаморфизма. При этом стресс-метаморфизм играет особую роль в оценке деформации, так как он неразрывно связан с деформацией и характеризует ее на мини- и микроуровнях. Стресс-метаморфизм распространен очень широко и позволяет измерять деформацию с удовлетворительной точностью. Количественное изучение тектонического течения является основной задачей современной структурной геологии, имеющей также и прикладное значение. В рудных районах структурные рисунки контролируют положение месторождений, а стресс-метаморфизм определяет характер минерализации.

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MESOZOIC DEVELOPMENT OF THE EUROPEAN CONTINENTAL MARGIN IN THE TRANSYLVANIAN-PANNONIAN AREA

Within the Transylvanian-Pannonian area, lying between the Vardar and the Penidic zones, several major events took place during the Mesozoic:

In the Middle-Upper(?) Triassic the opening of the Transylvanian and Darno-Bukk-Meliata basins started with oceanic floor like ophiolites, whereas in the Vardar zone the basic rocks provide strongly contaminated features.

In the Lower Jurassic the Vardar zone opened as an ocean-type basin; further on, in the western part of the Transylvanian Basin, the first compressive movements started resulting in a magmatic arc in the South Apusenids.

During the Upper Jurassic the first marginal-type basin opened in the South Apusenids. In the Vardar zone the uppermost Jurassic coincided with the closing of the innermost furrow.

The compressive movements, connected with the Neokimmerian (Neoco-

mian) phase, featured some granitoid rocks along the western margin of the Transylvanian Basin and led to the opening of a second marginal-type basin in the South Apusenids.

The occurrence of ophiolitic rocks in the Mucsek zone and northwards - the Intra-Pannonian belt - is also assigned to the Neocomian - Barremian (?).
The Mid-Cretaceous tectogenesis, which had affected the Transylvanian Basin, produced east-vergent structures in the uppermost units of the South Apusenids and accomplished the suture between this area and the South Carpathians. In the Darno-Bukk area subduction also took place.
The late Cretaceous events in the Transylvanian-Pannonian area were influenced by the compressive processes in the Inner Dinarids and Darno-Bukk area, responsible, beside some reversed subduction processes in the South Apusenids, for the north vergences of all the Apuseni structures.

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TERRESTRIAL HEAT FLOW OF CONTINENTAL RIFTS

The magnitudes of terrestrial heat flow (q, $mW.m^{-2}$) increase from continental (Baikal rift) to intercontinental (Red Sea) and oceanic rifts (Mid-Atlantic ridge). At the continents q depends on the type of rift and the age of the latest tectono-thermal evidence in the regions. The rift zones of the recent folding structures have the highest q (Rio Grande rift > 100). The dome-volcanic rifts (Kenya and Ethiopia zones) get heated more (> 75-100) than such slit-like rifts as the Upper Rhine (72), Tanganyika (55) or Malavi (42) ones.

The distribution of q is affected by the main rift structures. The low q (< 40) is characterized the "shoulders" of the rifts and the interdepression uplifts. The value of q increases in the rift depressions and in the fracture zones especially limiting or intersecting these areas (half the size and more). If the rift zone development is accompanied by the hydrothermal activity or volcanism the local anomaly of q reaches 250-400 (Gregory, Rio Grande, Baikal rift, etc.).
The endogenic processes are the source of the increased value of q

as well as a whole rifting. They are closely associated with the density decrease of upper mantle and the position of astenosphere diapir.

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ТЕПЛОВОЙ ПОТОК КОНТИНЕНТАЛЬНЫХ РИФТОВ

Величины тепловых потоков (ТП, МВт·м$^{-2}$) увеличиваются от континентальных (Байкальский рифт) к межконтинентальным (Красное море) и океаническим (Срединно-Атлантический хребет) рифтам. На континентах ТП зависят от типа рифта и возраста последней тектоно-магматической активизации кристаллического фундамента. Рифтовые зоны молодых складчатых сооружений имеют самый высокий ТП (рифт Рио-Гранде более 100). Сводово-вулканические рифты (Кенийская и Эфиопская зоны) прогреты сильнее (более 75-100), чем такие щелевые рифты, как Верхнерейнский (72), Танганьикский (55) или Ньясский (42).
Распределение ТП контролируется основными внутририфтовыми структурами. Низкий ТП (менее 40) характерен для "плечей" рифтов и междувпадинных перемычек. Величина ТП увеличивается в рифтовых впадинах и особенно в зонах разломов, ограничивающих или пересекающих эти впадины (в 1,5 раза и более). Если развитие рифтовой зоны сопровождается гидротермальной активностью или магматизмом, то локальные аномалии ТП достигают 250-400 (рифты Грегори, Рио-Гранде, Байкальский и др.).
Эндогенные процессы являются источником повышенных величин ТП, как и рифтогенеза в целом. Они тесно связаны с уменьшением плотности в верхней мантии и положением астеносферного диапира.

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TAPHROGENESIS THROUGH GEOLOGICAL HISTORY IN CHINA

Taphrogenesis has occurred episodically in China from Precambrian to the Cenozoic. The Proterozoic taphrogenic events are considered to be related to the major change in the tectonic regime that occurred after the consolidation of the proto-continent through the Fuping (2.5 Ga ago), Luliang (1.85-1.7 Ga ago), and Jinning (0.9-0.85 Ga ago) tectogenesis. Large cratons centering around north, north-western and southwestern China became sites of rift formation.

Subsequent important rifting epochs include the early and late Paleozoic.
The late Triassic Indosinian orogeny has caused profound changes in the tectonic pattern of China. Continental conditions became predominent in China since Jurassic. During the Mesozoic and Cenozoic, China has experienced a series of taphrogenic events under widely different tectonic environment, which fragmented the continental crust and form different types of intracontinental extensional structures. This paper gives a general account of their distribution, nature and origin. It is hoped that this study will offer some new insight on the dynamics of the continental lithosphere and constraints to the seismic activity of China.

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SYNTHESIS OF DEVELOPMENT AND STRUCTURE OF THE WEST CARPATHIANS AND RELATION TO ADJACENT REGIONS

The West Carpathian Mts. are one of the most complex sediments of the alpides thanks to:
-representation of all basic geotectonic zones including the inner zones of dinaride type
-relation to the Pannonian central massif, bearer of rejuvenization.
Articulation in zones of "heavy" and "light" crust is shown already by Hercynian geosyncline. Crystalline zones with abundant basic rocks form a basis for Early-Paleozoic grabens, paralio- to taphrogeosynclinal Triassic zones, troughs of several types in the Jurassic and Lower Cretaceous. Crust articulation is reflected in geotectonically diverse flysch types: flysch geosyncline, heterogeneous flysch including wild-flysch in the zone of oceanic subduction - Vahicum, black-arc basin with late-tectonic central-Carpathian flysch and late-geosynclinal longitudinal basins of early molasse. The West Carpathians serve as an example of several types of oceanic crust subductions, namely intrasialic and several morphostructural and genetic types of nappes. We consider tectonic melange of the Klippen belt for accompanying phenomenon of oceanic Vahicum subduction, created from the articulated island arc. Vahicum represents a continuation of the Piemont zone from the Alps to the West Carpathians. Tatricum and crystalline belt of the Eastern Carpathians are substituted in a coulisse way. The Central Carpathians are divided from the Apuseni Mts. by a transversal trough and their development is already different from the Jurassic.

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GEODYNAMIC ZONAL DEVELOPMENT OF CONTINENTAL MARGINS TYPES

Division of continental margins into meridional types of passive (Atlantic type) - spreading and active (Pacific type) - compression seems to us not to be full. Peculiarity of northern margins of Eurasia, North America and southern ends of continents suggests existance of latitudinal types of continental margins, characterized by development of pelagogenic depressions in junctions of the largest fault belts. Polar type margins (Atlantic type) differ from them in morphology, active and independent geological history, they are represented by the belt of marginal mobile platforms, separated from the continent by deep fractures and broken down by transverse faults. In their junctions pelagogenic depressions associated with total continental margin extension form. Southern type margins are characteristic of South America, Africa and Australia ends and represent island and subsea-ridged "structural tails"-linear groups of microcontinents with continental and subcontinental crust, having evidences for continental or shallow water geological history in the recent past. Development of dislocations by shifting and associated sphenochasms in structure of southern margins suggests them to be a result of shear interrelation of a continent and an ocean. In Central-American junction meridional compression dominates with formation of structures of transverse shear. As a result of this interaction detachment of continental crust to west and east occurs, accompanied with its rupture and pelagogenic depressions of regional near-shear extension form (the Gulf of Mexico and basins of the Caribbean Sea). In area of interaction between African and European continents combination of depressions of wedge-shaped and normal expansion is characteristic, they are superimposed on ancient platform depressions and associated with junctions of the largest fault belts. The most typical feature for the third type junction-Malay type-is latitudinal interrelation of continental and oceanic crust masses. A giant system of deep shears may exist in its southern part, which is more than 500 km in width and has sublatitudinal trend for more than 15000 km. Depressions of Malay Archipelago, conjugated with the shear system, apparently have the same nature as depressions of the two previous junctions. So, continental margins of the tropical zone may be also related to geodynamic type of shear margins.

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ГЕОДИНАМИЧЕСКАЯ ЗОНАЛЬНОСТЬ ТИПОВ КОНТИНЕНТАЛЬНЫХ ОКРАИН

Деление окраин на меридиональные типы: пассивных (атлантических) - растяжения и активных (тихоокеанских) - сжатия, - представляется неполным. Своеобразие северных окраин Евразии и Северной Америки, южных окончаний континентов говорит о наличии широтных типов континентальных окраин, для которых характерно развитие пелагогенных впадин, возникающих в узлах пересечения крупнейших поясов разломов. Окраины полярного типа, отнесенные к атлантическим, отличаются от них морфологией, активной и самостоятельной геологической историей, и представлены поясом окраинных подвижных платформ, отделенных от континента глубокими расколами и разбитых разломами, поперечными к окраине. В узлах их пересечения возникают пелагогенные впадины, связанные с общим растяжением континентальной окраины. Южный тип окраин, присущий окончаниям Южной Америки, Африки и Австралии, представляет собой островные и подводно-грядовые "структурные хвосты" - линейные группы микроконтинентов с континентальной и субконтинентальной корой и следами континентальной или мелководной геологической истории в недавнем прошлом. Развитие в структуре южных окраин сдвиговых нарушений и связанных с ними клиновидных дислокаций позволяет считать их результатом сколового взаимодействия континента и океана. В Центрально-Американском узле преобладает сжатие вдоль меридиана с образованием структур поперечного сдвигания. Следствием такого взаимодействия является отжатие континентальной коры к западу и востоку с разрывом "гранитного" слоя или всей коры и образование пелагогенных впадин регионального присдвигового растяжения типа Мексиканского залива и бассейнов Карибского моря. В области взаимодействия Африканского и Европейского континентов характерно сочетание депрессий клиновидного и нормального раздвигания, наложенных на древние платформенные депрессии, а в глубинной структуре - связанных с узлами пересечения крупнейших поясов разломов. Для третьего - Малайского - узла наиболее существенно широтное взаимодействие масс континентальной и океанической коры. В его южной части предполагается гигантская система глубинных сдвигов шириной не менее 500 км, прослеживающаяся в субширотном направлении более чем на 15000 км. Котловины Малайского архипелага, сопряженные с этой системой, по-видимому, имеют ту же природу, что и впадины двух предшествующих узлов. Таким образом, континен-

тальные окраины тропической зоны также могут быть отнесены к геодинамическому типу окраин скалывания.

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TECTONICS AND EVOLUTION OF THE NORTHERN EAST PACIFIC RISE: 25 M.Y. B.P. TO THE PRESENT

The northeast Pacific topography and magnetic lineations (25 m.y. B.P. to the Present) record the traces of three major spreading reorganizations. Only one spreading center is observed today, but there is evidence for several ephemeral episodes of twin spreading accompanying the evolution from an extensive Pacific-Guadalupe plate boundary to a much shortened Pacific-Cocos and Pacific-Rivera plate boundary. The 25 m.y. B.P. plate reorganization culminated with the formation of the Guadalupe plate, bound by the Murray fracture zone to the north and the Cocos-Nazca spreading ridge to the south. Between 25 and 12.5 m.y. B.P. spreading continued while the plate retained the same general outline. The 12.5-11 m.y. B.P. reorganization resulted in the creation of a much shortened Pacific-Cocos plate boundary located in its early stages over the Mathematician seamounts and a much reduced Cocos-plate. The last reorganization (6.5-3.5 m.y. B.P.) resulted in the abandonment of the Mathematician spreading ridge as a Pacific-Cocos plate boundary in favor of the East Pacific Rise.

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DIE MORPHOTEKTONISCHE ENTWICKLUNGS-GESCHICHTE DES NEOGEN BECKENS VON ANO MESSINIA (SW-PELOPONNES,GRIECHENLAND) ALS BEISPIEL ZUR KLÄRUNG DER GENESE NICHT-MARINER PLIOQUARTÄNÄREN BECKEN GRIECHENLANDS

Das kleine nicht marine neogen-Becken von Ano Messinia ist ein Teil des Kalamata-Kyparissia Grabens.

Die charakteristischen geologischen Merkmale des Beckens sind:

- Der nordöstliche Rand des Beckens fällt mit der Störungs-Zone des Grabens zusammen, während die südwestlichen Ränder nicht.
- Das Becken ist von allen Seiten von Bergen und Hügeln,die aus alpidischen-Formationen aufgebaut sind, umschlossen.
- Die heutige Entwässerung geschieht durch einen engen Bereich (rd.80 m breit) am südlichen Rand des Beckens.Das Flussbett schneidet in diesem Bereich die Flysch-Schichten der Tripolitza-Zone ein.
- Die Mächtigkeit der postalpidischen terrestrischen Sedimente,im zentralen Bereich des Beckens, beträgt über 280 m.

Der tiefste Punkt des Beckensuntergrundes liegt rd. 200 m. unter dem heutigen Meeres-Spiegel.
Südlich und nordwestlich des Beckens liegen die marinen neogenen Ablagerungen viel höher als die Höhe des flachebenen Teiles des Beckens.
Von den Obenerwähnten ist klar, daß von geomorphologischem Standpunkt das Becken von Ano Messinia *nicht einer echten "intramontane plain" entspricht, sondern daß* die Erosions-Prozesse durch einen synsedimentären Bruchtektonismus mit Rotations Charakter, unterbrochen sind.
Diese Tektonismus zeigt Ähnlichkeiten mit demjenigen der Erdbeben vom Februar 1981 aus den Bereichen des ostlichen korintischen Golfes und Beotien.

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BLOCS EXOTIQUES NEOTETHYSIENS: PLATEFORMES PELAGIQUES ET/OU PLATEAUX OCEANIQUES. Remarques paléogéographiques à partir de quelques exemples des chaînes alpino-himalayennes (Taurus occidental , Oman, zone de suture Indus-Tsangpo)

Une revue critique et comparative de diverses unités tectoniques souvent appelées "blocs exotiques" ou "exotics" dans la littérature géologique des chaînes alpines péri-gondwaniennes, permet de mettre en évidence un certain nombre d'homologies et d'analogies caractéristiques de ces unités exotiques-allochtones. Ces analogies et homologies se situent sur différents plans, stratigraphique et sédimentologique: par exemple, localisation des fameux faciès triasiques condensés de type Hallstatt, tectono-sédimentaire: présence de dykes neptuniens, de méga-brèches d'escarpement de failles sous-marines, magmatique: liaison fréquente avec un important volcanisme *sous-marin de type alcalin; tous* ces phénomènes étant en dernière analyse étroitement controlés par une intense activité tectonique tant distensive: tectonique en horst et hémi-grabens, que décrochante ("wrench tectonic") correspondant aux premières étapes d'amincissement crustal, par extension: failles listriques normales, et lacération: failles décrochantes qui aboutirent à la formation de la Néotéthys *alpine et de ses marges complexes.* Enfin, en accord avec les reconstructions palinspastiques communément admises pour les trois secteurs étudiés (Taurus occidental, Oman et Indus-Tsangpo), ces unités "exotiques" occupent topologiquement une position intermédiaire entre "l'océan" néotéthysien lui-même et un sillon fortement subsident à croûte amincie (?), domaine du dépôt des formations détritiques (flysch ?) *précoces et* des radiolarites mésozoïques. Cette zone intermédiaire, particulièrement active et instable, forme une lanière plus ou moins continue, ramifiée par endroit, qui correspond à un ensemble complexe de plateforme (-es) et/ou plateaux océaniques (au sens large - y compris leurs marges effondrées -).

Les diverses unités exotiques que nous passons en revue ici, témoignent de l'existence de cette zone, probablement installée pour partie sur la marge continentale périgondwanienne elle-même, et/ou, à la limite croûte continentale et océanique (s.s.) les bouleversements tectoniques successifs de l'orogenèse alpino-himalayenne venant souvent occulter notre vision de cette pièce remarquable de l'organisation paléogéographique néotéthysienne.

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EXOTIC TERRANES IN THE EASTERN MARGIN OF THE EURASIA PLATE AND THE PALEOGEOGRAPHIC RECONSTRUCTION OF THE SEA OF PANTHALASSA AT 175 MaBP

Paleogeography of the Sea of Panthalassa at 175 MaBP was constructed based on available geological-petrological-paleomagnetic data and quantitative calculation of relative plate motion back to 175 MaBP by Engebretson (1982). Along the eastern margin of the Eurasia, the Mesozoic-Cenozoic subduction zone complex include much older exotic terranes with continental or island arc affinities. They are Kurosegawa (collision time: - 120 Ma, and origin of plate: Izanagi), Tahin (-120, Izanagi), South Kitakami (-135, Izanagi), Omolon (-140, Izanagi), Annamia (-70, Indian), Okhotsk-East Hokkaido (-75, Kula), Kyushu-Palau (-50 to 0, Philippine Sea), Izu (-3, Philippine Sea), Amami Plateau (0, Philippine Sea), Daito Ridge (0, Philippine Sea) and Okino-Daito Ridge (0, Philippine Sea). Among them, those with pre-Jurassic rocks are Kurosegawa, Omolon, South Kitakami, Tahin, Okhotsk-East Hokkaido, and Annamia. Their travel histories except Annamia are delineated according to the relative plate motions back to 175 MaBP by Engebretson (1982). The result together with the Wrangelia reconstruction (Engebretson, 1982), indicate that those microcontinents or island arcs were scattered in the central part of the Sea of Panthalassa at 175 MaBP. Our reconstruction and the Triassic-Jurassic paleogeography of Main Land China (Klimetz, 1983; Zhang et al., 1983) do not support the concept of "one supercontinent and one superocean". Our reconstruction is based on the assumption that hot spots in the Pacific and Africa plates have been immobable with respect to asthenosphere since 175 MaBP. This assumption was supported by the paleomagnetism on the rocks with different ages in the Kurosegawa terrane in Japan, which indicates the abnormally rapid northward migration with about 20 cm/yr during Early Cretaceous; the value is in good accordance with the relative plate motion calculated by Engebretson (1982).

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CENOZOIC SEDIMENTARY FORMATIONS OF THE BAIKAL RIFT ZONE

In the sedimentary filling of the Baikal Rift Zone (BRZ) depressions three lithostratigraphic complexes of formation rank are recognized. The Late Cretaceous-Eocene complex constitutes the weathering crust formation developed upon forming and warping the initial prerift surface. By the end of the stage, the contours of the Baikal Rift main morphostructures had been outlined. The Rift stage is represented by Eocene-Middle Pliocene lower molasse and Late Miocene-Tertiary upper molasse. The sliding of age boundaries underlines the migration of the processes of rift structure formation along the strike. The lithogenetic features of the formations are defined by mutual effect of tectonic, climatic factors and concrete facial situation of sedimentation, the ratio of the role of these factors varying. The BRZ molasse features are as follows: greater thickness; relation between sedimentary and alkaline-basalt formations and traces of low temperature hydrothermal metasomatosis in sediments of amagmatic depressions; lithostratigraphic asymmetry; the marginal facial zones of the depressions occupied by large lakes are extremely narrow and characterized by lithofacial diversity, the inner zone sediments being relatively uniform; presence of flyshoid sediments; wedging out of coal-bearing sequences from the marginal to inner zones; strengthening of the sedimentary polymictic character, inadequate for the climate upward the stratigraphic section; the inverse trend of the change in fragment size in sediments of the marginal and inner zones of the depressions. The formation boundaries reflect the turning points of the BRZ history. As established by N.A.Florensov, N.A.Logachev, the movements at the end of Middle-the beginning of Late Pliocene were of special importance. They have led to an outburst of effusive activity and degradation of lake basins in the Tunka depressions. In the Baikal depression considerable areas seem to be also dried, but some refugiums remained thus providing for a successive development of endemic fauna which roots go far to Upper Oligocene-Lower Miocene. Due to the Middle Pleistocene movements the Baikal depression acquired an appearance close to recent.

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ОСАДОЧНЫЕ ФОРМАЦИИ КАЙНОЗОЯ БАЙКАЛЬСКОЙ РИФТОВОЙ ЗОНЫ

В осадочном наполнении впадин Байкальской рифтовой зоны (БРЗ) выделяются три литостратиграфических комплекса ранга формаций. Поздний мел-эоценовый комплекс составляет формацию коры выветривания, формировавшуюся в связи с выработкой исходной предрифтовой поверхности и ее короблением. В конце этапа наметились в общих чертах контуры основных морфоструктур Байкальского рифта. Рифтовый этап представлен эоцен-среднеплиоценовой нижней молассой и позднемиоцен-четвертичной верхней молассой. Скольжение возрастных границ подчеркивает миграцию процессов формирования рифтовых структур по их простиранию. Литогенетические особенности формаций определяются совокупным влиянием тектонических, климатических факторов и конкретной фациальной обстановкой накопления осадков при различном соотношении роли этих факторов. Особенности моласс БРЗ: повышенная мощность, связь осадочных формаций с щелочной базальтовой и следы низкотемпературного гидротермального метасоматоза в осадках амагматических впадин; литостратиграфическая асимметрия; краевые фациальные зоны впадин, занятых крупными озерами, предельно узкие, они отличаются литофациальной пестротой при относительной выдержанности осадков внутренних зон; наличие флишоидных отложений; выклинивание угленосных толщ от краевых зон к внутренним; усиление полимиктовости осадков вверх по разрезу, не адекватное изменениям климата; противоположные тенденции изменения размерности обломков в осадках краевых и внутренних зон впадин. Границы формаций отмечают переломные моменты в истории развития БРЗ. Как установлено Н.А. Флоренсовым и Н.А. Логачевым, особое значение имели движения в конце среднего-начале позднего плиоцена. Они привели к вспышке эффузивной деятельности в Тункинских впадинах и вырождению в них озерных бассейнов. В Байкальской впадине также, по-видимому, были осушены значительные площади, но сохранились рефугиумы, что обеспечило преемственное развитие эндемичной фауны, корни которой уходят в верхи олигоцена - низы миоцена. В результате движений среднего плейстоцена Байкальская впадина приобрела облик, близкий к современному.

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EMPLACEMENT CRITERIA FOR THE VOURINOS OPHIOLITE, NORTHERN GREECE: RELATIONS TO THE UNCONFORMABLE JURASSIC SEQUENCE

The lower-Jurassic Vourinos Ophiolite is overlain by Malm-Kimmeridgian Jurassic carbonate sequences: the latter includes at its base a lateritic surface areally, grading to coral-, calpionellid-, and oölite-bearing limestones. Comparison of original horizontality in the ophiolitic magmatic rocks to that of the Jurassic limestone indicates that the ophiolitic rocks were rotated 40-80 degrees before deposition of the Jurassic continental series. Younger Cretaceous limestone also overlies an erosional unconformity that in places cuts through the Jurassic series.
Independent data suggest that Vourinos was formed at a slow-spreading center: there are no internal deformation structures in the ophiolite correlating to the emplacement period. In the 50(?) million year time span between oceanic crustal formation and deposition of the fossiliferous Jurassic section, the ophiolite i) if transported by sea-floor spreading, could not have been conveyed more than 250-350 km; ii) probably underwent up-lift and rotation of block-faulted units; iii) was eroded nearly contemporaneously with emplacement; iv) subsided to shallow-to-deep continental sea conditions. The depth of Jurassic erosion into the ophiolite varies from 0.5 to 1.5 km. We believe that geometric and structural relations between the ophiolite and carbonates are best explained by locating the Vourinos "ocean" to the west of the ophiolite's present locale.

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LA EVOLUCION GEOLOGICA DEL OCCIDENTE CUBANO DURANTE EL MEZOZOICO Y SU METALOGENIA

Se presenta un modelo explicativo de la evolución geologica del Occidente Cubano durante el Mezozoico, basado en la interpretación de determinaciones radiométricas de edad absoluta, así como del carácter de las secuencias que aparecen en las zonas estructuro-faciales Guaniguanico, Bahía Honda y San Diego de los Baños y sus equivalentes en la parte central de la isla.

El Modelo adoptado acepta el funcionamiento de una zona de subducción de tipo B en el área desde fines del Jurásico Superior. La mencionada zona de subducción se mantuvo activa hasta el Eoceno Medio, dando lugar a la Formación de un arco insular.

Las cuencas Guaniguanico y San Diego de los Baños son caracterizadas como cuencas marginales, del tió interarco en el segundo caso, formadas durante el retroceso hacia el Sureste del arco volcánico.

Estos procesos estuvieron acompañados de una intensa actividad metalogenética, cuyas particularidades son enunciadas y de las cuales se presentan sus principales exponentes: los yacimientos sulfurosos estratiformes de edad Jurásico Medio-Jurásico Superior Temprano y de edad Cretácio (Pre-Campaniano) de la zona estructuro-facial Bahía--Honda.

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ABOUT THE NATURE OF REFLECTORS IN THE CONTINENTAL CRUST

As can be shown by a great number of examples from various continents seismic reflectors in the steep-angle area generally consists of three types.

They may be:

(1) layered intrusions, e.g. crystalline seams of magmatic bodies;
(2) layered metamorphic rock units, e.g. metasediments;
(3) layered fault zones.

Various criteria are used for a discrimination between these 3 types, e.g.

(i) continuity and strength of reflections;
(ii) reflection polarity, phase consistency;
(iii) observations of flexures and/or faulting;
(iv) reflector density and reflector sequences;
(v) correlation to wide-angle reflectors.

Especially the reflector density is completely different in old shield areas and younger parts of the continents. These observations may be correlated to the different structure and the different heat flow provinces. The ductile lower crust in warm areas may easily be intruded by rising basaltic magmas from the mantle which may spread out laterally and form crystallization seams which provide good reflectors upon solidification. The Variscan orogeny in Central Europe with its large thermal anomaly is the place of extremely strong and

continuous reflectors in the lower crust and provides a good example for reflectors of type (1). It is speculated that in a tensional regime even a new Moho may be formed by a huge intrusion in a similar way as below oceanic rifts.

The more brittle behaviour of cold crusts may give rise to reflectors, if different sediments are transported down to the lower crust (and possibly up again, as in case of the Ivrea body). Such metasediments have rather high velocities and may also form layered sequences. Such sequences may have undergone only a mild metamorphosis and have not encountered a low-viscosity, near-melting stage. Their maximum of reflector density is generally not in the lower crust. They may be intimately connected with fault zones. But faults zones themselves in the brittle upper crust and in the ductile lower crust are able to reflect seismic waves. This is a consequence of their laminated structure, of several mylonitic branches and of higher pore pressure in their weakened material. Often, such fault zones can be observed down to the upper mantle.
In the wide-angle range reflections are either from a reflector (or a reflector sequence) with positive polarity or from a strong positive-gradient zone. Their correlation to steep-angle reflectors and their apparent velocities helps to establish reliable models for the true nature of such reflectors.

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A NEW "COMPACT" GLOBAL TECTONICS MODEL FOR ASIA TOWARDS THE PERMO-TRIASSIC BOUNDARY

By using a magnetized sphere supporting mobile plates, an adjustment as compact as possible has been researched for Asia towards the permo-triassic boundary, after the position in latitude and attitude of Europe, Africa, India, Australia has been fixed. Asia itself has been divided into more or less big plates limited by the main mantellic accidents. The proposed model shows, if it is taken care too of the folded belts, that it is possible to avoid the big hiatus appearing on most of the well known plate tectonics reconstructions of Asia on its southern and south-eastern borders. The model implicates large rotations in a mainly east-west direction and shows good agreement in the reconstitution of sedimentary facies belts.

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THE CANADIAN ARCTIC ISLANDS FROM 70 Ma TO THE PRESENT

Up to 70 Ma the area was undergoing marine mud sedimentation at a time of high sea level and tectonic quiescence. With initiation of a triple junction off Labrador, and Labrador Sea-Baffin Bay spreading, Greenland began counterclockwise rotation against Ellesmere Island. The eastern Arctic was differentiated into broad basins (Remus, Meighen, West Sverdrup) and upwarps (Grantland, Princess Margaret, Cornwall), with local (Paleocene) thrust faulting. Rift basins with coarse fluvial fill were initiated in northeast Ellesmere and Bylot Islands. Elsewhere (Remus, Meighen basins) shallow marine and deltaic clastics accumulated.

Between 55 and 35 Ma Greenland drifted northeast relative to Canada. The eastern Arctic Islands acted as a transpressive, diffuse plate boundary. Upwarps were rejuvenated and coarse fluviodeltaic sandstones and coals accumulated in Remus and Lake Hazen Basins. Total sinistral displacement of Greenland totals 200-300 km, most of it diffused across strike-parallel faults of Eurekan Fold Belt. Displacement on Nares Strait probably was minor. Deformation culminated at about 35 Ma with generation of open folds and gently- to steeply-dipping reversed faults, with local fanglomerate wedges.

After about 35 Ma relative movement of Greenland ceased, and extensional faulting has predominated, particularly during the Miocene, when local wedges of nonmarine clastics accumulated.

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STRUCTURE OF CONTINENTAL RIFT ZONES AND HYDROCARBON TRAPS

Continental rift zones (avlakogenes, riftogenes, grabens etc.) are regional hydrocarbon accumulators. Basins are mostly grabenlike and have similar structure, history and reservoir characteristics.
The lower units of the graben cover have block structure, the upper ones are plicated. Basin relief ridges created due to consedimenta - tional development of antithetic longitudinal fractures are overlapped by organogenic units high reservoir characteristics.
In case of graben separation from the open sea rift sediments are sure to contain salt formations deposited in a transgressive environment. A new - applicative - type of transgressive sedimentation is introduced, implying the greatest thickness and completeness of basal salt horizons at the relief highs.
The infered paragenetic relationship between halogenic formations and alkalic volcanites as well as the composition of the former make it possible to refer them to volcanogenic-sedimentary units.
Hydrocarbon accumulates predominantly in tectonic and combined traps. Secondary hydrocarbon migration, structure and position of traps are controlled by longitudinal and diagonal shifts.
Detailed paleotectonic analysis techniques have been further refined. Methods of tectonic trap investigation and criteria for detecting buried shifts have developed.

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ОСОБЕННОСТИ СТРОЕНИЯ И НЕФТЕГАЗОНОСНОСТИ КОНТИНЕНТАЛЬНЫХ РИФТОВЫХ ЗОН

Континентальные рифтовые зоны, описываемые как авлакогены, грабены, рифтогены и другие структуры, регионально нефтегазоносны. К ним приурочены бассейны преимущественно грабенового типа, характеризующиеся общностью строения, развития и нефтегазоностности.
Нижним комплексам чехла грабенов присуща блоковая структура, верхним - пликативная. Отмечается антитетический характер продольных разломов. Конседиментационное их развитие определяет наличие гряд в рельефе бассейнов, контролирующих карбонатное осадконакопление. На грядах рельефа формируются органогенные постройки с высокими емкостными свойствами.
В условиях изолированности грабена в составе осадков рифтового этапа типично наличие соленосных формаций, которые по положению в седиментационных циклах являются трансгрессивными. Выделяется разновидность трансгрессивного залегания (аппликативное), при котором на выступах рельефа накапливалась максимальная толщина базальных горизонтов соленосной толщи при наибольшей полноте разреза. Установлена парагенетическая связь щелочных вулканитов и галогенных формаций, что наряду с особенностями состава соленосных пород позволяет относить их к вулканогенно-осадочным образованиям.
Залежи углеводородов локализуются преимущественно в тектонически экранированных или комбинированных ловушках. Характерны продольные и диагональные сдвиги, определяющие условия вторичной миграции углеводородов, особенности строения и размещения ловушек.
Автором уточнены способы детального палеотектонического анализа, позволяющие прогнозировать участки развития коллекторов; разработаны приемы анализа тектонически экранированных ловушек, критерии выделения сдвигов в закрытых районах. Это иллюстрируется примерами по Припятскому нефтеносному бассейну.

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RIFTING THROUGH THE GEOLOGICAL HISTORY

Linear extensional rift and rift-like structures have been generated many times during varios periods of the Earth history since early stages. These structures have varied with time, hover, in scale, morphology, formations, paragenesis of tectonic features, regularity of distribution and evolution. We distin-

guish five major stages of rifting: Archean, Early Proterozoic, Late Proterozoic, Paleozoic and Mesozoic-Cenozoic. Linear structures of the Archean stage combine features of structure and development similar to those typical of both rift and geosynclinal zones in the late periods of the Earth history. At the Early Proterozoic stage protorift and protogeosynclinal structures can be distinguished for the first time, though differences are not very distinct. Paleorift zones of the Late Proterozoic stage appeared contemporary with geosynclinal belts and partly regenerated during the Paleozoic stage differ essentially from geosynclinal belts and zones; their structural position and evolution, however, was related to the position and development of letter. In contrast, the distribution and evolution of the rift zones and belts during the Mesocenozoic stage are connected mainly with the distruction of continents and formation of the "secondary" oceanic basins; they are complementary to the Mesocenozoic geosynclinal-orogenic belts. Periods of the greatest development of rift-like and rift structures (Archean, Riphean and Mesocenozoic) probably correspond to the major phases of the Earth expansion wich can be distinguished in its pulsating evolution.

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ЭВОЛЮЦИЯ РИФТОГЕНЕЗА В ИСТОРИИ ЗЕМЛИ

Линейные рифтовые и рифтоподобные структуры растяжения возникали в истории Земли многократно начиная с самых ранних ее эпох. Однако со временем их размеры, морфология, формации, парагенезы тектонических форм, закономерности размещения и характер развития испытывали изменения. Мы различаем пять мегаэпох рифтогенеза: архейскую, раннепротерозойскую, позднепротерозойскую, палеозойскую и мезо-кайнозойскую. Линейные структуры архейской мегаэпохи сочетали в себе черты структуры и развития, присущие как рифтовым, так и геосинклинальным зонам последующих периодов истории Земли. В следующую, раннепротерозойскую мегаэпоху проторифтовые и протогеосинклинальные зоны впервые могли быть обособлены, однако их различия были еще неотчетливы.

Палеорифтовые зоны, возникшие в позднепротерозойскую мегаэпоху одновременно с геосинклинальными поясами и частично регенерированные в палеозойскую мегаэпоху, существенно отличаются от структур последних, но в своем расположении и развитии тесно связаны с ними. Напротив, в мезо-кайнозойскую мегаэпоху заложение и эволюция рифтовых поясов и

зон были в основном связаны с процессами распада континентов и формирования "вторичных" океанических впадин; их структурная позиция и развитие были комплементарны по отношению к мезо-кайнозойским геосинклинально-орогенным поясам. Главные эпохи активизации рифтоподобных и рифтовых структур (архейская, рифейская и мезо-кайнозойская), возможно, отвечают основным фазам некоторого расширения Земли в ходе ее пульсационного развития.

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EL MACIZO DE ESCAMBRAY: COMPOSICION DE UNA GIGANTESCA VENTANA TECTONICA EN CUBA SUR-CENTRAL

El macizo de Escambray (ME) consiste de dos grandes antiformas cupuliformes donde unas secuencias nappe-escamadas sufrieron un metamorfismo de alta presión-baja temperatura, asociado con diferentes fases de plegamiento. Aquí se encontraron fósiles del Oxfordiano, Titoniano y Neocomiano. Los sedimentos más antiguos del ME son metaclastitas ricas en cuarzo, con algunas intercalaciones metacalcáreas, metavolcánicas y metasilicíticas (J_1-J_3 ox). Las unidades metacarbonáticas están representadas por mármoles oscuros y bituminosos del J_3-K_1 (formaciones Mayarí y Collantes) y por la Fm.Cobrito de tipo Flysch (J).

Los mármoles claros de estratos delgados con metabrechas (Fm.Loma Quivicán) y metagrauvacas (Fm.Sabina) parecen corresponder al Cretácico Medio-Superior. Todas estas litologías se correlacionan con el corte sedimentario de Cuba Occidental y parcialmente, con la Zona Placetas del norte de Cuba Central.

El ME difiere de las sequencias mencionadas arriba por la presencia de metabasitas toleíticas, que constituyen las formaciones siguientes: Yayabo (J_1-J_2), Yaguanabo (J_3-K_1) y el miembro Felicidad (J_1-J_3 ox). Las vulcanitas Cretácicas calcoalcalinas y las anfibolitas de Mabujina, más antiguas, yacen en posición alóctona sobre el ME (Somin y Millán, 1976, 1981). El metamorfismo invertido del ME estuvo conectado con una subducción de sus secuencias debajo de la región del arco volcánico, probablemente situada al sur. Por lo tanto, el ME parece representar diferentes elementos de un margen continental activo situado detrás de un arco volcánico.

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STRUCTURAL DEVELOPMENT OF METAMORPHIC ASSEMBLAGES AND THE PROBLEM OF HORIZONTAL TECTONIC FLOWS

Many structure formation processes, when considered on a certain scale, appear to follow the laws of hydrodynamics of viscous liquid and can be interpreted as a result of a shear flow. This suggests that the geosyncline folding represents structural reflection of steep tectonic flows whereas the nappe systems reflect horizontal flows, which are essential constituents of tectonic layering of the lithosphere. The flow evidence is more pronounced in metamorphic rocks than in unmetamorphosed terrains, therefore metamorphic areals are thought to be indicators of tectonic flows. The horizontal flow in metamorphic terrains exhibits an ubiquitous and pronounved pattern of bedding cleavage, folds of bedding shear flow and other characteristic of an early stage of the evolution of most assemblages.

Geophysical evidence suggests that the horizontal tectonic flows occuring at the background of regional ultrametamorphism correspond to all the features of asthenolens (low velocity layer, zone of low density, horizontal focal surface). Thus, the zones of regional metamorphism can be referred to as crustal asthenolens of pre-existing geological periods. The study of metamorphic areals of thermal domes occurring at different levels above the zones of regional melting, i.e. both at the asthenolens-lithoplate boundary and within the lithoplate, shows that the horizontal flow - in its apparent or obscure form - takes place at all the levels of tectonically layered lithosphere of active belts. Further study of the horizontal tectonic flows requires a combined geophysical and structural-petrological approach alongside with the development of quantitative methods of estimating the plastic component of a shear.

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СТРУКТУРНОЕ РАЗВИТИЕ МЕТАМОРФИЧЕСКИХ КОМПЛЕКСОВ И ПРОБЛЕМА ГОРИЗОНТАЛЬНЫХ ТЕКТОНИЧЕСКИХ ПОТОКОВ

Многие процессы структурообразования, при рассмотрении их в определенном масштабе, в первом приближении подчиняются законам гидродинамики вязкой жидкости и могут интерпретироваться как результат сдвигового течения. С этих позиций есть основания рассматривать

геосинклинальную складчатость как структурное выражение крутоориентированных тектонических потоков, а системы покровов - как выражение горизонтальных потоков - важнейшего элемента тектонической расслоенности литосферы. В метаморфических породах процессы течения проявляются гораздо отчетливее, чем в неметаморфизованных, поэтому метаморфические ареалы выступают в роли индикаторов тектонических потоков. Горизонтальное течение в метаморфических толщах находит очень четкое и повсеместное выражение в послойной сланцеватости, складках послойного сдвигового течения, других особенностях, характерных для ранней стадии развития большинства комплексов.

Горизонтальные тектонические потоки, развивающиеся на фоне регионального ультраметаморфизма, по геофизическим характеристикам должны отвечать всем признакам астенолинз (волновод, область разуплотнения, горизонтальная фокальная плоскость землетрясений). Отсюда зоны регионального ультраметаморфизма могут рассматриваться в качестве коровых астенолинз геологического прошлого. Изучение метаморфических ареалов термальных куполов, развивающихся на разных уровнях над зонами регионального плавления, то есть на границе астенолинза-литопластина и в самой литопластине, показало, что горизонтальное течение в явной или завуалированной форме осуществляется на всех уровнях тектонически расслоенной литосферы подвижных поясов. Дальнейшее изучение горизонтальных тектонических потоков требует комплексного геофизического и структурно-петрологического подхода, а также разработки количественных методов оценки пластической составляющей сдвига.

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MESOZOIC SEDIMENTATION PATTERN AND PALAEOGEOGRAPHIC DEVELOPMENTS - NORTH WESTERN INDIA

The palaeogeographic developments during Mesozoic in the northwestern India were mainly governed by its epeirogenic history which in turn guided the sedimentation pattern. The Aravalli mountains acted as a major promontory for conspicuous development of drainage systems on its eastern and western flanks. It also served as a provenance for the sediments deposited in adjacent basins. Fragmentation of Gondwanaland with anticlockwise rotation of Indian subcontinent and its northward flight possibly induced crustal forces in the area resulting into rejuvination of old tectonic elements. Sedimentation history of each basin was thus affected by tectonic evolution of the area.

The conceptual sedimentation models and palaeogeographic developments suggest that the Indian shield which had a northerly slope

was gradually encroached southward by the Tethys sea progressively with time since Permian. Likewise, the drainage system to the west of Aravalli mountains also changed its course anticlockwise from north to south through west. The development of delta complex during Lower Cretaceous regressive phase was much wider than the Upper Jurassic. Jurassic sedimentation was confined only to Rajasthan, Kutch and adjoining Indus basin. The Cenomanian transgression affected as far south as Narmada basin where sediments were deposited under an ephemeral epicontinental sea. Major part of area now occupied by Cambay basin mainly had a fluvial influence during Mesozoic history. At the end, the pronounced Deccan Trap volcanic activity which commenced in phases from Late Cretaceous to Palaeocene nearly affected one half of the area.

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PLATE TECTONICS AND MINERALIZATION IN HIMALAYAS

The theory of plate tectonics has created new ideas on the evolution of Himalayas and the genesis of ore deposits. It is generally believed that the collision of the Indian and Tibetian shields resulted in the origin of Himalayas. The purpose of this paper is to discuss the plate tectonic phenomena and the associated metallogeny, based on the relevant data from the Himalayas and the adjacent tectogens representing parts of tethyan regions.

The presence of peripheral ophiolites in the cretaceous sequence, representing part of ocean floor, flysch sediments, faunal assocation, development of syntaxial band and the paleomagnetic data, have suggested an early Cenozoic age (40-60 million years) for the collision. The major mountain building in the Himalayas began at least 35 million years ago. The northern margin of the original Indian continent cannot be located exactly because it is deformed in creation of Himalayas. The Indus-Tsangpo junction marks the suture of microcontinents and the Tibet. The region of the syntaxial band in the Eastern Himalayas and the adjoining Brumese Arc is an important junction of the plate boundaries. The Siwalik and the Indogangetic troughs had developed successively as large linear, downbuckles during progressive stage of collision when the Indian plate got jammed against the Tibetan plate. Thus, when essentially continent-continent interaction was operative in the Cenozoic in the Himalayas, complex continent-ocean-island arc interaction were taking place in the adjacent Manipur-Nagaland-Arakan Yoma-Andaman-Nicobar-Indonesian belt.

The relation between mineralization and the plate tectonics is discussed by considering the various tectonic settings in which the ore can form.

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PATTERNS OF RIFT FAULTING AND CAUSATIVE STRESS-FIELDS

Much attention has recently been given to the form of normal faults in the vertical dimension. Much more attention needs to be given to their form along strike, to obtain a 3D picture of normal faults. The Ethiopian rift valley shows a variety of fault patterns, few of which can be explained by current theories and models of crustal rifting (eg. Cloos, 1958; Morton & Black, 1975; *Freund & Merzer*, 1976; *Illies*, 1981). *Among unexplained structures we* can select the following:

A. Rift margins First, the right offset of the rift valley at 9.5^{9}N latitude is marked by a direct southward projection of the western margin of Afar into the eastern margin of the rift valley. The accompanying switch in polarity of downthrow suggests severe control on the rifting stress-field by a pre-existing crustal structure. Second, antithetic block-faulting of Morton-Black type is only visibly developed at Hora Mirrga (eastern margin of rift, lat. 8.5^{9}N), in conjunction with an offset of the margin where a pattern of obliquely intersecting faults occurs. Such a pattern is also detected in the western margin of Afar: is block-tilting therefore facilitated by two sets of intersecting normal faults? Third, the Amaro horst (Ethiopia's Ruwenzori, at lat. 6.5^{9}N) is fringed by steeply inward-tilted blocks on the floors of both the graben separated by the horst. The horst thus appears to represent a block of preserved, unthinned crust risen from the axis of a zone of strongly thinned crust.

B. Rift floor Finer structures than those of the rift margins are developed in the Quaternary fracture patterns of the rift floor. Some enigmatic styles include: 1. high-standing blocks of horizontal strata obliquely athwart zones of tilted strata; 2. narrow "lip horsts" that exaggerate the topography on the upthrown side of block faults; 3. segmented faults, where each segment terminates obliquely within the upthrown side of the block; and 4. the plan of the facing of scarps of rift-floor faults is more commonly convex than concave towards the downthrown block. None of these four *structural styles* has yet been modelled or explained.

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TECTONICS OF THE LOW SPREADING OCEANIC RIFTS: RESULTS OF STUDY OF THE REYKJANES AND RED SEA RIFTS WITH SUBMERSIBLES

The Reykjanes Ridge was studied at 58°N where spreading rate is of 2 cm/year. The rift valley of 15-17 km wide is situated in the ridge center. It is bordered by fault scarps of 500-700 m high.

Fault pattern is alligned 30-40 NE parallel to the ridge strike and oblique to the direction towards the pole of plate opening, an angle is approximately 20°,. The rift valley is occupied by an echelon system of Holocene volcanic ridges each of them being 500 m high, 2.5-3 km wide and 30-40 km long. They are oriented 10-15 NE orthogonally to the plate motion direction. The volcanic ridges consist of tube lava flows of basalts with the mean oceanic tholeiitic composition.

The axial valley in the Red Sea rift at 18°N (spreading rate of 1.6 cm/year) is 4-5 km wide. It is bordered from both sides by staircases of fault scarps. An extrusive zone of 1 km wide occupies the central part of the rift valley. It consists of volcanic ediffices of 150-300 m high. Both fault scarps and the extrusive zone go parallel to one another and orthogonal to the plate motion. Basalts belong to high-Fe tholeiites.

Differences between the Reykjanes and Red Sea Rifts are due to: (1) oblique spreading in the Reykjanes Ridge in distinction from orthogonal spreading in the Red Sea Rift, and (2) very high productivity of basalt eruption in the Reykjanes Ridge no less than 5 times more than in the Red Sea Rift as a result of the Reykjanes Ridge being near the Iceland hot spot.

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ТЕКТОНИКА ОКЕАНИЧЕСКИХ РИФТОВ С МАЛОЙ СКОРОСТЬЮ СПРЕДИНГА ПО РЕЗУЛЬТАТАМ ПОДВОДНЫХ ИССЛЕДОВАНИЙ ХРЕБТА РЕЙКЬЯНЕС И КРАСНОГО МОРЯ

Хребет Рейкьянес был изучен с помощью подводных обитаемых аппаратов на 58° с.ш., где скорость спрединга равна 2 см/год. Здесь выделяется рифтовая долина шириной 15-17 км, ограниченная сбросовыми уступами высотой 500-700 м. Уступы простираются (СВ 30-40°) параллельно общей ориентировки хребта и косо, под углом примерно 20° к направлению на полюс раскрытия. Рифтовая долина занята эшелонированной системой вулканических гряд голоценового возраста высотой до 500 м, шириной 2,5-3 км и длиной до 30-40 км. Они ориентированы (СВ 10-15°) на полюс раскрытия перпендикулярно направлению движения литосферных плит. Вулканические гряды сложены трубами и массивными потоками базальтов. Базальты по составу отвечают среднему океаническому толеиту.

В Красноморском рифте (скорость спрединга 1,6 см/год) в районе 18° с.ш. осевая долина имеет ширину 4-5 км, с обеих сторон обрамлена лестницей сбросовых уступов. В центре располагается экструзивная зона шириной около 1 км, состоящая из голоценовых вулканических

центров высотой 150-300 м. Сбросовые уступы и экструзивная зона ориентированы параллельно друг другу и перпендикулярно направлению движения литосферных плит. Базальты принадлежат к высокожелезистым океаническим толеитам.

Различия в строении рифтов хребта Рейкьянес и Красного моря обусловлены двумя причинами: косым спредингом хребта Рейкьянес в отличие от ортогонального в Красном море и значительно большей (не менее, чем в 5 раз) интенсивностью вулканизма на хребте Рейкьянес по сравнению с Красным морем, что вызвано близостью хребта Рейкьянес к Исландской горячей точке.

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THERMO MECHANICAL PROCESSES OCCURING IN THE LITHOSPHERE DURING RIFTING

The birth of a rift is modelized assuming an initial thermal perturbation in the asthenosphere. We study the evolution of the system, lithosphere-astenosphere, by the mean of a thermomechanical model with hypothesis of a non newtonian rheological behaviour function of the depth. The vertical movements of the crust, the lithospheric thinning, the stresses, the gravity anomalies and the heat flow are computed as a function of the time during the rifting. The results are compared to available examples of rifts (Gulf of Suez, Rhin Graben, Baikal Rift...).

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GEOPHYSICAL CONSTRAINS ON THE DEVELOPMENT OF THE RIO GRANDE RIFT

The Rio Grande rift is a major tectonic feature in the southwestern United States, which is composed of a series of interconnected tectonic depressions extending over 900 km from central Colorado through New Mexico into northernmost Mexico and westernmost Texas. Seismicity in the area is diffuse, but indicates extension within the rift. Refraction and surface wave studies show the crust to be thinned and suggest anomalously low upper mantle seismic velocities beneath the rift. Reflection profiling and gravity studies corroborate geological data and indicate that most of the rift depressions involve complicated, strongly asymmetrical structures. When the gravitational effects of these depressions and structures are removed, a broad gravity high is generally present. Heat flow and electromagnetic sounding data indicate high crustal and upper mantle temperatures, but the shallow thermal field is complex. Two distinct extensional events have occurred at the site of the Rio Grande rift. Starting approximately 30 m.y. ago, relatively shallow, northwest

trending basins were developed, characterized by low angle faulting and relatively large extensions. The modern rift structure was formed 10 to 5 m.y. ago, and is characterized by high angle block faulting disecting earlier basins. Thermal models indicate that the change in tectonic style between the two extensional events was due to cooling of the lithosphere after a major phase of magmatic heating which preceeded the first event.

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SEA LEVEL AS A NEW MEANS OF STUDYING THE EARTH'S INTERIOR

At least 9/10 of the present geoid relief must originate from sub--lithospheric density irregularities. Sea level analyses of different geological time units unanimously indicate that the geoid relief deforms with rate of about 10 mm/yr (and amplitudes of up to some 100 meters).

Such rapid changes within the Earth are likely to take place at phase-transitional boundaries (e.g. olivine/spinel at about 420 km and spinel/oxides at about 670 km), in the thickness and properties of the low-viscosity zone, and/or at the core/mantle interface.

Studies of eustatic sea level changes (due to the deformation of the geoid relief), preferably in combination with paleomagnetism, provide a new tool for studies of the Earth's interior; its motions, phase-changes, irregularities, etc.

Besides, "gravitational drop motions" have been identified. These are gravitational highs and lows that travel up and down the globe in regular rhythms. They must be caused by similar motions within the upper mantle.

The upper mantle seems on the whole to be the place of very much geodynamic activity.

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EARLY TERTIARY MAGMATISM IN THE SOUTHWEST ROCKALL PLATEAU AND THE IMPLICATIONS FOR THE ORIGIN OF THE DIPPING REFLECTOR SEQUENCE

Drilling during DSDP Legs 48 and 81 has revealed that substantial igneous activity accompanied the separation of the Rockall Plateau from Greenland during the early Tertiary. Volcanism began during the late Palaeocene with the extrusion of extensive tholeiitic basalt flows which give rise to the series of oceanward-dipping seismic reflectors characteristic of this and several other passive continental margins. Basalt extrusion apparently terminated close to the Palaeocene-Eocene boundary, and a period of relative quies-

cence followed. When volcanism recommenced, its character was markedly different, being highly explosive and of more variable chemistry. A series of air-fall tuffs and lapilli tuffs were deposited at this time; although these are largely of a tholeiitic nature, subsidiary intermediate and alkali basalt types also occur. The intensity of pyroclastic activity declined suddenly later in the early Eocene, coincident with a major transgression over the SW Rockall area. Subsequently, only thin sporadic tholeiitic tuffs were deposited, associated with a renewal of basalt extrusion. The significance of these phases of volcanism is discussed in terms of the evolution of the margin, particularly with regard to the mode of generation of the basalt pile which forms the dipping reflector sequence.

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ЛИНЕАМЕНТЫ ПРЕДСУДЕТСКОЙ ОБЛАСТИ

В Предсудетской области (юго-западная часть Польши) выявлено несколько глубинных разломов, простирающихся на другие тектонические единицы. Данные по этим разломам получены на основании геофизических исследований и глубокого бурения. Предсудетская область относится к верхнепалеозойской (варисцийской) платформе и в связи с этим развитие глубинных разломов в осадочном чехле можно проследить начиная с верхнего палеозоя. Наиболее детально изучены разломы простирания СЗ - ЮВ: тектонические зоны Средней Одры и Дольская, образовавшиеся во время заальской фазы. Эти разломы оказывали сильное влияние на фациальное развитие перми (особенно красного лежня) и триаса. Тектоническая зона Средней Одры является отрезком линеамента Гамбург - Краков. Она была весьма активной во время альпийского орогенеза. Данные сейсмических зондирований коры и верхней мантии показали, что вдоль разломов Средней Одры и Дольского прослеживаются нарушения поверхности Мохо с амплитудой порядка 2-4 км. Указанные разломы отражаются, кроме того, в аномалиях гравиметрического и магнитного полей. К другим линеаментам, выявленным в Предсудетской области, относятся линеаменты Ныса - Кошалин меридионального простирания и Жары - Остшешув - Серадз широтного простирания. Принимается предгерцинский возраст их образования, так как они представляют границы более древних блоков. Эти разломы оказывали сильное воздействие на фациальное развитие перми и даже мезозоя. Под влиянием растягивающих напряжений во время киммерийской складчатости в осадочном чехле верхнепалеозойской платформы в зонах этих линеаментов проявилась соляная тектоника и образовались кулисообразные гравитационные грабены.

Некоторые из этих линеаментов отражаются на космических снимках. Исследование линеаментов играет важную роль в поисках залежей нефти и газа, а также других видов полезных ископаемых.

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PELAGONIAN ZONE IN GREECE: A POLYPHASE - DEFORMED FRAGMENT OF THE CIMMERIAN CONTINENT

Data from the northwestern Macedonia in Greece, correlated with those which have been reported for northern Turkey, indicate that the Pelagonian zone of Hellenides represents a continental fragment which is part of the Cimmerian continent. The Pelagonian zone consists of rocks of continental assemblage which overlie a sialic basement composed of polyphase-deformed metamorphic rocks. Upper Palaeozoic granites (U/Pb isotopic-age 302.4^{+5}_{-15} m.y) intrude this basement. Structural analysis in the Pelagonian zone showed that six folding phases are evident within the polyphase-deformed basement.
The comparisons of the geotectonic conditions between the western Pelagonian margin and the western margin of Serbomacedonian zone show similarities in the lithological succession and the structure, suggesting an analogous palaeogeographic development since Permotriassic times. A permotriassic age is suggested for the separation of the Palaeozoic continent and the initial rifting in the two oceanic basins east and west of the Pelagonian. The closure time of these two basins as well as their possible correlations with the Paleo- and Neo-Tethys are discussed.

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STRUCTURAL ZONATION AND APPLIED FORCES WITHIN THE NORTHERN PART OF ARABE PLATFORM

In studying the geological materials of the Northern part of Arab Peninsula and also by means of photo satellite interpretation we may distinguish as already known a stable and a mobile part within the body of the platform, and it is also possible to detect many minor and major faults and several structural features, as an "embrionic geosyncline" caused by the movement of adjacent geosyncline area that is palmyrid system.
Some alternating forces are on the basis of development through geologic ages of the major structural units of the studied area. Hereby,

in the Precambrian the constraint force predominated, causing so the formation of the folded Baikal basement in the eastern and western borders of Arab platform (actually the Zagross and the Taurus areas). Later during the upper Proterozoic-Paleozoic the forces of extension caused the formation of Alpine geosyncline.
In the Meso-Cenozoic stages of folding, tangential-constraint forces, predominated, north easterly directed for the Zagross area and north westerly directed for Tauraus.
Within the said stage we believe that the development of palmyrid is as an embrio geosyncline in the body of Arab platform.
It is formed between the major faults of south-north east direction caused by the curveture of southern periphereal Zagross.

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PECULIARITIES OF THE EARLY HISTORY OF DEVELOPMENT OF SOUTHERN TIEN-SHAN FROM POSITION OF PLATE TECTONICS

Southern Tien-Shan is regarded as a hercynian underthrust faulting structure which came into existence as result of covergence of the Baisun and mid-Tien-Shan consolidated massifs. At detailed study of structure as well as substance composition of lower allohthonous units which possess a maximum degree of dissemination in the Kyzylkum prepaleozoic and early mid-paleozoic indicator complexes were determined in respect of formation of the oceanic core and its subsequent transformation into an intermediate core.
Pre-late proterozoic complex is represented intensively and repeatedly metamorphized tuffs and subvulcanic bodies of alkaline basaltoids, melanowacks and shallow-waters clastic sediments of continental origin which are so natural for initial stages of development of the rift zone.
In the late proterozoic and early Silurian periods in Southern Tien-Shan presence of mature oceanic core is established with internal and external isolated zones. Complexes of internal zone accumulated themselves in deep-water conditions as materials were received with the elevations of oceanic bed, while the external zone, in more shallow waters as result of material supply of vulcanomictic material from insular bulge or from active continental outskirts. Caledonian deformations evolved in two stages: in the early Silurian period complexes of the internal zone moved closer in latitudinal direction beneath the complexes of external zone,

while in the late Silurian period they have jointly experienced a shift in southern direction towards the Baisun massif. Synchronously displayed itself dynamometamorphism of biotite-chlorite and sericite-chlorite subfacies and, as a result of double shuffling thickness of core increased by 2-3 times and the oceanic core, which adheres to Baisun massif, has turned into an intermediate core with a subsequent tectonic regime of a passive outskirt of the continent.

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ОСОБЕННОСТИ РАННЕЙ ИСТОРИИ РАЗВИТИЯ ЮЖНОГО ТЯНЬ-ШАНЯ С ПОЗИЦИИ ТЕКТОНИКИ ПЛИТ

Южный Тянь-Шань является герцинским шарьяжным сооружением, возникшим при сближении Байсунского и Срединно-Тяньшаньского консолидированных массивов. При детальном изучении структуры и вещественного состава нижних аллохтонных единиц, имеющих наибольшее распространение в Кызылкумах, были установлены допалеозойские и ранне-среднепалеозойские комплексы-индикаторы формирования океанической коры и преобразования ее в промежуточную.

Допозднепротерозойский комплекс представлен интенсивно и неоднократно метаморфизованными туфами и субвулканическими телами щелочных базальтоидов, мелановакками и мелководными кластическими осадками континентального происхождения характерными для начальной стадии развития рифтовой зоны.

В позднем протерозое – раннем силуре в Южном Тянь-Шане устанавливается наличие зрелой океанической коры с внутренней и внешней обособленными зонами. Комплексы внутренней зоны накапливались в глубоководных условиях при поступлении материала с поднятий океанического дна, а внешней – в более мелководных условиях при существенном поступлении вулканомиктового материала с островной дуги или активной континентальной окраины. Каледонские деформации происходили в два этапа: в раннем силуре комплексы внутренней зоны пододвинулись в широтном направлении под комплексы внешней, а в позднем силуре – совместно испытали поддвиг в южном направлении в сторону Байсунского массива. Синхронно проявился динамометаморфизм биотит-хлоритовой и серицит-хлоритовой субфаций. В результате двойного шарьирования мощность коры увеличилась в 2-3 раза и океаническая кора, прилегающая к Байсунскому массиву, превратилась в промежуточную с последующим тектоническим режимом пассивной окраины континента.

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DEVELOPMENT OF INTRA-CONTINENTAL RIFTING IN CENTRAL EUROPE

Tectonic investigations of continental rifts often give a good insight into the movement rates along single faults or the subsidence of the whole graben. Many aspects about the tectonic intensity in time are given by examination of the stratigraphy, thickness measurements of the different series and the analysis of given unconformities in the graben segment. But to gain more information about the whole history and specially the prehistory of a rift, the winning of many palaeogeographical and facies data and the control of the relation between the development of grabens and the appearance of volcanic events are also necessary for the whole region. With regard to these facts the report gives a methodical condensed description of the development of three types of continental palaeorifts in Central Europe: the Hessian Trough, the Eifel Depression and the Upper Rhine Graben. In this way the conformity and the difference between the geological evolution of such structures can be shown. The course of graben development will be compared to tectonic experiments conducted since many years in Frankfort on the Main.

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MESOZOIC TECTONICS AND MAGMATISM IN EAST ASIA

A comparative analysis of tectonic structures and magmatism development history is made within the framework of the IGCP Project 'Correlation of tectogenesis global phases and epochs' in East Asia. The analysis is fulfiled in three large provinces (megablocks): North (Verkhoyano-Chukotka), Central (Mongolo-Okhotsk-Stanovoi) and Southern (Indochina-Sunda-Philippines). Mesozoic tectono-magmatic activity within their boundaries was manifested contineously and irregularly in time and space. Longer stages of quite development of the synsedimentary structures alternated with short impulses of intensive movements - phases of folding, overthrusting etc. Herewith the contraction, folding and piling of continental blocks together with magmatism manifestations of the predominantly calc-alkaline series in some zones were synchronous with the processes of extension and downwarping accompanied by mainly basaltoid magmatism of different

series in other zones. The studies identified the following stages of tectono-magmatic activity: 1)Triassic (usually Late)-Jurassic; 2)Early-middle Jurassic; 3)Late Jurassic-Early Cretaceous; 4)Late Cretaceous-beginning of Paleogene. The most extensive tectonic movements and magmatism manifestations were timed to the boundaries between the Middle and Late Triassic (or to the first half of the Late Triassic), between the Middle and Late Jurassic (or to the beginning of the Late Jurassic - Callovian-Oxfordian), between the Early and Late Cretaceous. Mesozoic volcano-plutonic assemblages of East Asia are predominantly represented by the rocks of calc-alkaline series, formed both in condition of active continental margins and zones of collision between lithospheric plates and in the zones of intraplate fold-block dislocations developing, connected possibly with large subhorizontal faults inside the Earth crust and upper mantle. Such manifestations of intraplate tectono-magmatic activity can be explained with the position of the lithosphere sheeting conception.

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МЕЗОЗОЙСКАЯ ТЕКТОНИКА И МАГМАТИЗМ ВОСТОЧНОЙ АЗИИ

В плане осуществления проекта МПГК "Глобальная корреляция фаз и эпох тектогенеза" проведен сравнительный анализ истории развития тектонических структур и магматизма трех крупных областей (мегаблоков) Восточной Азии: Северного (Верхояно-Чукотского), Центрального (Монголо-Охотско-Станового) и Южного (Индокитайско-Зондско-Филиппинского). Мезозойская тектоно-магматическая активность в их пределах проявлялась непрерывно и неравномерно во времени и пространстве. Более продолжительные этапы спокойного развития конседиментационных структур сменялись кратковременными импульсами интенсивных движений - фазами складчатости, шарьирования и т.д. При этом процессы сжатия, складкообразования, скучивания континентальных блоков и проявления магматизма преимущественно известково-щелочной серии в одних зонах были синхронны процессам растяжения и прогибания в сопровождении главным образом базальтоидного магматизма различных серий в других зонах. Намечаются следующие главные этапы тектоно-магматической активности: I) триас, обычно поздний,- ранняя юра; 2) ранняя - средняя юра; 3) поздняя юра - ранний мел; 4) поздний мел - начало палеогена. Наиболее интенсивные тектонические движения и проявления магматизма приурочены к рубежам среднего и позднего триаса (или к первой половине позднего триаса), средней и поздней юры (или к началу

поздней юры – келловей-оксфорд), раннего и позднего мела. В мезозойских вулкано-плутонических ассоциациях востока Азии заметно преобладают породы известково-щелочной серии, формировавшиеся как в условиях активных континентальных окраин и зон столкновения литосферных плит, так и в зонах развития внутриплитных складчато-глыбовых дислокаций, сопряженных, по-видимому, с крупными субгоризонтальными срывами в земной коре и верхней мантии. Подобные явления внутриплитной тектоно-магматической активности могут быть объяснены с позиций концепции глубинной расслоенности литосферы.

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PLATE TECTONICS AND THE GEODYNAMIC MODEL OF THE EARTH

Plate tectonic hypothesis is a likelihood working hypothesis which provides a kinematic model of the upper layer of the Earth. In this contribution the global geodynamic model of the Earth will be build. The model discussed is based on the hypothesis of plate tectonics, on the presumption about densical differentiation of the Earth materials, on the presumption about phase transitions of the Earth masses under high temperatures and high pressures, on the theory of thermo-elasticity and visco-plasticity together with the electromagnetic theory and take into account all experimental and theoretical results of all geophysical fields. The model facilitates to explain from point of view of geodynamics some of the geological observations, such as unfolded sediments in the regions of deepoceanic trenches in Aleutian and Peruan-Chilean trenches as well as the deformation of African lithospheric plate or some of geothermal anomaly regions, like as the Panonian basin, without presumption about diapirism.

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PRIMORDIAL AGE FOR A SPIRALING GLOBAL SYSTEM OF LITHOSPHERIC SLICES

A global system of counterclockwise spiralling lithospheric slices, whose "eye" is located along the Alpine-Himalayan orogenic belt, was recently described. This system is considered to be a primordial torsional feature, genetically associated with currents within the lower mantle which are induced by the right-hand spin of the Earth. As the modern plate tectonics system is generated by the heat released from the upper mantle, these two systems should be driven by two different

mechanisms. Some coordination does exist however between the movements within these two lithospheric systems.

Substantial support to the above hypothesis is offered by the identification of an analogous counterclockwise converging spiralling system of geosutures on the planet Mars. The "eye" of this system is located along the Martian equator and its age is assumed to be also primordial. The absence of plate tectonics in this single plate planet is the reason for the better state of preservation of the spiral pattern on Mars as compared with that on Earth. The twin of spiralling patterns of geosutures, found around both poles of Mars, could indicate the existence of their equivalents on Earth as well. The observed opposite sense of convolution of the Martian twin suggests dextral torsions which may affect the rotational axes of these two planets.

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EARTH CRUST OF THE MAIN TECTONICAL STRUCTURES IN THE NORTHERN PACIFIC

During 1978-1982 four complex geological and geophysical expeditions (21, 23, 28 and 29 Cruises of R/V D.Mendeleev) were organized by Institute of Oceanology of the USSR Academy of Sciences to the northern part of the Pacific ocean. Detailed site and route geophysical survey was made in the Northwest, Northeast, Central and East Caroline basins, Shatsky and Hess rises, big deep-seated fault zones (Imperor, Merrey ets.). New data obtained and the old ones were corrected as a result of these seismic works. Seismic refraction sections were compared with the results of dredging of bedrocks in the deep-seated fault zones.

On the basis of the obtained data as well as of those which were published the comparison of the deep composition of the main tectonical structures was made. The dependence of Seismic parameters of the Earth crust on the lithosphere age was analysed.

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СТРОЕНИЕ ЗЕМНОЙ КОРЫ ОСНОВНЫХ ТЕКТОНИЧЕСКИХ СТРУКТУР ДНА СЕВЕРНОЙ ЧАСТИ ТИХОГО ОКЕАНА

В течение 1978-1982 гг. Институтом океанологии АН СССР проведены четыре комплексные геолого-геофизические экспедиции в северной части Тихого океана - 21, 23, 28 и 29-й рейсы НИС "Дмитрий Менделеев". На детальных полигонах и маршрутной геофизической съемкой исследованы Северо-Западная, Северо-Восточная, Центральная и

Восточно-Каролинская котловины, возвышенности Шатского и Хесса, зоны крупных глубинных разломов (Императорский, Меррей и др.). В результате сейсмических работ получены новые и уточнены имеющиеся сведения о строении земной коры изученных районов. Сейсмические разрезы сопоставлены с материалами драгировок коренных пород в зонах глубинных разломов; сделаны выводы о вещественном составе основных слоев земной коры. На основе полученных данных и опубликованных материалов других экспедиций выполнено сравнение глубинного строения основных тектонических структур и проанализированы зависимость сейсмических параметров земной коры от возраста литосферы.

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DER VORGANG DER STRUKTURBILDUNG DES LAGERSTATTENBEZIRKES VON NIKITOVKA (DONBASS) NACH DEN DATEN TEKTOPHYSIKALISCHER REKONSTRUKTIONEN UND EXPERIMENTELLER MODELLIERUNG

Für die praktischen Ziele der Lagerstattengeologie bei der Prognose der Vererzung von fünf Lagerstätten des Nikitivsker Lagestättenbezirkes wurden neben den tradizionellen Methoden der geologischen Erkundung spezielle tektophysikalische Erkundungsmethoden angewendet. Das gestattete ein strukturelles tektophysikalisches Modell des Nikitovsker Lagerstattenbezirkes von der Position der Morphologie, Kinematik, den Bedingungen und Gesetzmäßigkeiten der Formierung der hauptsächlichen erzkontrollierenden und erzkonzentrierenden Deformationselemente auszuarbeiten und die Strukturzone der Erzverteilung zu klären. Der bedeutende Umfang von Teilrekonstruktionen tektonischer Spannungen mittels kinematischer Analyse der geklüfteten und gestärten Strukturen gestattete ein paleotektonisches Spannungsfeld regionalen Niveaus, zu errichten, dessen Bau die Strukturbildung des lagerstattenbezirkes unter Bedingungen horizontaler rechtseitiger Verschiebung im freien Teil der haupterzkontrollierenden Faltenstruktur Gorlowker Antiklinale bestimmte.
Die physikalische Richtigkeit des vorlierenden Vorganges der Strukturbildung wurde experimentell nach der bekannten Methode der Modellierung tektonischer Prozesse durch Äquivalentmateriale überprüft. Die Resultate der quantitativen und qualitativen Erforschung der Deformation und Verschiebung an Modellen gestatten grundlegende erzkonzentrierende Strukturen als Elemente einer einheitlichen strukturellen Paragenese zu betrachten, die im Prozeß einer einmaligen Deformation mit den Erzablagerungen im mittleren Stadium der Strukturbildung des Lagerstättenbezirkes unter den Bedingungen der struktu-

rellen Abgeschlossenheit des Gebiets durch hydrothermale Tätigkeit entstehen. Beim Vergleichen der Resultate der tektophysikalischen Rekonstruktionen mit den Daten der Lagerstättengeologie werden zwei erzkontrollierende tektophysikalische Parameter, die den Bau des paleotektonischen Spannungsfelds auf lokalem Niveau bestimmen, festgestellt.

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МЕХАНИЗМ ФОРМИРОВАНИЯ СТРУКТУРЫ НИКИТОВСКОГО РУДНОГО ПОЛЯ (ДОНБАСС), ПО ДАННЫМ ТЕКТОНОФИЗИЧЕСКИХ РЕКОНСТРУКЦИЙ И ЭКСПЕРИМЕНТАЛЬНОГО МОДЕЛИРОВАНИЯ

Для практических целей рудничной геологии при прогнозировании оруденения на пяти месторождениях Никитовского рудного поля наряду с традиционными методами геологического изучения были использованы специальные тектонофизические методы исследований. Это позволило с позиций морфологии, кинематики, условий и закономерностей формирования основных рудоконтролирующих и рудовмещающих деформационных элементов разработать структурно-тектонофизическую модель Никитовского рудного поля и выявить структурную зональность рудораспределения. Значительный объем частных реконструкций тектонических напряжений методом кинематического анализа трещинно-разрывных структур позволил восстановить палеотектоническое поле напряжений регионального уровня, строение которого определило механизм формирования структуры рудного поля условиями горизонтального правостороннего сдвигания в сводовой части главной рудоконтролирующей складчатой структуры (Горловской антиклинали).
Физическая обоснованность данного механизма структурообразования была проверена экспериментально по известной методике моделирования тектонических процессов на эквивалентных материалах. Результаты качественного и количественного изучения деформаций и перемещений на моделях позволяют рассматривать основные рудовмещающие структуры как элементы единого структурного парагенезиса, возникшие в процессе одноактной деформации с рудоотложением на средней стадии формирования структуры рудного поля в условиях структурной закрытости области гидротермальной деятельности.

В процессе сопоставления результатов тектонофизических реконструкций с данными рудничной геологии выделены два рудоконтролирующих тектонофизических параметра, определяющих строение палеотектонического поля напряжений на локальном уровне.

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PHYSICO-PETROLOGICAL HETEROGENITIES OF TECTONOSPHERE AND GENESIS OF ORES OF THE SIBERIAN PLATFORM

Synthesis of new data has revealed: 1. Root zones of Tungus, Vilui trappean depressions-syneclises of Verhoyansk, Baikal-Patom folded regions at depths from 80-120 to 300 km are underlined by conductive low-velocity heterogenities-asthenolenses - probable long time developing thermoenergetic sources of tectonomagmatic processes of orogenic and platformic stages. The limits of asthenolenses and syneclises are coinsided in the plan. Depressions are inheretedly developed from Riphean to Mesozoic; Phanerozoic magmatism is exibited in cycles with the interval 120-150 m.y.; minerogenesis related to basaltic and alkali-ultrabasic magmas has an inherited character. 2. Consolidated core of the platform-Central-Asian zone (CAZ) of linear submeridional folding AR_2-PR_1 - differs by its high electrical resistance and seismic velocities, banded gravimetric fields, absence of asthenosphere till the depth of more then 350 km, domination of peridotites and eclogites of dimond-pyrop phacies. CAZ from Riphean to Mesozoic is developed as amagmatic resonance relative uplift. 3. Endogenic minerogenesis of the platform is predetermined by mantle magmatism of high alkalinity. Ore-bearing redions are arranged discretely, confined to the marginal alongated zones of deepseated heterogenities to which in sedimentary cover the depression-syneclise wings correspond. Relatively to centres of power-intensive basite magmatism the space-time mineralization sequence is traced: magnetitic - related to kimberlites - carbonatitec. 4. Similarity of geological development style and main characteristics of minerogenesis of all mentioned submerging structures in Mesozoic are sharply disturbed, that may be related to the continuing reduction of asthenolenses under trappean depressions and the rise of thermoenergetics developed under Verhoyanie and Baikal-Patom Upland.

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ФИЗИКО-ПЕТРОЛОГИЧЕСКИЕ НЕОДНОРОДНОСТИ ТЕКТОНОСФЕРЫ СИБИРСКОЙ ПЛАТФОРМЫ И РУДОГЕНЕЗ

Синтезом новых данных выявлены: I. Корневые зоны Тунгусской, Вилюйской трапповых впадин-синеклиз, Верхоянской, Байкало-Патомской складчатых областей на глубинах от 80-I20 до 300 км подстилаются электропроводящими низкоскоростными неоднородностями - астенолинзами, предполагаемыми длительно развивающимися теплоэнергетическими источниками тектоно-магматических процессов орогенного и платформенного этапов. Границы астенолинз и синеклиз в плане почти совпадают. Впадины унаследованно развивались с рифея по мезозой; магматизм фанерозоя проявлялся циклически с интервалом I20-I50 млн. лет; минерагения, связанная с базальтовой и щелочно-ультраосновными магмами, имеет преемственный характер. 2. Консолидированное ядро платформы - Центрально-Азиатская зона (ЦАЗ) линейной субмеридиональной складчатости AR_2-PR_1 - отличается высокими электросопротивлениями и сейсмическими скоростями, полосовыми гравимагнитными полями, отсутствием астеносферы до глубин более 350 км, преобладанием среди мантийных ксенолитов перидотитов и эклогитов алмаз-пироповой фации, довендским эрозионным срезом до 40-50 км. ЦАЗ с рифея по мезозой развивалась как амагматичное резонансное относительное поднятие. 3. Эндогенная минерагения платформы предопределена мантийным магматизмом повышенной щелочности. Рудные районы размещены дискретно, приурочены к пограничным протяженным зонам глубинных неоднородностей, которым в осадочном покрове соответствуют крылья впадин-синеклиз. Относительно центров энергоемкого базитового магматизма прослеживается пространственно-временной ряд минерализации: магнетитовая - связанная с кимберлитами - карбонатитовая. 4. Сходство геологического развития и основных черт минерагении всех упомянутых структур погружения в мезозое резко нарушилось, что правомерно связать с продолжающейся редукцией астенолинз под трапповыми впадинами и возрастанием теплоэнергетики астенолинз под Верхояньем и Байкало-Патомским нагорьем.

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COMPARISON OF EARLY MESOZOIC EVENTS IN HIDA BELT OF JAPAN AND SOUTH KOREA

The succession of geologic events in the Hida Belt and south Korea has been believed to have a remarkable similarity. Moreover, a lot of geophysical data suggest opening of the Japan Sea presumably in Cenozoic Era. So, geologic continuation of the two regions has been a focus of dispute in these years.
Comparison and examination on their conjunction favor the continuation in some respects but do not in others. For instance, Jurassic granites, Funatsu Granitic Rocks in the Hida Belt and Daebo Granite in Korea, are similar in age and geologic situation but are different in petrographic character. For another instance, recently in the Hida Belt, there are found a few exposures of hornfels definitely younger than the Hida Metamorphic Rocks and being affected thermally by the Funatsu Granitic Rocks. The original rocks of the hornfels are supposed to be lower Jurassic. This succession, Precambrian Hida Metamorphic Rocks - lower Jurassic hornfels - Jurassic Funatsu Granitic Rocks, is similar to that of Korea, Precambrian Gyeonggi Massif - Triassic Jurassic Daedong Group - Jurassic Daebo Granite.
It is considered that, as for early Mesozoic age, these two resembled regions were not continuous but probably were parallel in time and space.

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THE IMPORTANCE OF OBLIQUE TECTONICS DURING THE DEVELOPMENT OF OPHIOLITIC BELTS

The development of ophiolitic belts results from successive distentional and compressive processes generally linked to wrench tectonics effective in various geotectonic environments. From the chronological and structural relationships of the ophiolites and the associated formations belonging to the margin and to post-depositional volcano-sedimentary sequences, it may be shown that ophiolites are initially generally derived from multiple short-lived oceanic basins of limited size bordered by a passive subsident margin before the development of an island arc. Examples are taken from the Mediterranean area: Corsica, Greece, Cyprus, Oman and Iran.

An oblique system during opening may result from the superposition of tectonics related either to ridge at a small angle to the margin and transform zone or to ridge in pull-apart basin limited by shear faults subparallel to the margin. Subvertical attitudes of the structural and petrological planes in some ophiolitic fragments from Troodos, Sabzevar, Iran are more easily explained by wrench tectonics than the slightly inclined planes in other ophiolites as in southern Oman, related to a more efficient extensional tectonic regime, in agreement with a structural classification (OHNENSTETTER M., 1980). The strike-slip model coupled with specific continental rotational separation is preferred, explaining the variable degree of extension along a suture zone as well as the complexity of the structural trends within a single ophiolitic slice.

During oblique closure an inferred rotation of the major stress axis from strike-slip to compressive systems is responsible for the setting of the final magmatic events, the folding of some deep-seated ophiolitic members and the mecanisms of emplacement of ophiolites.

From a classification of ophiolites into two groups (ROCCI et al., 1975), it may be proposed that type I ophiolites showing close affinities with MOR magmatism may have been generated during the *breakup of major* continents. Type II ophiolites, bearing some resemblance to immature island arc magmatism and locally associated with type I ophiolites, may result from the disruption of preexisting reactivated fragile zones at the margins of large continents which may sometimes become active after the emplacement of ophiolites.

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Ongoing geological/geophysical/geochemical research is integrating multidisciplinary data on crust/upper-mantle structure, lithosphere evolution, and contemporary tectonics for the Cenozoic continental Rio Grande rift (RGR). Crust/mantle *boundary relief* is most accurately known from five 350-km-long DSS (refraction/wide-angle reflection) profiles. Dominant features of DSS interpretations are moderate crustal thinning (33 km compared with 42-50 km beneath the flanks), and anomalous P_n-velocity (7.6-7.8 km/s) beneath the rift axis, which are also observed in other Cenozoic rifts (e.g., Rhinegraben and Baikal). Several shorter (100-200 km) refraction profiles crossing the rift give details of shallower crustal velocity structure and, in conjunction with intersecting near-vertical incidence (COCORP) profiling, show thin (~1 km) sill-like magma bodies or partial melt layers at midcrustal depths (~20 km).

Although the volume of volcanics *is small compared* with Kenya and Baikal, ongoing igneous processes nevertheless appear to be important for RGR dynamics and evolution. At least two major crustal fracture or shear zones intersect the rift obliquely and are loci of volcanic and contemporary earthquake activity. Some rift/shear zone intersections are sites of midcrustal magma bodies. The lower crust below 20 km appears nearly aseismic (plastic?) and patterns of upper crustal earthquakes within 300 km of the rift suggest contemporary seismicity is largely due to movement of magmatic fluids.

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NEW IDEAS IN THE STUDIES OF THE BAIKAL RIFTING

Under the action of convectional exchange of masses and rotational forces the lithosphere in the northeast Eurasia moved in the southwestern direction in the Mesozoic and Cenozoic periods. The Verkhoyansk folded area thrusts the Siberian platform, and the latter, in its turn, presses its southern framing. Tangential compression produced by the plate is transformed into large displacements: a left one along the system of depressions in the northeastern flank of the Baikal rift zone and a right one along the Main and Biryusa fault in the East Sayan. In the general compression field between these displacements separate fault/extension fracture structures develop. They are South, Median and North Baikal depressions. The Baikal depression as a whole rotates counter-clockwise. The prevailing compression produced by the plate manifests itself in other features of the structure and development of the rift zone, namely, in the sigmoid form in plan, in the kinematics of the structures, in the asymmetric tectonic relief, in the locations of manifestations south of the zone axis, in the transverse warping with the length of warping wave equal to 200 km, etc. With this warping main features of spatial distribution of volcanicity manifestations are connected: its pronounced local nature and equal intervals between fields of volcanites and positive phases of warping wave. With these phases transverse zones of maximum seismicity coinside too. Three types of mechanisms of earthquake foci are known. They are "rift" one with horizontal orientation of extension axes (Baikal depression), "non-rift" one with different orientation of compression and extension axes (flanks of the zone), and "non-zonal" one, with orientation of extension forces parallel to the axis of the zone. The first two types reflect tension state and dynamics of crustal structures under conditions of northeastern transregional compression. The "non-zonal" type is a result of the transverse warping of the rift structure caused by the some transregional compressions.

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НОВОЕ В ИЗУЧЕНИИ БАЙКАЛЬСКОГО РИФТОГЕНЕЗА

Под действием конвективного обмена масс, ротационных и полюсобежных сил Земли литосфера северо-востока Евразии смещается в мезозое и кайнозое в юго-западном направлении. Верхоянская складчатая область надвигается на Сибирскую платформу (плиту), а Сибирская плита, в

свою очередь, оказывает давление на южное обрамление. Тангенциальное сжатие со стороны плиты трансформируется на юге в крупные сдвиги: левый - вдоль цепи впадин северо-восточного фланга Байкальской рифтовой зоны и правый - вдоль Главного и Бирюсинского разломов Восточного Саяна. В общем поле сжатия между этими сдвигами развиваются частные сдвиго-раздвиговые структуры: Южно-, Средне- и Северобайкальская впадины; Байкальская впадина в целом разворачивается против часовой стрелки. Господствующее сжатие со стороны плиты реализуется и в других особенностях строения и развития рифтовой зоны: сигмоидальном плане, кинематике структур, асимметрии тектонического рельефа, положении ареалов мезозой-кайнозойского вулканизма южнее оси зоны, редукционном (поперечном) короблении с длиной волны коробления в 200 км и др. С последним связаны главные черты пространственного распределения ареалов вулканизма - его ярко выраженный очаговый характер и совпадение величины интервалов между полями вулканитов с положительными фазами волны коробления. С этими фазами совпадают также поперечные зоны максимальной сейсмичности. В Байкальской зоне известны три типа механизмов очагов землетрясений: "рифтовый" с горизонтальной ориентировкой осей растяжения вкрест простирания зоны (Байкальская впадина), "нерифтовый" с различной ориентировкой осей сжатия и растяжения (фланги зоны) и "азональный" с параллельной простиранию зоны ориентировкой растягивающих напряжений. Два первых типа отражают напряженное состояние и динамику структур земной коры в условиях трансрегионального сжатия с северо-востока, а третий - производное сжатия - редукционное коробление структуры рифта.

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OPHIOLITE BELTS OF THE KORYAK UPLAND, NORTHEAST ASIA

Ophiolite (OPH) outcrops occur in horst-anticline cores and are arranged in extensive belts up to 1000 km long. Penzhina-Pekul'nei (outer), Khatyrka and Vatyna (inner) belts and the Central Koryak OPH zone are recognized. They are confined to the cores of near-fault anticlinoria and uplifts formed during the orogenic stage. Polymyct serpentite melange is significant in the OPH geologic structure; it resulted from the OPH shearing and napping on tuffoterrigenic and flysch J_3-K_2 complexes of the continental slope. Five rock complexes distinguished by their age and structural limits are identified in the OPH association: (1) metamorphic peridotites, (2) cumulate mafics--ultramafics, (3) hypabyssal gabbro-diabase tonalites, (4) siliceous volcanic rocks, and (5) metamorphic schists and amphibolites.

1. Metamorphic peridotite massifs are divided into dunite-harzburgidite and harzburgidite-lherrolite ones. Both types co-occur in the most extensive Ust'-Belaya massif.

2. As distinct from (1), cumulate complexes exhibit significant variations in their rock and mineral compositions due to compositional features of the volcanites associated with them. Three zones may be identified in their structure: ultramafic, transitional and mafic.

3. This complex consists of diabase, keratoph ore and diorite sills and dykes; its rocks are also intruded by bigger plagiogranite bodies.

4. These complexes are PZ_3-T, J_3-K_1 or K_{1-2} in age; an age decrease trend is observed oceanward. The most frequent are J_3-K_1 complexes with antidrome structure, ranging from islandites, keratophyres and tholeite basalts at the base to melanobasalts and picrites in the upperlying beds. The Vatyna zone's K_{1-2} volcanites are commonly subalkaline; zoned dunite-clynopyroxenite massifs of the Uralian-Alaskan type are associated with them.

5. Metamorphic rocks evolved from complexes 4,3 and 2. Mineral paragenesis and K-Ar age determinations suggest a relationship between metamorphism and OPH piling up prior to and during the obduction. Investigations of complexes 4 and 5 enable to envisage the J_3-K_2 ophiolites as crust fragments from the Mesozoic marginal seas of the north-western Pacific.

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ОФИОЛИТОВЫЕ ПОЯСА КОРЯКСКОГО НАГОРЬЯ (СЕВЕРО-ВОСТОК АЗИИ)

Выходы офиолитов (ОФ) расположены в ядрах горст-антиклиналей, они группируются в протяженные пояса длиной до 1000 км. Выделяются внешний Пенжинско-Пекульнейский, внутренние Хатырский и Ватынский пояса и Центрально-Корякская зона ОФ. Все они маркируют ядра приразломных антиклинориев и поднятий орогенного этапа развития региона. В геологическом строении ОФ важную роль играет полимиктовый серпентинитовый меланж, возникший при шарьировании ОФ на туфотерригенные и флишевые комплексы J_3-K_2 континентального склона, их тектоническом расчешуивании.

В строении ОФ участвуют пять комплексов пород, разделенных возрастными и структурными границами: 1) метаморфических перидотитов; 2) кумулятивные мафит-ультрамафитовые; 3) гипабиссальные габбро-диабаз-тоналитовые; 4) кремнисто-вулканогенные; 5) метаморфических сланцев и амфиболитов.

I. Массивы метаморфических перидотитов классифицируются как дунит-гарцбургитовые и грацбургит-лерцолитовые; в наиболее крупном Усть-Бельском массиве сочетаются оба этих типа. 2. Кумулятивные комплексы отличаются от (I) существенными вариациями состава пород и минералов в зависимости от состава ассоциирующих вулканитов. В их строении иногда выделяются три зоны: ультрамафитовая, переходная и мафитовая. 3. Комплекс (3) сложен силлами и дайками диабазов, кератофиров, диоритов, здесь развиты также более крупные тела плагиогранитов, интрудирующих эти породы. 4. Комплексы (4) датируются PZ_3-T, J_3 -K_1 и K_{1-2} с тенденцией омоложения от континента к океану. Наиболее развиты комплексы J_3-K_1 с антидромным строением - от исландитов, кератофиров и толеитовых базальтов в нижних толщах до меланобазальтов и пикритов в верхних. Вулканиты K_{I-2} Ватынской зоны имеют щелочную тенденцию химизма, с ними ассоциируют зональные дунит-клинопироксенитовые массивы Уральского-Аляскинского типа. 5. Метаморфические породы развиты по комплексам (4),(3),(2). Минеральные парагенезисы и K-Ar датировки позволяют предполагать связь метаморфизма с тектоническим расслоением и скучиванием ОФ до и во время обдукции.

Изучение комплексов (4),(5) позволяет считать офиолиты J_3-K_2 фрагментами коры мезозойских окраинных морей северо-запада Тихого океана.

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TECTONIC EVOLUTION OF THE HELLENIDES

The Hellenides represent mainly the southern margin of the Tethys, which has been deformed in a rather continuous process since Late Jurassic. The southern tethyan margin has been developed over an Hercynian,or unknown,basement throughout Triassic - Middle Jurassic. Eversince,an orogenic island - arc system has been formed and evolved almost continuously up to the present Hellenic Arc and Trench. The obduction of oceanic crust over parts of an internal platform in Late Jurassic - Early Cretaceous marked the beggining of the destruction of the southern margin and it was accompanied by other geodynamic phenomena such as metamorphism, ductile deformation , magmatism e.t.c. .The organization of evolving island - arc systems is best established for the periods : Late Jurassic - Early Cretaceous, Late Cretaceous - Early Tertiary, Oligocene - Early Miocene and Pliocene - present. The overall deformation of the southern margin has been controled by the initiation of low angle thrusts , that dissected the margin during its orogenic evolution into : (i) subducted or underthrusted parts, intensively deformed in a very

complex style and metamorphosed,which alltogether constitute the Metamorphic Hellenides,and into (ii) parts that continued their sedimentary history, after their detachement from the subducted adjacent paleogeographic units,until their final participation to the orogenic arc with very simple deformation.

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MESOZOIC TECTONIC EVOLUTION OF NORTHEAST ASIA

Tectonic evolution is distinguished by the recognition of tectono-stratigraphic terranes and their lateral zonations similar to those of the modern island arcs, active and passive continental margins and by analysis of fault systems of different ages and structural analysis of folding.

Separation of the Eastern-Siberian continent, Chukotskii, Bureinsko-Khankaiskii and hypothetical Okhotomorskii microcontinents is supposed for the Early Mesozoic. Also, Alazeiskaya volcanic arc formed on Paleozoic oceanic crust is considered as a microcontinent. The south-east boundary of the continent was determined by the Udsko-Murgal'skaya, the north one by the Oloyskaya island arcs and the south boundary by an active continental margin, which was fixed by the granodioritic batholites belts of the Stanovoy Range. The microcontinents had mainly passive margins. Lateral zonations of the tectono-stratigraphic terranes, ophiolitic belts allow to suppose that the continent was separated from the microcontinents by the basins with oceanic crust. Early Mesozoic folding is conditioned by mutual convergence and collision of the sialic megablocks. Collision of the Eastern-Siberian continent with the Bureinsko-Khankaiskii microcontinent was at the end of Middle and the beginning of Late Jurassic. Closing of the ocean basin in the place of the South-Anyuyskaya folded system and collision of the Chukotskii microcontinent with the continent occurred at the end of Neocomian.

At the end of Neocomian Northeast Asia assumed the outlines similar to the modern ones.It was separated from the Pacific ocean by the active continental margins of an Andian type, which were marked by the Okhotsko-Chukotskii and Sikhote-Alinskii volcano-plutonic belts. Cretaceous meridional strike-slip faults of Sikhote-Alin are the transform ones. They have appeared after collision of the Bureinskii microcontinent with the Eastern-Siberian continent and are conditioned

by continuation of the Kula plate movement in Cretaceous together with the Okhotomorskii microcontinent to the north in the direction of the Okhotsko-Chukotskii belt.

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ТЕКТОНИЧЕСКАЯ ЭВОЛЮЦИЯ СЕВЕРО-ВОСТОЧНОЙ АЗИИ В МЕЗОЗОЕ

Тектоническая эволюция определяется на основе установления структурно-вещественных комплексов и их латеральных последовательностей, характерных для современных островных дуг, активных и пассивных континентальных окраин, анализа разновозрастных надвигов, сдвигов и сбросов, структурного анализа складчатости.

Для раннего мезозоя предполагается разобщенность Восточно-Сибирского континента, Чукотского, Буреинско-Ханкайского и предполагаемого Охотоморского микроконтинентов. В качестве микроконтинента рассматривается также Алазейская островная дуга, сформировавшаяся на палеозойской океанической коре. Юго-восточная граница континента определялась Удско-Мургальской, северная - Олойской островными дугами, южная - активной континентальной окраиной, которая фиксируется поясом гранодиоритовых батолитов Станового хребта. Микроконтиненты имели преимущественно пассивные окраины. Латеральные последовательности структурно-вещественных комплексов, пояса офиолитов позволяют предполагать, что континент отделялся от микроконтинентов бассейнами с корой океанического типа. Раннемезозойская складчатость обусловлена взаимным сближением и коллизией сиалических блоков. В конце средней - начале поздней юры имела место коллизия Восточно-Сибирского континента с Буреинско-Ханкайским микроконтинентом. К концу неокома относится закрытие океанического бассейна на месте Южно-Анюйской складчатой системы и причленение к континенту Чукотского микроконтинента.

В конце неокома северо-восточная часть азиатского континента приобретает очертания, близкие к современным. От Тихого океана она отделялась активными континентальными окраинами андийского типа, которые маркируются Охотско-Чукотским и Сихотэ-Алинским вулканоплутоническими поясами. Меловые субдолготные сдвиги Сихотэ-Алиня являются трансформными разломами. Они возникли после причленения Буреинского микроконтинента к Восточно-Сибирскому и обусловлены продолжающимся и в меловое время перемещением плиты Кула совместно с Охотоморским микроконтинентом к северу в направлении Охотско-Чукотского пояса.

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THE TECTONIC FACIES AND APPRECIATION OF THE DEFORMATIONAL DEGREE OF THE FOLDED STRUCTURES

The tectonic facies are the natural rocks series according to the station degree with their typical structural paragenesis. It was thought formely, that the deformational degree of the folded structures could be appreciated only by a single indication (for example, by "the fold straightening"). It is clear now, that any single indication itself doesn't decide the problem . It is necessary the total consideration of all indications on the micro-, meso- and mega-levels in their cooperation, that is the comparative structural - paragenetic approach, enriched with experimental and theoretical data. This is a sense of the tectonic facies. The tectonic-facies analysis results of the Kazakhstan folded system series are showed by the profiling in the direction of the tranverse sections (in the histograms). The analysis made it possible to quantify totally (according to 10--ball scale of the tectonic facies) the deformational degree of the folded system (it's elements: structural-formational zones, anticlinoria , synclinoria) the structural stages of different ages, lithologically differentiated rock types etc. So on the base of the comparative structural - paragenetical analysis, we can receive the new qualitative tectonical information, which actually escaped the geologists notice earlier (the degree of the structural deformation on various scales the structural stages and rocks). The method of the tectonic-facies analysis doesn't depend on the theoretical ideas about the mechanism of the dislocation process, because of it's basical idea of the formation analysis. Therefore, it's data can have a common significance for understanding of the tectonical problems regardless of the expert convictions. As a matter of fact, today, it is the only way to receive a notion about the deformational degree of the folded structures and their elements.

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ТЕКТОНОФАЦИИ И ОЦЕНКА СТЕПЕНИ ДЕФОРМИРОВАННОСТИ СКЛАДЧАТЫХ СООРУЖЕНИЙ

Тектонофации - суть естественные ряды пород по степени дислоцированности с характерным для них структурным парагенезисом. Раньше представлялось, что степень деформированности складчатых сооружений возможно оценить по какому-то одному признаку (например, "рас-

прямлением" складок). Теперь стало ясным, что ни один из существующих признаков сам по себе проблему не решает. Необходимо совокупное рассмотрение всех признаков на микро-, мезо- и мегауровнях в их взаимосвязи, т.е. сравнительный структурно-парагенетический подход, пополненный экспериментальными и теоретическими данными. Таков смысл тектонофаций. Обсуждаются результаты тектонофациального анализа ряда складчатых систем Казахстана путем профилирования в направлении поперечных сечений (в форме гистограмм). Анализ позволяет вскрыть количественно (в 10-балльной шкале тектонофаций) степень деформированности складчатой системы в целом (ее элементов - структурно-формационных зон, антиклинориев, синклинориев), разновозрастных структурных этажей, литологически различных типов пород и пр. Таким путем на базе сравнительного структурно-парагенетического анализа удается получить качественно новую тектоническую информацию, фактически ускользавшую ранее из поля зрения геологов, о степени деформированности структур самых различных масштабов, структурных этажей и пород. Метод тектонофациального анализа не зависит от теоретических представлений о механизме дислокационного процесса, т.к. в основу его положена идея формационного анализа. Поэтому данные его могут иметь общее значение для понимания проблем тектоники независимо от убеждений исследователя. По существу, это единственный способ на сегодняшний день получить представление о степени деформированности складчатых сооружений и их элементов.

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THE MAIN CENTRAL THRUST OF UTTAR PRADESH HIMALAYA

The Main Central Thrust is one of the most important tectonic structures in the Himalaya. This thrust brings the Central Himalayan Crystalline rocks to physically overlie the sedimentary sequence of the Lesser Himalaya. It was first recognized by Heim and Gansser in the Ganga valley. Detailed study has suggested that the Main Central Thrust actually represents the eastward continuation of the two tectonic units, the Chail and the Jutogh Thrust of Himachal Pradesh. These two tectonic units have been also recognized as separate entities in some parts of the U.P.Himalaya; while in some sections, underlying Chail has been eliminated and rocks comparable to the overlying Jutogh nappe rest directly over the sedimantaries. Hence, in some sections the Chail Thrust has named the Main Central Thrust, while in others the Jutogh Thrust has been so designated. Structural interpretations indicate that the Chail Thrust had been a more acti-

ve plane in this area with the overlying Jutogh nappe riding as a passive mass over the Chail Thrust. The main southward movement was probably in Mid.Miocene period. This plane represents a highly tectonised zone along the Central Himalayan geanticline and is not in the nature of a subduction zone.

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THE RECIPROCAL CONDITIONING OF THE ALPINE TECTONIC MOVEMENTS IN THE EASTERN AND SOUTH CARPATHIANS

The formation of the structure of the two catenas was accompanied by an important crust shortening.
In the E.C. the belt of isoclinal folds allows by unfolding the approximate determination of the spatial restriction (about 200-250 km). In the S.C. this determination is more difficult, but it seems clear that the shortening was as important as that from the E.C.
In the S.C. the shortening stoped generally at the beginning of the Tertiary, while in the E.C. practically continued until today. The two catenas form an almost square angle. The space of approximately 150 km. disappeared during the Tertiary in the E.C. was solved in the S.C. by eastward movements of the Panonian and Transylvanian blocks in relation to the Moesian Platform (which, all this time, did not move towards the east-european Platform). The important tangential Tertiary movements in the S.C., achieved by a plastic flow phenomenon, were very discreet in their structural appearance and their existence can be demonstrated only by examining the E.C. folded belt.

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SOME CHARACTERISTICS OF THE FORMATION OF THE SOUTH CARPATHIANS

The South Carpathians were founded from the joining and pressing together of several microplates, fractured from the European Platform, probably in the Triassic and Jurassic, and separated by areas with oceanic crust.
The joining of the microplates occurred mainly in the Cretaceous by bringing together the Moesian and the Pannonian and Transylvanian massifs. The oceanic areas disappeared and nappes with ocean-floor material or with crystalline schists of continental crust were generated. The continental crust of the blocks was

strongly distorted. Most of the old structures were redirected according to the Alpine direction; the blocks narrowed and thickened. After the Cretaceous, important tangential translations continued.
The Alpine reorientation and the rejuvenation of the K/Ar ages are very obvious in the crystalline basement structures. In spite of the strong Tertiary distortions, the nappes seem to be little deformed after their settling; the sedimentary microplates cover often preserved an almost horizontal position. It is possible that during the Tertiary movements the sedimentary cover was detached from its crystalline basement.
It is supposed that in the new chains the directions parallel to the chains of the old structures are generally caused by a more recent redirection.

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CRUSTAL STRUCTURE OF DEEP DEPRESSIONS

Seismic models of deep sedimentary basins: platform depressions, rift grabens, inner and outer seas, have some common features. Thickness of the consolidated crust decreases beneath the basins and the average crustal velocities increases. In result in an equilibrium of the upper 40-60 km thick layer of the lithosphere, that may be considered as one of typical regularities of its inner structure. The equilibrium is made not only with "antiroots" in the M-discontinuity form but with intrusions of high velocity matter into the crust (Cura Depression, Dnieper-Donetz Depression, Red Sea). The "antiroots" amplitude and the intrusion volume are in correlation with the sediment thickness and density. The example of slow sinking is West-Siberian Platfrom, and the sharp one - Viluy Depression or Black and Mediterranean Seas. These structure features testify a mobility of the deep crustal boundaries at the basins formation. During their development and the sediment metamorphising the "antiroots" disappear (Tunguss Depression, Donbass). It means that the deep boundary mobility is not mechanical but is resulted with moving in depth of physico-chemical altering of the crustal rocks.
There are exceptions when the equilibrium of the crust is not observed and deep depressions combine with nearly plane M-discontinuity and low velocity in the consolidated crust (Fergana and South-Caspian Depressions).

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СТРУКТУРА ЗЕМНОЙ КОРЫ ГЛУБОКИХ ОСАДОЧНЫХ БАССЕЙНОВ

Сейсмические модели осадочных бассейнов: глубоких платформенных впадин, авлакогенов, рифтовых грабенов, внутренних и окраинных морей,- несмотря на все многообразие, имеют некоторые общие черты. Мощность консолидированной коры под этими прогибами сокращается и увеличиваются средние скорости в ней. Это создает общую уравновешенность верхнего (40–60 км) слоя литосферы, что можно считать главной закономерностью ее внутренней структуры. Уравновешенность создается не только за счет "антикорней" по границе М под прогибами фундамента, но и за счет внедрения в их кору высокоскоростных образований (Куринская, Днепровско-Донецкая впадины, Красное море). Амплитуда поднятия границы М и объема внедрений в земную кору пропорциональны мощности осадков и степени их рыхлости (примером медленного прогибания является Западно-Сибирская впадина, быстрого - Вилюйская впадина, Шетландско-Фарерский желоб, впадины Черного и Средиземного морей). Это свидетельствует о значительной подвижности глубинных границ земной коры во время формирования впадин. В процессе их "старения" и метаморфизма пород осадочного чехла "антикорни" постепенно стираются (Тунгузская впадина, Донбасс). Последнее свидетельствует о том, что подвижность глубоких сейсмических границ не является механической, а связана с перемещением уровней физико-химических преобразований вещества коры.
Имеются исключения из общего правила, когда уравновешенность слоев земной коры не соблюдается: мощная (до 15–20 км) осадочная толща сочетается с почти плоской границей М и низкими скоростями в консолидированной коре (Ферганская, Южно-Каспийская впадина).

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REGULIARITIES IN FORMATION OF PHANEROZOIC CONTINENTAL CRUST (ON TECTONIC ZONATION OF CONTINENTS)

Research into folded mountains has shown that their most ancient formations are rocks of the ophiolitic association similar to the corresponding association of the ocean.

Eugeosynclines emerged on the crust of the oceanic type whose fragments have preserved in the structure of folded mountains. Three stages can be delineated in the development of their crust: (1) oceanic; (2) transitional, and (3) continental.

Typical of the oceanic stage are tholeiite-basalt volcanites with pelagic sediments.

The transitional stage is characterised by structural-formational zones with different vertical rows of formations. Most typical are paleo-island arcs where rocks of the oceanic stage are covered by contrast series volcanites, greywacke, and sometimes, limestones. They are overlain by limestone-alkali series volcanites topped by molasse. Deeper zones of these structures feature metamorphism and plagiogranitization resulting in the formation of plagiogranites. This forms a new granite-metamorphic layer. The transitional stage shows also rocks of marginal seas basins, shelfs, continental slopes and continental rises.

Further evolution of the crust is related to final stages of the global folding. A mature continental crust emerges as a result of intense piling up of mountain rocks, potassium granitization, formation of K granites, and steady build-up of thick nappes. It is these structures that have various combinations of rocks of different layers of the Earth crust and bring ophiolitic allochthones out to the surface. This mode of the genesis of folded mountains is fully backed up with the theory of mobilism.

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ЗАКОНОМЕРНОСТИ ФОРМИРОВАНИЯ КОНТИНЕНТАЛЬНОЙ КОРЫ В ФАНЕРОЗОЕ (К ПРОБЛЕМЕ ТЕКТОНИЧЕСКОГО РАЙОНИРОВАНИЯ МАТЕРИКОВ)

Изучение складчатых сооружений показало, что древнейшими их образованиями являются породы офиолитовой ассоциации, подобные соответствующей ассоциации океанов.

Эвгеосинклинали возникали на коре океанического типа, фрагменты которой сохранились в структуре складчатых сооружений. В развитии коры этих сооружений выделяются три стадии: I) океаническая ; 2)переходная и 3) континентальная.

Типичными для океанической стадии являются толеит-базальтовые вулканиты совместно с пелагическими осадками.

Для переходной стадии характерны структурно-формационные зоны с различными вертикальными рядами формаций. Особенно типичны палеоостроводужные структуры, в которых породы океанической стадии надстраиваются вулканитами контрастной серии, граувакками, иногда известняками. Выше следуют вулканиты известняково-щелочной серии, перекрытые молассой. В глубоких зонах этих структур развиваются метаморфизм и плагиогранитизация с образованием плагиогранитов. Так возникает новообразованный гранитно-метаморфический слой. Среди формаций переход-

ной стадии выделяются также породы, соответствующие котловинам краевых морей, шельфам, континентальным склонам и их подножьям. Дальнейшая эволюция коры связана с завершением глобальных эпох складчатости. Возникает зрелая континентальная кора в результате интенсивного скучивания горных масс, калиевой гранитизации, возникновения калиевых гранитов и неуклонно нарастающего образования мощных покровных структур. Именно эти структуры совмещают в различных комбинациях породы разных слоев земной коры, в том числе выводя на дневную поверхность офиолитовые аллохтоны. Такой путь созидания складчатых сооружений целиком определяется теоретическими положениями мобилизма.

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THE SHEAR AND ITS ROLE IN DEFORMATION ROCKS

Numerous structures resulted of deformation of geological bodies of various shopes and dimensions can be interpreted with a high degree of probability as structures of a simple shear. Manifestation of other deformation types are mainly limited to shear displacements of elements of bodies subject to deformation. Surfaces and shear vectors are oriented in one or several directions under contraction or stretching, while under bending or torque action their orientation is numerous. The more complex is a deformation the more intricate is a system of shear displacements. Thus, shear plays a leading role agent in deformation processes as a basic type of deformation. The distribution of shear displacements within deformed geological bodies explicitly determines changes in pre-deformation structures.

The post-deformation structure features, together with the type of a pre-deformation structure and distribution of displacement reflect also a spatial relationship of displacements with the pre-deformation structure. In the case of a simple shear when it cuts across stratified structures, this relationship is characterized by φ angle between a banded structure and shear, ranging from 0 to 180°. With $\varphi = 90°$ the resultant structure shapes at sections normal to shear surface are identical to a curve shape showing the distribution of simple shear. These curves are characterized by a limited set of simple and complex harmonic functions. Structure shapes due to φ value changes are much more varied than those of displacement distribution which cause the formation of these structures.

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РОЛЬ СДВИГА И ЕГО РАСПРЕДЕЛЕНИЙ В ПРОЦЕССАХ ДЕФОРМАЦИИ ГОРНЫХ ПОРОД

Весьма значительная часть структур, возникших в результате деформаций геологических тел различного строения и размеров, уверенно аппроксимируется в качестве структур простого сдвига. Проявления других видов деформации в существенной мере сводятся к сдвиговым смещениям элементов деформируемых тел. При сжатии или растяжении поверхности и векторы сдвига ориентированы в одном или нескольких направлениях. При изгибе, кручении и др. - в множестве направлений. Усложнение деформации равнозначно усложнению системы сдвиговых смещений, реализующихся в процессе деформации. Соответственно сдвиг играет в деформационных процессах ведущую роль, являясь фундаментальным видом деформации.

Распределения сдвиговых смещений в пределах деформированных участков геологических тел однозначно определяют изменения додеформационных структур этих участков. В особенностях постдеформационной структуры, наряду с характером додеформационной структуры и распределением смещений, отражается также пространственное соотношение системы смещений с додеформационной структурой. В случаях простого сдвига, секущего слоистые структуры, это соотношение характеризуется величиной угла φ сечения слоистости сдвигом, варьирующей от 0 до 180^0. При $\varphi = 90^0$ формы результирующих структур в разрезах, нормальных к поверхностям сдвига, идентичны формам графиков распределений смещений в этих разрезах. Вариации наблюдаемых распределений простого сдвига характеризуются ограниченным набором простых или сложных гармонических функций. За счет вариаций значения φ формы структур значительно многообразнее форм распределений смещений, обусловивших образование структур.

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"CONTINENT-OCEAN" TRANSITION ZONES IN THE GEODYNAMIC SYSTEM OF THE ARCTIC OCEAN

Morphology. Aside from the continental rise and slope usually recognized, an additional side, namely, a chamfered edge or a border facet develops in place of a shelf edge; a single transition zone is di-

vided in terms of the facet configuration, into constituent morphostructures which are similar independently of the genesis of abyssal basins.

Tectonic structure. The system of dislocations consists of continental foredeeps, marginal uplifts and a connecting flexure-fault zone which are characterized by three structural stages. This Cenozoic epi-platform mobile belt is characterized by a miogeosynclinal mode of development.

Kinematics of movements. There are recognized three phases: pre-Oligocene - quiet downwarping; Oligocene-Miocene - active subsidence in the slope zone; Pliocene-Quaternary - quiet downwarping in the abyssal-shelf system. The amplitude and rate of the Oligocene-Miocene collapse are estimated to be 2.5-3 km and 10 cm per 1000 years, respectively.

Position in the geodynamic system. The continental slope situated in the contact zone of the forming massif of femic lithosphere is complemented by slopes of the boundary orogenic belt which are associated with the contact zone of the forming massif of new salic lithosphere. The development of transition zones caused by the spreading of bipolar massifs of lithosphere is pulsed-wavy in nature. According to the morpho-tectonic characteristics the transition zone under study belongs to the Atlantic type. The pulsed-wavy development allows us to introduce an additional criterion for classification in terms of which the transition belongs to subtype I of the phase of collapse.

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ПЕРЕХОДНЫЕ ЗОНЫ МАТЕРИК - ОКЕАН В ГЕОДИНАМИЧЕСКОЙ СИСТЕМЕ СЕВЕРНОГО ЛЕДОВИТОГО ОКЕАНА

Морфология. Кроме обычно выделяемых подножия и склона, на месте бровки развивается дополнительная грань - бровковый скос, или фасет, по конфигурации которого единая переходная зона расчленяется на составные морфоструктуры, одинаковые вне зависимости от генезиса абиссальных котловин.

Тектоническая структура. Систему дислокаций составляют предконтинентальные прогибы, окраинно-шельфовые поднятия и сопрягающая их флексурно-разломная зона, характеризующиеся тремя структурными этажами. Этот кайнозойский эпиплатформенный подвижный пояс обладает миогеосинклинальным стилем развития.

Кинематика движений. Выделяются три стадии: доолигоценовая -

спокойное прогибание; олигоцен-миоценовая - активные проседания в зоне склона; плиоцен-четвертичная - спокойное прогибание в системе абиссаль - шельф. Амплитуда олигоцен-миоценового обрушения оценивается в 2,5-3 км, а скорость - 10 см за 1000 лет.

Позиция в геодинамической системе. Материковому склону, расположенному в "экзоконтакте" формирующегося массива фемической литосферы, комплементарны склоны пограничного орогенного пояса, отвечающие "экзоконтакту" формирующегося массива новой салической литосферы. Развитие переходных зон, обусловленное разрастанием биполярных массивов литосферы, носит импульсно-волновой характер.

По морфотектоническим показателям рассматриваемая переходная зона относится к атлантическому типу. Импульсно-волновое развитие позволяет ввести дополнительный классификационный критерий, согласно которому она принадлежит к подтипу I фазы обрушения.

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TECTONICS OF THE BANAT-SREDNOGORIE RIFT

The Banat-Srednogorie rift extends from Apuseni Mts through the South Carpathians, the Timok and Srednogorie zone and dips into the Black Sea. It was formed during the Upper Cretaceous, along the boundary zone between the Moesian platform, and the Rhodope and Serbo-Macedonian Massif. The rift is superimposed on Precambrian basement of continental type and intersects unconformably Caledonian-Hercynian and Early Alpine structures. The extension of the Earth crust and the formation of the rift was related to intrusion of a mantle diapir, marked by positive graviti and magnetic anomalies. The rift is filled by Upper Cretaceous rocks with thickness from 3 to 8 km. The lower part of section is represented by Cenomanian-Turonian coal-bearing-terrigenous and flysch deposits. They are overlain by a sedimentary-volcanogenic complex, followed by Maestrichtian flysch. The volcanic and plutonic formations are referred to the Ca-alkaline, K-alkaline and superalkaline series. In the respective regions they were intruded in the above sequence, due to the penetration of the rift forming faults in depth. The origination of the Ca-alkaline rocks is related to the large thickness of the granitic layer.
The following stages are distinguished in the evolution of the rift: 1- initial stage - formation of the Cenomanian-Touronian sedimentary trough; 2- rifting-general subsidence, accompanied by intensive magmatism and tephroidal-flysch sedimentation;
3- inversion - Laramide folding and formation of linear folds.
The Banat-Srednogorie rift is an independent structural zone in

the Alpine fold system of the Balkan Peninsula. The epicontinental rifting occured in the pre-orogenic stage of the geotectonic development of the Balkanide-Dinarides, posterior to the closure of the Vardar oceanic Basin and the formation of the embrional orogenic arc on the Rhodope and Serbo-Macedonian Massif. During the orogenic stage individual parts of the rift associated with different structural zones. In the Srednogorie zone a regeneration of the the extension regime took place and a number of graben structures formed, infilled by molasse deposits. The endogenic metallogeny of the rift is governed by copper-pyrite, porphyry-copper, vein polymetallic-copper, as well as skarn iron, copper and Tungsten-molibdenum mineralizations.

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ON METHODS OF TECTONIC ZONING OF RIPHEAN MIDDLE SIBERIA

The Siberian paleocraton took its final shape by 1900±100 mln.y. ago with the mass sialization of the Earth crust. Riphean geological development of Middle Siberia had as one of the leading processes a step-by-step rifting. Its spatial association depended on the pre-Riphean structural-formational peculiarities of the region. These, as well as the intensity of the rifting, caused the differentiation of Riphean geostructures according to the type of the Earth crust - oceanic, continental, transitional - already at early stages of formation. The basis for the proposed method: each type of the crust predetermines structural and material transformations of specific geostructures. Examples. Continental blocks of the Siberian paleocraton, which were not exposed to rifting in the Riphean accumulated a thin platform sediment cover or no sediments at all (Anabar Shield and its southern subsidence). Amagmatic continental-crust became precursors of platform depressions (Kotuykan rift - Tungusska syneclise). Thick clastic sequences, often a marked alkali-basaltic magmatism characterise aulacogens with wide-range spreading and subsidence (Type I of the transitional crust). They were exposed to inversion with the formation of swell-like uplifts, the Udzhin, Irkiney-Chadobets uplifts, etc. In some areas, a heavy rifting reworking of the basement led to diverse initialy magmatism, appearance of ophiolites, a pronounced geocynclinal (sial-forming) process with final orogeny, thick stratigraphically complete sequences of Riphean formations with polysyclic sections (Type II of the transitional crust; Priyenisey trough of the Yenisey Ridge - Igarka). Intense rifting under the paleozoids of the

Ural-Mongol belt seems likely. It is crushing the stretching of the Riphean crust that are supposed to be the precursors of a large upper Riphean - lower Paleozoic oceanic structure there. Certain spatial regularities of Riphean rifting are discernible. In best studied areas of southern Middle Siberia, its intensity grows unevenly from the Aldan Shield and the whole of the "ancient summit of Asia" of V.A.Obruchev in the direction of the Altay-Sayany paleozoids and western Mongolia.

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К МЕТОДИКЕ ТЕКТОНИЧЕСКОГО РАЙОНИРОВАНИЯ РИФЕЯ СРЕДНЕЙ СИБИРИ

Становление Сибирского палеократона завершилось к 1900±100 млн. лет массовой сиализацией земной коры. Один из ведущих процессов рифейского геологического развития Средней Сибири - поэтапный рифтинг. Его пространственная приуроченность зависела от особенностей предрифейского структурно-формационного плана региона. Эти особенности и интенсивность рифтинга обусловили различия рифейских геоструктур по типам земной коры - океаническому, континентальному, переходным - уже на начальных стадиях формирования. Основа разрабатываемой методики: тип коры предопределяет последующие преобразования геоструктур. Примеры. На континентальных блоках Сибирского палеократона, не испытавших рифтинга, в рифее накапливались маломощные платформенные осадки или седиментация отсутствовала (Анабарский щит и его южное погружение). Амагматичные рифты с континентальной корой явились материнскими для платформенных прогибов (Котуйканский рифт - Тунгусская синеклиза). Мощные обломочные формации, нередко существенные проявления щелочнобазальтоидного магматизма характеризуют авлакогены с большой амплитудой раздвигания и погружения (I тип переходной коры). Структуры этой категории испытали инверсию с образованием валообразных поднятий - Уджинского, Иркинеевско-Чадобецкого и др. В ряде районов значительная рифтогенная переработка фундамента обусловила разнообразный инициальный магматизм, появление офиолитов, отчетливое развитие геосинклинального (сиалеобразующего) процесса и заключительного орогенеза. Типичные мощные стратиграфически полные ряды рифейских формаций с полициклическим строением разрезов (II тип переходной коры; Приенисейский прогиб Енисейского кряжа - Игарки). Интенсивный рифтогенез вероятен под палеозоидами Урало-Монгольского пояса. Предполагается, что именно дробление и растяжение коры в рифее создали предпосылки для существования здесь крупной верхнерифейской-нижнепалеозойской океанической структуры. Намечаются пространственные закономерности проявления рифейского рифтогенеза. В наиболее изученных южных районах Средней Сибири его интенсивность неравномерно возрастает от Алданского щита и всего "древнего темени Азии" В.А.Обручева в направлении к палеозоидам Алтае-Саянской области и западной Монголии.

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THRUST FAULTING, TECTONIC WEDGING AND DELAMINATION OF THE LITHOSHERE: EXAMPLES FROM THE CANADIAN CORDILLERA

Displacement of tectonic wedges, bounded above and below by thrust fault zones with opposing vergence, has produced tectonic delamination at various stratigraphic levels and times in the Rocky Mountain fold and thrust belt of Canada. The "triangle zone", along the eastern edge of the belt, comprises an easterly tapering wedge of imbricate thrust slices and delamination in Upper Cretaceous molasse deposits. The Porcupine Creek anticlinorium is a fan fold resulting from the insertion of a wedge of Proterozoic rocks along a zone of delamination at the base of the Lower Paleozoic shale succession. In the Selkirk fan structure, which involves metamorphic infrastructure of the Cordillera, delamination has occurred as the result of the insertion of an apparently allochthonous mass (a "suspect terrane") between the detached parauthochthonous supracrustal rocks and the authochthonous basement complex.

The characteristic feature of tectonic wedging and delamination is a reversal in vergence between the bottom and the top of the wedge. Conspicuous tectonic overprinting generally occurs above the wedge, and has commonly been described as "black folding" or "polyphase folding" and ascribed to polyphase orogeny. Tectonic wedging and delamination are widespread in compressional fold belts of various ages. Other examples occur in early Proterozoic (Wopmay Orogen), Paleozoic (Caledonide-Appalachian) and Cenozoic (Alps) mountain belts. Moreover, tectonic wedging and delamination occur over the whole spectrum of scales from the microscopic to the lithospheric. They are an inherent part of the development of most large thrust sheets, including crystalline basement sheets and obducted ophiolites, all of which comprise a strong upper layer that has been delaminated from the rest of one lithospheric plate, and has overlapped another lithospheric plate that has been wedged beneath it. Geometric and kinematic relationships discernible in well documented natural prototypes of tectonic wedging and delamination on a small scale provide a basis for inferring relationship that are more difficult to establish directly on a large scale.

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THE BAHIA HONDA FACIES-STRUCTURAL SUBZONE, PINAR DEL RIO: ITS TECTONIC AND SOME DATA ABOUT THE UPPER CRETACEOUS-PALEOCENE SEDIMENTATION AND PALEOGEOGRAPHIA

In the northeastern part of Pinar del Río Province, the Bahía Honda area is considered as a facies-structural subzone of the main Zaza zone. From Cretaceous to Paleocene, the formations Chirino, Felicidades, Vía Blanca, Penalver, Capdevila and Universidad, are briefly described. On this subzone - two main nappe units are distinguished: meridional and septentrional. The first unit is mainly composed of Cretaceous rocks, while the septentrional (higher) unit contains the ophiolitic complex followed by the volcanic-sedimentary and sedimentary sequences of Cretaceous and Paleogene ages. Both tectonic units have a complicated internal structure. The allochthonous Bahía Honda subzone overthrust from the south above the miogeosyncline units of Guaniguanico zone. The Vía Blanca Formation (Campanian Early Maestrichtian) and Capdevila Formation (Paleocene-Early Eocene) show a remarkable lithological and facies resemblance. The Vía Blanca Formation have been deposited on a flysch basin, outward of the extinct volcanic arc, and located to the north (or northeast) of a shallow calcareous-clastic sedimentation zone. The flysch deposits of the Capdevila Formation were located on a more wide basin than that of the Vía Blanca deposits. The clastic material have been transported from southwest. Some conglomerates have rocks fragments of the miogeosyncline formations of Sierra del Rosario. It is possible that the formation of nappes of the Guaniguanico Range ended by Late Lower Eocene while the northward movement of the eugeosyncline mantle of Zaza zone ended most probably before Late Eocene time.

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NAPPE AND THRUST FAULT STRUCTURES IN THE NORTH-WESTERN FRAMING OF THE PACIFIC

The tectonic analysis of mountain chains in the north-western framework of the Pacific ocean has been carried out until recently by many authors, leaving out of account the horizontal displacements of rock

masses. Structures of many regions of the USSR East seemed as series of anticlinoria and sinclinoria separated by deep faults, whereas thrusts and nappes were regarded as complexes of no principal concern. The studies of a number of regions (Sikhote-Alin, Sakhalin, Eastern Kamchatka, Koryak Ridge) carried out at the Geological Institute of the USSR Academy of Sciences revealed wide distribution of Late Mesozoic and Cenozoic nappe and thrust fault structures within the region concerned. In the continental structure of Southern Sikhote-Alin and in the similar structure of the Koryak ridge the nappe formation began as early as in the pre-Middle Cretaceous time. On Sakhalin, in a younger tectonic zone, it began in the Middle Cretaceous and continued till the end of the Cretaceous period. On Eastern Kamchatka the earliest movements are recorded in the Late Maestrichtian, and the subsequent thrusts are of the Cenozoic age. Thus, the analysis of the epochs of thrust formation emphasizes the main regularity of structural development in a near oceanic zone of the North-Western Pacific: progressive, though contradictorily proceeding accreting of the continental margin.

No universal epochs of thrust formation can be established due to differences in the geological history of the given regions. Nevertheless, there can be correlated between separate regions. For instance, Middle Cretaceous and Pre-Maestrichtian movements were common for Sakhalin and the Koryak ridge, whereas Turonian - Early Senonian ones for Sakhalin and Southern Sikhote-Alin. Therefore, we can say that the thrust formation spread all at once over vast spaces, exceeding in the present-day structural plan the distance of 2000 km between the Koryak ridge and Sakhalin.

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ТЕКТОНИЧЕСКИЕ ПОКРОВЫ И НАДВИГИ В СЕВЕРО-ЗАПАДНОМ ОБРАМЛЕНИИ ТИХОГО ОКЕАНА

Тектонический анализ горных сооружений в северо-западном обрамлении Тихого океана до последнего времени проводился многими авторами без учета горизонтальных перемещений горных масс. Структуры многих районов Востока СССР представлялись как серии антиклинориев и синклинориев, разделенных глубинными разломами, а надвиги и покровы рассматривались как образования, не имеющие принципиального значения. В результате изучения целого ряда районов (Сихотэ-Алинь, Сахалин, Восточная Камчатка, Корякский хребет), проведенного Геологическим институтом АН СССР, установлено широкое распространение в регионе покров-

ных и чешуйчато-надвиговых структур позднемезозойского и кайнозойского возраста.

В материковой структуре Южного Сихотэ-Алиня и близкой к таковой Корякского хребта покровообразование началось еще в досреднемеловое время. На Сахалине, в более молодой тектонической зоне, оно началось в среднем мелу и продолжалось до конца мелового периода. На Восточной Камчатке самые ранние движения отмечаются в позднем маастрихте, а последующие надвиги имеют кайнозойский возраст. Таким образом, анализ рубежей надвигообразования подчеркивает основную закономерность развития структур в приокеанической зоне северо-западной Пацифики: прогрессивное, хотя и противоречиво протекающее наращивание континентальной коры.

В связи с различиями в геологической истории рассматриваемых регионов для всех них, естественно, не выявляется единых рубежей надвигообразования. Но между отдельными регионами корреляция существует. Например, для Сахалина и Корякского хребта общими были среднемеловые и предмаастрихтские движения, а для Сахалина и Южного Сихотэ-Алиня турон-раннесенонские. Поэтому можно говорить об охвате надвигообразованием сразу больших пространств (в современном структурном плане расстояние между Сахалином и Корякским хребтом превышает 2000 км).

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RIFT MAGMATISM IN KERALA: ITS IMPLICATIONS FOR THE TECTONIC EVOLUTION OF THE SOUTH-WESTERN PART OF INDIAN CONTINENT

Basic magmatism in Kerala State is represented mostly as dikes trending WNW-ESE, ENE-WSW and NW-SE directions sympathetically to the major tectonic lineaments and/or shear zones. Geochemical data of these rocks indicate that they resemble the continental rift tholeiites with minor mildly alkaline basaltic types. The continental rift tholeiites are identified by larger range in TiO_2 (0.80 - 3.6%), low P_2O_5 (0.10 - 0.70%), K_2O (0.16 - 0.60%), Rb (1-10 ppm), Sr (60 - - 250 ppm), Ba (100 - 300 ppm), Zr (16 - 180 ppm), Y (5 - 21 ppm), Nb (10 ppm) and depleted to slightly enriched LREE trend. The alkali basaltic types are characterized by smaller range of TiO_2 (2.13 - 4.00%), high P_2O_5 (0.32 - 1.00%), K_2O (0.60 - 2.50%), Rb (10-71 ppm), Sr (300-1084 ppm), Ba (350-620 ppm), Zr (165 - 600 ppm) and Y (21 - 28 ppm). Paleomagnetic results indicate a pole position (44°N; 135°E) closer to that of the 1830 ± 200 M.Y. Gwalior traps. It is suggested that continental rifting and linear fracturing had initiated during mid-Proterozoic period (≈ 2000 M.Y.). Subsequently the fractures were rejuvenated and culminated with the magma ejection along a few frac-

tures simultaneous to the development of the passive southwest continental margin of India and to the rift volcanic phase of the Deccan traps.

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PHYSICAL CHARACTERISTICS AND EVOLUTIONARY TRENDS OF CONTINENTAL RIFTS

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PATAGONIA: A PALEOZOIC CONTINENT ADRIFT

Recent tectonic studies have shown that most of the pre-Ordovician basement of the Southern Andes of Argentina and Chile are composed of one or more allocthonous continental blocks that have collided against the continent during Early Paleozoic times. Such interpretation is based on:

- an almost continuous bélt of ophiolites along the eastern foothills of the Andes,composed by typical Bogdanov sequences,
- a west verged and highly deformed Early Paleozoic foldbelt, located eastward of the obducted oceanic crust, which has a moderate pressure - low temperature metamorphism,
- and a magmatic arc of Cambrian to Ordovician age.

The suture zone continues southward below 5 to 6,000 m of Late Mesozoic to Cenozoic deposits of the aulacogenic Colorado basin, which is located at the old southwestern continental margin of Gondwana. This interpretation implies that the Patagonian block was acreted during the Paleozoic to the Gondwana craton, and is based on:

- a thick Paleozoic miogeoclinal sequence (SAMFRAU geosyncline of du Toit), deposited on a foreland basin north of the Colorado basin;
- a northwestern verging fold-thrust belt deformed during the Gondwanic orogeny in Late Paleozoic, which continues eastward in the Cape System of South Africa;
- a magmatic arc and related metamorphic rocks south of the proposed suture, normal to the present Pacific margin;
- and a positive gravity anomaly situated south of the infered roots of the fold-thrust belt.

The petrotectonic assemblages, the timing of deformation and the areal relationships of the tectonic elements, strongly suggest a collision of Patagonia against the Gondwana craton during the Late Permian.-

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THE QUANTITATIVE EVALUATION OF ROCK DEFORMATION: A REVIEW

A general discussion of the strain state and the relationships between displacement and strain leads to a review of the practical methods whereby we are able to measure strain in naturally deformed rocks. Methods for describing strain using maps and graphical techniques are described. The geotectonic significance of making strain measurements is discussed with particular emphasis on how strain data enable a geologist to appreciate more exactly the significance of large scale and small scale tectonic features of the earth's crust.

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RHEOLOGICAL STRATIFICATION OF THE CONTINENTAL LITHOSPHERE AND ITS TECTONIC CONSEQUENCES

It has become increasingly clear that, in order to account for the kinematic history of a given tectonic zone, it is often necessary to consider not only relative movements of lithospheric plates and associated deformation, but also relative movements of slices or "flakes" of lithosphere one on top of another. The evidence for such decoupling of lithospheric slices along sub-horizontal surfaces is quite clear and comes both from seismic studies of the lithosphere and from geometric constraints imposed by palaeogeographic reconstructions.

It is therefore necessary to envisage geodynamic processes resulting in decoupling and large-scale relative movements along zones situated at depths varying from a few kilometers to a few tens of kilometers. The possibility and characteristics of these zones are here assessed from the viewpoint of rheology.
The creep strength of silicate rocks is a function of composition, pressure, temperature, grain size, strain rate, presence of H_2O, and other rheological parameters. Considering several models of continental lithosphere reflecting its vertical zonation in different tectonic zones, profiles of strength versus depth, effective viscosity versus depth, and deformation maps in stress-grain size coordinates are constructed. These show that, for favourable but realistic combinations of parameters, zones of tectonic decoupling are not only possible but required.
The models are constrained by experimental and theoretical results on rock deformation, and tested against geodynamic observables such as distribution of seismicity with depth, seismic velocity and elctrical conductivity distribution, and tectonic evidence in selected regions.

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DETERMINATION OF PARAGENETIC GROUPS OF TECTONIC FAULTS AS A METHOD OF PALEOGEOMECHANICAL ANALYSIS OF MOUNTAIN ROCKS DEFORMATION

On the basis of compared natural, experimental and theoretical models of the structures of destruction, the work considers certain general geomechanical types of fault groups corresponding to different types of stress and deformation, *reological behaviour* and outer loading of elementary geomechanical bodies. Each type has a definite structural pattern of its own, i.e. regular distribution of different structures of destruction. This regularity may be attributed to a number of physical mechanical factors: common reological behavior of the medium during the destruction (elastic-brittle, elastic-plastic, visco-elastic, or combined), preferred type of macroscopic destruction (shearing, sliding, flattening, or breaking), the character of outer loading (compression, extension, shift or torsion), type of tension (triaxial-anisotropic; biaxial-anisotropic with active compression or extension; triaxial-anisotropic, axially simmetric; with fixed positions of axes b_1 or b_3; Bi- or triaxial-anisotropic, with the tensor rotating in the main kinematic plane), or the deformed state (straight-line or rotary tectonic motion; plain or jet flow). According to the combination of these parameters, the deformed massif can show different groups of structures of destruction, associations of tectonic faults, with common genesis, but differing morphokinematic parameters and orientation.

Combinations of *these faults* form definite geometric bodies (systems of flattening, sliding or breaking; coaxial shears; pyramid or cone of shearing; belt of flow or rotation). Geological kinematic aspects of study of tectonic faults in deformed bodies reveal natural associations of regularly combined faults of different morphology and orientation, paragenetic groups of faults comparable in their structural patterns with model structures of *destruction*. Fault patterns is an important stage of the geomechanical analysis of the deformations of the geological past in various scopes of research.

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ВЫЯВЛЕНИЕ ПАРАГЕНЕТИЧЕСКИХ СЕМЕЙСТВ ТЕКТОНИЧЕСКИХ ДИЗЪЮНКТИВОВ КАК МЕТОД ПАЛЕОГЕОМЕХАНИЧЕСКОГО АНАЛИЗА ДЕФОРМАЦИЙ ГОРНЫХ ПОРОД

На основании сопоставления природных, экспериментальных и теоретических моделей структур разрушения рассматриваются некоторые общие геомеханические типы дизъюнктивных семейств, отвечающие различным видам напряженно-деформированного состояния, реологического поведения и внешнего нагружения элементарных геомеханических объемов. Каждый тип характеризуется определенным структурным рисунком, т.е. закономерностью взаимного размещения различных структур разрушения. Закономерность эта определяется целым рядом физико-механических причин: общей моделью реологического поведения среды в момент разрушения (упруго-хрупкая, упруго-пластическая, упруго-вязкая или сложная), преобладающим видом макроскопического разрушения (скалывание, скольжение, сплющивание или отрыв), характером внешнего нагружения (сжатие, растяжение, сдвиг или кручение), видом напряженного состояния (трехосно-анизотропное; двухосно-анизотропное при активном сжатии или растяжении; трехосно-анизотропное осесимметричное; при стационарном положении оси σ_1 или σ_3; двух- или трехосно-анизотропное с вращением тензора в главной кинематической плоскости) или деформированного состояния (прямолинейное или вращательное тектоническое перемещение масс; плоское или струйное течение). В зависимости от сочетания этих параметров в деформируемом массиве возникают различные семейства структур разрушения - ассоциации единых по генезису, но различных по морфокинематическому габитусу и пространственной ориентировке тектонических нарушений, сочетания которых образуют вполне определенные геометрические фигуры (системы сплющивания, скольжения или отрыва; парные сколы; пирамида или конус скалывания; пояс течения или вращения). Геолого-кинематическое изучение тектонических нарушений деформированных объемов позволяет выявить в них естественные ассоциации закономерно и устойчиво сочетающихся между собой дизъюнктивов разной морфологии и ориентировки - парагенетические семейства тектонических нарушений, структурные рисунки которых могут быть сопоставлены с типовыми фигурами разрушения. Выявление дизъюнктивных структурных рисунков является важнейшим звеном геомеханического анализа тектонических деформаций геологического прошлого в самых различных масштабах исследования.

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THE PRE-RIFTING STAGE IN THE EVOLUTION ("MATURING") OF CONTINENTAL RIFT ZONES

Structurally and geohistorically the continental rifting is inherited from the previous geological history. Data from the Red Sea and other rift zones serve a basis for distinguishing a pre-rifting stage in continental riftogenesis. The pre-rifting stage implies a complex of tectonic and magmatic processes affecting one or another rift zone upon formation of the mature continental crust within it and prior to structural and morphological shaping of a rift. The continental rifting is the most active in the areas where the lithosphere was highly heated, thermally unstable or destabilized. Such an environment can result from a pre-rifting endogenic regime of progressively recurrent type characteristic for a long-term pulse-like reactivation of the mantle as evidenced from repeatedly generated mantle and crust magmas at various depths. Consequently, the rifting is preceded by specific conditions under which a preparation (a kind of maturing) of lithosphere for the rifting process occured long before its major Cenozoic paroxysms. The endogenic mantle activation during the pre-rifting stage is localized along certain zones tracing its earliest foci. At the depth, the pre-rifting stage is caused by the mantle multifocal or diffuse activation concentrated along linear zones or in "riftogenic conduits", later inherited by mantle diapirs. Geohistorically, the continental rifting is predetermined by two major causes: 1) the presence of major lithospheric inhomogeneties originated mostly in the Precambrian and, 2) the long intermittent mantle reactivation at the pre-rifting stage. Both factors evidence in favour of deep roots of the riftogenesis. Interrelations between the rifting and the pre-rifting stages occur at the mantle and crust levels. At the mantle level these interrelations are determined by the inheritance of the endogenic regime which makes up the essence of the riftogenesis pre-determination. At the crustal level the riftogenesis is shaped by the structural anisotropy of the basement.

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ДОРИФТОВЫЙ ЭТАП РАЗВИТИЯ ("СОЗРЕВАНИЯ") КОНТИНЕНТАЛЬНЫХ РИФТОВЫХ ЗОН

Континентальный рифтогенез структурно и геоисторически связан с предшествующей геологической историей, т.е. развитие его протекает предопределенно. На примере Красноморской и других рифтовых зон обосновано выделение дорифтового этапа в развитии континентального рифтогенеза. Под дорифтовым этапом понимается совокупность тектоно-магматических процессов, имевших место в той или иной области рифтогенеза после формирования в ней зрелой континентальной коры до структурно-морфологического оформления рифта. Наиболее активно континентальный рифтогенез развивается в областях, литосфера которых на дорифтовом этапе оказалась наиболее разогретой, термически "расшатанной" или дестабилизированной. Подобная обстановка создается при прогрессивно-рекуррентном типе дорифтового эндогенного режима, главнейшей чертой которого является длительное, пульсационное возбуждение мантии, проявленное в повторном генерировании разноглубинных мантийных и коровых магм. Следовательно, образованию рифтов предшествуют своеобразные условия, способствующие подготовке, как бы "созреванию" литосферы для рифтогенеза задолго до его главных пароксизмов в кайнозое. Эндогенное возбуждение мантии на дорифтовом этапе локализуется вдоль определенных зон, трассирующих самые ранние очаги ее возбуждения. В глубинном аспекте дорифтовому этапу отвечает очаговое (диффузное) возбуждение мантии, локализующееся в линейных зонах или "рифтогенных стволах", наследуемых на рифтовом этапе мантийными диапирами. Геоисторические предпосылки континентального рифтогенеза определяются двумя важнейшими факторами: I) существованием крупных литосферных неоднородностей, возникших, главным образом, в докембрии, и 2) длительным прерывистым возбуждением мантии на дорифтовом этапе. Оба эти фактора свидетельствуют в пользу существования глубоких "корней" рифтогенеза. Соотношение рифтового и дорифтового этапов происходит на разных уровнях: мантийном и коровом. На мантийном уровне предопределенность обусловлена преемственностью эндогенных режимов, на коровом - зависимостью рифтогенеза от структурной анизотропии фундамента.

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ALPINE TECTONICS OF THE INNERMOST ZONE OF WEST CARPATHIANS /CZECHOSLOVAKIA/

The innermost tectonic zone of West Carpathians on the Czechoslovak territory reveals complicated nappe structure created by Alpine orogeny. Alpine orogeny was of polyphase character with different mechanism of the tectonic structures forming.
Mesozoic /predominantly Triassic/ consists of at least two paleotectonically and facially different sequences which form independent tectonic units /nappes/. The lower one /Meliata unit/ is composed of deep sea formations with presence of basic volcanics and radiolarites /incomplete ophiolite suite/ deposited in the through with oceanic or transitional crust. High pressure metamorphism of the unit is interpreted by the process of intracrustal subduction. The upper one /Silica nappe/ composed predominantly thick carbonate sequence /sediments of differentiated carbonate platform on the continental type crust/ was thrusted as superficial nappe with southern vergency on the already metamorphosed sequence of the lower unit.
The south vergency of the Silica nappe movement is interpreted by gravity tectonics from the rising Gemeride zone with granite intrusions and the higher temperature Alpine metamorphism of the pre-Mesozoic basement.
Both units together were subsequently deformed by the younger /post Upper Cretaceous/ thrusting which formed fan-like system of thrust structures.

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IMPORTANCE DES DEPLACEMENTS LONGITUDINAUX DANS LES CHAINES ALPINES TETHYSIENNES

On sait depuis longtemps que la mobilité du domaine téthysien s'est traduite par de grands charriages pouvant se mesurer en centaines de kilomètres. Il apparaît de plus en plus qu'elle s'est traduite aussi par des déplacements longitudinaux d'importance égale sinon supérieure.

L'intérêt de cette nouvelle approche des chaînes téthysiennes sera illustré par quatre exemples montrant des stades plus ou moins poussés de l'analyse.

Dans les Alpes occidentales, la classique interprétation par charriages est certes fondamentale mais insuffisante pour rendre compte des variations longitudinales, de certaines données structurales et du problème d'espace dans les reconstructions. Combiner aux charriages des déplacements longitudinaux de plusieurs centaines de kilomètres permet de rendre compte de façon plus précise de la répartition du matériel, des caractéristiques structurales et du développement tectonique d'ensemble.

Dans le Magreb, l'analyse tectonique du Rif, sous les nappes, montre un couloir de déformation pénétrative, large de 50 Km et dominé par le déplacement longitudinal. Le moteur essentiel de la tectonique est ici un déplacement longitudinal supérieur à 500 Km; les nappes, essentiellement gravitaires d'ailleurs, jouent un rôle secondaire.

Dans la liaison entre Hellénides et Taurides, le transport longitudinal apparaît comme une nécessité logique: les deux chaînes formant un coin, tout déplacement par charriage sur l'une correspond à un déplacement longitudinal sur l'autre. La différence de développement tectonique s'explique par la différence d'orientation face au mouvement des plaques.

Au Moyen Orient, le bloc Sud-Arménien, situé face à l'arc du Petit Caucase, ne pouvait y être au Mésozoïque et pourtant il appartenait à la même marge. Un glissement longitudinal sur plusieurs centaines de kilomètres est une hypothèse intéressante.

Ces quatre exemples montrent que la connaissance des déplacements longitudinaux est aussi importante que celle des charriages pour l'interprétation des chaînes téthysiennes.

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GENESIS OF HYDROTHERMAL METALLIFEROUS SEDIMENTS IN THE MESOZOIC TETHYS OCEAN COMPARED WITH MODERN SPREADING AXES

Plate tectonic reconstructions of the Alpine-Mediterranean Tethys area show that hydrothermal metalliferous oxide-sediments are widely associated with continental rift volcanism, seamounts and subsiding carbonate platforms, passive margins, and, particularly, the formation of ocean crust (ophiolites) at Upper Jurassic (Italy)and Upper Cretaceous (Turkey, Oman, Cyprus) spreading axes. These will be reviewed in the context of current knowledge on hydrothermal processes at modern spreading axes.

The Tethys highlights processes at rifted continental margins inaccessible in the modern oceans. Early, to Middle Triassic rifting was associated with Pb-Zn brine exhalations, then widening rifts (e.g. Upper Triassic, Antalya) were accompanied by major mafic alkalic volcanism and early hydrothermal Fe-Mn and Mn-oxide accumulation (Oman, Antalya). Metal accumulation also took place on subsiding carbonate build-ups by more hydrogenous processes (e.g. ammonitico rosso). Along passive margins later in the Mesozoic occasional intercalations of Mn-hydrothermal-oxide-sediments document major volcanism (spreading) basinwards.

Modern counterparts can be found in various spreading axes like the East Pacific Rise, Mid-Atlantic Ridge, S W Pacific marginal basins and the Red Sea, but the Tethyan examples point to an even greater diversity of metalliferous deposits, modern and ancient, than yet discovered in the oceans.

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THE RELATIONSHIP OF MACRO-,MESO- AND MICROSTRUCTURES IN THE ALLOCHTONOUS PLATE OF THRUST NAPPE AND MECHANISM OF THE ROCK DEFORMATION

One part of thrust nappe of proterozoic chartyss formation of the highland Sangilén (Tuvá) has been studied. The allochtonous plate has been thrusted northward, the distance from root- to frontal part of thrust nappe is 6-8 km. The thrust fault plane, almost horizontal in the north, becomes steep (to vertical) in the South. The rocks of allochtone have been crumpled in the form of lying isoclinal folds of different scales. The generalized axial planes, the bedding, and the cleavage of axial plane (S_I) have dip azimuth I60°, ∠ I0° (i.e. to the SE). The folds hinges (B) plunge azimuth to the SE I44°,∠ 9°. Boudinage, ptigmatic structures, mylonites are widely developed, but for S_I especially near the bottom of allochtone. The little folds inside the boudines are in accordance with the macrostructures of district, that is an evidence of simultaneous deformation of boudines and the host rocks.

Biotite, quartz, calcite of shists and marble limestones have been studied in microstructural respect. The planes (00I) of biotite are parallel to the cleavage of axial plane S_I. The optic axes of quartz lie in S_I parallel to B. The optic axial planes of anomaly biaxial quartz are perpendicular to S_I and parallel to B. The bisectorial plane of optic axes angle coincides with SI.

The diagrams of optic axes and the normales to the twinning plane e(0II2) of calcite of marbles are analogous to those of deformed monocrystal of calcite. The axes of compression, that caused the twinning of calcite are oriented submeridionally plunge southward under angle from I6° to 60°; with S_I form the angles from I0-I5° to 60-70°, but nowhere are normal to S_I.

It means that deformation resulted in the development of axial planes cleavage S_I was the combination of simple shear and pure shear with predominance of the first one, i.e. it is the rotational strain and cleavage of axial planes (S_I) has been developed parallel to one of the two circular sections of strain ellipsoid. The folds developed in the allochtonous plate are shear folds in the case involved.

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СООТНОШЕНИЕ МАКРО-, МЕЗО- И МИКРОСТРУКТУР В АЛЛОХТОННОЙ ПЛАСТИНЕ НАДВИГОВОГО ПОКРОВА И МЕХАНИЗМ ДЕФОРМАЦИИ ПОРОД

Изучена часть надвигового покрова протерозойской чартысской свиты нагорья Сангилен (Тува). Аллохтонная пластина надвинута на север, расстояние от корневой зоны до фронтальной части надвигового покрова 6-8 км. Поверхность сместителя, почти горизонтальная на севере, становится крутой (до вертикальной) на юге. Породы аллохтона смяты в разномасштабные лежачие изоклинальные складки. Генерализованное залегание осевых плоскостей складок, слоистости пород и кливажа осевой плоскости (S_I): азимут падения 160^0, угол падения 10^0. Азимут погружения шарниров складок (B) 144^0, угол погружения 9^0. Кроме S_I, широко развиты будинаж, птигматитовые структуры, милонитизация, особенно интенсивные вблизи подошвы аллохтона. Мелкие складки внутри будин согласуются по ориентировке с мезо- и макроструктурами района, что указывает на одновременность деформации будин и вмещающих пород.

В микроструктурном отношении изучены биотит, кварц, кальцит кристаллических сланцев и мраморизованных известняков. Плоскости (001) биотита ориентированы параллельно кливажу осевой плоскости S_I. Оптические оси кварца лежат в S_I параллельно B. Плоскости оптических осей аномально двуосного кварца перпендикулярны S_I и параллельны B, биссекторная плоскость угла оптических осей совпадает с S_I.

Кальцит мраморизованных известняков характеризуется диаграммами оптических осей и нормалей к плоскости двойникования e(01$\bar{1}$2), аналогичными таковым деформированного монокристалла кальцита. Оси сжатия, вызвавшего двойникование кальцита, ориентированы субмеридионально, погружаются на юг под углом от 16^0 до 60^0, составляют с S_I углы от 10^0-15^0 до 60-70^0, но ни в одном случае не ориентируются нормально к S_I. Это означает, что деформация, приведшая к образованию кливажа осевой плоскости S_I, является сочетанием простого сдвига и чистого сдвига с преобладанием первого, т.е. представляет результат действия пары сил - вращательного стресса, а кливаж осевой плоскости S_I развит параллельно одному из двух круговых сечений эллипсоида деформации. Складки в аллохтонной пластине представляют складчатость скалывания.

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CRUSTAL STRUCTURE AND GEODYNAMIC EVOLUTION OF THE PALAEOZOIC MAURITANIDES OROGENIC BELT (WEST AFRICA) AS DEDUCED BY GRAVITY STUDIES

The Mauritanides, characterized by submeridional structural trends and eastward thrusting, are a polyphased belt that has been gradually developped from South to North through Panafrican, Caledonian and Hercynian events.

The gravity anomaly pattern reflects an eastern crustal domain with broad negative values corresponding to the West African craton and its cover, and a western one, beneath the Atlantic coastal basins, where positive anomaly field suggests a denser crustal basement. These two continental blocks are delimited by a prominent belt of gravity highs which parallels, slightly to the West, the main outcropping chain.

Changes in gravity trend and pattern in a NE-SW zone in Eastern Senegal reflects a transverse alignment separating the Southern and Central Mauritanides.

In Guinea and South-Eastern Senegal, the linear gravity highs have been interpreted as west dipping mafic bodies reflecting a Panafrican suture.

In North-Eastern Senegal and Mauritania, the Panafrican deformation is masked by Caledonian and Hercynian events and gravity features confirm the thin-skinned thrusting style of the belt. The major positive anomaly, parallel to the belt, is interpreted there as the trace of the collision of two continental blocks (a Taconian event ?).

The geodynamic interpretation of the Hercynian nappes of Northern Mauritania and South Morocco implies that a rift or an ocean has closed farther to the West in the coastal region or even farther west beneath the U.S. Atlantic Coastal Plain.

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TECTONICS OF ANDAMAN - NICOBAR BASIN, INDIA

The Andaman-Nicobar basin is associated with convergent plate boundary. Varion tectonic elements are the structural high or the trench slope break represented by the island chain, the subduction complex with slope basins in the west of the island chain, the fore-arc basin and the magmatic arc occurring in the east of the structural high. Though subdued, the trench can be also recognized in the west of the subduction complex.

The subduction complex consists of thrust sheets with anticlinal folds. Late Neogene slope basins with undisturbed sediments have developed over these Miocene and Paleogene folded sediments.

Parallel folds within the Paleogene turbidite sequence, associated with ophiolite and melange, constitute the main features of the

structural high. The fore-arc basin shows bizzare structural mosaic with smaller basins filled with fairly undisturbed Neogene sediments unconformably overlying the strongly folded Paleogene sediments and blocks containing second and third order sharp folds resulted from wrench movements. These second order wrench faults have originated from a first order dextral regional transcurrent fault, coinsiding probably with the chain of volcanoes marking the magmatic arc.

Above conclusions are based on deep drilling results and 20,000 kms of seismic data including log regional lines across the tectonic elements.

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THE NAGA HILLS OPHIOLITE: FRAGMENTS OF ANCIENT OCEANIC LITHOSPHERE?

The Late Mesozoic-Early Cainozoic Naga Hills ophiolite is a part of the major ophiolitic suture lying along the eastern margin of the Indian plate. It occurs as a narrow (1-15 km wide), NE trending, westerly convex, linear (90 km) tectonic belt in the northern part of the Indo-Burman mountain ranges. It is a dismembered ophiolite with a tectonic chaos characteristic of an ophiolite mélange. Its various lithomembers are classified into four major units: 1)metamorphic ultramafites(dunite-harzburgite-minor lherzolite), 2)cumulate mafic-ultramafics, 3)volcanics and volcanoclastics, 4)layer I oceanic sediments. It is intruded by stocks and bosses of granitoid rocks with disseminated and vein-type sulphides. An Oligo-Miocene, shallow water, coarse, clastic, sedimentary cover unconformably overlies the ophiolite. The metaultramafites show ubiquitous presense of chrome spinel(picotite), recrystallization and evidences of plastic deformation. The cumulate sections exhibit small-to-large-scale igneous layering of inconsistent thicknesses. The metamorphic rocks are greenschist, blueschist, glaucophane-bearing metagreywacke, antigorite schist, amphibolite and quartz--pyroxene-garnet rock. Rodignite occurs at places. The ultramafics have varying degree of serpentinization, mainly of antigorite type. The ophiolite is affected by NE high angle thrust and reverse faults. The tectono-metamorphic evidences suggest a subducting event prior to its obduction into the orogenic belt. The volcanic rocks have a geochemical affinity with the effusive derivatives of modern oceanic crust and Bay of Islands ophiolite. The metaultramafites are richer in Ni, Co, Cr and deficient in CaO, Al_2O_3 compared to their cumulate counterparts. The TiO_2 content(0.12%) of the cumulate rocks is significantly lower than that of the known non-ophiolitic layered igneous complexes(Skaergaard, Bushveld, Stillwater). Syngenetic mineralizations in the ophi-

olite suite include igneous magnetite, podiform chromite, Ni, Co, Pt (traces) and limestone. The epigenetic mineralizations are of Cu-Mo sulphides comparable with the sulphides of the Circum Pacific belt, and minor chrysotile, talc-steatite and magnesite. The reconstructed lithostratigraphy, and structural, petrological and geochemical characteristics suggest that this ophiolite could be nonsubducted parts of an ancient oceanic lithosphere underlying the southern Tethyan seaway. A late Early Tertiary obduction emplaced it into the Indo-Burman orogenic belt following eastward underthrusting of the Indian plate and subsequent collision between the Indian and SE Asian continents.

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EVOLUTION OF THE HOKKAIDO-SAKHALIN FOLDED SYSTEM

The Hokkaido-Sakhalin folded system was formed as a result of a successive eastward migration and closure of two geosynclinal troughs: Edzo-Sakhalin Late Paleozoic (?) - Early Cretaceous trough and Nemuro-East-Sakhalin Jurassic (?) - Late Cretaceous one. Beginning since Late Paleozoic (?) up to the end of Early Cretaceous (Albian stage) the Earth crust warped down within the Edzo-Sakhalin trough and a thick (of more than 12 km) complex of eugeosynclinal deposits, represented by the alternation of deep sea sandy-argillaceous shaly series, including olistostrome horizons with siliceous-volcanogenic series had been formed. Those formations were crumpled into narrow folds, close to isoclinal ones. Folding intensity decreases upwards along the cross-section. A serpentinite melange is developed along the thrusts. Inshore marine and marine terrigenic deposits of miogeosyncline type occurred in Late Cretaceous within the trough, being in Northern Sakhalin with intercalations of continental carboniferous deposits. Within the Nemuro-East-Sakhalin trough the formation of the complex of deep-sea eugeosynclinal deposits, including olistostrome horizons had been continued almost till the end of Late Cretaceous. Plates of ophiolites are marked at the base of the complex. Early orogenic uplift of Sakhalin and Hokkaido and intrusion of granitoids along the folded system axial zone occurs in Late Cretaceous - Early Paleogene. In Cenozoic Sakhalin was within the area of the marginal sea, where cyclic series, including both continental and marine deposits of pseudoplatform type occurred. The formation of tectonic structures was stipulated by block displa-

cements along submeridional faults. The Hokkaido-Sakhalin orogenic belt and molasse deposits within the adjacent basins were formed in Pliocene-Quaternary time.

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ЭВОЛЮЦИЯ ХОККАЙДО-САХАЛИНСКОЙ СКЛАДЧАТОЙ СИСТЕМЫ

Хоккайдо-Сахалинская складчатая система возникла в результате последовательной миграции в восточном направлении и замыкания двух геосинклинальных прогибов: позднепалеозойского(?)-раннемелового Эдзо-Сахалинского и юрского (?)-позднемелового Немуро-Восточно-Сахалинского. С позднего палеозоя (?) до конца раннего мела (альб) в пределах Эдзо-Сахалинского прогиба происходило прогибание земной коры и образовался мощный (свыше 12 км) комплекс эвгеосинклинальных отложений, представленный чередованием глубоководных песчано-глинисто-сланцевых толщ, включающих олистостромовые горизонты, с кремнисто-вулканогенными толщами. Эти образования смяты в узкие, близкие к изоклинальным складки. Интенсивность складчатости вверх по разрезу уменьшается. Вдоль надвигов развит серпентинитовый меланж. В позднем мелу в пределах прогиба отлагались прибрежно-морские и морские терригенные отложения миогеосинклинального типа, на Северном Сахалине с прослоями континентальных угленосных отложений. В пределах Немуро-Восточно-Сахалинского прогиба формирование комплекса глубоководных эвгеосинклинальных отложений, включающих олистостромовые горизонты, происходило почти до конца позднего мела. В основании комплекса отмечаются пластины офиолитов. В позднем мелу-раннем палеогене происходит раннеорогенное поднятие Сахалина и Хоккайдо и внедрение гранитоидов вдоль осевой зоны складчатой системы. В кайнозое Сахалин находится в области краевого моря, в пределах которого отлагались цикличные толщи, включающие континентальные и морские отложения, псевдоплатформенного типа. Формирование тектонических структур было обусловлено сдвиговыми движениями блоков вдоль субмеридиональных разломов. В плиоцен-четвертичное время происходит формирование Хоккайдо-Сахалинского орогенного пояса и молассовых отложений в соседних с ним впадинах.

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COMPARISON OF MAJOR PRE-ALPINE TECTONIC BOUNDARIES OF THE CARPATHIANS, BALKANS AND EASTERN ALPS

The pre-Alpine history of the Carpathians, Balkans and Eastern Alps features the Variscan and Salairic (500-530 mln.y.) tectonic events related to regional metamorphism and restructuring. There is also some evidence of the Dalslandian orogeny (850-900 mln.y.) in the Balkan Mountains and in most part of the Carpathians. Similar radio- and geochronology, as well as indirect data, suggests that evidence of this orogeny is available also in the Eastern Alps. The gneiss-mica-schist complexes may be the metamorphism product of the Dalslandian geosynclinal deposits, with greenschist complexes being the metamorphosed Salairic products, while the phyllite complexes may have emerged under the metamorphism of Lower-Middle Paleozoic deposits at the time of Variscan events. The fact that no Upper Riphean-(Lower) Cambrian greenschists are available in the Eastern Alps and the Western Carpathians may suggest that initially this part of the geosynclinal area had no Salairic troughs. At the Salairic stage, the ancient complexes of this part were exposed to diaphthoresis and intense radiological rejuvenation. Another option is an anomalously high Salairic metamorphism in the Eastern Alps and Western Carpathians, which leads to the conclusion that there are no older complexes there. It follows that the greater part of the Carpathians and the Balkans show a considerably lower rate of the crustal evolution at the Dalslandian and Salairic stages, with the uniform Caledonian-Variscan development throughout the considered area. There is indirect evidence that the first option is more probable.

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СОПОСТАВЛЕНИЕ ОСНОВНЫХ ТЕКТОНИЧЕСКИХ РУБЕЖЕЙ В ДОАЛЬПИЙСКОЙ ИСТОРИИ КАРПАТ, БАЛКАН И ВОСТОЧНЫХ АЛЬП

В доальпийской эволюции Карпат, Балкан и Восточных Альп выявлены варисский и салаирский (500-530 млн. лет) тектонические рубежи, с которыми связаны региональный метаморфизм и структурная перестройка. В Балканах и на большей части Карпат установлен также дальсландский тектогенез (850-900 млн.лет). Сходство радиогеохронометрической информации и косвенные данные позволяют предполагать наличие этого тектогенеза и в Восточных Альпах. Гнейсово-слюдяносланцевые комплексы, вероятно,

представляют продукты метаморфизма отложений дальсландских геосинклиналей, зеленосланцевые комплексы являются метаморфизованными салаирскими продуктами, а филлитовые комплексы возникли при метаморфизме отложений нижнего–среднего палеозоя на варисском рубеже. Невыявленность в Восточных Альпах и Западных Карпатах зеленосланцевых комплексов верхнего рифея –(нижнего) кембрия отражает, вероятно, изначальное отсутствие салаирских прогибов в этой части геосинклинальной области. Древние комплексы испытали здесь на салаирском этапе диафторез и глубокое радиологическое омоложение. Альтернативное решение представляет вариант аномально высокой интенсивности салаирского метаморфизма в Восточных Альпах и Западных Карпатах, что ведет к заключению об отсутствии здесь более древних комплексов. Из этого должен следовать вывод о гораздо более медленной эволюции коры на большей части Карпат и в Балканах на дальсландском и салаирском этапах, поскольку каледоно–варисское развитие на всей территории единообразно. Косвенные соображения указывают на большую вероятность первого из намеченных вариантов.

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GIANT BASE-METAL OREBODIES: RESULTS OF HYDROTHERMAL CONVECTION IN SUBMARINE CONTINENTAL RIFTS; DRILLING EVIDENCE

The giant exhalative sediment-hosted base-metal deposits such as Mount Isa, Australia, are generated during early rifting of hot continental crust. A model is presented in which hypersaline sea or lake water is drawn down into the newly permeable uppermost crust, heated till buoyant and returned in a convective plume to the surface. The lower boundary to the convection cell is presumably controlled by a temperature dependent zone marked by a change from brittle to ductile behaviour, although the rate of pressure solution or hydration along fractures may effectively lift this boundary.

As the crust is cooled by this process the convection cell deepens and widens. Updraught temperatures rise to a maximum of 250 to 300°C depending on the rock type in the upper crust. Magmatic intrusion is not envisaged as a factor in driving the convective process. Hydrothermal metamorphic reactions modify the saline seawater to a mineralizing solution.

Recent deep drilling lends support to the model. Throughout the 11.5 km depth of the Kola super-deep drill-hole, USSR, which intersected rock up to 220°C, strongly mineralized waters were encountered circulating in broad deformed zones (Kozlovsky 1982). The geother-

mal drilling project at Camborne, Cornwall, UK (Pine and Batchelor, 1982) has shown that the horizontal stress contrast in the crust there is 1:2.5, so that water pumped into a 2km hole fills joints that propagate downwards to at least 3 km thus increasing the volume of the reservoir. Only one quarter of the water returns up a second bore-hole. This behaviour is expected from the model under such stress conditions.

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TECTONIC LAYERING OF LITHOSPHERE

The analysis of the surface and deep-seated structure of some fold mountains of the continents shows that the lithospheric plates' layering is consistent with the system of deep-seated décollements, with a number of sheets with differentiated displacement. Their "mixture" in the sequence determines the structure of many fold belts. At present, this phenomenon is supported both by geophysical and geological research. Such type of deformations i s reflected in: (1) décollement nappes (both the surface and deep-seated ones); (2) anomalous types of ophiolitic sequences; (3) the structure of dike complexes of ophiolitic association; (4) certain anomalous relations between volcano-sedimentary covers and ultrabasite-basite basement; (5) evidence of specific tectonic breccias - indicators of the layer décollements.
The present data suggest that, alongside asthenosphere, there are other décollement discontinuities, with the M and K discontinuities in the first place.

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ТЕКТОНИЧЕСКАЯ РАССЛОЕННОСТЬ ЛИТОСФЕРЫ

Анализ поверхностной и глубинной структуры некоторых складчатых сооружений континентов показывает, что литосферные плиты расслаиваются по системе глубинных срывов на серию дифференцированно смещаемых пластин. Их "перемешивание" в разрезе определяет структуру многих складчатых поясов. Это явление в настоящее время обосновано как геофизическими, так и геологическими наблюдениями. Отражением подобного рода деформаций являются: I) сорванные покровы (как поверхностные, так и глубинные); 2) аномальные типы офиолитовых разрезов; 3) строение дайковых комплексов офиолитовой ассоциации; 4) некоторые аномальные соотношения вулкано-

генно-осадочных чехлов с ультрабазит-базитовым основанием; 5) появление своеобразных тектонических брекчий - показателей послойных срывов.
Имеющиеся сейчас данные позволяют считать, что наряду с астеносферой существуют другие поверхности срыва, в первую очередь таковыми являются поверхности М и К.

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STRUCTURAL ORGANIZATION OF MAJOR CONTINENTAL TRANSCURRENT FAULT ZONES: WITH SPECIAL EXAMPLES IN SOUTH AMERICA

The analysis major transcurrent fault zones shows several similarities which could be postulated as common laws. They are:
a. The microscopic fabric of quartz c axis girdles around the stretching lineations;
b. Fold axes which subparallel the directions of dislocation;
c. Bands of crushed materials along the direction of movement;
d. In certain cases a clear component of flatenning of major grains along the milonitic foliation;
e. Large ductile shear deformation near the major shear zones;
f. Joint systems represented by X, Y, P, R, R' and T joints;
g. Secondary faults related to rotation of one or more of the mentioned joint systems;
h. Distension features shown by the trapping of low grade blocks in between high grade blocks;
i. Compression features associated with thrusting;
j. Other features.

Studied examples in Brazil are the following faults:
1. Pernambuco - Ngourandere lineament (more than 1000km)
2. Paraíba fault zone
3. Cubatão fault zone (about 1000km in length)
4. Taxaquara fault zone (about more than 150km)

Systems of subparallel transcurrent faults show very large cumulative displacements with more than 400km.

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TECTONICS OF THE MAIN CENTRAL THRUST ZONE, LESSER GARHWAL HIMALAYA

The Lesser Himalaya in Garhwal is tectonically delineated by two major structural discontinuities, namely, the Dharkot/Pratapnagar Thrust and the Main Central Thrust. In recent years attempts have been made to correlate the thrusts with reference to the adjoining regions of the Garhwal Himalaya and this had led to many tectonostratigraphic and structural controversies. The conventional Main Central Thrust has been correlated by some workers with the Chail Thrust of the Himachal Pradesh Himalaya and in this exercise the position of the Main Central Thrust has been shifted from the Lesser Himalaya to the Higher Himalaya. The

Dharkot/Pratapnagar Thrust has also been grouped into the structural units of the Chail Nappe.

The author opines that the term Main Central Thrust should not be correlated with the Chail Thrust. The Main Central Thrust represents the southernmost limit of the gneisses and schists resting over the prolific belt of the Pratapnagar/Berinag quartzites. Most of the workers have regarded the Main Central Thrust as a single plane which is repeated due to folding. In fact, it is a highly sheared zone where imbricate structures are frequently associated with the cataclasites.

The evolution of the Main Central Thrust has led to the sequential development of imbricate structures showing their disposition along and across the thrust propagation direction. It shows two distinct structural elements viz., the roof- and the floor-thrusts associated with the imbricate structures characteristically present in the footwall zone of the thrust in the Ghansyali area of Lesser Garhwal. These can be grouped into a minor duplex system also called as the Chhatera Duplex.

At the higher tectonic level the Chhatera imbricate is bordered in its upper limit by the roof-thrust while the last imbricate at lower tectonic level is the Western Naikwada imbricate characterized at its base by the floor-thrust and the two constitute together the Main Central Thrust. The development of the imbricates may be ascribed to failure of the footwall ramps and the abandonment of parts of the older surface of it. The displacement of the imbricates has been recorded up to 170 metres. The faulting of imbricate structures occurred subsequent to the folding of the Main Central Thrust.

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PALEOZOIC SOUTHERN URALS AND NORTHERN CAUCASUS EAST EUROPEAN CONTINENT ACTIVE MARGINS.

The Southern Urals and the Northern Caucasus of the Ural-Mongolian and Mediterranean mobile belts respectively, are considered as transitional regions from the East European paleocontinent to the adjacent paleooceanic basins. The analysis of the formational complexes of the two folded regions, as well as palinspastic reconstructions, points to the identical character and synchronism of the major geological events, with certain minor differences.

At the beginning of Paleozoic the old continental margin was destroyed which led to the formation of the Sakmarian and Northern Caucasus marginal seas. The basins were isolated from the exterior by residual microcontinental blocks, that is,by the Central Urals and Central Caucasus blocks. The basins reached their maximum width in the beginning of Silurian, when the formation of the ophiolite association was completed.

The general change in geodynamic regime takes place in the Middle Silurian in the Caucasus and at the end of Silurian in the Urals. Basins' width gradually decreases and their bottom morphology becomes much more complicated; ocean crust rocks enter the subaqual

erosion zone. In the Silurian and Devonian boundary inner volcanic uplifts appear, which develop into island arcs. In the first half of Givetian the volcanic activity dies out both in the Sakmarian and Northern Caucasus basins. Tectonic piling up leads to further contraction of the marginal basins area and thrust formation and folding of their sequence.

In the Middle Devonian - Late Devonian boundary (the Urals) and in the first half of Visean (the Caucasus) the marginal basins close up and this process is accompanied by ophiolite allochthones formation.

Similiarity and synchronisn of major geological events prove the integrity of the Early - Middle Paleozoic Paleotethys and Paleourals. The Western Paleotethys including the Greater Caucasus, and Paleourals were the branches of a single ocean extending eastwards into Central Asia. Since Late Paleozoic the development of the two geosynclines followed different routes.

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ЮЖНО-УРАЛЬСКАЯ И СЕВЕРО-КАВКАЗСКАЯ АКТИВНЫЕ ОКРАИНЫ ВОСТОЧНО-ЕВРОПЕЙСКОГО КОНТИНЕНТА В ПАЛЕОЗОЕ

Южный Урал и Северный Кавказ, относящиеся соответственно к Урало-Монгольскому и Средиземноморскому подвижным поясам, рассматриваются как области перехода от Восточно-Европейского палеоконтинента к соседним палеоокеаническим бассейнам. Анализ формационных комплексов двух складчатых областей и палинспастические реконструкции указывают на одинаковый характер и синхронность определяющих геологических событий при некоторых второстепенных отличиях.

В начале палеозоя произошла деструкция древней континентальной окраины, которая привела к образованию краевых морей - Сакмарского и Северо-Кавказского. С внешней стороны бассейны были отшнурованы остаточными микроконтинентальными блоками - Центрально-Уральским и Центрально-Кавказским. Максимальной ширины бассейны достигают в начале силура, в это время завершается формирование пород офиолитовой ассоциации.

Общее изменение геодинамического режима наступает на Кавказе в середине, на Урале в конце силура. Ширина бассейнов постепенно сокращается, сильно усложняется морфология их дна, в сферу подводного размыва выводятся породы океанической коры. На рубеже силура и девона возникают внутренние вулканические поднятия, которые развиваются в островные дуги. В первой половине живета вулканическая деятельность затухает как в Сакмарском, так и в Северо-Кавказском бассейнах. Тектоническое скучивание привело к дальнейшему сокращению площади краевых бассейнов, расчешуиванию и смятию их разрезов.

На рубеже среднего и позднего девона (Урал) и в первой половине визе (Кавказ) окраинные бассейны закрываются, этот процесс сопровождается формированием офиолитовых аллохтонов.

Сходство и синхронность определяющих геологических событий свидетельствуют о несомненном единстве в раннем-среднем палеозое Палеотетиса и Палеоурала. Западный Палеотетис, включая Большой Кавказ и Палеоурал, представляли собой ветви единого океана, продолжавшегося на восток в Центральную Азию. С позднего палеозоя развитие обеих геосинклинальных систем шло различными путями.

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COMPARED ALPINE GEOTECTONIC MODELS

Following the actual structure and the alpine evolution of different segments of the Tethyan folded chains, several geotectonic models are distinguished.

Two groups of processes have led to the structure and constitution of the folded chains: the extensive (drifting) processes followed by the compressive processes. Specific lithofacies are generally connected to each of these processes; exceptions are also recorded.

From both structural and paleotectonic points of view the symmetry of the folded chains is determined by the oceanic (ophiolitic) suture, the oceanic area respectively.

Excepting the units proceeding from the oceanic area the folded chains involved also split continental margins to which one or several intracontinental (intracratonic) sutures may be associated.

The intracontinental sutures were generated by more or less developed rifting zones, throughout which thinned crust and/or oceanic crust do occur. Thus the obducted units may be oceanic or intracontinental.

The crustal shortening of the mobile areas corresponding to the furtner folded chains may be the result of: oceanic crust consumption, thinned crust consumption or continental crust shearing. The consumption paleoplanes (oceanic and/or intracontinental) may be parallel, convergent or divergent.

The underthrusting processes are the most frequent mechanism generating the tectonic units of the folded chains. Underthrusting involved mainly the foreland but may occur inside the mobile belt too.

The motion of the different panels of the foreland and the primary shape of the continental margins directed the shape of the bending areas of the folded chains.

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ANTIQUE PRECAMBRIAN FAULTS IN THE BASEMENT OF THE INDO-GANGA FOREDEEP AND THEIR CONTROL ON THE HIMALAYAN OROGENY AND UPLIFT

The Precambrian faults in the basement of the Indo-Ganga foredeep at the foot of the rising Himalaya have been intermittently rejuvenated since they came into existence. During the Tertiary and Quaternary Eras, their intermittent reactivation led to down faulting and sinking, and to a certain extent underthrusting of the basement beneath the Outer, the Lesser and the Central Himalaya. The resulting gravitational and isostatic disturbances and inequilibrium in turn led to a proportional uplift of the various transverse sectors of the Himalaya like the Punjab, the Kumaon, the Nepal and the Eastern Himalaya to restore isostasy and equilibrium thus disturbed. The extraordinary depth to which the Mohorovicic discontinuity plunges beneath the Central and the Tibetan Himalaya implies isostatic compensation which is also revealed by gravity anomalies. Isostasy does prevail in the Himalaya to a certain extent in certain areas.

The foredeep, and parts of Outer and Lesser Himalaya are lacking in mass whereas the Central Himalaya and the Tibet have an excess of it on account of the inflow of heavier material from below which made the roots denser and deeper.

The greater the depth to which the basement sank in the frontal deep of the foredeep, higher the uplift of the transverse sectors, particularly the Central Himalayan zone, facing them took place.

Geophysical data, Landsat I Imagery and other satellite and aerial photographs reveal the extention of the Precambrian lineaments into the Outer, the Lesser and the Central Himalaya in depth. These have influenced the sedimentation of the Tertiary and Pre-Tertiary sediments of the region, besides exercising control over the evolution of the Himalava and their uplift during the Cenozoic.

In spite of such uplifts, and mechanics of attaining gravitational and isostatic compensation and extraordinary heights, there is still a gravity deficit in many parts of the Himalaya to be compensated. Buoyancy of the crust may also be a contributing factor towards this deficit. Perhaps this also explains the continuing rise and uplift of the Himalaya.

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SPECULATIONS ON THE ORIGIN AND EVOLUTION OF THE ALEUTIAN-BERING SEA REGION AND ITS TECTONIC DESTINY

The arcuate Aleutian Ridge formed across the northern part of the Pacific Basin in response to intraplate rupturing of a northward-moving oceanic plate and the consequent inception of offshore subduction and arc volcanism. Building of the arc massif began at least by 55-50 m.y. B.P. but greatly slowed after about 40 m.y. B.P. North of the arc the trapped fragment of Mesozoic oceanic lithosphere--Aleutia--accreted to the Beringian margin of the North American plate and presently forms the basement of much of the Bering Sea Basin. The age progression and northward alignment trend of the Emperor Seamounts attest that lithospheric fracturing did not involve the Pacific plate. However, the slowing of Aleutian volcanism is roughly coeval with the start of more westerly motion of the Pacific plate at 42-45 m.y. B.P. Aleutia is therefore probably not a fragment of Pacific plate but, possibly, of the Kula plate that formed east of the Emperor Seamounts about 85 m.y. B.P.

Thick masses of sedimentary beds (4-12 km) and arc-magmatic rocks (1[illegible]0 km) have accumulated in the Aleutian-Bering Sea region as an overlap assemblage above the accreted terrane of Aleutia. At late Cenozoic sedimentation rates, the basin will fill in about 50 m.y. with a geosynclinally thick (10-20 km) sequence of deep-water to paralic strata. Tectonic collapse of this basin initiated by changes in plate-boundary conditions (e.g. inception of backarc subduction, collision with microplates, or rifting along regional transform faults) will create a magnificent Pacific-rim orogen hundreds of km wide replete with a variety of tectonostratigraphic terranes. Significantly, most of these terranes will have been derived from inplace deformation and differential breakup of the autochthonous overlap assemblage rather than from the tectonically far-traveled and much older oceanic-basement terrane of Aleutia.

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BASIN FORMATION BY COMPRESSION IN A THICKENING CRUST - THE INTERMONTANE BASINS IN THE PUNA AND THE EASTERN CORDILLERA OF NW-ARGENTINA (CENTRAL ANDES)

In the Puna of NW-Argentina the mountain ridges reach more than 5 000 m above sealevel. The salars and other morphologic depressions up to 3 700 m above sealevel form intermontane basins, in which during the Cenozoic the detritus of the ridges has been deposited. In the Eastern Cordillera, these basins are deeply eroded forming valleys and in this region their tectonic structure can be studied in some detail.

The basins are limited by high angle reverse faults with vertical block movements of several thousand meters. The thickness of the

continental sediments within the basins is of the same order.

The development of some basins will be illustrated.

The compressive block movements along the high angle reverse faults caused crustal thickening and the very thick crust in the Central Andes, at least in part is the result of this tectonic deformation.

Calc-alkaline volcanics are situated on the high angle reverse faults. They have been erupted on a crust still under compression as can be demonstrated by very young movements on these faults.

The compression must be related to the convergent plate boundary and may explain some of the difficulties in explaining the generation of the magmas in the Central Andes.

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ASPECTS OF THE GEOTECTONIC DEVELOPMENT OF THE RHENO-HERCYNIAN ZONE OF THE WEST- AND CENTRAL-EUROPEAN PALEOZOIDS

The Rheno-Hercynian zone is distinguished from the inner parts of the Variscan orogen by different lithologic, magmatic and structural development from Cambrian up to Namurian. Many stratigraphic gaps referring to vertical movements appear in change of facies too. The crystalline basement of the West- and Central-European paleozoids originated from Precambrian sediments. This basement influenced essentially the zonation of the Paleozoic paleotectonic structures. The Caledonian movements are dominated especially by intracrustal magmatic mobilizations and structural deformations with deeper draft. The Hercynian deformations are shallow movements. They are connected with gravitative nappe-slidings.

The structural development of the Rheno-Ardennian and the Rheno--Hercynian are demonstrated on base of four regions: South-Western England, Ardennian, Rhenish Massif and the Harz. Some stages and palinspatic reconstructions of the Caledonian-Hercynian development are analysed and discussed by the known biostratigraphic, lithologic, geochemic and tectonic features. The results of these regional comparisons are tested on geotectonic models. The contrasts, which distinguished the platetectonic models from the geosynclines are explained by combination of elements of geosynclinal theory - f.i. a southward downstream - with platetectonic structures - f.i. the N-vergency of overthrusts, decollements and accretion, the thin-skinned structures, and EW - strike-slip movements.

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DEVELOPMENT OF THE EARTH'S LITHOSPHERE WITH RESPECT TO PLATE TECTONICS, GEOSYNCLINAL EVOLUTION AND OROGENIC REVOLUTION

Analysis of essential geotectonic theories is made to ascertain main observations which unite to a general view of lithospheric development.

1. Moving plates due to steady sea-floor spreading by mantle convection are convincingly explained by many facts, like magnetic anomalies, age increase of oceanic rocks with distance from ridge, ocean-crust extension and subduction at Benioff zones. Problems arise out of geosynclinal and orogenic interpretations.

2. Orthogeosynclines are long-living belts of activity with significant sinking, sedimentation, and magmatism. Connections exist between mantle diapirism or micro-spreading and crustal widening, thinning and sinking. Young representatives are active marginal seas, but not the trenches with scraping off-sediments.

3. Orogeny with strong shortening and granodiorite plutonism in orthogeosynclinal regions generates continental crust. It occurs during episodic and short-lived phases, each with worldwide synchronous motions. Orogenic phases and readjustments of plate movements mainly with slowing-down spreading are time-parallel. The geokinematic events appear like superposed peaks within the course of plate drift.

The geotectonic development shows two different types of movement due to character and timing, the irregularly operating plate drift and the more regularly active orogenesis. Plate tectonic and geosynclinal-orogenic theories complement each other for an overall view of global tectonics.

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FACTS AND PROBLEMS OF THE SHAPING AND HISTORY OF HIMALAYAN SHORTENING STRUCTURES

Comparative tectonic studies in the Himalaya reveal five mesoscopic structure generations B1 to B5 with different age, formation and trend. Each generation shows its specific folds, lineations, cleavages and thrust planes. Facts and problems of the deformation history are considered.

The age sequence of the structures results from their interference pattern. B1 and B2 are transversal, B3 and B4 longitudinal, and B5 again transversal. Because of the heterogeneity of cross fabrics and their interpretations B1 and B2 present problems. Strong indications of pre-Himalayan age and WNW-ESE compression for B1 and B2 folds exist. B3 and B4 with NNE-SSW shortening correspond to the large Himalayan nappes and folds and B5 with WNW-ESE vector to large cross folds. B3, B4, B5 are of Himalayan age. B1 to B5 express D1 to D5 shortening deformations.

Coordination of D1 and D5 with orogenic phases: D1/D2 may correspond to Precambrian and/or Paleozoic, D3/D4 to Upper Cretaceous-Miocene, D5 to Pleistocene phases.

Kinematic correlation between Himalayan orogenic phases and reorganizations of Indian ocean-floor spreading on the basis of time parallels bears some implications. Himalayan orogenies firstly may correspond to

strong underthrusting of oceanic crust during spreading decrease and secondly to continental convergence as partial process of worldwide orogenic compression. Short-term pulsating orogeny interrupts episodically the long-term course of sea-floor spreading.

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TIMING OF MOVEMENT EVENTS IN CONTINENTAL AND OCEANIC CRUSTAL REGIONS DURING MESOZOIC-CENOZOIC AND IMPLICATIONS ON GEODYNAMIC DEVELOPMENT

The temporal and spatial occurrence of episodic geokinematic events in continental and oceanic areas during Mesozoic-Cenozoic is investigated on basis of a map sketch and a timetable. An event is expressed by a set of various worldwide and synchronous processes occurring frequently during a short time, like orogenic compression, granodiorite plutonism, regional metamorphism, readjustment of ocean-floor spreading, and regression.

New data again confirm that peaks of mountain building correspond to already known orogenic phases, like the Nevadian, Austrian, Pyrenean etc. Additionally, these phases are time-parallel with changes of sea-floor spreading in speed and direction. This points to a close mechanical connection of both.

The geokinematic events alternate with rather long stages of relatively weaker tectonic motion.

Thus, the geotectonic development reveals two fundamentally different types of movement based on timing and character, the irregular and nearly steady plate drift due to various spreading and the more regularly operating orogenesis, specific in episodes and each having global simultaneity of shortenings. Both types of motion, as shown by the present data, determined together the geotectonic development. The forceful geokinematic events appear superposed on the normal course of plate drift, and these suggest implications on geodynamics.

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STRUCTURAL EVOLUTION OF THE OMAN MOUNTAINS THRUST BELT

During the Cenomanian-Campanian closing of Tethys in Eastern Arabia, a 14 km thick complete ophiolite sequence was emplaced onto the passive continental margin. A downward (foreland-directed) progradation of thrusting affected a series of thrust sheets of oceanic sediments and volcanics beneath the ophiolite. During later stages of emplacement secondary thrusts cut through the already assembled allochthon locally reversing the normal stacking order of thrust sheets emplaced from the NE. In the Hawasina Window shortening in the shelf margin sediments is accommodated by giant, en echelon, recumbent synclines similar to the Helvetic nappes of the Western Alps. In the central part of the Window all major folds and thrusts are backward verging, and backthrust towards the NE. A large frontal ramp, possibly the actual Cretaceous shelf edge, is postulated at

depth to account for this backthrusting, with a large "pop-up" structure in the core of the Hawasina Window culmination. Both floor and roof thrusts are folded in this pile-up of thrust sheets and later Tertiary folding of the Jebe Akhdar anticline is considered to have enhanced the late Cretaceous antiformal stack of the Hawasina Window.

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ALPIDES AND CIMMERIDES: THE DOUBLE NATURE OF THE ALPINE-HIMALAYAN MOUNTAIN RANGES

The Alpine-Himalayan mountain ranges consist, between the eastern Carpathians and the Pacific shores, of two independent, but largely superimposed orogenic complexes. The older one, here called *the Cimmerides*, formed between the ?early Carboniferous and the early Cretaceous by the subductive removal and collisional elimination of *Palaeo-Tethys*, the original westwards-narrowing, triangular embayment of Pangaea, between Laurasia and the Cimmerian Continent plus the North and South China platforms and Annamia. The younger one, *the Alpides*, formed between the late Jurassic and the present by subduction of *Neo-Tethys* and , locally, by the collision with Eurasia of various fragments of the dispersed Gondwana-Land. Where the original width of the Cimmerian Continent was small, as in the Carpathian/Balkan/Anatolian regions, the superposition of the Cimmerides by the Alpides was nearly complete and the recognition of the former now is difficult. In regions where the width of continental pieces between Palaeo- and Neo-Tethys was large, as in eastern Asia, there is a clear spatial distinction between the Cimmerides and the Alpides. The Cimmerides contain a multi-strand suture network along which ocean closure occurred diachronously. Cimmeride collisions created a complex field of cratonic deformations in southeastern Europe and Asia generating intra-continental strike-slip faults, both extensional and compressional basins, and widespread 'inversion' phenomena from the Dnyepr-Donets aulacogen to eastern Siberia. Some of these structures nucleated on older, Palaeozoic (in places late Precambrian) structures and also later localised Cainozoic cratonic structures related to Alpide collisions, thus giving the impression of 'autochthonous' repeated posthumous reactivations of old structures, although every posthumous reactivation was a 'new' event, a part of a much larger deformation field independent of both the preceding and the succeeding events. The great similarities between the Cimmeride-related cratonic structures and those of the Alpides result from the spatial coincidence of Cimmeride and Alpide orogenic events. The Cimmerides seem to be a more complicated orogenic system than the Alpides involving large 'orogenic collages' probably containing numerous 'exotic' terrains of Panthalassan origin and large areas of ocean-floored accretionary complexes, such as that of Songpan-Ganzi of China, contributing to the areal growth of Asia during the late Palaeozoic-Mesozoic. Appreciation of the *double nature of the Alpine-Himalayan mountain ranges* will greatly contribute not only to a better understanding of the *'Tethysides'* of Eurasia, but also to the tectonics of nearly the whole of Asia. In the light of this concept many of the palaeobiogeographic dilemmas of the Alpine-Himalayan areas, such as the presence of *Glossopteris* flora north of the Neo-Tethyan sutures, disappear, and the need to resort to such geophysically untenable hypotheses as earth expansion to circumvent the problem of the 'Tethyan paradox' is obviated.

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EVOLUTION OF THE GEOLOGICAL STRUCTURE OF KAMCHATKA AND OFFSHORE AREAS IN THE LATE MESOZOIC AND CENOZOIC

Three stages are distinguished within the last 100 million years' history of the Kamchatka section of ocean-continent transitional zone: Late Cretaceous, Paleogene-Miocene and Pliocene-Quaternary. The Late Creatceous depressions are characterized by strong submarine volcanism accompanied with quick sedimentation. No recent analogues can be found to these depressions in terms of formation types and volcanism. Acid clastics were coming into these depressions from the east. Depressions may be considered as geosynclines because the folding and thrusting characteristic to them in the Paleocene. The second stage was characterized by predominance of molassic-type and subaerial volcanic formations. Clastics were coming from the east as earlier. During this stage no typical epigeosynclinal orogenesis took place in the Kamchatka section of transitional zone. Short-time orogenic pulses were supressed by downward displacements with intensive volcanism and generation of grabens. Morphostructure of this region gains its present features of the ocean-continent transitional zone of the Pacific type only at the third stage of development as a result of eastward subsidence. No unidirectional eastward migration of the zones of calc-alkali volcanism has been ascertained.

The following scheme is elaborated for the Late Mesozoic and Cenozoic development of Kamchatka and offshore areas: eugeosyncline-unformed orogenic belt - system of island arcs and marginal seas. The development of the transitional zone in the Cenozoic led to destruction of continental blocks and formation of the marginal oceanic structures instead of them. Similar scheme - from geosynclines through different orogenic structures to the oceanic margins of different types with predominance of destruction is characteristic for the modern stage of Mesozoic-Cenozoic history of some regions, such as Japan, New Zealand and California.

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ЭВОЛЮЦИЯ СТРУКТУРЫ КАМЧАТКИ И ПРИЛЕГАЮЩИХ АКВАТОРИЙ В ПОЗДНЕМ МЕЗОЗОЕ И В КАЙНОЗОЕ

Последние 100 млн.лет истории Камчатского сегмента переходной зоны делятся на три этапа: позднемеловой, палеоген-миоценовый и плиоцен-четвертичный. Для позднемеловых прогибов характерен интенсивный подводный вулканизм в сочетании с быстрым осадконакоплением. По типу формаций и вулканизму эти прогибы не имеют современных аналогов. С востока в прогибы поступал кислый обломочный материал. Развитие их в палеоцене завершается складчатостью и надвигообразованием, что позволяет считать их геосинклиналями. Второй этап характеризуется преобладанием молассоидных и наземно-вулканогенных формаций. Продолжал поступать обломочный материал с востока. Камчатский сегмент переходной зоны на этом этапе не проходит стадию типичного эпигеосинклинального орогена: кратковременные орогенические импульсы подавляются нисходящими движениями с мощным грабенообразованием и вулканизмом. И только на третьем этапе в результате опусканий к востоку морфоструктура этого региона приобретает современный облик переходной зоны Тихоокеанского типа. Однонаправленного смещения зон известково-щелочного вулканизма к востоку не наблюдается.

Позднемезозойское и кайнозойское развитие Камчатки и смежных акваторий сводится к следующей схеме: эвгеосинклиналь - незавершенный орогген - система островных дуг и окраинных морей. В кайнозое развитие переходной зоны привело к деструкции континентальных блоков и формированию на их месте краевых структур океана. Аналогичная схема - от геосинклинали через различного рода орогены к различному типу окраин океана с преобладанием процессов деструкции на новейшем этапе - характерна для мезо-кайнозойской истории ряда регионов: Японии, Новой Зеландии, Калифорнии.

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GRANITE-GNEISSIC DOMES AND PALEOISLAND ARCS IN THE LIGHT OF CORRELATION BETWEEN ANCIENT AND MODERN GOESYNCLINES

The point of protogenic and neogenic granite-gneissic domes are closely connected with the problem of correlation between ancient and modern geosynclines. These domes are analogues to ancient island arcs in the geological past and manifested in the Baikal mountain region.

The paleoisland arcs of Mongolo-Ochotsk folded belt and island arcs of transition zones between the Asian continent and the Passific ocean evidently form the systems of geoanticlinal uplifts. They are separated by ancient (greenstone) and modern riftogenous downwarps respectively.

Geoanticlinal uplifts are subdivided into mature and young. The former, having powerful roots on each side of the Passific ocean coasline, are noted for the predominance of acid magmatizm, the latter for the prevalence of basic magmatizm. The elevation of protogenic domes towards ancient island arcs and transformation of the latter into volcanic-plytonic-metamorphic belts have obscured the early (oceanic) geoanticlinal uplifts of folded orogenes. According to the "granite" layer under mature island arcs, high-grade metamorphic belts, which are identical with metamorphic belts of folded orogenes, geoanticlinal uplifts of marginal seas have roots, composed of young granite-gneissic domes. In view of similarity between mature and incipient orogenic system, there is a good reason to believe that the two tectonic pairs are compared in ancient and modern geosynclines: granito-gneissic domes and greenstone downwarps are on the one hand and volcanic domes and riftogenous structures are on the other hand.

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ГРАНИТО-ГНЕЙСОВЫЕ КУПОЛА И ПАЛЕООСТРОВНЫЕ ДУГИ В ПРОБЛЕМЕ СОПОСТАВЛЕНИЯ ДРЕВНИХ И СОВРЕМЕННЫХ ГЕОСИНКЛИНАЛЕЙ

Вопрос о протогейских и неогейских гранито-гнейсовых куполах - глубинных аналогах древних островных дуг в геологическом прошлом, раскрытый на примере Байкальской горной области, восходит к проблеме сопоставления древних и современных геосинклиналей.

Рассматривая в этом аспекте палеоостровные дуги Монголо-Охотского складчатого пояса и островные дуги переходной зоны между Азиатским континентом и Тихим Океаном, можно заметить, что они образуют системы геоантиклинальных поднятий, разделенных в первом случае древними (зеленокаменными) и во втором - современными рифтогенными прогибами.

Геоантиклинальные поднятия подразделяются на зрелые и молодые. Первые имеют мощные корни по обе стороны от береговой линии Тихого океана и отличаются преобладанием кислого магматизма, вторые - основного. Признаки раннего (океанического) развития геоантиклинальных поднятий складчатых орогенов затушеваны "всплыванием" протогейских куполов к древним островным дугам и превращением последних в вулкано-плутоно-метаморфические пояса. Геоантиклинальные поднятия

окраинных морей, судя по "гранитному" слою под зрелыми островными дугами, высокоградным метаморфическим поясам, идентичным метаморфическим поясам складчатых орогенов, имеют корни, сложенные молодыми гранито-гнейсовыми куполами. С установлением сходства зрелых и зарождающихся орогенных систем становится очевидно, что в древних и современных геосинклиналях сопоставимы две тектонические пары. С одной стороны, это гранито-гнейсовые *купола - зеленокаменные прогибы*, с другой - вулканические купола - рифтогенные структуры.

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PALINSPASTIC RECONSTRUCTIONS IN THE REGIONS WITH COMPLICATED FOLDING AND THRUSTING TECTONIC FRAMEWORK

The Uralian folding region is one of many regions of the Soviet Union with complicated tectonic structure. Palinspastic *reconstructions* were made only for its western part, where thrusting and faulting deformations spread very wide. The thrust and fault planes dip to east at the angles from 10°-20° to 40°-60°. Horizontal displacement of the thrust blocks changes from I km to 30-50 km and fault *displacements* consist of I5-35 km. Palinspastic reconstructions were made during two stages. At the first stage the thrust blocks are transfered to primary position before dislocation. Size of displacement and primary position of each block are determined by using contrasting facial complexes (e.g. marginal zones of Kamsko-Kinelian sistem of troughs) spreading across thrusting deformations. At the second stage straightening of the folds is done by using some geological sections in each thrust blocks *with reconstructing* initial outline of each block. Palinspastic reconstructions permit to restore prethrust plane; to ascertain mechanism of folding and thrusting; to suppose thickness, composition of deposits and natural resources; to establish tectonical *features of thrusting substrata*.

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ПАЛИНСПАСТИЧЕСКИЕ РЕКОНСТРУКЦИИ В ОБЛАСТЯХ СО СЛОЖНОЙ СКЛАДЧАТО-РАЗРЫВНОЙ ТЕКТОНИКОЙ

Уральская складчатая область является одной из многих в пределах Советского Союза, имеющих сложную тектоническую структуру. Палинспастические реконструкции выполнены только для ее западной части, характеризующейся широким развитием надвиговых и сдвиговых деформаций. Надвиги и сдвиги имеют восточное падение сместителей с углами от 10-20° до 40-60°. Величина горизонтального перемещения блоков по

надвигам изменяется от I км до 30–50 км, а сдвиговая составляющая – от I5 до 35 км. Палинспастические реконструкции выполняются в два этапа. На первом этапе блоки перемещаются в положение, близкое к первоначальному. В качестве коррелятивов для определения величины раздвигания и первоначального положения каждого блока используются достаточно контрастные фациальные комплексы (например, бортовые зоны Камско-Кинельской системы прогибов), ориентированные в направлении, секущем зону надвиговых деформаций. На втором этапе по серии геологических разрезов в каждом из раздвинутых блоков производится распрямление складок с последующим восстановлением первоначальных контуров каждого блока в плане. Палинспастические построения позволяют реконструировать донадвиговую поверхность; выяснить механизм формирования складчатости и надвигов; прогнозировать под аллохтонами надвигов мощности, состав отложений и полезные ископаемые; выявить особенности тектонической структуры постели, по которой шло надвигание.

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MAPA TECTONICO DE CUBA EN ESCALA 1: 500 000

El mapa tectónico de Cuba en escala 1: 500 000 constituye la materialización de las investigaciones realizadas por especialistas cubanos y soviéticos para explicar la constitución geológica profunda de Cuba basándose en las nuevas concepciones movilistas. En sunota explicativa se describen las principales estructuras del área las cuales se dividen en profundas y superpuestas. Las estructuras profundas son:
- el borde pasivo de la Plataforma de Bahamas y su talud;
- el orógeno de choque del arco insular cubano con el borde pasivo del continente;
- estructuras profundas del mar intercontinental (Mar Caribe).
Las estructuras superpuestas son:
- las regiones de hundimiento eugeosinclinales cubana occidental, central y oriental;
- la depresión marginal norte cubana.
Tiene un gran interés la descripción de las unidades tectónicas desplazadas al norte en la zona de recubrimiento tectónico.
Se describen las fases principales de tectogénesis así como las etapas y características del magmatismo, vulcanismo y metamorfismo. Se puntualizan la dirección, carácter y amplitud de los desplazamientos horizontales y fallas profundas de la corteza.
Se argumenta la historia del desarrolo tectónico de Cuba y su relación con las estructuras adyacentes de la región Caribe-Mejicana

puntualizándose los dos ciclos principales: Premesozoico (Prealpino) y Mesozoico (Alpino). En el ciclo Prealpino se establecen los principales eventos geológicos que condujeron a la formación del basamento cristalino. Para el ciclo Alpino se establecen tres épocas:
- Alpina Temprana (Triásico-Jurásico Superior Oxfordiano);
- Alpina Media (Oxfordiano-Turoniano);
- Alpina Tardía (Cenomaniano-Cenozoico).

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STAGES IN THE CENOZOIC OLISTHOSTROME FORMATION AND THEIR RELATION TO THE FORMATION OF THE ALPINE NAPPE-FOLDED STRUCTURE

The Cenozoic Alpine fold area bounded by the Pyrenees Peninsula and the Middle Asia tectonically active area shows stage formation of the olisthostromes of the nappes and vertical ruptures. The clastic material generated in these structures as a result of rock disintegration in the course of tectonic motions is transported then to depositional basins in a form of slumps. The stage in the olisthostrome formation is closely related to general tectono-sedimentary cycles in the development of the fold area. The late Alpine orogenesis registers 6 tecto-sedimentary cycles. Each of the stages begins with a general subsidence (a transgressive phase) to end up in a general uplifting (a regressive phase). Epochs of, or stages in, the olisthostrome formation coincide chielfly with the regressive phases. The beginning of these phases sees intense movement of nappes preceding the general uplifting. In the nappe front, there form olistostrome units of the gravity-tectonic origin. Gradually, due to growing uplifts, the domineering role passes to the olistostrome units of the slump-sliding (gravity) origin, most widely spread at the cycles' border lines when tectonic regimes changed. Such regularity in the formation of olistostromes is traced very well along the Alpine fold area. The cross-section shows the change of synchronous-nappe olistostromes of the outer zones with the contemporaneous slump-sliding formations of the inner zones.
Stages of olistostrome formation which coincide with the end of the Eocene (42-46 mln.y.), the end of the Oligocene (28-24 mln.y.), the end of the early Miocene (19-16 mln.y.), the end of the middle-beginning of the late Miocene (15-9 mln.y.), beginning of the Pliocene (6-4 mln.y.), the Pliocene-Pleistocene boundary (2-0.7 mln.y.), and extend over a period of 1-6 mln.y., are correlated with the Pyrenean, Savic, Shtirian, Attic, Rodanian and Valakhian orogenies according to G.Stille. These phases are discernible throughout the Alpine area, which speaks for their universal manifestation within the area though

in a more diverse manner than G.Stille believed. This indicates that the late Alpine orogenesis had not only universal tecto-sedimentary cycles, but also a basically universal rhythm of tectonic movements.

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ЭТАПЫ КАЙНОЗОЙСКОГО ОЛИСТОСТРОМООБРАЗОВАНИЯ И ИХ СВЯЗЬ С ФОРМИРОВАНИЕМ ПОКРОВНО-СКЛАДЧАТОЙ СТРУКТУРЫ АЛЬПИЙСКОЙ ОБЛАСТИ

В кайнозое на территории всей Альпийской складчатой области между Пиренейским полуостровом и областью тектонической активизации Средней Азии обнаруживается определенная этапность в формировании олистостромов, связанных с покровами и зонами вертикальных разломов. В этих структурах в результате дезинтеграции пород во время тектонических подвижек возникает обломочный материал, поступающий затем в виде оползней в седиментационные бассейны. Этапность олистостромообразования тесно связана с общей тектоно-седиментационной цикличностью развития складчатых областей. В эпоху позднеальпийского орогенеза выделяется 6 тектоно-седиментационных циклов. Каждый из них начинался с общего погружения (трансгрессивная стадия) и завершался общим поднятием (регрессивная стадия). Эпохи или этапы олистостромообразования совпадают главным образом с регрессивными стадиями. В начале этих стадий происходит мощное перемещение покровов, предваряющее общее воздымание. Во фронте покровов образуются толщи олистостромов тектоно-гравитационного происхождения. Постепенно за счет роста поднятий начинают преобладать олистостромы обвально-оползневого происхождения, наиболее широко распространенные на границе циклов при смене тектонических режимов. Такая закономерность олистостромообразования широко прослеживается вдоль складчатых зон Альпийской области. В поперечном сечении наблюдается смена синхропокровных олистостромов внешних зон одновременными им обвально-оползневыми образованиями внутренних зон. Этапы олистостромообразования, приходящиеся на конец эоцена (42-46 млн.лет), конец олигоцена (28-24 млн.лет), конец раннего миоцена (I9-I6 млн.лет), конец среднего-начало позднего миоцена (I5-9 млн.лет), начало плиоцена (6-4 млн.лет), границу плиоцена и плейстоцена (2-0,7 млн.лет) и имеющие продолжительность I-6 млн.лет, коррелируются с пиренейской, савской, штирийской, аттической, роданской и валахской фазами тектогенеза Г.Штилле. Эти этапы проявлены повсеместно в Альпийской области, что позволяет говорить о повсеместном проявлении фаз тектогенеза в ее пределах, имеющих,однако, более разнообразное выражение, чем предполагал Штилле. Наряду с общностью тектоно-седиментационной цикличности это говорит о принципиальной общности ритма тектонических движений в эпоху позднеальпийского орогенеза.

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PULSATION TECTONICS RELATED TO THE BREAKUP OF CONTINENTS

New data from the recent IPOD drilling of DSDP Site 534 in the Blake-Bahama Basin give a definitive age for the spreading-center shift involved in the breakup of the North American Atlantic margin. A basal Callovian age (155 m.y.) is determined for the Blake Spur magnetic anomaly marking this spreading-center shift that signals the birth of the modern North Atlantic Ocean. This is some 20 m.y. younger than previously thought. An implication of this younger age for the Blake Spur event is that very high spreading rates are now required for the Jurassic magnetic quiet zone, not only in the western Atlantic, but in the eastern Atlantic and Pacific as well. It appears that this Jurassic fast spreading episode is a global event. This association of a relatively high spreading rate on a global scale with a magnetic quiet zone is similar to that for the mid-Cretaceous and implies a link between the processes controlling plate spreading, which are in the upper mantle, and the processes controlling the magnetic field, which are in the outer core. A theory of pulsation tectonics involving the cyclic eruption of plumes of hot mantle material from the lowermost mantle could explain the correlation. Plumes carry heat away from the core/mantle boundary and later reach the asthenosphere and lithosphere to induce faster spreading. The pulse of fast spreading in the Jurassic apparently followed the breakup of continents bordering the North Atlantic Ocean. Other pulses of global fast spreading appear to correlate with major ocean openings on various parts of the globe, implying that this might be a prevalent process. Rifting of passive margins may be controlled by the more fundamental global processes described by the theory of pulsation tectonics.

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TYPES OF MOVEMENTS AND DESTRUCTION OF THE CRUST OF THE CONTINENTAL RIFT ZONES

Rifting in the continental crust is accompanied by its extension and destruction. Extension affects movements of the crust and the velocity of movements influences deformation and destruction processes. Character and stage of destruction determines types of continental rift zones (CRZ), details of their features and dynamics of attendant processes.

As a result of destruction, main rift structures are formed on the Earth's surface: depressions, interdepression uplifts, faults, and also secondary well mapped elements showing details of movements of the crust. Therefore, there is, as a rule, a good, rarely satisfactory, correlation between types of movements of the crust, destruction of the crust and main neotectonic structures and processes.

It testifies to unity and paragenetic relationship between processes and structures that express megadestruction of the crust. Complex of these phenomena and structures related to CRZ is considered here.

Empirical data on CRZ of the Earth made it possible to establish the analytical form of relationship between parameters of main neotectonic structures (faults, depressions), between neotectonic structures and processes (fault density, heat flow and seismicity), between types of movements of the crust, structures and processes. Analytical equations of relationships between the above mentioned parameters are given. Physically, deformation and destruction of the crust during continental rifting are best described by elastico-viscous Maxwell's body. The established regularities enable us to describe neotectonics and zoning of CRZ quantitatively.

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ТИПЫ ДВИЖЕНИЙ И ДЕСТРУКЦИЯ КОРЫ КОНТИНЕНТАЛЬНЫХ РИФТОВЫХ ЗОН

Рифтогенез в континентальной коре сопровождается ее растяжением и деструкцией. Растяжение отражается в движениях коры, а скорость движений влияет на процесс деформации и деструкции. Характер и стадия деструкции предопределяют типы континентальных рифтовых зон (КРЗ), детали их структуры и динамику сопутствующих процессов. В результате деструкции на поверхности Земли образуются основные структуры рифтовых зон: впадины, межвпадинные перемычки, разломы, а также вторичные хорошо картируемые элементы, отражающие детали движений коры. Поэтому между типом движений коры, ее деструкцией и основными неотектоническими структурами и процессами существует, как правило, хорошая, реже удовлетворительная корреляция. Она свидетельствует о единстве и парагенетической связи процессов и структур, выражающих мегаразрушение коры. Комплекс этих явлений и структур рассмотрен на примере КРЗ.

Цифровой эмпирический материал по КРЗ Земли позволил установить аналитическую форму связи между параметрами основных неотектонических структур (разломами, впадинами), между неотектоническими структурами и процессами (плотностью разломов, тепловым потоком и сейсмичностью), между типом движений коры, структурами и процессами. Даны уравнения связи между упомянутыми параметрами. С физической точки зрения деформация и разрушение коры при континентальном рифтогенезе наилучшим образом описываются упруго-вязким телом Максвелла. Установленные закономерности позволяют перейти к количественному методу описания неотектоники КРЗ и их районированию.

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EARLY MESOZOIC ACTIVE MARGIN OF MESOTETHYS IN CENTRAL ASIA

Late Permian collision of Eurasia and Gondwana plates removed the last structures of the Paleozoic basin of the oceanic type in the Parapamiz, Hindu Kush, Northern Pamirs, Kunlun. At the same time the Khash Rud (Varaz) - Pshart - Tanghla Shan line showed signs of rifting of the early stage of Mesotethys. Accretion of the oceanic crust was at its highest by the late Triassic. It is believed to have taken place together with the subduction of the newly formed crust under the subsialic blocks that bounded the basin on the north. This stage coincided with the formation of the active continental margin in places of the structures formed of the deposits of vanished Paleotethys and its southern passive margin. It consisted (moving from the south to the north) of a continental slope (Rushan - Pshart zone in the Pamirs, Farah Rud in Afghanistan), extensive shelf with carbonate and terrigenous sediments (Hariröd zone in Afghanistan, the Central and Northern Pamirs), as well as of an ensialic island arc and gently sloping back-arc depression with shallow sea sedimentation in some parts of it (Parapamiz - Bande-Turkestan - western Badakhshan - northern edge of the Darvaz-Zaalay zone of the Northern Pamirs). In the east, the northern margin of Mesotethys corresponded to the part of the Tanghla Shan zone and the Northern Tibet. In the north this system was bounded by the continent of the Southern Tien Shan - Kunlun where (Tien Shan) formed a marginal volcanic belt.

Active development of the margin gave way to passive by the early or middle Jurassic. This must have been determined by the end in the active accretion of the oceanic crust in Mesotethys and the beginning of convergence. The existence of the active continental margin in the north is supported by the geochemistry of upper Triassic - lower Jurassic magmatic rocks. Typical of the rift volcanic continental rise are tholeiitic and alkali-olivine, SiO_2-poor basalts. In the island arc, widely developed are calc-alkaline rocks of different acidity while the marginal volcanic belt has typical alkaline rocks. The development of the Mesotethys margin is similar to that of the Andes in the late Triassic - Oxfordian.

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РАННЕМЕЗОЗОЙСКАЯ АКТИВНАЯ ОКРАИНА МЕЗОТЕТИСА В ЦЕНТРАЛЬНОЙ АЗИИ

В конце пермского периода в результате коллизии Евразийской и Гондванской континентальных плит исчезли последние структуры палеозойского бассейна океанического типа на Парапамизе, Гиндукуше, Северном Памире и Куньлуне. Одновременно южнее вдоль линии Хашруд (Вараз) – Пшарт – Тангла Шан проявился рифтогенез начального этапа формирования Мезотетиса. Максимальной интенсивности процесс аккреции океанической коры достиг к позднему триасу. По-видимому, он сопровождался субдукцией новообразованной коры под ограничивавшие бассейн с севера субсиалические блоки. С этим этапом совпадает формирование активной континентальной окраины на месте структур, образованных из отложений исчезнувшего Палеотетиса и его южной пассивной окраины. Она состояла из (с юга на север) континентального склона (Рушанско-Пшартская зона на Памире, Фарахрудская зона в Афганистане), обширного шельфа с карбонатными и терригенными осадками (Герирудская зона в Афганистане, Центральный и Северный Памир), а также из энсиалической островной дуги и пологой задуговой депрессии, на части которой установились условия мелководной седиментации (Парапамиз – Банди-Туркестан – Западный Бадахшан – северный край Дарваз-Заалайской зоны Северного Памира). На востоке северной окраине Мезотетиса соответствовала часть зоны Тангла Шан и Северный Тибет. На севере эта система ограничивалась континентом Южного Тянь-Шаня – Куньлуня, на части которого (Тянь-Шань) образовался краевой вулканический пояс. Активное развитие окраины сменилось пассивным к началу или середине юрского периода. Это, вероятно, было обусловлено окончанием активной аккреции океанической коры в Мезотетисе и началом процессов конвергенции.

Существование активной континентальной окраины на севере подтверждается геохимическими особенностями верхнетриасовых – нижнеюрских магматических пород. Для рифтогенного вулканического континентального подножья характерны толеитовые и щелочно-оливиновые базальты, недосыщенные кремнеземом. На островной дуге распространены известково-щелочные породы разной кислотности, на краевом вулканическом поясе – щелочные. По развитию окраина Мезотетиса сходна с развитием Анд в позднем триасе – оксфорде.

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FRACTURE TRACE ANALYSIS AS A TOOL FOR ASCERTAINING KINEMATICS OF MANIKPUR AREA OF BANDA DISTRICT, UTTAR PRADESH (INDIA)

Analyses of fracture traces observed in consolidated rock formations around Manikpur town of Banda district, India have been carried out to infer the Kinematics of the area. The terrain is characterised by the presence of Kaimur sand stone belonging to the Vindhyan supergroup (1400 - 900 million years). The rock formations exhibit conspicuous microfractures along N135 - 315°, N120 - 300°, and N45 - 225°, and also less prominently along North-South and East-West directions. The photolinears (fracture traces and lineaments) delineated from the aerial photographs show a fairly good agreement with the microfractures. The fracture trace map of the area has revealed occurrence of a ENE-WSW trending shear zone (Manikpur Shear Zone) characterized by the development of related Displacement and Riedel Shears, Conjugate Riedels, and the tension fractures. The probable direction of the maximum horizontal compressive stress (σ_1) seems to be along East-West, with the minimum horizontal stress (σ_3) being along North-South. The release of the stresses consequent to the formation of different types of slip surfaces may have resulted in the reactivation of NW-SE trending shears as tension joints. In some places, within the shear zone, shear lenses are also observed. In the framework of regional tectonic setup comprising Narmada Sone lineament, the Manikpur shear Zone can be considered to have originated by a stress pattern similar to the one operative in the whole region and may be an off shoot of the system of fractures, exhibited in the Narmada Sone area.

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TECTONIC DESIGN AND GEOLOGIC EVOLUTION OF CENTRAL HIMALAYA

A systematic mapping of Lesser and Higher Central Himalaya has revealed that from South to North. The whole segment of Himalaya could be divided into sub-parallel structural Facies (formational) Zones. The Main Boundary Fault (MBF) is the major lineament separating the Himalayan folded belt with the Indian shield area. It is interesting to note that there are granitic bodies of Pre-Cambrian age abutting against this fault plans. The Central Crystalline complex in the Himalaya occupies the major part of the higher Himalayan rampart with lofty peaks which are sometimes capped with sedi-

ments of Tethyan zone lying in its adjacent northern part. The "roots" of the Lesser Himalayan crystalline nappe are confined in this zone. This highly deformed and metamorphosed group of rocks with sediments from various ages including Precambrian to Phanerozoic have suffered different grades of geodynamic processes and intensity of metamorphism, and were remobilized during Oligocene-Miocene period. The southern extremity of crystalline complex is demarcated by Main Central Thrust (MCT). On the basis of recent researches it is proposed that Himalayan region should be geologically divided into two major geologic zones by a structural line called the MAIN AXIAL ZONE (MAZ). MAZ incorporates the roots of Higher Himalayan nappes. The northern boundary of "Vaikrita Group" (Crystalline) is tectonic and it has been called as Tethyan Thrust (TT). Further north Great Himalayan Suture (GHS) divides the northern extremity of Himalaya with the Karakoram belt.

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CONTRASTED BASEMENT INVOLVEMENT FACIES IN THE HIMALAYAS

In a scheme of orogenic polarity in the Himalayan region the age of development of major tectonic belts decreases southward. The Indus suture is the oldest (Early Eocene), the Main Central Thrust (MCT), intermediate (Miocene), and the Main Boundary Fault (MBF), the youngest (Pleistocene). The age of the rock sequences, lying to the south of the Central Crystalline axis, varies from Precambrian to Tertiary. These are involved in Cenozoic tectonism. The bulk of the metasedimentary rocks of the Lesser Himalayas is Upper Proterozoic. The main deformation and metamorphism of these and of the Palaeozoic rocks are Tertiary.

Basement involvement in the Himalayas shows three tectonic facies types : (1) involvement of pre-Palaeozoic Caledonian (?) basement in Lower Gondwana-Blaini-Krol-Tal structural belt, (2) involvement of pre-Upper Proterozoic granite basement in Lesser Himalayan Daling-Buxa-Shali-Simla-Jaunsar-Dogra structural belt, and (3) variable degrees of basement mobilisation within the Central Crystalline zone.

The Caledonian (?) basement in facies (1) was involved in Hercynian rifting, the basement having been welded with the cover during Cenozoic tectonism and metamorphism. In facies (2) the granitic basement rocks were upthrust, downgraded and mylonitised in schuppen zones. The nappe stack overlying the MCT in the Higher Himalayas in facies (3) is probable vestiges of a microcontinent whose rocks are reconstituted during Cenozoic thermal event.

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GUYOTS AND TECTONICS OF THE MID-EMPEROR CHAIN

The bathymetry of the Mid-Emperor Chain from 37°30'N to 46°00'N and 170°30'E and is comprised of seven guyots and twin seamounts as delineated by a multi-beam sonar system. The accuracy of this system giving total feature coverage allows for the application of previous theories to enhance further tectonic possibilities including multiple conduit activity and plate direction change. Conduit activity is likened to surficial geyser expression to show how the hot spot erupts in progressively larger amounts throughout the entire pulse of activity. This is shown by size increases from Saga, Showa, Yōmei, and Nintoku guyots with the anomalously small twin seamounts, Ninigi and Godaigo, lying between Yōmei and Nintoku. The length of this complete pulse of volcanic activity is 518km and occurred over a 7 m.y. period. The twin seamounts enhance the multiple conduit theory. It is also possible for a conduit off the main stem to erupt and cause the more elastic hot spot region to rotate. This gives the appearance of plate flow direction change of the entire Pacific Plate while not actually doing so. Not only do the slightly different azimuths on the features show this, but also an entire change on each end reflected in the azimuths of Suiko and Jingu/Ojin guyots allows this interpretation, the azimuthal difference between the trends being 60°.

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PARTICULARIDADES DE LA FORMACION DE LAS ESTRUCTURAS LOCALES EN LA ZONA MIOGEOSINCLINAL EN LA COSTA NORTE DE LA REPUBLICA DE CUBA

La zona miogeosinclinal en la Isla de Cuba, ocupa la costa norte y parte de su platforma marina y en ella se descubren cuatro complejos de rocas. Estos son: el complejo paraautóctono miogeosinclinal del Jurásico Superior-Eoceno Inferior; el complejo alóctono miogeosinclinal del Cretácico Inferior-Paleoceno; el complejo alóctono eugeosinclinal del Cretácico Inferior-Eoceno Inferior; el complejo neoautóctono del Eoceno-Cuaternario.

Los pliegues locales que se encuentran en los tres primeros complejos, se diferencian de los del complejo neoautóctono; por ello el estudio de dichos pliegues ha permitido diferenciar dos categorías geneticamente diferentes.

Una categoría la integran los pliegues de estructuras de sobrecorrimiento; estos pliegues son de constitución compleja, donde sus bordes septentrionales son abruptos, con ángulos que llegan hasta 90° y los meridionales con valores de hasta 50°; la dirección de los mismos es noroccidental suroriental y son característicos para los complejos alóctono y paraautóctono de las rocas carbonatadas miogeosinclinales y esporadicamente para el complejo alóctono eugeosinclinal. Estos pliegues han sido descubiertos por numerosos pozos y afloran en la Costa Norte de la Isla de Cuba. El proceso de formación de dichos pli-

egues, con sus particularidades, se analiza el presente trabajo en siete etapas, comenzando a partir del Jurásico Superior hasta el Eoceno Inferior inclusive.

Corresponden a otra categoría, los pliegues del tipo heredados y a consecuencia de fallas.

Ellos se relacionan con los pliegues de constitución menos compleja, que poseen ángulos de buzamiento más suaves en ambos flancos y con dimensiones mayores de sus ejes. Estos pliegues son característicos para el complejo de rocas del neoautóctono, el cual está representado por rocas carbonatadas predominantemente. Su formación ha ocurrido como resultado del proceso consedimentario, a través de diferentes etapas, comenzando a partir del Eoceno Medio hasta el Cuaternario.

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NEW INTERPRETATION OF SOME QUESTIONS ABOUT GEOTECTONIC DEVELOPMENT OF CENTRAL EUROPE

Renohercynian and Saxo-Turing sinclinorium of variscian /Central Europe/ were characterised in paleozoic by miogeosynclinal condition in the north-western part of edge, gradational complexity in the axial zones and eugeosynclinal condition in the south-eastern part of edge, where reconstructed distinctive troughs: "zone of Vippra" of Renohercynicum and "Western Saxonian syncline" of Saxo-Turingicum.

These troughs can be compared with deepwater trench of recent oceanic basins on the basis of: their tectonic position in the zones between paleozoic basins and microcontinents, their linear elongations, abrupt changes in their thickness of sediments, wide development of initial volcanites and possible submergence under microcontinents /as per the results of deep seismic prob/.

Important roles in laying these structures and intensive dynamometamorphism of their sedimentry rocks are played by Mansfield /Hunsruck/ and Central-Saxonian lineaments correspondingly, which have inherited direction of variscian deep /seismofocal ?/ zones.

Basic differences in developments of Renohercinicums and Saxo-Turingicum are conditioned by Central-Saxonian deep zone, which dipped under Orehill microcontinent, occupied the fixed position for a long time and resulted as main reason in formation oftheir active borders giving rise to thickness of crust 33 km with formation of granite-gneissoic cupols. Mansfield zone, judging on movement of flysch troughs and folding fronts (M. Schwab),

in the period of paleozoic, migrated from south-eastern to north-west and therefore its effect on neighbouring edge of Middlegermany microcontinent could not continued.Due to this reason in Middlegerman microcontinent there is less thickness of earth crust (27-31km), and similarly appeared in Renohercynickum system island arc with sulphide deposits of type "curocko."

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ИНТЕРПРЕТАЦИЯ НЕКОТОРЫХ ВОПРОСОВ ГЕОТЕКТОНИЧЕСКОГО РАЗВИТИЯ ВАРИСЦИД СРЕДНЕЙ ЕВРОПЫ С НОВЫХ ПОЗИЦИЙ

Реногерцинский и Саксо-Тюрингский синклинории варисцид Средней Европы характеризовались в палеозое миогеосинклинальным режимом развития краевых северо-западных частей, постепенным усложнением условий к осевым зонам и ярким проявлением черт эвгеосинклинального развития в юго-восточных краевых частях, где реконструируются своеобразные линейные троги: "зона Виппры" Реногерциникума и "Западно-Саксонская синклиналь" Саксо-Тюрингикума.

По своему тектоническому положению в зонах, переходных от палеозойских бассейнов к микроконтинентам, линейной вытянутости, резким перепадам мощностей выполняющих их отложений, широкому развитию инициальных вулканитов и вероятному погружению под микроконтиненты (судя по материалам ГСЗ),эти троги могут быть сопоставлены с глубоководными желобами современных океанических бассейнов.

Важную роль в заложении этих структур и интенсивном динамометаморфизме выполняющих их пород сыграли соответственно Мансфельдский (Хунсрюкский) и Центрально-Саксонский линеаменты, унаследовавшие направление варисских глубинных сейсмофокальных(?) зон.

Основные различия в развитии Реногерциникума и Саксо-Тюрингикума обусловлены тем, что Центрально-Саксонская глубинная зона, падавшая под рудногорский блок, занимала фиксированное положение на протяжении длительного времени и явилась главной причиной формирования у активной окраины Рудногорского микроконтинента мощной (до 33 км) коры на фоне роста гранито-гнейсовых куполов. Мансфельдская зона, судя по перемещению флишевых трогов и фронта складчатости (М.Шваб),в течение палеозоя мигрировала с юго-востока на северо-запад и влияние ее на прилегающий край Среднегерманского микроконтинента не могло быть таким же продолжительным. В этом одна из причин формирования в пределах последнего недостаточно мощной (27-31 км) земной коры, а также возникновения в Реногерциникуме систем островных дуг с колчеданными месторождениями типа "куроко".

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DEEP INHOMOGENEITIES IN THE UPPER MANTLE AND THEIR INFLUENCE ON THE STRUCTURE AND DYNAMICS OF THE EARTH CRUST

Heterogeneity of the structure, composition and physical state is the basic feature of the Earth interior. Lithospheric inhomogeneities are divided into two varieties - sharp and distributed. The former (layers, blocks, intrusions) are clearly bounded, while the latter (gradual material transition, zones of partial melting, anomalous gradients of property variations) have indefinite outlines. Natural models are very complex. This involves a wide variety of basic reasons. Inhomogeneities are due to the different compositions and properties of rock complexes and lithospheric zones formed historically in the course of accumulation of rocks and their subsequent tectonic displacement under thermodynamic effects, metamorphism, phase transforms, partial rock melting, high jointing, etc. Layers are one of the main types of inhomogeneities. Like other inhomogeneities, they are, generally, unstable. In the course of time they are being transformed, displaced, altered in physical appearance, especially in the areas where various active processes occur. These transformations are accompanied by expansion and compression of matter and redistribution of stresses and deformations which are different at different depth levels. Seismological manifestations also vary from one lithospheric stage to another, both subvertical and subhorizontal seismogenic units being outlined. Large inhomogeneities are due to deep faults most of which have asthenospheric "roots". Along these faults blocks and plates are being displaced vertically and horizontally; here, rock melting, physical property variations, etc. are established. The direct correlation between crustal units and mantle inhomogeneities does not always hold. There are mantle inhomogeneities to which mineral resources are, evidently, related which have been channelled to the ground surface along implicit permeable zones within geological structure.

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ГЛУБИННЫЕ НЕОДНОРОДНОСТИ ВЕРХНЕЙ МАНТИИ И ИХ ВЛИЯНИЕ НА СТРУКТУРУ И ДИНАМИКУ ЗЕМНОЙ КОРЫ

Неоднородность строения, состава и физического состояния земных недр является их важнейшей особенностью. Неоднородности литосферы подразделяются на две разновидности: резкие и рассредоточенные. Пер-

вые (слои, блоки, интрузии) имеют четкие ограничения, вторые (постепенные вещественные переходы, зоны частичного плавления, аномальные градиенты свойств) - нечеткие. Естественные модели очень сложны. Это отражает многообразие создающих их причин. Неоднородности обусловливаются отличиями в составе и свойствах комплексов и зон литосферы, возникшими исторически в ходе накопления пород или их последующих тектонических перемещений, вследствие термодинамических воздействий, метаморфизма, фазовых переходов, частичного плавления пород, их повышенной трещиноватости и т.д.

Одним из основных видов неоднородностей являются слои. Они, как и другие неоднородности, в общем нестабильны. Со временем, особенно там, где идут активные процессы, они преобразуются, перемещаются, меняют физический облик. Эти преобразования сопровождаются расширением и сжатием материалов, перераспределением напряжений, деформациями, различными на разных глубинных уровнях. Сейсмологические проявления в разных этапах литосферы также неодинаковы, при этом намечаются как субвертикальные, так и субгоризонтальные сейсмогенные структуры.

Крупные неоднородности обусловливаются глубинными разломами, большинство из которых имеет астеносферные "корни". По разломам происходят вертикальные и горизонтальные подвижки блоков и пластин, к ним приурочиваются участки плавления пород, изменения физических свойств, и др.

Между структурами коры и неоднородностями мантии прямое соответствие наблюдается не всегда. Намечаются мантийные неоднородности, с которыми, очевидно, связаны месторождения полезных ископаемых, достигших земной поверхности по неявно выраженным в геологических структурах зонам проницаемости.

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ENSIALIC BLUESCHIST BELTS AND ITS RELATION TO SUBDUCTION

According to widespread opinion, blueschists are product of metamorphism of oceanic crust and deep-trench sediments within subduction zones. Metasomatic model of blueschist metamorphism postulates also simatic or ensimatic nature of protolith. In fact, blueschist terranes have different composition. E.g. the predominant part of the J-K_2 Escambray complex of Cuba contain miogeosynclinal sequences (mature clastics, limestone, etc.). The Caracas Group of Venezuela has similar composition. These sequences were formed on sialic crust. The old sialic basement appears under the Pt-$\mathcal{E}_I$ blueschist Niarovey Fm. in the Polar Urals. The Upper Protherozoic ec-

logite - blueschist Maksut, Makbal and Chegem complexes in the Urals, Tien-Shan and Caucasus respectively are shelf-type sediments. In the Hellenides, Betic Ranges, Alps, Calabria, Corsica, New Caledonia and Oman HP/LT metamorphism affects the sialic granite-metamorphic basement and (or) shallow-water carbonate-clastic cover, molasse often with evaporite, coal and acid volcanic interbeds, and flysh sequences.

There are no ophiolites in blueschists of the Northern Caucasus, in some blueschist zones of the Urals, the External Hellenides, the Sesia Lanzo zone in the Alps, in the Betic Ranges. The blueschists in these zones are situated often below thick sialic nappes. There are no ocean basins existence evidences in these zones just before HP/LT metamorphism. Therefore HP/LT metamorphism seems here to be provocated by intracontinental buckling (upthrusting). Accelerating effect of grinding might be important for origin of the blueschists in the narrow shear thrust zones in the Urals, Calabria, etc. under conditions of great lithostatic pressure. In the cases when ophiolites are present subduction of continental crust may be proposed (that does't completely agrees with the classic plate tectonic theory) or alternatively a deep-seated upthrusting took place. In general, blueschist metamorphism is undoubtedely determined by deep-seated lateral tectonic movements but not all blueschist belts mark subduction zones.

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ЭНСИАЛИЧЕСКИЕ ГОЛУБОСЛАНЦЕВЫЕ ПОЯСА И ИХ ОТНОШЕНИЕ К СУБДУКЦИИ

Широко распространено мнение, что голубые сланцы - это продукт метаморфизма пород океанической коры и осадков глубоководных желобов в зонах субдукции. Метасоматическая модель голубосланцевого метаморфизма также постулирует симатический или энсиматический характер исходного материала. В действительности голубосланцевые комплексы имеют различный состав. Так, преобладающая часть эскамбрайского комплекса Кубы ($J-K_2$) состоит из миогеосинклинальных толщ (известняки, зрелые обломочные породы и т.п.). Сходный состав имеет мезозойская группа Каракас Венесуэлы. Эти голубосланцевые (с эклогитами) толщи были сформированы в сиалической коре. Древний сиалический фундамент известен под няровейской свитой Полярного Урала ($Pt-C_1$). Верхнепротерозойские эклогит-голубосланцевые нижнемаксютовский, макбальский и чегемский комплексы, известные соответственно на Урале, Тянь-Шане и Кавказе- это в основном метаосадочные толщи шельфового типа. В Эллинидах, Бетских Кордильерах, Альпах, Калабрии, на Корсике, Новой Каледонии, в Омане голубосланцевый метаморфизм проявился

в сиалическом гранитно-метаморфическом фундаменте и (или) в его мелководном карбонатно-терригенном чехле, в молассах с прослоями эвапоритов, углей и кислых вулканитов, во флишевых толщах.
На Северном Кавказе, в некоторых районах Урала, Внешних Эллинидах, зоне Сезиа-Ланцо в Альпах, в нижних покровах Калабрии голубые сланцы не ассоциируют с офиолитами и тектонически перекрываются энсиалическими комплексами. В этих районах перед началом голубосланцевого метаморфизма не было океанических бассейнов. Здесь, очевидно, метаморфизм был вызван глубинными надвигами при внутриконтинентальном скучивании (в терминах тектоники плит это обстановка коллизии). При этом в формировании голубых сланцев в узких надвиговых зонах (Урал, Калабрия и др.) при большом литостатическом давлении важную роль, возможно, имело акселерирующее действие деформаций сдвигового типа. В тех случаях, когда присутствуют офиолиты, могут предполагаться как субдукция значительных масс континентальной коры (что не вполне согласуется с классической тектоникой плит), так и активное глубинное надвигание. Голубосланцевый метаморфизм в целом обусловлен глубинными горизонтальными движениями, но не приурочен исключительно к зонам субдукции.

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TECTONIC ZONATION OF CONTINENTS BY TYPE AND AGE OF THE EARTH CRUST FORMATION, DISTRIBUTION OF STRUCTURAL-MATERIAL COMPLEXES AND FAULT SYSTEMS WITH THE REFERENCE TO THE AFRICAN-ARABIAN CRATON

The I:5 000 000 maps of fault tectonics and structural-material complexes of Africa and Arabia give an example of tectonic zonation based on the analysis of the main evolution stages of the crust and its components - the structural-material complexes. The concept of accretion and destruction tectogenesis reflecting the formation process of the mature continental crust and the further evolution has been applied in this study to distinguish the main development stages. Structural-material features of geological complexes have served as a basis for tectono-formational analysis. Geosyncline, orogen and platform complexes have been defined with respect to the material composition, and folded and non-folded ones with respect to structures. Ultrametamorphic units are grouped into a specific nuclear class. Paragenesis of geological formations have been distinguished. A "chronotype" scale - a set of time-span of formation of specific type - complexes - was proposed to reveal the relationship between

these complexes. The continent fault system has been described. The combined map analysis has resulted in some conclusions bearing on the problems of tectonic zonation for metallogenic construction. Main stages of craton evolution are the following: I. Setting up the protometamorphic layer (Catarchean - Late Archean); 2. Destruction of protometamorphic layer with the formation of intracratonic protogeosyncline complexes (Archean-Early Proterozoic); 3. Accretion of mature continental crust or cratonization (Proterozoic, partly Late Archean); 4. Partial or complete destruction of mature continental crust in the marginal parts of Africa and Arabia with the formation of aulacogens, geosynclines, rifts and setting up the subcontinental, suboceanic and oceanic crusts (Riphean-Phanerozoic).

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ТЕКТОНИЧЕСКОЕ РАЙОНИРОВАНИЕ КРУПНЫХ ТЕРРИТОРИЙ ПО ТИПАМ И ВРЕМЕНИ ФОРМИРОВАНИЯ ЗЕМНОЙ КОРЫ, РАСПРОСТРАНЕНИЮ СТРУКТУРНО-ВЕЩЕСТВЕННЫХ КОМПЛЕКСОВ И СИСТЕМАМ РАЗЛОМОВ НА ПРИМЕРЕ АФРИКАНО-АРАВИЙСКОГО КРАТОНА

На примере карт разломной тектоники и структурно-вещественных комплексов Африки и Аравии масштаба I:5 000 000 показана возможность тектонического районирования на основе анализа главных этапов формирования земной коры и слагающих ее структурно-вещественных комплексов. Для выделения этапов развития использована концепция аккреционно-деструктивного тектогенеза, отражающая процесс формирования зрелой континентальной коры и дальнейшую ее эволюцию. Для формационно-тектонического анализа использованы структурно-вещественные признаки геологических комплексов. По вещественному составу выделены геосинклинальные, орогенные и платформенные комплексы, по структуре - складчатые и нескладчатые. Ультраметаморфические образования обособлены в самостоятельный класс - нуклеарный. Выделены парагенезы геологических формаций. Для выявления соотношений комплексов предложена шкала "хронотипов" - наборов интервалов времени образования конкретных эталонных комплексов. Охарактеризована система разломов континента. Совместный анализ карт позволил сделать ряд выводов, связанных с задачами тектонического районирования для металлогенических построений. Главными этапами эволюции кратона являются: I) становления протометаморфического слоя (катархей - поздний архей); 2) деструкции протометаморфического слоя с формиро-

ванием комплексов интракратонных протогеосинклиналей (архей - ранний протерозой); 3) акреции зрелой континентальной коры (кратонизации - протерозой, частично поздний архей); 4) частичная и полная деструкции зрелой континентальной коры в краевых частях Африки и Аравии с формированием авлакогенов, геосинклиналей, рифтов и становлением субконтинентальных, субокеанических и океанических кор (рифей - фанерозой).

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TECTONIC ZONATION OF CONTINENTAL CRUST ON THE BASIS OF PALEOTECTONIC ANALYSIS

The paleotectonic analysis the essence of which lies in recostructing of tectonic bodies as they existed in the epochs when their formation took place, as well as in tracing the history of their evolution, has shown that these bodies were formed as a result of several types of evolution. The change in the type of development was accompanied by some major structural reorganization caused by fracturing, destructing of the bodies existed earlier and appearance of new ones. The present-day structural pattern of continental crust comes as a result of the permobile type, greenstone type, protoplatform - protogeosynclinal type and koylogenic - orogenic type of evolution. In accordance with these different types of development, one recognizes the following tectonic bodies within the continental crust: 1. plate-like bodies (lithoplints) with an ovoid (nuclear) structure; 2. megablocks composed of uplifts of the deformed basement separated by greenstone belts; 3. megablocks representing protoplatforms and protofolded belts separating the former; 4. megablocks represented by platforms and folded belts which can be divided into folded systems of different structural patterns and mid-masses; 5. megablocks represented by koylogenic areas, orogenic belts, areas and systems. The first three units usually compose the basement of platforms, the remaining ones are distinguished as indepent structural units.

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ТЕКТОНИЧЕСКОЕ РАЙОНИРОВАНИЕ КОНТИНЕНТАЛЬНОЙ КОРЫ НА ОСНОВЕ ПАЛЕОТЕКТОНИЧЕСКОГО АНАЛИЗА

Палеотектонический анализ, сущность которого заключается в реконструкции тектонических тел для эпох, в которые они возникли, и прослеживании их дальнейших изменений, показал, что эти тела фор-

мировались в результате проявления нескольких типов развития. Смена одного типа развития другим сопровождалась крупными перестройками структурного плана, обусловленными разломами, деструкцией ранее возникших тел и появлением новых. Эти тела в комплексе с прежними сохранившимися телами, определяли характерные особенности структуры регионов для данной эпохи. Современная тектоническая структура континентальной коры образовалась в результате пермобильного, зеленокаменного, протоплатформенно-протогеосинклинального, платформенно-геосинклинального и койлогенно-орогенного типов развития. Соответственно этим типам развития при ее районировании выделяются: I) плитообразные тела (литоплинты) с овоидной (нуклеарной) структурой; 2) мегаблоки, состоящие из поднятий деформированного фундамента, разделенных зеленокаменными поясами; 3) мегаблоки, представляющие протоплатформы и разделяющие их протоскладчатые пояса; 4) мегаблоки в виде платформ и складчатых поясов, подразделяющихся на складчатые системы разной структуры и срединные массивы; 5) мегаблоки, представленные койлогенными областями, орогенными поясами, областями и системами. Первые три подразделения обычно составляют фундамент платформ, остальные выделяются в современной структуре в виде самостоятельных подразделений.

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INTERPRETATION OF THRUST FAULT GENESIS IN AN ALPINE CHAIN SEGMENT - EAST CARPATHIANS

The East Carpathians dominant structural feature is given by the rootless nappes that can be either sedimentary cover nappes only or basement-shearing nappes. The paper deals with the flysch nappes inner structure and their genesis. The largest part of the Flysch Zone-namely the Moldavides-accumulated on continental substratum; only its innermost part-the Outer Dacides-overlay an oceanic type crust. However,the structural image of the Flysch Zone displays elements common to some continental active margin segments :folds, thrust folds with different vergences and amplitudes, and overthrusts.

As the two zones mentioned above have similar structure types, there must be a common cause of the genesis of the latter, besides tangential stress. It has been considered that the genesis of thrust faults with different vergences (seaward and landward) can be accounted for by the existence of low shearing strength levels which corresponded to certain piles of overpressured pelites. The existence of overpressured clay levels can also explain the variability of the inner structure along the same nappe, the genesis of the overthrusting planes at certain stratigraphic levels and the complete lack of the flysch normal substratum.

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DEEP SYNCLINAL STRUCTURES IN CENOZOIC ROCKS IN NEW ZEALAND

In the South Island of New Zealand, northwest of the Alpine Fault (now the Indian/Pacific plate boundary), Eocene to Miocene sedimentation in one basin - the Murchison basin - reached over 10 km in thickness. The basin was originally c.40 km long and c.20 km wide. Pliocene-Quaternary compression shortened the shorter axis to c.16 km; marginal uplift was up to 10 km, and at the axis of the deepest syncline uplift was c. 2 km. The tectonic depression thus results from differential uplift not from downfolding, and the deep involvement of Cenozoic rocks results from 40 million years of downwarping and sedimentation. The folding is interpreted as concentric. The anticlines, one of which was penetrated over 3 km in near-vertical beds by an oil-prospecting well, are disrupted. The synclines, which are boat-shaped, are well-preserved, with dips steepening towards the axes. A few major faults, slightly oblique to the long axes of the major folds, cut through the depression. The style of folding is important for its dependence largely on bedding-plane slip, and for the corollary that the pre-Cenozoic granitic basement rocks must be effectively "folded" by small displacements on minor fractures.

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BASIC CHARACTERISTICS OF NEOID STRUCTURES IN CHINA

The basic characteristics of tectonic activities in China since Miocene can be summarized as follows:

1. The Neoid tectonic movements in China have taken place with horizontal movement as their main parts, associated with regional upwarpings and subsidences. The tectonic activities largely followed the tectonic systems and structural zones formed since the Yenshan movement, among which the Neocathaysian, Xiyu system, Qilianshan-Luliangshan-Helanshan system and Qinghai-Tibet eta-type structure are especially important.

2. The structural features of the new tectonics are mainly with fractures, less of folds. The associated magmatic activity is with eruption as its main part. The periods of the activity are: late oligocene to late Miocene, Pliocene to Pleistocene and Pleistocene to early Holocene.

3. Since Cenozoic, the deposits of large basins and troughs in China gradually become younger from north to south, and it is atvious that the central part of China continent sheared southward relatively to its east and west parts.

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SOME PATTERNS OF ROCK MOVEMENTS ON FAULT PLANES AND SLICKENSIDES

Measurements of rock movements on fault surfaces in the Beijing-Tianjin area in China have been carrying on for more than ten years to monitor the occurrence of earthquakes. An analysis of the results shows that rocks have generally moved toward a certain direction on the fault surface by repeatedly following a curved round, instead of continuously linear, path similar to an ellipse or the Arabic numeral 8 with a period of about a year. The rock reverses its direction of displacement in a different track symmetrical to the previous normal advance at half period, but does not return to its original position. The apparent periodicity is proved not to result from the seasonal change of temperature and precipitation.

Slickensides which can be traced to have described similar paths have also been observed on fault planes in the field. It appears that this is no accidental coincidence. It is believed that this round about displacement of rocks may indicate a change in the state of stress and a variation of friction over the fault surface, the reversal of motion representing a release of stress as is suggested by the unloading of a rock specimen in a compression test.

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THE ARCTIC-NORTH ATLANTIC RIFT MEGASYSTEM

The structure of early Mesozoic rift systems in the West Siberian platform, the Northwest Europe, North Sea, North America has been analysed as well as that of Cenozoic mid-ocean ridges in the Arctic and Atlantic oceans. These rift systems and mid-ocean ridges are considered as structural forms of a destructive stage of the earth crust evolution which has become apparent in Mesozoic-Cenozoic eras within the Northern Hemisphere. In this segment of the Earth, under the influence of the agitated mantle centers the downwarping of large areas and formation of the Permian depositional basins took place during the initial period of megasystem formation. The growing man-

tle influence on the lithosphere resulted in the lithosphere break during Triassic and formation of the abovementioned rift systems including the areas of future mid-ocean ridges. During the late Mesozoic, particularly Cenozoic, the mantle agitation process is concentrated in the central parts of the Arctic and North Atlantic which caused the lithosphere plate spreading and basin formation of the Arctic and Atlantic oceans. In the axial zones of oceans mid-ocean ridges with the new crust of ocean type are forming.
By the end of Jurassic the peripheral rift systems have disappeared and on their places the sedimentary basins characterized by considerable sediment thickness have been formed as a result of inherited downwarping. The Cenozoic period in the Arctic and North Atlantic oceans is apparently a culmination destructive stage of the earth crust evolution. The subsequent stage in this area may be marked by the formation of geosynclinal-folded belt.

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АРКТИКО-СЕВЕРО-АТЛАНТИЧЕСКАЯ РИФТОВАЯ МЕГАСИСТЕМА

Проанализировано строение раннемезозойских рифтовых систем Западно-Сибирской плиты, Северо-Западной Европы, Северного моря, Северной Америки, а также кайнозойских срединно-океанических хребтов Северного Ледовитого и Атлантического океанов. Эти рифтовые системы и срединно-океанические хребты рассматриваются как структурные формы деструктивной стадии развития земной коры, проявившейся в мезозойско-кайнозойскую эры в пределах Северного полушария. В этом сегменте Земли под воздействием очагов возбужденной мантии в начальный период формирования мегасистемы произошло прогибание больших территорий и образование пермских бассейнов седиментации. Прогрессирующее воздействие мантии на литосферу привело в триасе к расколу литосферы и образованию указанных выше рифтовых систем, в том числе и на месте будущих срединно-океанических хребтов. В конце мезозоя, особенно в кайнозое, процесс возбуждения мантии концентрируется в центральных частях Арктики и Северной Атлантике, что обусловило спрединг литосферных плит и образование впадин Северного Ледовитого и Атлантического океанов. В осевых зонах океанов формируются срединно-океанические хребты с новой корой океанического типа.
Периферийные рифтовые системы к концу юрского периода отмерли, и на их месте в результате унаследованного прогибания формировались осадочные бассейны, характеризующиеся значительной мощностью осадков.

Кайнозойский период для Арктики и Северной Атлантики, по-видимому, является кульминационным этапом деструктивной стадии развития земной коры. Вероятно, последующий этап на этой территории ознаменуется формированием геосинклинально-складчатого пояса.

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CATACLASIS AND RECRYSTALLIZATION OF QUARTZ IN MURZINSKY SHEAR ZONE, MIDDLE URALS

The Murzinsky shear, one of the largest in the Urals, lies to the east of the Sysert complex in the rocks of greenschist and staurolite metamorphic facies. In the shear zone metamorphic rocks and quartz veins were subjected to intensive postmetamorphic deformation up to the formation of mylonites.

During the initial mylonitization stage the original quartz grains were transformed by systems of ductile shear microfractures or faults (Griggs and Handin, 1960) into an aggregate of ribbon or rombic fragments. The fragments were displaced around each other along faults and at the same time were subjected to intrafragment plastic deformation. Combination of fragmentation and plastically deformed quartz dynamic poligonization resulted in transformation of original quartz grains into a poligonization subgrains aggregate.

At the following mylonitization stage as a result of dynamic recrystallization new small quartz grains have appeared in the original quartz grains along faults. The c-axes of recrystallized grains show strong preferred orientation and are diverged from c-axis of original grain to the direction of fault planes. The recrystallization degree increases with the increase of deformation. During deformation the grain and subgrain size remains nearly constant. The most intensive recrystallization is observed in quartz grains of the central part of the shear zone and in ultramylonites.

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КАТАКЛАЗ И РЕКРИСТАЛЛИЗАЦИЯ КВАРЦА В ЗОНЕ МУРЗИНСКОГО СДВИГА (СРЕДНИЙ УРАЛ)

К востоку от Сысертского комплекса один из самых крупных на Урале Мурзинский сдвиг проходит в области развития пород, метаморфизованных в условиях зеленосланцевой и ставролитовой фаций регионального метаморфизма. В приуроченной к сдвигу мощной зоне смятия метаморфические породы вместе с залегающими среди них кварцевыми жилами под-

верглись интенсивной посткристаллизационной деформации, вплоть до образования милонитов.

При катакластическом течении на начальной, макроскопически еще не заметной стадии милонитизации системы трещин вязкого скалывания расчленяют зерна кварца на фрагменты полосовидной или ромбической формы, которые, пластически деформируясь, смещаются вдоль трещин относительно друг друга. Достаточно высокие температуры деформации создают условия для синтектонической полигонизации пластически деформируемых участков кварца. Сочетание процессов фрагментации и полигонизации приводит к превращению исходного кристалла в совокупность блоков (субзерен).

При более сильной милонитизации пород в индивидах исходного кварца вдоль трещин вязкого скалывания появляются мелкие зерна рекристаллизованного кварца, оптические оси которых, наследуя ориентировку наиболее сильно искривленных участков матрицы, стремятся расположиться возможно ближе к направлению трещин. Степень синтектонической рекристаллизации с увеличением деформации возрастает. Размер зерен и блоков полигонизации при этом остается постоянным. В результате отсутствия упрочнения, свойственного пластической деформации, течение кварца с началом рекристаллизации усиливается. Наиболее сильно рекристаллизован кварц в участках, примыкающих к шовной зоне разлома, и в ультрамилонитах.

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TECTONIC ZONATION THROUGH ANALYZING THE FAULT SYSTEMS

Under fault systems are meant regular space groupings of faults occuring under conditions of different geodynamic environments peculiar to some or other structural elements of the Earth crust.

The regmatic net of continents is subdivided into three classes of the fault systems: sutural, banded and areal, differing in extension, space patterns, geologico- geophysical parameters and position in regional structures.

The largest systems of the first order with linear, arched-rhombic and isometrical-mosaic patterns disrupt the melanocratic basement. They appear at the oceanic and transitional stages, are synchronous with eugeosynclinal basins, trenches, mid-oceanic ridges, early island arcs. The systems of the second order are localized in the consolidated crust above the Moho discontinuity - in orogenic areas, mature island arcs, median massifs. They are formed on the background of intense formation of the granitic layer, making the

configurations of the preceding stages more complicated. The systems of the third order correspond to the stage of isolation of late orogenic structures and plates. They develop over the granitic-metamorphic basement in the sedimentary and volcanogenic-sedimentary covers and are characterised by small dimensions and the mosaic or linear mosaic patterns.

Sutural, banded and areal fault systems subdivide the lithosphere into the limited number of clumpy tectonic types over all continents whose contours and geological-geophysical characteristics can be easily revealed by means of analysis of space patterns of faults.

The established regularities allow us to use the regmatic net with the aim of the Earth surface tectonic zonation.

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ТЕКТОНИЧЕСКОЕ РАЙОНИРОВАНИЕ НА ОСНОВЕ АНАЛИЗА СИСТЕМ РАЗЛОМОВ

Системами разломов мы называем закономерные пространственные группировки разломов, возникшие в условиях различных геодинамических обстановок, свойственных тем или иным структурным элементам земной коры.

В регматической сети континентов выявляются три класса систем разломов - шовные, полосовые и ареальные, отличающиеся по размерам, пространственному рисунку, геолого-геофизическим параметрам и положению в региональных структурах.

Наиболее крупные системы I-го порядка с линейным, дугообразно-ромбическим и изометрично-мозаичным рисунками нарушают меланократовое основание. Они возникают на океанической и переходной стадиях, синхронны эвгеосинклинальным котловинам, желобам, срединно-океаническим хребтам, ранним островным дугам. Системы 2-го порядка локализуются в консолидированной коре выше поверхности Мохо- в орогенных областях, зрелых островных дугах, срединных массивах. Они образуются на фоне интенсивного формирования гранитного слоя, усложняя рисунки предшествующих стадий. Системы 3-го порядка соответствуют стадии обособления позднеорогенных структур и плит. Они развиваются над гранитно-метаморфическим фундаментом в осадочном и вулканогенно-осадочном чехлах, имея небольшие размеры и мозаичный или линейно-мозаичный рисунки.

Шовные, полосовые и ареальные системы разломов расчленяют литосферу на ограниченное число тектонотипов глыб, встречающихся на всех континентах, контуры которых и геолого-геофизические особенности легко улавливаются анализом пространственных рисунков разломов. Установленные закономерности позволяют использовать регматическую сеть в целях тектонического районирования земной поверхности.

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MAPPING OF RIFT OCEANS

Popular theoretical premises for structural analyses of the ocean floor are hypothesis of continental drift and expanding of the Earth. Telescoped riftogenesis as common volcano-tectonic structure of volcanic belts in application rift ocean also solves the main problems of their structure not according to the hypothesises. Along this it is explaned: a) symmetrical increasing 2 layer basaltic age of ocean floor towards the continents; b) successive change of the vertical section of the bottom deposit upwards from basalts of 2 layer to shallow-water limestones and deep-water ooges; c) decreasing of mesozoic and cainozoic transgression rate as a result of increasing of oceanic basin volume along with narrowing of rift volcano-tectonic belts and their rifts towards the center of oceans with corresponding decreasing of eruptive basaltic area. Observed slow grouth of transgressions and fast process of regressions is explained by continuation of volcanism exchanging by swift collaps of volcano-tectonic dome after ceasing of the eruption, the tension in them is due on heatomass transport to zones of volcano-tectonic rises, following by total increasing of structure volume by 10-15%. The stages of subsequent collapse are due on vertical movements. Comparing with processes presumable on base of new global tectonics hypothesis volcano-tectonic rise of domes coinsides with period of "spreading" and stages of "spreading ceasing" coinside with periods of volcano-tectonic dome collapse and accumulation in forming trough of sedimentary thickness.

Telescoped riftogenes explains the floor ocean without speculative construction on base of laws of volcanism and tectonics (allowing to make up maps not following new global tectonics).

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КАРТИРОВАНИЕ РИФТОГЕННЫХ ОКЕАНОВ

Картирование дна океанов Атлантического типа раскрывает их геологическую историю, способствуя поискам полезных ископаемых. Крупные неоднородности в строении океанической коры свидетельствуют о формировании ее структуры под влиянием вертикальных и горизонтальных тектонических движений, сопровождающихся вулканизмом и осадкообразованием. Теоретическими предпосылками структурного анализа дна рифтогенных океанов являются гипотезы дрейфа континентов и расширения земного шара. Телескопированный рифтогенез как тривиальное вулканотектоническое структурообразование в вулканических поясах в приложении к рифтовым океанам также решает основные проблемы их строе-

ния, не прибегая к гипотезам. При этом объясняются: а)симметричное увеличение возраста базальтов 2-го слоя дна океана по направлению к континентам; б)последовательное изменение вертикального разреза донных отложений вверх от базальтов 2-го слоя к мелководным известнякам и глубоководным илам; в) уменьшение размеров мезозойских и кайнозойских континентальных трансгрессий и регрессий как следствие увеличения объема океанических бассейнов при сужении вулкано-тектонических поясов поднятий и их рифтов к центру океанов с соответствующим уменьшением площадей базальтовых излияний. Наблюдаемые при этом медленное нарастание трансгрессий и быстрый процесс регрессий объясняются длительностью вулканизма, сменяющегося стремительным обрушением вулкано-тектонических сводов вслед за исчерпанием излияний. Срединно-океанические хребты по генезису аналогичны континентальным вулкано-тектоническим сводовым поднятиям, увенчанным рифтами обрушения. Растяжение в них обусловлено тепломассопереносом в зоны сводовых вулкано-тектонических поднятий, сопровождавшимся общим увеличением объема структуры на 10-15%. Этапы последующего обрушения сводов обусловлены вертикальными движениями без крупных растяжений. При сопоставлении с процессами, предполагаемыми на основе гипотезы новой глобальной тектоники, вулкано-тектоническое поднятие сводов соответствует периоду "спрединга", а этапы "остановки спрединга" совпадают с периодами обрушения вулкано-тектонических сводов и накоплением в образующихся трогах осадочных толщ. Телескопированный рифтогенез объясняет образование структур дна океанов без умозрительных построений на основе законов вулканизма и тектоники, позволяющих составлять тектонические карты не руководствуясь новой глобальной тектоникой.

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ANOMALOUS ZONES IN THE UPPER MANTLE, THEIR PROBABLE NATURE AND ROLE IN THE DEVELOPMENT OF CRUSTAL STRUCTURES

The anomalous zones characterized by decreased seismic wave velocities, their attenuation and increased electrical conductivity are distinguished in the upper mantle of tectonically active areas. According to these features many of them can be related with partial melting zones which is proved by high heat flow in some areas. Data available suggest occurence of a few anomalous zones at different depth in the same areas being probably connected with each other. The formation of partial melting zones at some levels, existence conditions and possible heat transfer mechanisms result in an immense evacuation of high-temperature material from the Earth interior due to the stepped gravitational differentiation and wide development of

ultrabasic magma mainly within the upper mantle. The latter possess high mobility in vertical and horizontal directions with the formation of long partial melting zones like hydrorupture mechanism. The main driving force is pressure exess appearing because of magma and enclosing medium density difference. Anomalous zones in the upper mantle and their consequent evolution are the result of structural deformations of the Earth crust, crustal magmatism and vertical movements.

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АНОМАЛЬНЫЕ ЗОНЫ В ВЕРХНЕЙ МАНТИИ, ИХ ВЕРОЯТНАЯ ПРИРОДА И РОЛЬ В РАЗВИТИИ СТРУКТУР ЗЕМНОЙ КОРЫ

В верхней мантии тектонически активных районов часто выделяются аномальные зоны, характеризующиеся пониженными скоростями сейсмических волн, их затуханием и повышенной электропроводностью. По совокупности этих признаков многие из них могут связываться с зонами частичного плавления, что подтверждается в ряде районов наличием высокого теплового потока. Имеются также сведения о существовании в одних и тех же районах одновременно нескольких аномальных зон, расположенных на различной глубине, и, по-видимому, как-то связанных друг с другом. Рассмотрение причин образования зон частичного плавления на нескольких уровнях, условий их существования и возможных механизмов переноса тепла приводит к выводу о выносе из недр Земли вследствие ступенчатой гравитационной дифференциации огромного количества высокотемпературного материала и о широком развитии в пределах верхней мантии преимущественно ультраосновных магм. Последние обладают высокой подвижностью, распространяясь как в вертикальном, так и в горизонтальном направлениях с образованием протяженных зон частичного плавления по механизму гидроразрыва. Основной движущей силой при этом является избыточное давление, возникающее благодаря разнице плотностей магм и вмещающей среды. Возникновение аномальных зон в верхней мантии и их последующая эволюция служат причиной структурных преобразований земной коры, корового магматизма и вертикальных движений.

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PLATE TECTONIC EVOLUTION OF JAPANESE ISLANDS

The pre-Neogene geologic framework of Japan consists of the pre-Jurassic terranes, Jurassic subduction terranes and Cretaceous to Paleogene subduction terranes being jaxtaposed in a complex manner by strike-slip mobile zones. The pre-Jurassic terrances are either fragments of older continental blocks or older subduction complex laterally transported to the present position. The Jurassic subduction complex includes Carboniferous to Jurassic "oceanic plate facies"(basalt, reef limestone, pelagic chert and shale) intermixed with Jurassic trench clastics. Similary, Cretaceous to Paleogene subduction complex includes Lower Cretaceous basalt and pelagic chert with trench turbidites. Within strike-slip mobile zones, the exotic tectonic blocks of Silurian to Jurassic metamorphic, igneous and sedimentary rocks are incorporated with serpentinite matrix. Cretaceous strike-slip basins are developed along these zones. The plate tectonic evolution of Japan is closely associated with that of east Asia. Triassic to Jurassic collision of various continental masses around the Siberian craton produced basic framework of east Asia. Jurassic subduction terranes of Japan were a part of this, possibly produced at the margin of Yangtze block. Late Jurassic to early Cretaceous transform faulting at the eastern margin of the amalgamated Asian continent generated strike-slip mobile zones and reorganized and jaxtaposed various geologic terranes. Japanese strike-slip zones were a part of this system. Cretaceous to Paleogene subduction zone at the eastern margin of Asia completed preNeogene geotectonic framework.

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MESO-WESTPHALIAN DECOLLEMENT TECTONICS IN THE SE IBERIAN MESETA, SPAIN

Until 1980, many Variscan reverse faults, overriding structures and thrusts towards the NNW were known in the Ossa Morena and the Luso-Oretan Zones, but all remained disseminate and unrelated. Recent field investigations and MSS space and airborn images interpretation lead to a re-examination of these post-Westphalian B and ante-Westphalian D Tectonics.
For instance, the Despeñaperros Thrusts spread out following the stratigraphical formations limits: between Middle Ordovician shales

and Lower Ordovician "Armorican" sandstones, between this Lower Ordovician and the Upper Proterozoic basement,...; the low dips Rancojo Thrusts take root in the same contact zone with that basement.
The Almaden Syncline, the southern margin Ordovician strata of which are vertical from the field surface to a depth of 700 m min., is only a part of a mega-unit which extends northwards to a Sierra de Saceruela foot, overriding the Alcudian basement, with a 35 km heave.
Important tectonic reductions are known, e.g. in the Devonian complex: from the far-eastern Sierra Morena to Alamillo, Silurian shales ride directly over the basement.
All the Meso-Westphalian structures have been originated by décollement Tectonics as important here as in the northern Cantabrian and West-Asturian - Leonesian Zones and the whole Iberian Meseta seems to be concerned.

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LAWS OF GRANITE ACTIVITY AND MIGRATING OF THE TECTONIC ZONE OF THE NEOCATHAYSIAN TECTONIC SYSTEM IN SOUTH CHINA SINCE THE MESOZOIC ERA

The tectonic movements of south China may be divided into three periods which are the Indosinian ranging (T_2-J_1), the Yanshan ranging (J_2-E_1) and the Himalayan occurring in Tertiary since the Mesozoic era.

A series of the NNE trending upwarping and depression zones were resulted due to the Mesozoic tectonic movement. The Mesozoic granite intrisive bodies concentrated in the upwarping zones. The features of the Mesozoic granite are as follows : (1) EW and NNE trending zonal distribution; (2) The intrusive bodies in age from NW toward SE progressive younging; (3) Major compositions of mineral and chemical of the granites increase in acid and alkaline and decrease in basic from NW toward SE. It reflected that granite activities of the region have laws of cyclical, localization, the migration, toward certain direction and progressive change of material component. The activity laws are closely related the migrating of the Neocathaysian tectonic zone from NW toward SW. The Neocathaysian tectonic system sliding regime consists of a fore front-

midrise-back downwarp. The remelting or partial melting of deeper crust which results from the back downwarp depressing produced reworking granitic magma. The laterial compression produced during the sliding regime migrating toward east makes the remelting magma migrate toward fore front, through the fore front fracture zones the remelting magma uplifted into the fore front location different periods granites were formed.

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THE LAYERING OF THE VORONEZH CRYSTALLINE MASSIF LITHOSPHERE FROM GEOPHYSICAL, GEOLOGICAL AND PETROPHYSICAL DATA

The original macrolayering of the lithosphere, that is inferred from seismic (DSS), gravimetrical, geological and petrophysical data transforms into a more differentiated subhorizontal structure during the process of endogeneous petrogenesis.
The VCM Lithosphere is characterized by a thick crust (42-46 km), high mean velocity down to the Moho discontinuity (V=6,6 km/s), salic composition of the 30-km layer, high velocities of the lower crust (6,9-7,5 km/s) and a crust - mantle transitional layer.
The upper vertically and horizontally heterogeneous granite -gneiss layer (V=6,38 km/s) consists of three zones, which reflect the structural style and pecularities of the development of crustal differentiation and ultrametamorphogeneous granitization processes.
Crustal distribution of mean and layer velocities, as well as salic composition of the upper layer indicate significantly mafic composition of the lower crust of the massif. Velocities and seismic boundaries (M & M_1) of the transitional layer and the uppermost mantle correspond to various differentiates of ultramafites and pyroxenites.
From the studies of the seismic velocity anisotropy of the VCM crust, two levels with different orientation of extreme velocities are distinguished. The N-W trend of proterozoic folded structures corresponds to the direction of the maximum velocity, fixed in the granite-gneiss layer. The lower crust displays a layer anisotropy and N-E orientation of the maximum velocities. Large velocity dispersion in the lower crust indicates a higher heterogeneity as compared with the upper crustal layer.
The Conrad interface which divides the crust into two layers, played a significant and compositional role in the development of the VCM lithosphere.

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РАССЛОЕННОСТЬ ЛИТОСФЕРЫ ВОРОНЕЖСКОГО КРИСТАЛЛИЧЕСКОГО МАССИВА, ПО ГЕОФИЗИЧЕСКИМ, ГЕОЛОГИЧЕСКИМ И ПЕТРОФИЗИЧЕСКИМ ДАННЫМ

Первичная макрослоистость литосферы, устанавливаемая по сейсмическим (ГСЗ), гравиметрическим, геологическим и петрофизическим данным, в процессе эндогенного петрогенеза преобразуется в более дифференцированную субгоризонтальную структуру.

Для литосферы ВКМ характерны мощная кора (42-46 км) и высокая средняя скорость до раздела Мохо (v = 6,6 км/с), салический состав верхнего 30-километрового слоя, высокие скорости (6,9-7,5 км/с) в нижней коре, а также переходный слой кора - мантия.

Верхний гранито-гнейсовый слой (v = 6,38 км/с), обнаруживающий вертикальную и латеральную неоднородности, состоит из трех зон, отражающих специфику строения и особенности развития процессов первичной дифференциации и ультраметаморфогенной гранитизации коры. Распределение средних и пластовых скоростей в коре, а также салический состав верхнего слоя указывают на существенно мафический состав нижней коры региона. Скорости и сейсмические границы (М и M_I) переходного слоя и верхов мантии соответствуют различным дифференциатам ультрамафитов и пироксенитам.

По результатам изучения анизотропии сейсмических скоростей в земной коре выделяются два уровня с различной ориентировкой экстремальных скоростей. С северо-западными простираниями протерозойских складчатых структур совпадают направления максимальных скоростей, зафиксированных в гранито-гнейсовом слое. Нижнюю кору отличает более сильная анизотропия и северо-восточная ориентировка экстремальных скоростей. Большая дисперсия скоростей в нижней коре отражает более сильную неоднородность по сравнению с верхним коровым слоем.

Поверхность Конрада, разделяющая кору на два слоя, имела важное структурно-вещественное значение в процессе развития литосферы ВКМ.

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A MODEL OF THE CRETACEOUS ISLAND ARC IN CENTRAL CUBA

During the Late Cretaceous development of the area of Central Cuba the ancient oceanic crust of the Caribbean plate moved northwards upon the southern margin of the American continent (the Bahamian platform). In the process of obduction a specific volcanic island arc (VIA) originated on the oceanic crust, known as "Zaza Zone". During the first development stage (for which information is avai-

lable) this zone was a wide and deep basin. An ever 9000 m thick tephroidal flysch was deposited in it. Nearly permanent consedimentational fault deformadominated. They predestined the places of magma conduits and volcanic centres. The volcanic activity was basic to intermediate and subalkaline, submarine, mainly of areal type. At the end of this stage, the regional fold edifice of the arc began to raise very slowly in subaqual conditions. During the second stage the sedimentation was mainly of volcanogenic molasse type, accompanied by a normal Ca-alkaline volcanism. The latter was localized in: 1) a central (in respect of VIA) zone with andesite volcanism of central type, in parts subaerial; 2) a northern zone of mainly subaerial acid volcanism. Both zones developed nearly synchronously, the northern being relatively younger. The finale of the stage coinsides with the end of the obduction. At that time the consedimentational fault deformations and the continuous very slow growth of the arc structure terminated. During the very short time interval of the Early Campanian a complex and wide polyphase megastructure (anticlinorium) formed on the place of the two zones. This terminated the active formation of VIA. Its destruction began immediately and corresponded to intensive deformations north of the collision zone. Initially, a distinct megablock pattern was superimposed on the arc megastructure, controlled by submeridional faults, under amagmatic conditions. Later (still in the Early Campanian) a belt of granitoid bodies was intruded along deep longitudinal fractures. This belt runs approximately parallel to the boundary between the northern and central zone of the second sedimentation stage. In the beginning of the Late Campanian the area of VIA was already peneplainized. A wide basin of terrigenous-carbonate sedimentation formed. The quasiplatform development of the area began.

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CONTINENTAL RIFT LAKES AND SEDIMENTS : TECTONIC, VOLCANIC AND CLIMATIC CONTROL. A REVIEW FROM THE EAST AFRICAN RIFT

Extensional boundaries of the African and Somalian blocks, the eastern and western branches of the East African Rift show a suite of several tens to hundred kilometers long troughs, separated by transverse thresholds of tectonic or volcanic origin, and usually formed by kilometric to decakilometric elementary half-graben style troughs. Lakes of various size and water chemistry lie actually in these troughs, the larger ones, Lakes Tanganyika, Malawi, Kivu ..., being located in the western branch. Recent geophysical studies reveal several thousand meters thick sedimentary infillings suggesting a Miocene age for the setting of these large lakes. Most of the modern small lakes of the eastern branch appear during Upper Pliocene or Pleistocene, the older lakes, Miocene to Pliocene, being represented only by lacustrine

sediment exposures. Differences in the longevity of these various lacustrine basins as well as the differences between their size, their water chemistry, the thickness and lithology of their sedimentary infilling ... are directly upon influence of tectonic activity, volcanism and climates, acting alone or simultaneously. The East African Rift shows from Afar to Lake Malawi trough numerous pictures of such tectonic-volcanism-climates-lakes-sediments relationships.

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CENOZOIC DEVELOPMENT OF THE CARPATHIAN ARC

During the last five years a significant progress has been achieved in the study of the present-date structure and Tertiary development of the Carpathian arc. Presumably, the most important results have been obtained from the Transcarpathian reflection-seismic profiling. It seems now that during the last phases of the orogeny in Oligocene and Miocene thin-skinned tectonics had been in progress. Carpathian thrust sheets, composed of sheared-off sediments and crystalline flakes, 10-15 km thick, overthrust radially the foreland at a distance of more than 100 km. Also gravity, magnetotelluric and satellite images confirm this concept originally proposed by V.Uhlig in 1907 and repeated in a wider context by E.Argand in 1922. The sheared-off and porous sediments of the lowermost Krosno-menilite (Skole-Tarcau) nappes are at the same time the only Pan-Carpathian phenomenon. The arc itself and the basement of the Pannonian and the Transylvanian basins contain Pre-mid-Oligocene deformed fragments of the Magura-Pieniny, East-Alpine, Pontide and Dinaride groups of nappes.

Their Post-Lower-Oligocene interaction had been characterized by extremely complicated collision tectonics with strike-slip and thrust faulting. At the end of compression in the front of the arc and after it the significant back-arc extensive tectonics accompanied by orogenic andesite volcanism and relatively rapid subsidence gave rise to the Pannonian basin. The complicated Oligo-Miocene development of the Carpathian arc and its relation to the search for bitumen deposits are discussed in detail.

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SEDIMENTARY LAYER OF OKHOTSK AND BERING SEAS

According to the thickness (T) of Earth crust layer ratio and position of asthenospheric layer roof in Bering and Okhotsk water areas, six types of structure are marked out with specific internal structure of sedimentary layer (SL). Type I - depressions (North Sakhalin, North Okhotsk, West Kamchatka, Norton, Navarinsk and other) of riftogene destruction active display (asthenosphere roof is 75-100 km deep, T. of the Earth crust is 26-30 km, T. of "granitic" layer (GL) - 4-8 km and T. of SL is 5-12 km). SL of depressions is formed by 3 structural-stratigraphic assemblages (SSA). Each of them corresponds to a certain Cenozoic stage of depression development: active extension - filling and warming up - compression - levelling. Type II - depressions (Deryugin, TINRO etc.) of extremely active display of destructive processes. Here the asthenosphere is less than 50 km deep, T. of the Earth crust is less than 25 km, T. of GL makes 0-4 km, T. of SL - 3-5 km. Depressions develop in the condition of extension and are formed by poorly dislocated deep water sediments. Type III - deep water basins of maximal activity of destruction: T. of the Earth crust is decreased up to 10-12 km, GL is absent, T. of SL is 5-8 km. Poor dislocation and deep-water conditions of sedimentation are typical for basins of SSA. High level of "melting through" of lithosphere resulted in reworking of significant part of SSA. Type IV - depressions of partial display of riftogene destruction are situated in central part of Okhotsk Sea and Eastern part of Bering Sea. They are made by poorly dislocated, mostly sandy sediments with T. of up to 2 km underlying by GL with T. of up to 8-10 km.Types V and VI -where lithosphere destruction is small. T. of SL makes 0.2-2 km. Mid- and Upper Miocene SSA are crushed into folds and broken up into blocks during compression. Pliocene complex is not deformed. Thus internal structure and variations of T. of SL in Okhotsk and Bering Seas are determined by destruction level.

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ОСАДОЧНЫЙ СЛОЙ ОХОТСКОГО И БЕРИНГОВА МОРЕЙ

По соотношению мощностей (М) слоев земной коры и положению кровли астеносферного слоя в акваториях Берингова и Охотского (ДВ) морей выделяется шесть типов структур со специфическим внутренним строени-

ем осадочного слоя (СС). I т и п - прогибы (Северо-Сахалинский, Северо-Охотский, Западно-Камчатский, Нортон, Наваринский, Св.Георгия) активного проявления рифтогенной деструкции (кровля астеносферы расположена на глубинах 75-100 км, М земной коры 26-30 км, геофизического "гранитного" слоя (ГС) 4-8 км, СС 5-12 км). ОС прогибов сложен 3 структурно-стратиграфическими комплексами (ССК). Каждому из них соответствует определенный этап кайнозойской стадии развития прогибов: активное растяжение - заполнение и прогрев - сжатие - выравнивание. П т и п - прогибы (Дерюгинский, Тирно и др.) крайне активного проявления деструктивных процессов. Астеносферный слой в их пределах расположен на глубинах менее 50 км, М земной коры менее 25 км, ГС 0-4 км, ОС 3-5 км. Прогибы развиваются в условиях растяжения и выполнены слабодислоцированными глубоководными осадками. Ш т и п - глубоководные котловины с максимальной активностью деструктивных процессов: сокращена М земной коры до 10-12 км, отсутствует ГС при мощности ОС 5-6 км. Для ССК котловин характерна слабая дислоцированность и глубоководные условия осадконакопления. Высокий уровень "проплавления" литосферы привел к переработке значительной части ССК. IУ т и п - прогибы частичного проявления рифтогенной деструкции, расположены в центральной части Охотского и восточной - Берингова морей. Выполнены они слабодислоцированными преимущественно песчаными осадками мощностью до 2 км, подстилаемые ГС с М 8-10 км. У и УI т и п ы - поднятия, где проявления деструктивных процессов в литосфере незначительные. Мощность ОС варьирует в пределах 0,2-2,0 км. Средне- и верхнемиоценовые ССК смяты в складки и расчленены на блоки в процессе сжатия. Плиоценовый комплекс не деформирован. Таким образом, внутренняя структура и вариации мощности ОС Охотского и Берингова морей определяются уровнем активности деструктуивных процессов в литосфере.

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TECTONIC RECONSTRUCTIONS AS A FACTOR OF GEOLOGICAL EVOLUTION OF FOLDED AREAS

According to the space statistical analysis, tectonic reconstructions in the folded areas of Middle Asia, East Siberia, Altai and Far East are characterized by some general regularities of manifestation. Ubiquitously, the change of structural plans takes place with rotation tendency in the counter-clockwise direction in average angular velocity 0.3° per million years. The process is correlated with analogous rotation of paleomeridians. The reconstructions are typically developed in polycyclic areas of mosaic construction in structures with the regime of differential preferentially ascensi-

anal movements of large amplitude. At the megostructural level the mechanism of reconstructions operates latently, in structures of the lowest rank its successive stages are fixed. There is a cause and consequence relation between field stresses rotation and tectonic cyclicity. The largest phases of folding are repeated with field rotation by 35-45° but only with rotation by 90° the original structural reconstruction completing the cycle occurs. Thus, the field rotation serves as a factor stimulating the tectono-magmatic process. The observed phenomenon peculiarities vary depending on specific tectonic conditions but are found to be typomorphic for different stages of structure-substantial evolution of the earth crust.

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ТЕКТОНИЧЕСКИЕ ПЕРЕСТРОЙКИ КАК ФАКТОР ГЕОЛОГИЧЕСКОЙ ЭВОЛЮЦИИ СКЛАДЧАТЫХ ОБЛАСТЕЙ

По данным пространственно-статистического анализа,тектонические перестройки в складчатых областях Средней Азии,Алтая,Восточной Сибири и Дальнего Востока характеризуются некоторыми общими закономерностями проявления.Повсеместно смена структурных планов происходит с тенденцией вращения в направлении против часовой стрелки со средней угловой скоростью 0,3°в млн.лет.Процесс коррелируется с аналогичным вращением палеомеридианов.Типично перестройки проявляются в полициклических областях мозаичного строения в структурах с режимом дифференциальных преимущественно восходящих движений большой амплитуды.На уровне мегаструктур механизм перестроек действует скрыто,в структурах низшего ранга фиксируются его последовательные стадии.Есть причинно-следственная связь между вращением поля напряжений и тектонической цикличностью.Крупнейшие фазы складчатости повторяются при повороте поля на 35–45°,но только при повороте на 90° происходит коренная структурная перестройка,завершающая цикл.Таким образом,вращение поля выступает в качестве фактора,стимулирующего тектоно-магматический процесс.Особенности рассматриваемого явления варьируют в зависимости от конкретных тектонических обстановок,но оказываются типоморфными для различных стадий структурно-вещественной эволюции земной коры.

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NEW MODEL of GEOISOSTASY

The question is raised concerning the failure of the traditional models of the Earth crust (litosphere) as they artificially split that part of the Earth from the rest of the planet.

The new geoisostasy model is proposed on conditions that 1) the weight of the Earth sectors cut off by similar spatial angles must be equal; 2) densities in the interior parts of the Earth must be of such a range within which the potential values at any point of the Earth would correspond to the level surfaces, calculated in assuming that the shells of the rotating Earth became liquid.Therefore, defference between geoid and corresponding spheroid may serve as a criterion for the Earth equilibrium at each of those points.

Interaction between the Earth and the physical fields surrounding it results in transformations of the rotational regimes (the position of the rotation axe and angular velocity) and changes of the equilibrium state for unbalance. Equilibrium is restored accompanied by the vertical redistribution of densities inside the Earth, in litosphere, particularly;

Redistribution in density is regulated according to the law of preservation of movement moment and kynetic rotation energy related with it. The new geoisostasy model opens wide perspectives for solving the geological problems by the gravimetric methods, and, in particular, it may and must be utilized when constructing, along the gravity field, the density profiles of the Earth crust and the upper mantle. An opportunity is obtained to motivate the principal trend of the tectonic processes forward equilibration of the Earth. Due to the model proposed, the degree of the Earth balance at each point is possible to be quantitatively estimated.

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НОВАЯ МОДЕЛЬ ГЕОИЗОСТАЗИИ

Ставится вопрос о неправомерности использования традиционных моделей изостазии земной коры (литосферы) в связи с тем, что в них искусственно обособляется эта часть Земли от всей остальной планеты.

Предлагается новая модель геоизостазии, в основе которой лежит выполнение двух условий: I) равный вес секторов Земли, вырезанных одинаковыми центральными телесными углами;

2) такое распределение плотности в Земле, при котором значения потенциала в любой ее точке (включая точки дневной поверхности) соответствовали бы уровенным поверхностям, вычисленным в предположении, что оболочки вращающейся Земли стали жидкими. Следовательно, критерием уравновешенности Земли в каждой точке может служить отклонение геоида от соответствующего ему сфероида.

В результате взаимодействия Земли с окружающими ее физическими полями меняется ротационный режим (положение оси вращения и угловая скорость) - нарушается фигура равновесия планеты. Восстановление фигуры равновесия сопровождается вертикальным перераспределением плотности в недрах Земли, и в частности литосфере. Физическим законом, регулирующим это перераспределение плотности, является закон сохранения момента количества движения и связанной с ним кинетической энергии вращения. Новая модель геоизостазии открывает определенные перспективы решения геологических задач с помощью гравиметрии, в частности может и должна быть использована при конструировании по гравитационному полю плотностных разрезов земной коры и верхней мантии. Появляется возможность объяснения направленности тектонических процессов в сторону достижения равновесного состояния Земли. Имеется объективный количественный критерий оценки степени уравновешенности Земли в каждой ее точке.

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INTERNATIONAL GEOLOGICAL-GEOPHYSICAL ATLAS OF PACIFIC OCEAN AND PERSPECTIVES OF GEOLOGICAL MAPPING OF NORTH-WEST PACIFIC

Compilation of the International Geological-Geophysical Atlas of the Pacific ocean is arranged for summarization of original data with minimum of interpretation. The content of the atlas include the maps of the topography of the ocean floor, the thickness of sediments, the structure of the Earth crust on the basis of results of seismic refraction, the structure of anomalies of the magnetic and gravity fields, the heat flow, the seismicity and volcanoes, the type of bottom sediments and igneous rocks of the base-

ment of the ocean floor. The complex of all these data will be useful for geologists in their efforts of theoretical generalization of original data and speculation in form of geomorphological, geological and tectonic maps. Soviet scientists make their contribution to this atlas by preparation of the maps concerning the geology and geophysics of the North-West Pacific. For that region of the ocean-analysis of the maps which have been prepared give understanding of real perspectives for construction of the geological map. In the North-West Pacific typical are the horst and swell-type rises which expiriened the vertical and lateral displacements, the heterogeneety of the type of the igneous rocks of the basement, irregular thickness of sediments, the presence of unconformities in stratigraphy. The examples of well studied rises are Obruchev, Shatsky and Hess rises and Zenkevich swell. The vertical movements of these rises cannot be explained by thermal contraction of the lithospheric plate. The evidences of the young age of the deep trenches formed probably in Miocene only and overlaps the structures of the transition zone between continent of Asia and Pacific floor deserve the serious attention. It makes the subduction in trenches rather less real.

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МЕЖДУНАРОДНЫЙ ГЕОЛОГО-ГЕОФИЗИЧЕСКИЙ АТЛАС ТИХОГО ОКЕАНА И ПЕРСПЕКТИВЫ ГЕОЛОГИЧЕСКОГО КАРТИРОВАНИЯ СЕВЕРО-ЗАПАДНОЙ ЧАСТИ ТИХОГО ОКЕАНА

Подготовка международного геолого-геофизического атласа Тихого океана имеет целью обобщение фактических данных, полученных за последнее время, при минимальной роли интерпретации. Программа атласа включает карты рельефа дна, мощностей осадочного чехла, строения земной коры по данным глубинного сейсмического зондирования, структуры аномальных магнитного и гравитационного полей, теплового потока через дно океана, сейсмической активности и вулканизма, типов донных осадков и коренных пород фундамента. Комплекс этих данных будет полезен исследователям в их попытках теоретического обобщения и интерпретации фактических данных в форме геоморфологических, геологических и тектонических карт. Советские исследователи делают свой основной вклад в этот атлас подготовкой карт, освещающих строение дна северо-западной части Тихого океана. Анализ подготовленных карт позволяет говорить о перспективах построения геологической карты. При этом выявляются черты существенной неоднородности геологического строения и его

отличия от строения восточной части океана. Для северо-западной части океана характерны горстовые и сводово-глыбовые поднятия, претерпевшие значительные вертикальные и горизонтальные смещения, гетерогенный по составу коренных пород фундамент, значительная неравномерность мощностей осадочного чехла, наличие ряда несогласий в его разрезе. Примером хорошо изученных поднятий могут служить возвышенности Обручева, Шатского и Хесса. Вертикальные движения этих поднятий не получают объяснения в рамках представлений о термальной контракции литосферной плиты. Заслуживают внимания признаки молодости глубоководных желобов, заложенных, вероятнее всего, в миоцене, и их наложенности на структуры зоны перехода от континента Азии к ложу Тихого океана, что делает маловероятным процесс субдукции.

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OCEANIC RIFTOGENES - UNEVENESS IN THE SPACE AND TIME

Studies of oceanic riftogenal systems give numerous evidences of uneveness of their development in space and time. Such evidences are the differences of morphostructures riftogenal systems along their stretch, differences in distribution of thickness of sediments in deep structure of the crust, in anomalous structure of magnetic field and in distribution of the heat flow, in localization of hydrothermal activity and its products, in anomalies of age and properties of basal sediments and igneous rocks of acoustik basement. Special interest represent variations of focal mechanism of earthquakes in the rift zones which permit to ascertain the uneveness of movements related with development of rifts. To explain observed uneveness usually help fractionisation of main plates postulated by concept of plate-tectonics into the number of smaller, introducing the idea of plate assemblies. It deprive the concept of simplicity and elegancy. Alternative explanation of uneveness of development of oceanic rifts in space and time can be used the idea that active factor of riftogenic process is not a movements of plates accompanied by passive filling of opened rift fracture with basalt lava and accretion of margins of displaced plates but diapirism of the earth mantle which generate creation of arch-type rises, geotumors and rifting at their axial parts accompanied by gliding of lithospheric blocks from flanks of geotumors. Cell-type development of diapirs in space and uneveness of their development through the time results in unhomogenety of rifted systems.

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ОКЕАНИЧЕСКИЙ РИФТОГЕНЕЗ - НЕРАВНОМЕРНОСТЬ В ПРОСТРАНСТВЕ И ВРЕМЕНИ

Исследования океанических рифтогенальных систем дают множество свидетельств того, что их развитие в пространстве и времени происходит неравномерно. Такими свидетельствами представляются различия в морфоструктуре рифтогенальных систем вдоль их простирания, в распределении мощностей осадочного чехла и форме его залегания на фундаменте, в глубинном строении земной коры, в аномальной структуре магнитного поля, в распределении теплового потока через дно океана, в локальности гидротермальной активности и ее продуктов, в аномалиях возрастных характеристик базальных осадков и магматических пород акустического фундамента. Особенный интерес представляют вариации механизма очагов землетрясений рифтовой зоны, по которым может быть установлена неравномерность движений, связанных с развитием рифтовой зоны. Для объяснения отмечаемых неравномерностей строения океанических георифтогенальных систем чаще всего прибегают к дроблению основных литосферных плит, постулируемых концепцией плейт-тектоники, на ряд более мелких, вводя представление об ансамблях плит, что лишает первоначальную форму концепции ее простоты и логичности. Альтернативным объяснением неравномерности развития океанических рифтов в пространстве и времени может служить представление о том, что активным фактором рифтогенального процесса является не раздвижение плит, сопровождающееся пассивным заполнением рифтовой трещины мантийными выплавками, наращивающими края плит, а мантийный диапиризм, вызывающий образование сводовых поднятий, геотуморов, рифтогенез в их осевых частях и соскальзывание литосферных блоков по флангам. Ячеистость диапиризма в пространстве и неравномерность его развития во времени определяют неравномерность рифтогенеза в пространстве и времени.

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DEFORMATION FACIES OF SOME SHEAR BELTS IN JAPAN

Deformation facies and their geohistorical changes represented by minor structures are exemplified by two types of shear belts in Japan. At a part of the Hida Marginal Belt, intrafolial fold facies, crenulation cleavage facies, and kink facies can be identified to have been formed successively, and at the lower part of the Main Belt of the Hidaka Metamorphic Belt, successive formation of intrafolial fold facies, boudinage facies, and kink facies can be confirmed. Such a temporal change of deformation facies in these two areas are very similar in the point that

the mean ductility decreases with time, which reveals the decrease of temperature and/or effective pressure, and/or increase of the strain rate.
Based on the geometry and formative mechanism of facies structures composing deformation facies, the stress state at that time and its history can be restored. These change of environmental factors is regarded as being conformable with the kinematic picture of uplifting of the shear belts. This suggests that the concept of "deformation facies series" is plausible to be introduced.

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PECULIARITIES OF EVOLUTION OF THE URAL-MONGOLIA MOBILE BELT IN PALEOZOIC

In the Early Paleozoic there are established : 1. Sayan - Mongolian, 2. Uralian, 3. Kazakhstanion megasystems. The first two have one-sided zonation developing from the Siberian and Russian platforms into the belt. Zonation of the latter is more complex and in general it is connected with the position of the relatively stable Tarim-China region.

In the evolution of the belt there appear in various degree and form the relative stability of median masses included into it which play greates role in Kazakhstanian megasystem.

In space and time there is traced the sliding evolution of crust of the ocean, island - arc and continental type in the age intervals peculiar to each of three established megasystems.

The distinctive feature is the increase of the intrusive magmatism to the bend of the arched Sayan-Mongolian megasystem - in the Transbaicalian area where specific structure "plutonogen" was formed. This exceptional phenomenon may be connected with the combination of horizontal and vertical movements over the system of zones of underthrust of special type.

In the Middle-Late Paleozoic Zaisan - South Mongolia megasystem is probably formed by way of moving apart of the earlier created structures. The Uralian and South Tien-Shanian megasystems continue the directed evolution since the Early Paleozoic.

The Global reconstruction on the paleomagnetic data reveals sharply different arrangement of the established megasystems from the recent one which united into recent mozaic only by the end of Paleozoic.
This is in line with uncompletion of the "Caledonian" magmatism.

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ОСОБЕННОСТИ РАЗВИТИЯ УРАЛО-МОНГОЛЬСКОГО ПОДВИЖНОГО ПОЯСА В ПАЛЕОЗОЕ

В раннем палеозое выделяются мегасистемы: 1) Саяно-Монгольская; 2) Уральская; 3) Казахстанская. Первые 2 имеют одностороннюю зональность, развиваясь от Сибирской и Русской платформ вглубь пояса. Зональность последней более сложная, в общем связана с положением относительно Таримско-Китайской стабильной области.
В развитии пояса в различной степени и форме проявляется относительная стабильность включенных в него срединных массивов, которые особенно большую роль играют в Казахстанской мегасистеме.
Прослеживается скользящее во времени и пространстве развитие коры океанического, островодужного и континентального типов в возрастных интервалах, специфических для каждой из 3 выделенных мегасистем.
Характерно нарастание интрузивного магматизма к перегибу дугообразной Саяно-Монгольской мегасистемы в Забайкалье, где образовалась особая структура: "плутоноген". Это исключительное явление может быть связано с комбинацией горизонтальных и вертикальных движений над системой зон поддвига особого типа.

В среднем-позднем палеозое Зайсанско-Южномонгольская мегасистема образуется, по-видимому, в основном путем раздвига ранее созданных сооружений, Уральская и Южно-Тяньшанская мегасистемы продолжают направленное развитие с раннего палеозоя.
Глобальные реконструкции по палеомагнитным данным указывают на возможно резко отличное от современного расположения выделенных мегасистем, которые соединились в современную мозаику лишь к концу палеозоя. Это согласуется с некоторой незавершенностью "каледонского" магматизма.

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CONTINENTAL RIFTS BELOW SEA LEVEL

Four regions on earth are situated considerably below sea level: the Imperial Valley, California (-70 m), the Danakil Depression, Ethiopia (-159 m), the Dead Sea Rift Valley (-400 m) and the Qattara Depression, Egypt (-134 m). The latter is regarded as an erosive feature whereas the three other regions are elongated, north-south directed, Continental Rifts. The Dead Sea Rift was formed by a transform fault, whereas the Danakil (Afar) Depression was formed due to the opening of a spreading axis. The Imperial Valley (Salton trough), on the other hand is a combination of tensional strike slip movements associated with the opening of the Baja California and the East Pacific Rise.

All three rifts are close to the sea and their interception with the sea is manifested by embayments (Zula and Djibuti, the Baja and the Gulf of Elat). Their sedimentary fill, mostly alluvial, lacustrine and evaporitic is similar and all exist since the late Neogene. All three rifts show current tectonic activity and seismicity as well as geothermal phenomena. There exists a young intensive volcanism inside the Danakil Rift and less in the Imperial Valley. The volcanic activity in the Dead Sea Rift is situated mostly in the margins.

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STRUCTURE OF PALEOZOIC PASSIVE CONTINENTAL MARGIN AT NOVAYA ZJEMLJA

There may be distinguished deposits of different facial zones of Paleozoic (from Silurian, may be Ordovician, to Permian) passive continental margin at Novaya Zjemlja. There occur all the succession of sediments from the shelf facies at the West to the facies of continental slope foot at the East. They represent a prolongation of Polar Uralian Eletskaya and Lemvinskaya tectonic zones. The geological situation is suitable for detailed study of the facial transitions, the width of the facial zones, the changes of biocoenosis and so on.

There are three different stages in the geological history of the region. From Silurian to Middle Permian, when the terrigenic supply was restricted, the facial changes were caused mainly by depth of the basin. These changes consisted in gradual replacement of shallow water organogenic carbonate sediments by clay-silicious sediments, first of all by radiolarian muds. In some horizons the silicious layers include olistolites-boulders of limestones and riff massives, which have slumped down the slope from the West for tens of kilometres. At the latest Middle Devonian the shelf sinked partly and the edge of continental slope migrated westward for 30-35km. Some intrusions and basaltic eruptions of the earliest Late Devonian were connected, probably, with these events. In Early Permian the part of Eletskaya zone also sinked and the part of continental slope migrated farther westward for 120-150 km. The character of facial transitions did not change. The tremendous basin 500 km long was generated at the boundary between carbonate and silicious facies, the thickness of manganum carbonate ores is 30 m. At Late Permian intensive terrigenic supply from the Southeast began, turbidity piles up to 100 m were formed. These deep water sediments were gradually changed by shallow water sediments in Triassic. Slight folding and rising at the end of Triassic led to emergence of different facial zones. The investigation of this geological object may be found useful in research of contemporary passive continental margins, where pre-Quaternary deposits can be studied only by drilling.

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СТРОЕНИЕ ПАЛЕОЗОЙСКОЙ ПАССИВНОЙ КОНТИНЕНТАЛЬНОЙ ОКРАИНЫ НА НОВОЙ ЗЕМЛЕ

На Новой Земле присутствуют отложения различных фациальных зон палеозойской пассивной континентальной окраины, существовавшей от силура (м.б. ордовика) до конца перми. Сохранились отложения от шельфовых на западе до подножья континентального склона включительно на востоке. Первые являются продолжением Елецкой зоны Полярного Урала, вторые - Лемвинской. Отсутствие сложных дислокаций и гранитоидного магматизма, а также наличие ряда структур, вскрывающих одновозрастные разнофациальные отложения, позволяют подробно изучить характер фациальных переходов, ширину фациальных зон, геохимические особенности осадков, изменение биоценозов с увеличением глубины палеобассейна и т.п.

В истории развития региона выделяются три существенно различных этапа. С силура до середины перми при небольшом количестве поступавшего в бассейн терригенного материала основные фациальные изменения обуславливаются изменением глубины бассейна. Они сводятся к постепенному замещению мелководных, обычно органогенных карбонатных,

осадков глинисто-кремнистыми, существенно радиоляриевыми илами, формировавшимися в палеозойском океане ниже уровня карбонатной компенсации и не содержащими бентосной фауны. В отдельных горизонтах в кремнистых породах присутствуют олистолиты - валуны известняков и целые рифовые массивы, сползшие с запада вниз по склону на десятки километров.

В конце среднего девона происходит первое погружение части шельфа и смещение на запад бровки континентального склона на запад и юго-запад на 30-50 км. Вероятно, с этим связаны внедрение пластовых интрузий и излияния базальтов, происшедшие в начале позднего девона.

В начале перми испытывает опускание часть Елецкой зоны, в результате верхняя бровка континентального склона еще смещается на запад на 120-150 км. Характер фациальных переходов принципиально не меняется. В зоне сопряжения карбонатных и кремнистых фаций, т.е. вблизи уровня карбонатной компенсации формируется крупнейший марганцевый бассейн, протягивающийся на 500 км при мощности карбонатных руд марганца до 30 м.

В начале поздней перми начинается поступление в бассейн огромного количества терригенного материала с юго-востока. Среди осадков характерны отложения мутьевых потоков - несортированные терригенные пачки, содержащие обломки и глыбы терригенных и карбонатных пород. Мощности таких пачек достигают 100 м. Во второй половине поздней перми глубоководные осадки постепенно сменяются терригенными мелководными, а в триасе и континентальными.

Слабая складчатость в конце триаса обусловила общее поднятие региона и вывод на поверхность отложений различных фациальных зон. Изучение этого уникального объекта может существенно помочь в исследовании современных пассивных континентальных окраин, где дочетвертичные осадки могут изучаться лишь при помощи бурения.

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PALAEOZOIC RIFTS IN THE CIRCUM-MEDITERRANEAN AREA

Modal sedimentary sequences of many circum- and intra-Mediterranean pre-Alpine nuclei show evidences of rifting during three Palaeozoic intervals: the M.-U. Cambrian, the U. Ordovician - L. Silurian and the U. Devonian - Dinantian.

The M.-U. Cambrian rift across the circum-Mediterranean (CM) area is an outcome of the rift leading to a major breakup of the Proterozoic Supercontinent at ca. 560 Ma. It is suggested that actual continental separation within the CM area took only place between Africa and Sibiria blocks leaving Kazakhstania and Southeurope in sialic connection with Africa, but free of mutual dextral displacement by means of strike- and oblique slip fractures. Such setting accounts for 1) the transgressive trend of the Cambrian with clastics and evaporites, followed by shallow carbonates, by pelagic limestones and locally by clastic wedges or prismatic bodies in "anorogenic" type of development, 2) the transtensional isolated occurrences of pull-apart basins filled with

turbidites, 3) the transpressive local hiatuses or gentle folding known as "Sardic phase", 4) the distribution of magmatism. The drifting apart of the major Cambrian blocks responsible for the extensional and/or transcurrent patterns of the CM area is continuing also in the Ordovician producing the first folding phases in the Caledonian orogenic belts.

The U. Ordovician - L. Silurian rift across the CM area rejuvenate the previous Cambrian one in a thinned sialic crust. This is reflected by the U.Ordovician "thermal event" (at ca. 450 Ma) found all over the CM area where geologic evidences of Caledonian orogeny are lacking. True oceanic sea ways are unknown in the CM area. However, an increasing extensional trend corresponding to faster spreading (responsible for the Taconic collision in the internal Caledonides) is documented in the whole area by 1) the transgression with concurrent synsedimentary extensional tectonics and 2) the tight net of alkaline magmatism (often coupled with local calk-alkaline events suggesting previous, "anorogenic", limited subductions). Smaller scale fragmentation, larger amount and denser net of intrusions and volcanics, prevailing strike-slip sinistral movements and lesser mutual displacement of the blocks characterize the O.-S. rift as compared with the Cambrian one for the CM area.

The U.Devonian - Dinantian rift in the same area is comparable with the Jurassic Tethys one. A shallow, partly carbonate L.Devonian shelf sea with scattered reef-complexes facing two different oceans (Rheic to the W and Uralian + Palaeotethys to the E) is place of a rift system of prevailing strike-slip dextral movements breaking the still thinned sial in many blocks partly cut-across by narrow oceanic sea ways and always free of mutual displacement and interaction in both transtensional and transpressive settings. Such blocks control the subcircular pattern of the Hercynian deformation in the CM and European areas. This rift evolves up to the collisional stage, as compared with the two previous rifts, showing larger magmatism and higher mutual displacement of the CM blocks. During this rift the Carnic-Dinaric fragment (or easternmost internal block) is added permanently to the CM system.

All three rifts 1) correlate with or predate very closely three major world-wide transgressions and three maxima of sea level highstand, 2) are characterized by strike- and/or oblique slip movements in the CM area, and 3) pre-play a cinematic scheme which will be followed at least two times later (Triassic and Jurassic) in the same CM area.

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CONTINENTAL CRUST FORMATION PROCESS OF VIETNAM AND ADJACENT ZONES

Continental crust formation process of Vietnam and adjacent zones is analyzed firstly by the author. Based on Peive's conception proposed that the transformation from ocean crust into continental one undergone three stages: oceanic, transitional and continental. Each stage corresponds to respectively different complex and formations.

Precedent stages appeared through the geosynclinal process. Based on these principles author devided the territory of Vietnam and adjacent zones into defferent zones with its own continental crust formation history.

1. The pre-Ripheus continental crust formation zone (Contum massid, Song Hong suture zone, South China platform).
2. The Early Devonian continental crust formation zone (Catasia).

3. The pre-Ripheus spreading continental crust zone reforming the continental crust into Early Paleozoic (northwest).
4. The pre-Ripheus spreading continental crust and reforming the continental crust into Carbonian (north of Truong Son).
5. The pre-Ripheus spreading the continental crust and reforming the continental crust into Late Paleozoic (central and southern parts).
6. The Early and Middle Paleozoic repeated spreading and Late Triassic continental crust formation zones (Song Da zone).
7. The spreading zone with different ages and being in continental crust formation (east sea).

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LATERAL PETROPHYSICAL HETEROGENEITIES OF THE EARTH CRUST AND UPPER MANTLE

Lateral petrophysical regional heterogeneities, recognized by geophysical technique have layered, block and injection nature. Crustal and mantle blocks of different nature and amounts are the most distinct and ubiquitous types of petrophysical heterogeneities. Petrophysical haterogeneities in form of the endogenous blocks (contrarily to blocks-astroblems) are characterized by coincidence of upper and lower surfaces and horizontal boundaries of crustal layers and upper mantle, which results in descretions. In upper mantle these depths are of 50-60, 67-85, 85-95, 100-115, 120-240, 180-200, 300-350 km. Such heterogeneities have layered and uniform structure (i.e., granite massifs blocks), and may be piled up generation. Crust-mantle petrophysical heterogeneities of layered structure differ in number and depth of their division horizontal boundaries, which from the block to block change on lateral often quazivertical boundaries namely faults. Petrophysical, mainly, petro-density heterogeneity studies (their origin, composition, geological age, spatial characteristics etc.) have been performed by volumetrical modelling of horizontal and vertical sections within Markovo depression, on Ust-Belsk basitic and hyperbasitic massifs, in Belsk depression and on Pekulney structure, Chukotka (sections at the depths 1,5; 3,5; 5,0 km) in Tatar Strait and western Sakhalin (2,5 and 9 km) in USSR northeastern (10,20,30,40,60 km) in the central part of Enisey mountain-ridge (1,5 km) in northwestern part of Black Sea (17 km) in the southern part of Okhotsk Sea, on Hokkaido-Sakhalin island system and on southwestern flank of Kurile islands (14 and 20 km).

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ЛАТЕРАЛЬНЫЕ ПЕТРОФИЗИЧЕСКИЕ НЕОДНОРОДНОСТИ ЗЕМНОЙ КОРЫ И ВЕРХНЕЙ МАНТИИ

Выделяемые геофизическими методами латеральные петрофизические неоднородности регионального типа имеют слоистую, блоковую и инъецирующую природу. Наиболее ярко выраженным и повсеместно распространенным типом петрофизических неоднородностей являются блоки земной коры и верхней мантии разнообразной природы и размеров. Петрофизические неоднородности в форме блоков эндогенной природы (в противоположность блокам-астроблемам) характеризуются закономерным тяготением верхних и нижних их ограничений к горизонтальным границам расслоения земной коры и верхней мантии, вследствие чего глубины заложения их дискретны. В верхней мантии это глубины 50-60, 67-85,85-95, I00-II5, I20-I40, I80-220, 300-350 км. Такие неоднородности имеют слоистую или однородную структуру (например, блоки гранитных массивов), могут быть "бесструктурными", скученными образованиями. Коромантийные петрофизические неоднородности слоистого строения различаются числом и глубиной горизонтальных границ раздела, которые изменяются от блока к блоку на боковых,часто квазивертикальных боковых ограничениях - разломах. Изучение петрофизических, главным образом петроплотностных,неоднородностей (их происхождение, вещественный состав, геологический возраст, пространственные характеристики и т.д.) выполнялось путем построения объемных моделей по системам срезов и разрезов в Марковской впадине, на Усть-Бельском массиве базитов и гипербазитов, в Бельской впадине и на Пекульнейской структуре на Чукотке (срезы на глубинах I,5; 3,5; 5,0 км), в Татарском проливе и Западном Сахалине (2,5 и 9 км), на северо-востоке СССР (I0, 20, 30, 40, 60 км), в центральной части Енисейского кряжа (I,5 км), на северо-западной акватории Черного моря (I7 км), в южной акватории Охотского моря, на Хоккайдо-Сахалинской островной системе и юго-западном фланге Курильских островов (I4 и 20 км).

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THE PACIFIC OCEAN MESOZOIC-CENOZOIC FOLDING (PACIFIDES) AND ITS ROLE IN THE EARTH DEVELOPMENT

50 years ago the speaker spoke about the reason of necessity of singling out of independent Mosozoic folding. It shouldn't be considered either as fading out variscides or as rising alpides. Vast areas where Mesozoic folding was one of rather important or even

final one are singled out. Especially distinctly it showed itself in the circle of the Pacific Ocean and because of this it received the name of the Pacific folding (Pacifides). Sometimes they say that it is Mesozoic Kimmerian folding but according to E.Zyuss these are only Jurassic movements. This name is successful by itself, it is consonant with the Kimmerian stage of Pliocene. Wide acknowledgement of individual Mesozoic folding was followed by its regular singling out on the tectonics maps. More new regions of its prevalence were discovered in the time of this. Besides of the vast belt of the Verkhoyansk-Tchukotsk, Alaskian, Sikhote-Alinian, Indosinian folding regions, the Andes and the Cordilleras to the Pacifides should be also related the Antarctic Andes and a number of other regions. The Himalayas, the Pamirs and the Inner Carpathians (Tatro-Veporids) with their nappe structure, formed during cretaceous like that one in Marmarosh zone of the Outer Carpathians are related to them. Let's also remain Mesozoic ophiolite belt, Jurassic ophiolite formation in California, Triassic ophiolite zone of the Sierra-Nevada. Beginning of the formation of the Atlantic and the Indian oceans is connected with tectonic movements of orogenic character. Main beds of plateau basalts on the continents, including the Antarctic, are of the Mesozoic age. At last, "the second" (plateau basalt) bed of oceanic crust also began to be formed in the time of Jurassic. The strongest orogenic movements are connected with especially strong tectonic stresses which in moveable belts are formed as a kind of folding. The term folding of the Pacific Ocean, which appeared (Belousov) in the meaning of Cenozoic cycle, is wrong.

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МЕЗОЗОЙСКАЯ ТИХООКЕАНСКАЯ СКЛАДЧАТОСТЬ (ПАЦИФИДЫ) И ЕЕ ЗНАЧЕНИЕ В РАЗВИТИИ ЗЕМЛИ

Пятьдесят лет тому назад докладчик выступил с обоснованием необходимости выделения самостоятельной мезозойской складчатости. Ее нельзя рассматривать как затухающие варисциды и как возникающие альпиды. Выделяются обширные области, в которых мезозойская складчатость была одной из весьма значительных или даже завершающей. Особенно отчетливо она проявилась в Тихоокеанском кольце и поэтому получила наименование тихоокеанской складчатости (пацифид). Говорят иногда о мезозойской киммерийской складчатости, но по Э.Зюссу это только юрские движения. Само по себе название неудачное, созвучное с киммерийским ярусом плиоцена. За широким признанием самостоятельной мезозойской складчатости последовало и постоянное выделение ее на тектонических картах. При этом выявлялись все новые области ее

распространения. Помимо широкой полосы Верхоянско-Чукотской, Аляскинской, Сихотэ-Алиньской, Индосинийской складчатых областей, Анд и Кордильер,к пацифидам следует отнести и Антарктанды и еще ряд других областей. Сюда относятся Гималаи, Памир и Внутренние Карпаты (Татро-Вепориды) с их покровной структурой, сформированной, как и в Мармарошской зоне Внешних Карпат,в меловое время. Вспомним также мезозойский офиолитовый пояс, юрскую офиолитовую формацию в Калифорнии, триасовую офиолитовую зону Сьерра-Невады. С мезозойскими тектоническими движениями орогенного характера связано начало образования Атлантического и Индийского океанов. Основные толщи платобазальтов на континентах, включая Антарктиду, имеют мезозойский возраст. Наконец, "второй" (платобазальтовый) слой океанической коры также начал формироваться в юре. Крупнейшие орогенические движения связаны с особенно сильными тектоническими напряжениями, которые в более подвижных поясах реализуются в виде складчатости. Термин "тихоокеанская складчатость" появился (Белоусов) и в другом значении - как кайнозойский цикл, что неправильно.

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SOME CHARACTERISTIC FEATURES OF THE TRANSITION ZONE BETWEEN THE CONTINENTAL CRUST AND SUBOCEAN CRUST OF THE BLACK SEA DEPRESSION ON THE NORTH PART OF THE BLACK SEA

For the first time the map of structural layers of the Crimea peninsula on the scale 1:200 000 was compiled. It presents abyssal structure of the territory, characteristic features of distribution of the geosyncline and platform complexes of different ages, consedimental fractures of the folded basement and the zones of the island paleovolcanic archs. The complex analysis of geological and geophysical data makes it possible to regard this region as a transition zone from the continental crust of the Russian plate to the subocean crust of the abyssal Black Sea depression. The transition zone may be divided into two subzones as to its structure and geological development: South (South-Crimean) and North (North-Crimean). The South-Crimean subzone is characterized by the process of shearing of the Crimean mountains meganticlinorium structures with the subocean Black Sea depression edge along the line of the "granite layer" thickness reduction and the Crimean fragment of the Oder-Caucasian lineament. It is also characterized by the development of the island volcanic arch in the Middle Jurassic with andesite volcanism features and by the present-day seismisity. These features of the South transition subzone make it possible to regard it as an active transition zone of the continental crust. The North Crimean subzone is confined to the juncture of the ancient and epi-

kimmerian platform. It is characterized by the change of the M-discontinuity orientation, block tectonics, vraconian-cenomanian andesite volcanism. The subsone is aseismic now and resembles in its development the passive margins of the atlantic type.

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ОСОБЕННОСТИ СТРОЕНИЯ ОБЛАСТИ ПЕРЕХОДА КОНТИНЕНТАЛЬНОЙ КОРЫ К СУБОКЕАНИЧЕСКОЙ КОРЕ ЧЕРНОМОРСКОЙ ВПАДИНЫ В ПРЕДЕЛАХ СЕВЕРНОГО ПРИЧЕРНОМОРЬЯ

Впервые построена тектоническая карта структурных ярусов Крымского полуострова масштаба I:200000, на которой показаны глубинное строение территории, особенности распространения разновозрастных геосинклинальных и платформенных структурных комплексов, конседиментационные разломы складчатого основания и выделены зоны развития островных палеовулканических дуг. Комплексный анализ геолого-геофизических данных позволяет рассматривать регион как переходную зону от континентальной земной коры Русской плиты к субокеанической коре глубоководной впадины Черного моря. Переходная зона по своему строению и геологическому развитию делится на две подзоны: южную (Южнокрымскую) и северную (Северокрымскую). Для Южнокрымской подзоны характерны срезание краем субокеанической впадины Черного моря структур мегантиклинория Горного Крыма по линии резкого уменьшения мощности "гранитного слоя" земной коры вдоль крымского фрагмента Одер-Кавказского линеамента, развитие в средней юре островной вулканической дуги, характеризующейся андезитовым вулканизмом, современная сейсмичность. Эти особенности южной переходной подзоны позволяют отнести ее к активным переходным зонам на континентальной коре. Северокрымская подзона приурочена к шву сочленения древней и эпикиммерийской платформ. Она характеризуется изменением ориентировок структур поверхности Мохо, глыбовой тектоникой, вракон-сеноманским андезитовым вулканизмом. Подзона в настоящее время асейсмична и напоминает по истории развития пассивные окраины атлантического типа.

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THE GEODYNAMIC NATURE OF THE BAIKAL RIFT

The analysis of morphostructural plan of the Baikal region proves convincingly that the so-called Baikal Rift possesses an inward-outward shear nature which is determined by displacement of the lithosphere plate of the Siberian platform and its Irkutsk amphith-eatre in the

south-west direction. This kind of geodynamic stress of the lithosphere of the Baikal region is proved by the peculiarities of the coulisse-like orientation of major depressions and rises at the bottom of the Baikal, the morphostructural pattern of the whole Baikal region, the wide-spread left shears in the Trans-Baikal region and right shears in the Sayany region, the peculiarities of seismicity of that region and other features. The suggested pattern of the geodynamic stress field of Baikal region lithosphere corresponds well with the surface space orientation data of the local anomalous zone of mantle discovered by V.A. Rogozhina and others in this region. As the given orientation corresponds manifestly with that of the south-west and south-east edges of the Irkutsk amphitheatre, the mentioned phenomenon can be explained completely by the supposed tangent movement of the Irkutsk amphitheatre lithosphere plate. In the author's opinion, the Baikal region on the whole offers a standard example of the wide-spread development of shear tectonics and the manifest possibility (in the some cases) of tectogenic influence of rigid lithosphere plates on the contiguous sections of earth core and mantle. The suggested direction of geodynamic stresses of the Siberian Platform and Baikal region also corresponds well with other data concerning the peculiarities of local shear tectonics and those of the whole Asian Continent and is one of the most important proofs of the geodynamic reality of pole-fleeing forces of the Earth.

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ГЕОДИНАМИЧЕСКАЯ ПРИРОДА БАЙКАЛЬСКОГО РИФТА

Анализ морфоструктурного плана Прибайкалья убедительно показывает, что так называемый Байкальский рифт имеет раздвигово-сдвиговую природу, определяемую смещением литосферной плиты Сибирской платформы и ее Иркутского амфитеатра в юго-западном направлении. Такого рода геодинамическая напряженность литосферы Прибайкалья доказывается особенностями кулисообразной ориентировки основных впадин и поднятий на дне Байкала, рисунком морфоструктурного плана всего Прибайкалья, широким распространением в Забайкалье левых сдвигов, а в районе Саян - правых, особенностями сейсмичности этого региона и другими признаками. В предлагаемую схему поля геодинамических напряжений литосферы Прибайкалья хорошо укладываются и данные о пространственной ориентировке поверхностей местной аномальной зоны мантии, обнаруженной В.А.Рогожиной и другими в этом регионе. Поскольку указанная ориентировка явно соответствует ориентировке юго-западного и юго-восточного краев Иркутского амфитеатра, то приведенное явление вполне можно объяснить предполагае-

мым тангенциальным движением литосферной плиты Иркутского амфитеатра. В целом, по мнению докладчика, Прибайкалье предстает в качестве хрестоматийного примера широкого развития сдвиговой тектоники и реальной возможности (в некоторых случаях) тектогенного воздействия жестких плит литосферы на сопредельные с ними участки земной коры и мантии. Предлагаемая направленность геодинамических напряжений Сибирской платформы и Прибайкалья находится также в хорошем соответствии с другими данными об особенностях как местной сдвиговой тектоники, так и всего азиатского континента, являясь одним из важных доказательств геодинамической реальности полюсобежных сил Земли.

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MANTLE CONVECTION AND MAGMATISM

Firstly, we give a substantiation why convection is the most important motor of the geotectonic processes. Other geotectonic theories are considered, too. Starting from geochemical results, we assume that the lower mantle has a lower amount of radioactive heat produced per unit volume per unit time than the upper mantle. Consequently, the thermoconvective driving energy in the lower mantle is too weak to p e r m a n e n t l y maintain convection there. At the same time, however, the lattice and radiative heat conductivies are low there, so that the heat generated is dissipated only to a minor extent. Therefore, temperature increases. As a result, due to the well-known temperature dependence of the effective viscosity, the Rayleigh number increases until the critical Rayleigh number is surpassed and convection also starts in the lower mantle. Through the currents, heat is dissipated, causing an increase in the permanently existing upper-mantle convection, in magmatism and orogenesis as well as earth-wide transgressions. As a result of the heat dissipation, the Rayleigh number again drops beyond the critical value, i. e., due to the low internal heat source density lower-mantle convection dies down until the next convection interval is started after a long period of heat accumulation. The differential equations of the problem have been reduced to a system of equations with a Hammerstein integral equation and solved numerically. Four convection episodes re-

sulted which agree, in respect of time, with the four highest maxima of Gastil's curve of magmatic activity: These four overturns are found 2820, 3633, 4128 and 4496 m. y. after the accretion of the Earth, an age of the Earth of 4600 m. y. being assumed. A comparison of empirical curves showed that these times also correspond to earthwide transgressions and that the latter are found to precisely lie in the periods in the Phanerozoic in which the geomagnetic dipole field only rarely reversed polarity. The latter most probably has to do with the fact that the lower mantle determines part of the boundary conditions of the hydromagnetic convection in the Earth outer core. It is shown that there cannot be convection intervals without i n t e r n a l heating.

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INVERTING THE STRESS FIELD OF EASTERN ASIA BY THE METHOD OF SUPERPOSITION

After the tectonic structure and the mechanical parameters are chossen for the region to be inverted, the data regarding the relative slip of the fault zones and the predominant direction of principal stress at different places in the region are collected, suppose there are m such data. Divide the boundary into n segments and on each segment i in turn, give it a unit load and calculate the stress or displacement u_{ij} at point j. According to the principle of superposition, we should have:

$$\sum_{i=1}^{n} \alpha_i u_{ij} = \bar{u}_j$$

where $\bar{u}_j$ is the actual value at point j, the formula yields m simultaneous equations which contains n unknown parameters α_i. By means of the method of least square an optimal set of α_i and the corresponding stress field are obtained. The use of principal stress direction in inverted stress field is a great help in the work. The stress field of the Eastern Asia is used as an example, it yields the traction distribution along the Indian, Philippine and Pacific plates and the corresponding stress field.

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VORTEX-COLUMN STRUCTURES IN ALLOGOVITE AT TAISHAN, CHINA

The vortex-column structures developed in allgovite appear in the shape of columns on outcrops from the front and show vortical structural features on the cross section of the columns. In general, each vortex-column structure consists of a vortical core, vortical layers and vortical surfaces which appear in ring and radiant type discontinuous structures. The ring type structures show a circular continuous or an en echelon arrangement. All of the axes of vortex-column structures are almost horizontal and each of them is perpendicular to the strike of the dyke respectively.

In this paper, a theory of the origin of the vortex-column structures is presented. The structures were formed when vortex groups were created during magmatic flow in a state of turbulance, and then solidified. Some joints are discontinuous surfaces of magmatic flow and not fractures. The composite relationship causing these kinds of vortex-columns reflects the mechanism known as the karman's vortex street in fluid dynamics.

Finally, it is proposed that the directions of rotation of the vortex in magma might be determined by the ring type en echelon structures, and both paths and directions of a magmatic flow might be inferred from a synthetical analysis with the directions of rotation of vortexes and their composite relationship.

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BASIC CHARACTERISTICS OF TECTONITES IN SOUTHERN TANCHENG-LUJIANG FAULT ZONE

Based upon the analysis of macro-and microscopic characteristics of deformation and facies changes of tectonites in the southern Tancheng-Lujiang fault zone, the author points out in this paper that the fault zone is a Neocathaysian compresso-shear structure dominantly compressive and tries to reconstruct the stress state and thermal environment for the tectonite formation.

The analysis of the features and fabrics of the undulatory extinction, deformation laminae, deformation zone and sub-grain boundary of quartz resulting from plastic flows show that the tectonic stress field for the Tancheng-Lujiang fault zone is characterized by a nearly horizontal NWW-SEE principal compressive stress. The

density of dislocation for calcite averages 3.44 $10^6/cm^2$. The initial stress causing the dislocation is 392.75g/mm^2 average. The presence of low-temperature, high pressure mineral 3T type phengite (Si=3.35-3.44, mg=0.38-0.49, b_o value 9.045-9.058A), low-temperature plagioclase, and K-feldspar with a slightly higher order of 0.6-0.7 in the tectonite zone, indicates that the Tancheng-Lujiang fault zone was formed in a low-temperature, high-pressure geological environment.

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GEOLOGICAL COMPARISON FOR TWO OPHIOLITE BELTS IN XIZANG (TIBET) AND ITS TECTONIC IMPLICATION

There are two important ophiolite belts in Xizang (Tibet). One is of the well known Yarlung Zangbo ophiolite belt, and another is called the Bangong Lake-Nujiang ophiolite belt in the Northern of the former.
The ophiolites of the two belts have important differences in tectonic environment, period and mechanism of emplacement, petrological and geochemical characters.

Yarlung Zangbo ophiolites preserved complete original sequence, it is characterized by development of the sheeted sills and small magma chambers. The metamorphic peridotites can be distinguished from the peridotites of the Northern belt by stronger tectonic fabric and containing cr-diopside generally, indicating that it may represent the mantle residue of partial melting of lower degree. The REE geochemistry of the pillow lawas show the depleted pattern ($[La/Sm]_n$= 0.4-0.5) of MORB.

The Bangong Lake-Nujiang River ophiolite is of a tectonic disrupted complexes. Neither lherzolite nor harzburgite containing diopside have been found in the peridotites, indicating that it may represents the mantle residue of high depleted. The REE geochemistry of pillow lawas in this belt have three patterns: the enriched type with average $[La/Sm]_n > 2$, flat type with average $La/Sm_n \approx 1$ and the depleted type with average $[La/Sm]_n \approx 0.5$. This geochemical characteristic may be explained by the genetic model of the Hot Mantle Plume.

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CONTINENTAL RISE - TRANSITION BETWEEN CONTINENT AND OCEAN

In Jurassic and Cretaceous times, both the oceanic plate and the Chinese continent moved north-northwest. The Ocean moved quicker than the continent. In the east-west direction, the differential movements caused a transform fault on the continental border and left-lateral faults in the interior. No subduction phenomenon has ever been observed. While in the north-south direction, the fast moving oceanic plate underthrust below the continent. The thermal convection of the oceanic plate didn't cease after subduction. It offered a great thermal gradient and high heat flux, thereby, the igneous rocks widespread over southeast China. The continental "margin" was no more a negative element receiving sediments, but a high stand mountainous area.
Circular-distributed grabens filled with Jurassic sediments denote the core of the rise and show an echlon picture. Thick Cretaceous volcanics lie on the eastern slope. Granites intruded in the raised central part. This region is a new kind of transition between continent and ocean. It was a positive element and rose high above the sea level. It didn't enlarge the continent, but thickened the crust.

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BRITTLE DEFORMATION WITHIN DUCTILE FAULT ZONES

Ductile deformation is characterized by the following plastic deformation mechanisms: crystal plastic, mass transfer and grain boundary sliding. Each can be recognized microstructurally. Brittle deformation is by cataclasites which is marked by fracturing and fragmentation. Ductile fault zones are marked by mylonites and brittle zones by cataclasites. This paper concentrates on cataclasis in ductile fault zones. Four types of behaviour are to be distinguished: 1) cataclasis of hard mineral clasts in a soft mylonite matrix, 2) strain dependent cataclasis leading to plastic flow mechanisms and subsequent mylonite development, 3) widespread initial cataclasis with concomitant retrogression followed by plastic flow and 4) cyclical cataclastic and plastic flow.

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WESTERN PACIFIC SEISMIC STRATIGRAPHY, STRUCTURE AND SEDIMENTATION HISTORY, EAST MARIANA BASIN

An interpretation of the seismic stratigraphy, sedimentation history and structure of the East Mariana Basin has been made using recently collected seismic reflection and refraction data and data from DSDP sites. This Mesozoic(?) age basin, between the Marshall Islands and the Mariana Trench, is subdivided into three regions. The central region has a sedimentary section 1000 m thick which recent drilling has shown to be almost entirely redeposited material from surrounding seamounts. The crust in this region is abnormally deep suggesting unusual mantle or a dense lower part of the sedimentary section. The western region is characterized by a thinner sediment cover and a shallower acoustic basement with a sedimentation history combining pelagic input and a thin interval of turbidites derived from nearby volcanic highs. Extensive Late Cretaceous mid-plate volcanics apparently masks the lower section and forms acoustic basement. The eastern region (east of 157.5°E) contains WNW trending ridges which may be either fracture zones or high amplitude abyssal hills. The sedimentation appears controlled by the same factors as in the western region but the area was bypassed by most Cenozoic basin filling turbidites because of its elevation. The isostatically corrected basement depths between the three regions suggest that the crust east of 157.5°E may be substantially younger than in the rest of the East Mariana Basin, perhaps Cretaceous in age. This requires the existence of a tectonic boundary within the basin.

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THE CRUSTAL STRUCTURE OF EASTERN CHINA AND ADJACENT SEA AREA

Recently, geophysical data in the area have rapidly accoumulated. The paper is on the basis of variant geophysical data (seimsic wave velocity, gravity and magnetic field, heat flow, electroconductivity, etc.) with reviewing other papers, studies the physical nature and evolution of the crust and upper mantle. In order to accentuate the deep structural characteristics we compiled "The map of T magnetic anomalous axes in Eastern China and adjacent sea area", "The gravity anomalous map in East and Eastern Asian sea" "The geothermal information map in China". The geophysical nature and feature show that the structure of the crust and upper mantle in the area is heterogeneous both transversally and longgitudinally. The heterogeneity may be related to mutual conversion of materials between lithosphere and asthenosphere. The paper discusses the origination and evolution process of deep structural framework in Eastern China and the tectonic relationship between China continent and adjacent area. The paper

indicates that recent structural framework of Eastern China is mainly the results of the action of Pacific Ocean plate since Mesozoic era, e.g. the three massive blocks in Eastern China have been subjected to the action of Philippine Sea plate and moved towards west in turn. Moreover, since Cenozoic Era the massive block of South China has been subjected to the action of India plate and moved towards east. The junction porbably are transitional zones. The sea floor structure of Eastern China is a Natural prolongation of the continental structure, but the geological situation of the sea floor may be different from the east of Taiwan Province. The paper classified the area into several magneto-geotectonic units and revealed the basement structural nature. At the end the paper discusses the relationship between energy resources and deep structure and shows that the distribution of energy resources is controlled by the crustal physical nature.

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SHALLOW STRUCTURE OF THE SOUTHERN ALBUQUERQUE BASIN, NEW MEXICO, FROM COCORP SEISMIC REFLECTION DATA

Detailed examination of COCORP Line 1A across the Rio Grande rift suggests that neither dominant listric faults nor closed-space steep step faults exist beneath the Albuquerque Basin. Instead, a folded detachment surface and a set offan-shaped reverse faults have been recognized on the seismic section. The folded detachment is thought to be the subsurface projection of the curved, low angle Jeter fault exposed on the northeastern corner of the Ladron Mountains. Evidence indicates that both the folding of the detachment and thrusting along the reverse faults took place about 10 m.y. ago. It is, therefore, inferred that during that time the area occupied by present Albuquerque Basin was undergoing compression rather than extension. This compression might have resulted from the clockwise rotation of the Colorado Plateau relative to the Great Plains. After 10 m.y. ago compression apparently gave way to extension, perhaps caused by relaxation when the rotation of the plateau ceased.

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THE RELATIONSHIP BETWEEN SEDIMENTARY BODIES IN CLASTIC SEDIMENT SEQUENCES AND OIL AND GAS ACCUMULATIONS

With increasing of oil and gas exploration activities year by year, the subtle reservoir in petroliferous basins becomes to be the main targets of exploration. In a basin, all of the distribution of sedimentary bodies, the hydrodynamic condition, the migration of oil and gas, the arrangement of source and reservoir rocks and then, the distribution of oil and gas reservoir are controlled by paleocurrent systems. At present time, therefore, it is the first critical step in the secondary reconnaissance of oil and gas in an old petroliferous basin that we study the paleocurrent and paleosedimentary systems at ancient time. The sedimentary bodies such as deltas, fandeltas and fans associated closely with oil and gas accumulations are some sedimentary anticlines that resulted from excessive clastic supply and differential compaction. They are potential oil and gas plays. However, the lobates on deltas, the suprafans on fans and the channels which transported sediments into the sea are the elementary units in forming subtle reservoirs. Studying these framework facies are another keystone in researching subtle reservoirs. Improvement in gathering, processing and interpreting techniques of seismic data make us approaching to resolve this problem. Some successful examples in eastern China are cited in this paper.

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TECTONIC SLIDE DURING THE END OF PROTEROZOIC IN EAST ANHUI, CHINA

We recognized a huge northwestward syntectonic overthrust, namely tectonic slide as some European geologists suggested, in Pt_2 and Pt_3 metamorphics in the area studied. The front of it shows slightly convex to NW, bounding the distribution of Pt_2. Both major and subgrade slide planes dip gently to SE with their front listrically, and sometimes deformed subsequently into ductile shear belt with its "xz" plane subvertically. Diagnostic features of it are: (1) fault rocks are typically the penetrative and pepple-bearing mylonite bands, showing a ductile deformation behaviour; (2) mylonite bands and mylonitic foliation made up an intensification of deformation and a retrogression of metamorphism of the regional foliation S_1 (the axial foliation of the 1st. generation fold in Pt_2 and Pt_3),

though they are parallel to each other; (3) there is a peculiar unconformity between Pt_3 in the slide sheet and the overlying Cambrian in which the folding of first generation of Pt_{2-3} is absent; (4) data from drills proved that Pt_3 underlies Pt_2, with a major mylonite band at the base in contact with the still deeper Pt_1; (5) biotite in Pt_1 revealed by drills just mentioned shows an excellent "percussion figure" on its (001) plane, a shocking metamorphism resulted from the tectonic slide; (6) several klippen of Pt_3 distributed at the front of the tectonic slide.

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EVOLUTION OF MIDCONTINENT FEATURE; A PROPOSED HYPOTHESIS FOR THE ACTION OF MESOZOIC RIFTING IN LATE PRECAMBRIAN TIME

In the central part of the North American Continent, Keweenawan mafic igneous rocks, 1.2 to 1.0 b.y. old occupy an arcuate belt ever 1600 km long and about 60 km wide on average. This belt stretches from Lake Superior, in the north, to the Salina Basin in Kansas, in the south. It is believed that the mafic rocks were formed as a result of crustal rifting and subsequent spreading in Keweenawan time. This feature which is called Midcintinent Gravity High consists of a marked positive Bouguer gravity anomaly associated with strong magnetic intensity. Such phenomena also been detected around the rifted margins of the Atlantic, near the coast of Maine in northeastern United States, off the coast of Norway, and elsewhere. The Bouguer gravity anomaly map of the United States shows a subparallelism between the Midcontinent Feature and the Appalachian Orogen. At another scale, this subparallelism also exists between the Mid-Atlantic ocean Ridge, Appalachian Range, and the Midcontinent Feature. This general subparallelism of the geophysical characteristics may be interpreted as similarity in origin of these structures. In other words, the causative mechnism that produced the opening of the Atlantic during Mesozoic, was similar to that responsible for opening the Protoatlantic in Paleozoic time, and thus may be similar to that which resulted in rifting of the Midcontinent Feature 1300 to 1100 m.y. age.

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TECTONIC ANALYSIS OF THE CONTINENTAL MARGIN SPREADING AREA IN EAST ASIA

The continental margin spreading area in East Asia is a transitional area between the continent and ocean formed on the background of the general continental margin spreading towards the ocean. In this area, continental and oceanic crusts coexist, and are directly contacted through the lithosphere fault. The continental margin spreading area in East Asia may be divided into two opposite tectonic systems: one is the graben system of the continental margin formed by continental margin spreading, another is the arc-trench system resulted from continental margin compression. Owing to the distinct tectonic movements, the occurrences of the geomorphic feature, tectonic from, magmatism, depositional formation,metamorphism and mineralization are also different. The westwards movement of the Pacific plate and the wavelike creeping and spreading out of the mantle materials of East Asia towards the ocean is an important factor for forming the continental margin spreading of East Asia.

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STRUCTURE AND EVOLUTION OF THE EARTH CRUST IN SIBERIA ON THE BASIS OF STAGE-BY-STAGE TECTONIC REGIONALIZATION

1.During the compilation of "The Atlas of Tectonical Maps and Key Sections of Siberia" the method of zonation according to structure-material features of mineral masses developed in the Institute of Geology and Geophysics(SB AS USSR)has been modernized. In order to

obtain the detailed discription of deep parts of the crust the stage-by-stage zonation method (or the compilation of megacomplexes maps) is adopted. The sequence of megacomplexes forms the chronological framework of the Atlas.
2.Megacomplexes were subdivided into tectonical complexes. Proto- and deuteroorogenic complexes along with the traditional geosynclines and platformian ones are distinguished. This differes the given method from the others.
3.It is shown that the volume of continental crust within Siberia formed during Early Archean time. The following crust history manifested in breaking-up, reworking, spreading and pushing together of sialic blocks with comparatively small lateral accretion.
4.Special attention has been paid to the epochs of wide distribution deuteroorogenous complexes at the Early Proterozoic-Riphean and Later Paleozoic-Mesozoic boundaries.
5.Attention has been paid to the differences in sedimentary mantle structures on the both sides of Transasian lineament.

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СТРОЕНИЕ И ЭВОЛЮЦИЯ ЗЕМНОЙ КОРЫ СИБИРИ НА ОСНОВЕ ПОЭТАЖНОГО ТЕКТОНИЧЕСКОГО РАЙОНИРОВАНИЯ

I. При составлении "Атласа тектонических карт и опорных профилей Сибири"модернизирована разработанная в ИГиГ СО АН СССР методика районирования по структурно-вещественным признакам минеральных масс. С целью детальной характеристики глубинных зон коры принят способ поэтажного районирования, или составления карт мегакомплексов. Последовательность мегакомплексов создает хронологический каркас Атласа.
2. Мегакомплексы подразделены на тектонические комплексы. Наряду с традиционными геосинклинальными и платформенными комплексами выделены прото- и дейтероорогенные, что отличает принятую методику от предшествующих.

3. Показано, что основная масса континентальной коры на территории Сибири возникла в раннем архее, а ее последующая история выражалась в виде взламывания, переработки, раздвижения и сдвижения сиалических блоков при сравнительно небольшом латеральном наращивании.
4. Особое внимание уделено эпохам широкого распространения дейтеророгенных комплексов на рубежах ранний протерозой-рифей и поздний палеозой-мезозой.
5. Обращено внимание на различия в строении осадочной оболочки по разные стороны Трансазиатского линеамента.

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HETEROGENEITIES IN THE UPPER MANTLE AS THE INDICATOR OF TECTONIC DRIVING MECHANISMS

Geophysical and satellite data imply vertical and lateral heterogeneity of the upper mantle. The zonal boundaries show the difference of phase state, composition, material density and faults. The boundary position is subordinated to global laws expressed in the Earth crust, too. However, constructions of tectonic concepts of the expanding Earth, fixism and plate tectonics do not include these laws. The concepts mentioned above are kinematic - they are not provided by the driving forces and mechanisms.
The report deals with mechanics of global movements that had started 200 m.y. ago, after the Hercynian cratonization epoch. The driving mechanisms are defined by the solution of boundary value problems of celestial mechanics, rigidity theory, visco-plastic theory and hydrodynamics of small numbers of Reynolds. The initial and boundary conditions of the problems are given in the framework of the driving forces - a) gravitational interaction of the Earth with the Moon, the Sun and the planets, b) local perturbations of the asthenosphere sole and the corresponding heat flow. The latter explains the effects of convective cells or astenolites in the mantle. There were obtained driving mechanisms leading to: the upper mantle gravitational anomaly regularity, asthenospheric convexity below ancient platforms, lithospheric thinning and thickening below oceans and continents, ocean rift systems, latitudinal faults and meridional structure element distortion, zonal distribution of continents and oceans, tectonic foliation of the lithosphere, ocean crust obduction, rift separation into blocks.
Synthesis of the obtained data on post-Hercynian movements allows to determine the formation conditions of main structures of the

lithosphere. It is indicative of sufficient completeness of initial requisites for revealing the physical nature of the upper mantle inhomogenity that initiated the Earth's tectonic processes.

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НЕОДНОРОДНОСТИ ВЕРХНЕЙ МАНТИИ - ИНДИКАТОР ДВИЖУЩИХ МЕХАНИЗМОВ ТЕКТОНИКИ

Возрастающий комплекс геофизических и спутниковых данных указывает на неоднородность строения верхней мантии по вертикали и латерали. Границы однородных зон предположительно отражают различие фазового состояния, вещественного состава, плотности материала и разломы. Пространственное положение границ подчинено глобальным закономерностям, выраженным и в структуре земной коры. Однако эти закономерности не содержатся в построениях и выводах концепций тектонических (механических) движений расширяющейся Земли, фиксизма и тектоники плит. Указанные концепции сугубо кинематичны - они не оснащены движущими силами и механизмами.

В докладе методами механики исследуются глобальные движения, начавшиеся 200 млн.лет назад после относительного тектонического покоя - эпохи герцинской кратонизации. Для определения движущих механизмов поставлены и решены модельные и краевые задачи небесной механики, теории упругости, теории вязкоупругости и гидродинамики малых чисел *Рейнольдса. Начальные и граничные условия задач сформулированы* в рамках движущих сил: а) гравитационного взаимодействия Земли с Луной, Солнцем, большими планетами Солнечной системы и б) локальных возмущений подошвы астеносферы и связанного с ними теплового потока. Последние отражают эффект становления астенолитов или формирования конвективных ячеек в подастеносферной мантии. Получены движущие механизмы возникновения и формирования частичной упорядоченности гравитационных аномалий верхней мантии, выклинивания астеносферы преимущественно под древними платформами, утонения и утолщения литосферы под океанами и материками, океанических рифтовых систем, широтных разломов и искривления меридиональных структурных элементов, широтно-зонального распределения материков и океанов, тектонической расслоенности литосферы, обдукции океанической коры, блоково-грядовой расчлененности рифтовых зон.

Синтез полученных данных о послегерцинских движениях позволяет определить условия образования основных структурных элементов литосферы. Это свидетельствует о достаточной полноте исходных предпосылок для выявления физической природы неоднородностей верхней мантии, как движущего механизма тектонических процессов Земли.

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TECTONICAL ZONATION OF SUB-SALT SEQUENCE OF CASPIAN DEPRESSION BY DATA OF SEISMOSTRATIGRAPHICAL ANALYSIS

The nature of wave field in the Caspian depression distinctly outlines three zones: flange and its margin, peripheral and internal. The first of them is composed of thick (up to 2-3 km) Middle-Upper Paleozoic shallow-water carbonate assemblages. Towards the depression they are thinning out forming direct clinoforms and are placed for synchronous deep sea complexes. The clinoform roof creates carbonate flange steps (up to 2-3). The terrigenous complexes overlying the carbonate steps sharply increase their thickness forming reverse clinoforms transiting into relatively deep sea parallel-layered bodies of complexes filling the basin bottom. They lead to partial or complete bury of steps. Away from the areas of penetration into the basin the filling complexes approach the foot of carbonate steps and inset to the surface of more ancient carbonates. On the Tartai-Burankul area in the South-Eastern part of flange zone a rather gentle (up to 10°) surface of carbonate steps is overlain by sygmoidal bodies - progradational clinoforms. The Devonian-Lower Visean complex composed pericraton trough in the Southern and Eastern parts of the Caspian depression adjacent to the South-Emben and Urals folded geosyncline constructions. Upper Carboniferous-Artian complex fills a number of troughs on the territory of Eastern and Southern flange zones and their margins. In the internal zone of the Caspian depression, relatively thin Middle-Upper Paleozoic terrigenous deposits are overlain by thick (up to 10-12 km) possibly Riphean-Lower Paleozoic terrigenous complex, filling the deep depression.

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ТЕКТОНИЧЕСКОЕ РАЙОНИРОВАНИЕ ПОДСОЛЕВОГО РАЗРЕЗА ПРИКАСПИЙСКОЙ ВПАДИНЫ ПО ДАННЫМ СЕЙСМОСТРАТИГРАФИЧЕСКОГО АНАЛИЗА

По характеру волнового поля в Прикаспийской впадине отчетливо обособляются три зоны: бортовая и ее обрамления, периферическая и внутренняя. Первую из них слагают мощные (до 2-3 км) средне-верхнепалеозойские мелководные карбонатные комплексы. В сторону впадины они утоняются, образуя прямые клиноформы, и замещаются одновозрастными глубоководными комплексами. Кровля клиноформ создает карбонатные бортовые уступы (до 2-3). Терригенные комплексы над карбонатными уступами резко увеличиваются в мощности, образуя обратные клиноформы, переходящие в относительно глубоководные параллельно-слоистые тела комплексов заполнения днища бассейна. Они приводят к частичному или полному захоронению уступов. При удалении от площадей проникновения в бассейн комплексы заполнения подходят к подножью карбонатных уступов, прислоняясь к поверхности более древних карбонатов. На Тартайско-Буранкульском участке юго-востока бортовой зоны на относительно пологой (до 10^{0}) поверхности карбонатного уступа распространены сигмоидальные тела - проградационные клиноформы. Девонско-нижневизейский комплекс слагает перикратонный прогиб юга и востока Прикаспийской впадины, сопряженный с Южно-Эмбенским и Уральским складчатыми геосинклинальными сооружениями. Верхнекаменноугольно-артинский комплекс выполняет ряд прогибов на территории восточной и южной бортовых зон и их обрамлений. Во внутренней зоне Прикаспийской впадины под относительно маломощными средне-верхнепалеозойскими терригенными образованиями распространен мощный (до 10-12 км) комплекс, по-видимому, глубоководных терригенных пород рифея - нижнего палеозоя, выполняющих глубокую депрессию.

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POST ALPINE MOVEMENTS IN EASTERN ASIA

In Eastern Asia, including continental margins, Japanese Islands and Japan Sea area, some remarkable events occured as the post Alpine movements.

First, from the late Cretaceous to the Palaeogene period, acid-intermediate volcano-plutonism took place in Eastern Asia, and it is called as Enshan Movement in Asian continental margins, as well as Hiroshima Movement in Japan.
Secondary, Neogene Tertiary movement occurred, and the violent volcanic activities recognized in the inner zone of Japanese Islands and the southern part of Japan Sea area. The present event is called Green Tuff Movement in Japan. Through Green Tuff Movement, the numerous collapsed basins caused by magmatic activities came into existence at six epochs. As for the formation of these basins, we verified that these basins were caused by the horizintal tension at the upheavals of the magma bodies. Recently, the geological and geophysical data were obtained by the researches for gass and oil in the offshore parts of Japan Sea, and they show the existence of the collapsed basins.
Thirdly, from the Pliocene period to the present time, fault-block tectonics can be recognized in Island arcs and their neighbourhoods.
From the above-mentioned three tectonic movements, we can discuss the geological developments of Eastern Asia.

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VARISCAN-INDOSINIAN DEVELOPMENT OF PLATE TECTONICS IN SOUTHWEST PART OF CHINA

Caledonian collition between Sino-Korean and Yangtze continental plates brought about the formation of a united Cathaysian plate. The south-western margin of the Cathaysian plate produced a api-continental arc and a backarc basin in Devonian-Early Permian time. Paleotethys was then located to the southwest of Cathaysian plate. From Late Permial on, the southwestern margin of Cathaysian plate has undergone a main taphrogenesis. A triple junction was developed behind the epicontinental arc. A hot spot took place in a area surrounding Kangding (Sichuan), which linked up three arms that consist of Longmenshan arm developed as a transform fault, Kangdian failled arm and northwestern arm led to creation of a new oceanic basin, Bayan Har Sea. From this, it may be considered as a RRF triple junction. Up to the end of Triassic, southwest-dipping subduction of Bayan Har oceanic lithosphere led to collisional accretion of a migrated arc superposed then by new Late

Triassic Yidun arc, conseqently formed Garze-Litang suture zone. It is concluded that from Variscan to Indosinian, the southwestern margin of Cathaysian plate has undergone a separating and collision process, which is interpreted as a complete Wilson Cycle.

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ТЕКТОНИКА БОРШОДСКОГО БУРОУГОЛЬНОГО БАССЕЙНА

Боршодский миоценовый буроугольный бассейн находится в северо-восточной части Венгрии. Угленосная толща имеет мощность от 100 до 650 м, и состоит из переслаивания буроугольных пластов, глин, песков и промежуточных разностей пород. Пласты бурого угля обычно сменяются сначала глинами, а затем и песками. Осадочный разрез бассейна осложнен крупными сбросами, имеющими преимущественно северо-восточное - юго-западное простирание. Перпендикулярные к этому направлению разрывные нарушения встречены только в районе подножий гор Бюкк. Тектоническая нарушенность пород бассейна неодинакова. На нее влияют глубина и рельеф основания бассейна, повторные движения по сбросам, находящимся внутри бассейна и мощность угленосной толщи. Простирание сбросов незакономерное.

В крупных тектонических единицах сбросы, как правило, имеют небольшую амплитуду. Их густота и простирание бессистемно, а амплитуда изменяется по простиранию. Между длиной сбросов и их амплитудой имеется прямая зависимость. Для западной части бассейна обычно характерны редкие крупные сбросы, а для восточной - мелкие, но более частые разрывные нарушения. Рельеф лежачего бока оказывает влияние на распространение мелких сбросов.

Сложное строение угольных залежей зависит от наличия взбросов и грабенов. Закономерности между общей структурой бассейна и нарушениями в угленосной тоще устанавливаются не всегда. Но наиболее сильно тектонизированные зоны устанавливаются достаточно просто. Смещение угленосной толщи по ее кровле устанавливается только в восточной части бассейна. Экстраполяция наблюдений позволяет сделать вывод о возрасте нарушений.

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OKHOTSK-BERING EPIOROGENIC RIFT BELT

The Okhotsk-Bering rift belt is a peculiar example of incontinental, epiorogenic rifting(taphrogenesis) display. It's separate rift zones lie on vast shelves and coast of the Sea of Okhotsk(North-Okhotskaya, West-Kamchatskaya, East-Sakhalinskaya, Deruginskaya and others) and the Bering Sea(Chukchee-Alaska) and are traced on the territory of the USSR North-East(Penjinskaya rift zone). Specificity of rifting is following: 1) superpositional-inherited nature of rift zones development with respect to the structures of Late Mesozoic and Late Mesozoic-Early Cainozoic folded systems; 2) conjugation of rifting with the geosynclinal regim of the adjacent regions; 3) their location in the region with subcontinental type of the earth crust; 4) great thickness of strata mainly of marine and coastal-marin origin, and others. In the rift zones of the belt there are distinguished axial rift valleys(symmetrical and assymmetrical crevice and stepped grabens) and a lateral tension zones, which are formed by linear and arched tilted blocks, displaced by listric faults. The rift zones are specifically expressed in potential fields and characterized by high heat flow, seismicity, short thickness of the earth crust and some its layers, and lithosphere as a whole in some certain cases. According to seismic-reflection data up to three structural-material complexes of deposits are marked out in rift zones strata. The peneplans which has weathering deposits are fixed in the basement of two lower complexes, which correspond to two tension stages. There is a lowthickness complex of epirifting deposits above it. This complex is practically undislocated unlike the two lower complexes. As a whole the Okhotsk-Bering rift belt has a complex, heterogeneous structure. Within it rift zones are marked out, which are characterized by rifting process activity up to present time and which are unactive from Post-Miocene time. All this shows polycyclic character of rifting in the region under review.

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ОХОТСКО-БЕРИНГОВСКИЙ ЭПИОРОГЕННЫЙ РИФТОВЫЙ ПОЯС

Своеобразным примером проявления внутриматерикового эпиорогенного рифтогенеза (тафрогенеза) является Охотско-Беринговский рифтовый пояс, отдельные зоны которого расположены на обширных шельфах и побережье Охотского (Северо-Охотская, Западно-Камчатская, Восточно-Сахалинская, Дерюгинская и др.) и Берингова (Чукотско-Аляскинская) морей и прослеживаются на территории Северо-Востока СССР (Пенжинская рифтовая зона). Спецификой рифтогенеза в данном случае являются: 1) наложенно-унаследованный характер развития рифтовых зон по отношению к структурам позднемезозойских и позднемезозойско-раннекайнозойских складчатых систем; 2) сопряженность рифтогенеза с геосинклинальным режимом в смежных областях; 3) расположение в области развития коры субконтинентального типа; 4) большие мощности осадочного выполнения преимущественно морских и прибрежно-морских фаций. В рифтовых зонах пояса выделяются осевые рифтовые долины (асимметричные, симметричные щелевые и ступенчатые грабены) и боковые полосы растяжения, образованные линейными и дугообразными наклонными глыбами, смещенными по листрическим сбросам. Рифтовые зоны специфически выражены в потенциальных полях, характеризуются повышенным тепловым потоком, сейсмичностью, сокращенной мощностью земной коры, отдельных ее слоев, а по отдельным данным и литосферы в целом. По данным сейсмопрофилирования, в осадочной толще рифтовых зон выделяется до трех структурно-вещественных комплексов отложений. В основании двух нижних, фиксирующих две стадии растяжения, устанавливаются поверхности выравнивания с приуроченными к ним корами выветривания. Выше залегает маломощный комплекс осадков эпирифтовой стадии, в отличие от нижних практически недислоцированный. В целом Охотско-Беринговский рифтовый пояс имеет сложное, неоднородное строение. В пределах его выделяются рифтовые зоны,характеризующиеся как активностью процессов рифтогенеза в настоящее время, так и неактивностью с постмиоценового времени, что говорит о полициклическом характере рифтогенеза в рассматриваемом регионе.

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EARLY ALPINE STRUCTURE AND STRAIN DISTRIBUTION IN SOUTHWEST BULGARIA

Two structural subzones are distinguished in the pre-Priabonian Kraištid zone in Southwest Bulgaria: eastern paraautochthonous (Trân-Vlahina) and western allochthonous (Penkjovci-Elešnica). The Trân-Vlahina subzone is characterized by a stratigraphic hiatus (Cambrian - Carboniferous included) until the allochthonous subzone contains an almost complete Paleozoic section but lacks any Mesozoic formations. The main folding and thrusting is of Old Cimmerian and Austrian age. Total strain is studied quantitatively on suitable indicators in Permian and Triassic red beds within the paraautochthonous subzone. Strain ellipsoides are plane strain or moderately to strongly flattened, the parameter k varying between 1.2 and 0.1. Constricted ellipsoids developed locally due to interchanging principal strain directions. The deformation intensity is measured with the variation of γ_0 : from 0.0 (undeformed) through 0.5 (incipient cleavage) and up to 1.8. Total strain is irregularly distributed in the sections studied. High strains are concentrated at boundaries between formations of high competence contrast and in some thrust sheets under klippes of the allochthonous subzone. Deformation is gradually decreasing southwards.
A composition is attempted between the structural and deformational features of the Early Alpine structure of the Kraištids and the Late Alpine structure of the Western Alps.

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STRAIN VARIATION AND DEFORMATION FACIES

Methods and techniques of quantitative studies of deformation, scale and strain variation, deformation facies and their classification are discussed.

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AREAGEOSYNCLINES AND THEIR ROLE IN THE EVOLUTION OF THE FOLDED GEOSYNCLINE BELTS OF THE EARTH CRUST

1.Geosynclines is a part of the geosyncline belt possessing unity of structure and geologic development. Areageosynclines are regions of oval concentric-zonal structure and quasimetric configuration. They are opposed to linear geosyncline regions - stenogeosynclines. Areageosynclines occupy considerable part of the well-known belts - Paleozoic Uralian-Mongolian, Alpine-Himalayan, contemporary West-Pacific, etc. They are distinctly traced in world geosyncline belts.
2. Two types of areageosynclines are distinguished. The first is characterized by centripetal direction of evolution (full development) with residual geosyncline continually preserved in the centre examples are Kazakhstan-Tien-Shan and Mongolian areageosynclines). The second one is centrifugal evolution(incomplete development)with median massif of central nucleus type characterized by maximum thermal activity during the whole time of existence of geosyncline area: there is typical outer vergence and bipolar developed, distinctly traced foredeeps at the boundaries with platform regions in continental earth segments (examples are Variscan Mesoeurope, Alpine-Carpathian geosyncline region).
3. The process of areageosynclines formation begins with outer zones while central residual core is presented. The complete destruction of the core occurs only in areageosynclines of centripetal evolution. The progressive consolidation of the earth crust in areageosynclines is expressed differently. Areageosynclines of the full development (Ist type) are characterized by accretion around numerous residual median massifs (blocks of ancient continental crust) characterized by centripetal orogenic migration. Areageosynclines of incomplete development (2nd type) are characterized subsequent centripetal zonal accretion around the central core. The mechanism of areageosyncline formation and development is determined by existence of deep quasimetric energy sources appearing in the lower mantle and is likely to be independed to any extent of the type and thickness of the earth crust.

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АРЕАГЕОСИНКЛИНАЛИ И ИХ РОЛЬ В ЭВОЛЮЦИИ ЗЕМНОЙ КОРЫ СКЛАДЧАТЫХ ГЕОСИНКЛИНАЛЬНЫХ ПОЯСОВ

1. Геосинклинальная область - часть геосинклинального пояса, обладающая единством строения и геологического развития. Ареагеосинклинали - геосинклинальные области овального концентрически-зонального строения и квазиизометричных очертаний. Им противопоставляются линейные геосинклинальные области - стеногеосинклинали. Ареагеосинклинали занимают значительную часть известных геосинклинальных поясов - палеозойского Урало-Монгольского, Альпийско-Гималайского, современного Западно-Тихоокеанского и других. Наиболее отчетливо они выражены в широких геосинклинальных поясах.

2. Различаются два типа ареагеосинклиналей. Первый тип, обладающий центростремительной направленностью эволюции (полного развития), с длительно сохраняющейся в центре остаточной геосинклиналью (примеры: Казахстанско-Тяньшаньская и Монгольская ареагеосинклинали). Второй тип - центробежной эволюции (неполного развития) со срединным массивом типа центрального ядра, обладающего максимальной термальной активностью в течение всего времени существования геосинклинальной области; характерны внешняя вергентность и биполярное развитие, четко выраженные краевые прогибы на границах с платформенными областями в континентальных сегментах земли (примеры: варисцийская Мезоевропа, Альпийско-Карпатская геосинклинальная область).

3. Процесс заложения ареагеосинклиналей начинается с внешних зон, тогда как в центре сохраняется остаточное ядро. Полное разрушение ядра происходит только в ареагеосинклиналях центростремительной эволюции. Прогрессирующая консолидация земной коры в ареагеосинклиналях выражена по-разному. Для ареагеосинклиналей полного развития (1-го типа) характерна акреция вокруг многочисленных остаточных срединных массивов (блоков древней континентальной коры), выраженная центростремительной миграцией складчатостей. Для ареагеосинклиналей неполного развития (2-го типа) характерна последовательная центробежная зональная акреция вокруг центрального ядра. Механизм заложения и развития ареагеосинклиналей определяется существованием глубинных квазиизометричных энергетических очагов, возникающих в нижней мантии и, вероятно, в какой-то мере он не зависит от типа и мощности земной коры.

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COVER-FOLDED STRUCTURES OF JOINT ZONES OF THE SIBERIAN PLATFORM AND ITS MOUNTAINOUS SURROUNDINGS

The Siberian platform, being a core of the continental crust growth, in northern Asia is surrounded by Pre-Karelian, Karelian, Baikal, Caledonian, Hercynian and Mesozoic folded systems.
Cover-folded structures are abundant on both sides of the marginal suture of the Siberian platform, on the boundary of different age folded zones and inside them. However, their role is still underestimated and this complicates a kinematic and dynamic interpretation of tectonics of the present region.

When analysing these structures one makes a conclusion that most of them are subjected to great allochtone plates restricted from below by surfaces of failures found at different levels of lithosphere, i.e. in the sedimentary cover, granite-metamorphic and basalt layers and probably in the upper mantle. In upper crustal layers these plates are expressed in overthrusts and overthrust packets with the amplitude of horizontal shift of 10-15 km, in places up to 50 km. They are also observed as zones of linear folds, fold-overthrusts penetrating into the platform to the depth of 300 km. Thick beds of olistostromes, melange, zones of metamorphism of high pressure, diaphthoresis, blastomylonites and metasomatosis often follow them. Bodies of hyperbasites, basites and granites are common. According to morpho kinematic evidences it is possible to distinguish covers of shear (Stanovik), fold-overthrusts (Verkhoyanye, Patom upland), covering folds of longitudinal bend and flow (Baikal region, southern Verkhoyanye) and structures of complex genesis.

A wide spread of cover-folded structures in East Siberia which originated under conditions of tangential compressions was due to a horizontal interaction of the Siberian platform as well as of Kolyma massif with geosyncline-folded areas. The platform repeatedly (with periodicity subjected to compression epochs of each endogenic cycle) was subducted beneath folded structures.

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ПОКРОВНО-СКЛАДЧАТЫЕ СТРУКТУРЫ ЗОН СОЧЛЕНЕНИЯ СИБИРСКОЙ ПЛАТФОРМЫ И ЕЕ СКЛАДЧАТОГО ОБРАМЛЕНИЯ

Сибирская платформа, являющаяся ядром роста континентальной коры северной Азии, опоясана докарельскими, карельской, байкальской, каледонской, герцинской и мезозойской складчатыми системами.
Покровно-складчатые структуры широко развиты по обе стороны краевого шва Сибирской платформы, на границе разновозрастных складчатых зон и внутри последних. Однако их роль до сих пор недооценивается, что затрудняет кинематическую и динамическую интерпретацию тектоники данного региона.
Анализ этих структур позволяет сделать вывод о том, что они в своем большинстве подчинены крупным аллохтонным пластинам, ограниченным снизу поверхностями срывов, расположенных на разных уровнях литосферы - в осадочной оболочке, гранитно-метаморфическом и базальтовом слоях и, очевидно, в верхней мантии. В верхних горизонтах земной коры эти пластины выражены надвигами, пакетами надвигов с амплитудой горизонтального перемещения толщ на 10-15, местами на 50 км, зонами линейных складок, складко-надвигов, проникающих в платформу до 300 км. Часто они сопровождаются мощными толщами олистостром, меланжа, зонами метаморфизма высоких давлений, диафтореза, бластомилонитов и метасоматоза. К ним приурочены тела гипербазитов, базитов, гранитов. По морфокинематическим признакам среди покровно-складчатых структур выделяются покровы скалывания (Становик), складко-надвиги (Верхоянье, Патомское нагорье), покровные складки продольного изгиба и течения (Прибайкалье, Южное Верхоянье) и структуры сложного генезиса.
Широкое развитие покровно-складчатых структур в Восточной Сибири, возникавших в условиях сильного тангенциального сжатия, было предопределено горизонтальным взаимодействием Сибирской платформы, а также Колымского массива с геосинклинально-складчатыми областями. Сибирская платформа неоднократно, в периодичности, подчиненной эпохам сжатия каждого из эндогенных циклов, пододвигалась под складчатые сооружения.

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VARISCIDES IN SW POLAND

SW part of Poland belongs to Variscian fold belt. This fold belt is nowadays covered by strata of younger epiplatform cover, except for some outcrops in the Sudety Mts. Three zones of Variscan foldings

may be differentiated in Poland: Sudetic (adjoing the Bohemian Massif), Lower Silesian and Poznań.
The Sudetic zone, comprising western Sudety Mts, was initially assumed to be folded in Caledonian and, subsequently, in Early Variscan movements but there is growing evidence for its folding in the latest Dinantian or even at the turn of Dinantian and Silesian. The folding was accompanied by formation of intramontane molasse basins. The Lower Silesian zone is situated NE of the former, being separated from it, by Middle Odra metamorphic zone. It is built of flysh rocks folded in the Namurian and several overthrusts with core parts built of pre-Carboniferous rocks are inferred. NE boundary of that zone is drawn along Dolsk deep crustal fracture, along which Lower Silesian units are thrusted over the Poznań zone.
The Poznań zone represents external zone of the foldbelt, comprising Carboniferous flysch series folded after Lower Westphalian. Structures of the Eastern Sudety Mts (Moravosilesides), were hither to regarded as an extension of the above mentioned Lower Silesian and Poznań zones. Taking into account evidence for post-Dinantian foldings in the western Sudety Mts, I interpret the eastern and western Sudety Mts as a single tectonic unit. To SE, Lower Silesian and Poznań zones abrouptly end at the Pilica deep crustal fracture zone, which separates the Góry Swietobrzyskie Mts and Upper Silesian Coal Basin. The above mentioned tectonic zones correspond to separate crustal blocks as shown by deep seismic soundings.

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ON THE WAVY NATURE OF THE CRUSTAL MOVEMENT

(1) During the earth's history, there were 5 major periods, among which each included a series of subordinate periods with second, third, etc.. These may be considered that the earth evolves in wavy nature.

(2) The geologic structures display subequal spacings, which reveal that the crustal movement has a wavy feature spatially. This idea may be used in the mineral findings.

(3) Every district is always complex in the structure, because its tectonic development was controlled by different directional crust waves, of which the interweavings caused the crustal-wave mosaic structure.

(4) The interchanges of transgression and regression between semiglobes are the indication of the first grade crust waves and the greatest "balance-like motions". The balance-like repeated up and

down motions between two neighbouring blocks which were universal in significance.

(5) The tectonic belts were migrating to and fro in geologic times, nevertheless, there were no great changes in their directions, indicating that the crustal motions propagate along only a few directions.

(6) The sub-tetrahedral shape of the earth suggests that the pulse of contraction and expansion but contraction being essential is probable, so the pulsation and the resulted change of rotational rate could be the primary causes of the crustal wave movement.

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THE CONTROL OF PLATE TECTONICS OVER THE TECTONO-MAGMATO-METAMORPHIC BELTS IN THE SANJIANG REGION OF QINGHAI-XIZANG (TIBET) PLATEAU

This region is characterized by many overlapping tectono-magmatometamorphic belts, which are genetically related to several paleosuture zones, the latter formed probably during the period from Carbonifirous to Quaternary.

The tectono-magmatomorphic belts were formed mainly as a result of the subduction of the plate tectonics. In addition, after the collision of the plates the further sliding of the continental crust occurred along with the fracture zones of former sutures and the new magmatic, metamorphic and volcanic belts overlapped on the older tectono-magmatometamorphic belts due to the strong lateral compression.

On the basis of the analysis of the development history of the Jinshajiang tectonic belts, it can be supposed that there occurred the two-way subduction in the Permian, the decreased subduction in the Middle and Early Triassic and the eastward subduction in the early stage of the Late Triassic. The last subduction has led to the collision of the tectonic belts.

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TRANSFORMATION OF CONTINENTAL AND OCEANIC CRUST AND GEOTEXTURE OF THE WESTERN PACIFIC MARGIN

Three types of geological texture, i.e. continental, transitional and Western Pacific type, exist in the area studied. There was a united continental at the end of the Hercynian-Indosinian cycle. Since then, the area shows the trend that continental crust is tensed, thinned and oceanized to different degrees. Therefore, the creep and obduction of the Asiatic continental as well as spread and subduction of West Pacific Oceanic crust are appeared. Thus, continental rifts, margin basins and arc-trench systems occurred. Geotectonic cycle usually begins with tensile phase and ends with compressional phase. When tension predominates, various rifts can be formed on the continental crust. Finally, the oceanic crust appeares due to uprise of mantle. The sequence of occurence often appears as aulacogen - graben - miogeosyncline - eugeosyncline. In some cases, its evolution may be incomplete due to restriction of concrete factor. Therefore, it is possible to produce the abandoned rifts and other complex geotectonic features.

When compression predominates, the closing of ocean with accretion of continental often occur. The older oceanic crust transforms into the folded mountain belts and geosuture. Thus, the crust liferats and thickness. Tension phase and compression phase of tectonic cycle usually change to each other according to different time and place. The mechanism of the crustal movement and conversion are considered to be related to the Earth's rotation and undercrust thermodynamic action.

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FOURIER ANALYSIS OF FOLD SHAPES

Abstract-Fold morphology is rather complex to describe. Stabler (1968) has developed a simplified Fourier series analysis of symmetric fold shapes. But there are some mistakes in the formulae

which were given. The aim of this paper is to correct them. The right forms should be

$$b_1 = \frac{A + Y_1}{3} + \frac{Y_2}{2\sin 60} ;$$

$$b_3 = \frac{2Y_1 - A}{3} ;$$

$$b_s = \frac{A + Y_1}{3} - \frac{Y_2}{2\sin 60} .$$

The non-symmetric case is considered, it can also be done by the superposition of two symmetric cases. Some examples of dealing with non-symmetric folds in both ways are given.

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PALAEOZOIC OPHIOLITES IN WESTERN JUNGGAR AND ITS GEOLOGICAL SIGNIFICANCE

In Western Junggar foldbelt, which is a part of Central Asia-Mongolia geosyncline, there are several ophiolite zones: Tangbale, Maila, Darbut, and Khobuk formed separately in M.Ordovician, M.-L. Silurian, M.Devonian, and M.-L.Devonian. The ophiolites comprise, from base to top, the following: 1. meta-ultramafites (harzburgite + minor lherzolite); 2. mafic complex (cumulates + minor plagiogranite); 3. pelagic sediments (pillow lawa + radiolarian chert etc.). The sequence is commonly marked by 1) absence of sill-dike swarms; 2) poorly-developed cumulate gabbro and 3) small thickness. It might be regarded that these ophiolites reflect slow-spreading of the oceanic ridge above the chambers.

The facts of AL_2O_3/TiO_2 commonly 9-15, $TiO_2 < 2\%$, and (FeO) / MgO at 1.5 to 1.9, are similar to tholeiites abroad. The gradual reducing of K_2O content from south to north in this region. The slight concentration of LREE, La/Yb > 1, LREE 53-75%, Eu = 1.02, and La/Sm - La diagram etc. likely reflect the characters of ophiolite on the

ancient oceanic crust. According to rather low Al_2O_3/TiO_2, it might be deduced that the mafic complex had experienced a magmatic evolution. Based on these evidences, the consanguinity of these rocks, the degree of the partial melting of upper mantle in this region, are proved, and the genetic mechanism of the magma is discussed. These ophiolites show that there are at least three fossil subduction zones, that tectonic evolution of Western Junggar actually is the process of migration and closure of the ancient oceanic basin in different periods.

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SOME RADICAL PROBLEMS IN GEOTECTONIC STUDY IN AREAS OF NORTHEAST PART OF CHINA

It is well known that the polycyclic orogenic evolution of China platform spread widely all over the country. On basis of analyzing of a vast-territorial aeromagnetic survey map associated with geological data, the author furnished a quite new framework of the areal geotectonics. The most important skeletons of the areas are two crustal deep fracture zones with N-S trends, which generated in era of Precambrian. The paper pointed out the platform activization can be classified into three major types with different degrees of reformation. The highest is the geosynclinized folded-belts, the moderate is the geosynclinizing reformed massives, the lowest is called the remainder massive. All of the three are evoluted on former existed continental platforms. In the paper, an excellent explanation of the relationship between Anda remainder massive and its surroundings of Jilin-Heilonjiang geosynclinized folded region is given. This is one of the best examples in using the polycyclic orogenesis theory. The author firstly figured out the appearance of Inner Mongolian crystalized axis in aeromagnetic survey maps, clarified the generation and the evolution of the barrier axis stretching in a distance of about 1800 km, and pointed out what a role it had played in the evolution history of Sino-Korean paraplatform and North-east China paraplatform.

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RIFTS AND TRAPP MAGMATISM OF PANGEA

End of Palaeozoic and beginning of Mezozoic in the supercontinent Pangea are characterized by the foundation of prolonged rifts. Riftogenesys was accompanied by trapp effusions of great volumes of basic magma of mantle origin. Appearance of Permian-Triassic formation of Pangea, spread fragmentally on the territories of Western and Eastern Siberia, Western Europe, Algerian Sahara, coastal parts of north-western Africa and south-west of North America was a result of effusive magmatism. Rift system of Pangea is oriented meridionally and north-eastwards. Its appearance is connected with intensive Permian-Triassic stretching tensions of the Earth crust which is thinner in rift zones. The largest rift, located between Africa and North America further on remained permanently active; widening and lengthening it started forming of the Atlantic. Tectonic activity of separate rifts completed by the end of Jurassic. Trapps of Pangea are associated with Permian-Triassic terrigenious continental redbedsand evaporitic formations. They are composed mainly of basalts and dolerites of teleiitic facies, forming vast covers. Acid and alkali differenciates of basic magma, quartz porphyries, quartz porphyrites, ceratophyres and others have limited distribution. Maximal thickness of trapps achieves several kilometers. The thickest are discovered by boreholes in the central part of Western Siberia, where the trapps underlay the Meso-Cenozoic sedimentary cover. In this region borehole 2 Ombinskaya went through them 1222 m at the depth of 3 274,4 - 4 497,0, having discovered eleven lava trapps, interlaid by thin layers of tuf. In Algerian Sahara basalts and dolerites are partially plated due to effusion of basic lavas under the surface of saltwater lagoon. Magmatism accompanying the following stages of riftogenesys in Gondwana and Laurasia was less intensive and differed in chemical parameters from the Permian-Triassic one.

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РИФТЫ И ТРАППОВЫЙ МАГМАТИЗМ ПАНГЕИ

Конец палеозоя и начало мезозоя характеризуются заложением протяженных рифтов в сверхконтиненте Пангеи. Рифтогенез сопровождался трещинным излиянием огромных объемов основной магмы мантийного происхождения. Результатом эффузивного магматизма явилось образование пермо-триасовой трапповой формации Пангеи, распространенной фрагментарно в пределах Западной и Восточной Сибири, Западной Европы,

Алжирской Сахары, прибрежной части Северо-Западной Африки и юго-восточной окраины Северной Америки.
Система рифтов Пангеи имеет преимущественно меридиональную и северо-восточную ориентировку. Возникновение ее связано с проявлением в пермо-триасе интенсивных растягивающих напряжений земной коры, которая в рифтовых зонах утонена. Наиболее крупный рифт, располагавшийся между Африкой и Северной Америкой, в дальнейшем оставался постоянно активным, расширялся и удлинялся, дав начало Атлантике. Тектоническая активность остальных рифтов завершилась к началу юрского периода. Траппы Пангеи ассоциируют с красноцветной терригенной континентальной и эвапоритовой формациями пермо-триаса. Они сложены преимущественно базальтами и долеритами толеитовой фации, образующими обширные покровы. Кислые и щелочные дифференциаты основной магмы, кварцевые порфиры, кварцевые порфириты, кератофиры и другие распространены ограниченно. Максимальные мощности траппов достигают нескольких километров. Наибольшие вскрытые скважинами мощности их отмечаются в центральной части Западной Сибири, где траппы залегают под мезо-кайнозойским осадочным чехлом. В этом регионе мира скважина 2 Омбинская прошла по ним 1222 м на глубине 3274,4-4497,0 м, вскрыв одиннадцать лавовых покровов, разделенных маломощными прослоями туфов.
В Алжирской Сахаре базальты и долериты частично спилитизированы вследствие излияния основной лавы под воды обширной засоленной лагуны.
Магматизм, сопровождавший последующие этапы рифтогенеза Гондваны и Лавразии, был уже менее интенсивным и отличался по химизму от пермо-триасового.

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THE ARCTIC - NORTH ATLANTIC RIFT SYSTEM

The Arctic - North Atlantic rift-system is superimposed on the Caledonian and Hercynian sutures of Laurentia-Greenland, Fennosarmatia and Africa.
Devonian and Early Carboniferous wrench movements along the axis of the Arctic-North Atlantic Caledonides preceded the late Visean onset of crustal extention on the Barents Shelf and in the Norwegian Greenland Sea. These rifts remained intermittently active for some 270 Ma until crustal separation between Greenland and Fennosarmatia was achieved during the Early Eocene. The Carboniferous rifts of the British Isles and the Canadian Maritime Provinces became inac-

tive during the Late Hercynian distrophism, in which they became deformed to varying degrees by transgressional movements.
The Triassic development of the Tethys-Central Atlantic Gulf of Mexico rift-transform system was accompanied by rift propagation into the North Atlantic and West European domain whereby the reactivation of tardi-Hercynian wrench faults probably played an important role in the localization of individual grabens. The development of the North Sea and West Shetland Rockall rift system is probably related to the Late Permian and Triassic southward propagation of the Norwegian-Greenland Sea rift system.
Following crustal separation in the Tethys during the Mid-Jurassic, and in the North Atlantic during the Early Cretaceous, the rifts on the respective continental margins became inactive, while crustal extention continued in areas north of the Charlie Gibbs fracture zone. Particularly in the Norwegian-Greenland Sea area, a gradual concentration of rifting activity towards the future zones of crustal separation can be observed. This was accompanied by a decrease of rifting activities in marginal graben systems such as those of the North Sea and the Barents shelf. Following the Early Eocene crustal separation in the Iceland and Norwegian-Greenland Sea, grabens on the adjacent shelves became inactive. The duration of the rifting stage preceding crustal separation is highly variable (Central Atlantic $\pm$ 40 Ma, Norwegian-Greenland Sea $\pm$ 270 Ma). Volcanic activity in the Arctic-North Atlantic rift was generally at a very low level during its Palaeozoic and Mesozoic evolution, but increased prior to crustal separation. There is evidence for intermittent local thermal doming that is possibly related to the emplacement of discrete *asthenoliths*.
The hydrocarbon potential of the various branches of the Arctic-North Atlantic rift system is highly variable.

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TECTONICS OF INNER-CONTINENTAL FOLDBELTS

A short description of the structure and development of three foldbelts where continental collision is already finished is given, namely the Uralian, Central Asiatic and Verkhoyansk-Kolymian belts. All three belts are located along zones of former lithosphere plate convergence and have been originated on the place of previous ocenic basins. They had very different evolutionary pattern depending on how long was subduction activity, to what type it belonged, how long was continental collision, and how great was magnitude of continental convergeance. The Uralian belt was

created mainly from island arc and marginal basin terrains, and was undergone by the continuous continental collision no less than 90 m.a. long. The Central Asiatic belt initially also included island arcs but later active continental margins of the Nevadan and Andean types were more characteristic features. No long continental collision is recorded in the belt history. The Verkhoyansk-Kolymian belt was formed due to the one-act and very short continental collision.

Only the second stage of the Wilson cycle, an ocean closure, is obligatory for all the fold belts. An ocean opening constituting the first stage of the cycle could take place far away from an oceanic basin from which a fold belt eventually is born.

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ТЕКТОНИКА ВНУТРИКОНТИНЕНТАЛЬНЫХ СКЛАДЧАТЫХ ПОЯСОВ

Дано краткое описание структуры и развития трех складчатых поясов, где столкновение континентов уже закончилось: Уральского, Центрально-Азиатского и Верхояно-Колымского. Все три пояса расположены вдоль прежних зон сближения литосферных плит на месте прошлых океанических бассейнов и их окраин. Им свойственна резко различная история развития, зависящая от того, насколько продолжительной была субдукция, к какому типу она принадлежала, насколько длительным было столкновение континентов и какова была его величина. Уральский пояс был создан главным образом за счет комплексов островных дуг и окраинных морей и претерпел очень длительное столкновение континентов в течение 90 млн. лет. Центрально-Азиатский пояс первоначально также включал островные дуги, но позднее более характерными для него стали активные континентальные окраины невадийского и андийского типов. В его истории не отмечены продолжительные периоды столкновения континентов. Верхояно-Колымский пояс был образован благодаря одноактному и очень короткому периоду столкновения. Только вторая стадия цикла Вильсона, предусматривающая закрытие океана, обязательна для всех складчатых поясов. Раскрытие океана, составляющее первую стадию этого цикла, может происходить далеко от того океанического бассейна, из которого в конечном счете рождается складчатый пояс.

СОДЕРЖАНИЕ / CONTENTS

Section 06. ГЕОЛОГИЯ МИРОВОГО ОКЕАНА 5
GEOLOGY OF THE OCEAN BASINS

Section 07. ТЕКТОНИКА 88
TECTONICS

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181 Он – офицер
215 Офицеры
216 Офицеры – группа
233 Офицер
241 Офицеры и медсестра
243 Офицеры

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