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CHARACTERISTIC FEATURES OF PALEOALPINE AND EPIPALEOALPINE LANDMASS OF THE WEST CARPATHIANS

(1 Fig.)

Abstract: The submitted work deals with subaerial development of the quasiplatform basement which resulted from temporary stabilization of the Inner and Central West Carpathians during the Paleoalpine stage in the Upper (Middle) Cretaceous. The paper also pays attention to the formation and development of karst phenomena on the basement during the Paleoalpine and Epipaleoalpine stages. Paleokarst forms and sediments which were created on the basement under the conditions of monsoon and/or subequatorial climate are briefly described.

Резюме: Предлагаемая работа занимается субаэральным развитиим фундамента квазиплатформы которое является результатом временной стабилизации внутренних и центральных Западных Карпат в течении палеоальпийской стадии во верхнем (среднем) меле. В статьи уделяется внимание возникновлению и развитию карстовых явлений на фундаменте в течении палеоальпийской и эпипалеоальпийской стадиях. Описываются формы и осадки палеокарста возникнувшие на фундаменте в условиях муссонна и/или субэкваториального климата.

Introduction

Abundant, though discontinuous data on the West Carpathian development in the final phases of the Paleoalpine stage were accumulated in the 1970s and 1980s (Mello – Snopková, 1973; Mišík, 1978; Gross – Köhler et al., 1980; Mišík – Sýkora, 1980; Biely – Samuel, 1982; Köhler – Borza, 1984; Michalík, 1984; Mahel', 1986; Činčura, 1987, 1988 and others). Analysis of the accumulated knowledge indicates that subaerial development of extensive territories of the Inner and Central West Carpathians during the Paleocene and Lower Eocene (Andrusov – Köhler, 1963; Chmelík in Buday et al., 1967; Fusán et al., 1972, 1987; Samuel, 1973; Gross – Köhler et al., 1980) was preceded by a major period of subaerial development in the Upper (partly also Middle) Cretaceous. In many places of the West Carpathians, the Upper (and Middle) Cretaceous stage of subaerial development is very likely to have continued uninterrupted into the Paleogene one.

Lack or total absence of Senonian and Paleocene marine sediments in the Central and Inner West Carpathians, in comparison with adjacent areas, indirectly suggest possible uninterrupted subaerial development from the Upper (probably also Middle) Cretaceous to Paleocene and probably to Eocene. The hypothesis on continuous subaerial development in many places of the Central and Inner West Carpathians during the Upper (partly also Middle) Cretaceous is supported also by other facts. The most significant of them is regionally distributed paleokarst of Paleoalpine and Epipaleoalpine age in the Central and Inner West Carpathians (compare Mello – Snopková, 1973; Gross – Köhler et al., 1973; Činčura, 1987, 1988).

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Present-day knowledge on the Upper Cretaceous and Paleocene and/or also Lower Eocene development of the Central and Inner West Carpathians indicates that the Paleoalpine and Epipaleoalpine West Carpathians remained dry land for an exceptionally long period. This landmass has to be regarded as a linkage between older periods of Alpine tectogenesis which culminated in the overthrusting of subtatric nappes and the stage of neotectonic orogeny which is likely to have persisted longer than since the Upper Badenian as was assumed so far by Kvitkovič – Plančár (1979).

Quasiplatform basement in broader paleotectonic and paleogeographic context

A characteristic feature of the Paleoalpine stage are the most important folding phases – Austrian, Mediterranean and Subhercynian. From the structural viewpoint, these phases dominated the Inner and Central West Carpathians (Mahel', 1984).

From the paleogeographic point of view, the beginning of the formation of the Cretaceous landmass in the Inner and Central West Carpathians is problematic. On one hand, Mišík (1978) assumes that the Gemeric area was dry land already in the Neocomian (130–114 m.y.) and the Choč area in the Albian (107–95 m.y.). Southern part of the Krížna area emerged in the Cenomanian (95–91 m.y.), northern one in the Turonian (91–88 m.y.) and Tatric in the Vysoké Tatry area probably as late as in the Upper Turonian (88 m.y.). Accepting these views, however, we have to take into account that the nappes were thrust on dry land, which presents some problems concerning the mechanism of their transport.

On the other hand, fission-track age of apatite from granitoids – 75 m.y. for Veporic granites (Kráľ, 1977) interpreted as the age of the uplift of these rocks suggests that this part of the West Carpathians became dry land in the Campanian, i.e. after the dominant phases of Paleoalpine folding including thrusting of the subtatric nappes.

In spite of some unresolved problems and controversies, the formation of the Paleoalpine and Epipaleoalpine landmass in the Inner and Central West Carpathians seems to be a gradual process advancing from the south to the north. This process is likely to have begun already before the overthrusting of the subtatric nappes in the Inner West Carpthians but probably culminated as late as after their overthrusting had ended in the Central West Carpathians.

An important indicator of the overall trend in the West Carpathian tectonic regime is the fact that in the Central West Carpathians sedimentation ended by deposition of flysch mainly in the Cenomanian (Mahel', 1977), whereas in the Inner West Carpathians, in accordance with Mišík (1978), subaerial development can be assumed in this stage.

Unlike the Neoalpine and Variscan cycles in the West Carpathians, the Paleoalpine geotectonic cycle ended by the deposition of flysch without molasse sedimentation, the fact which requires explanation. On the basis of knowledge gained so far, this can be best explained by a stabilization of the Inner and later also the Central West Carpathians after the deposition of the Albian–Cenomanian flysch.

This stabilization resulted, among other phenomena, also in the emergence of the Inner and Central West Carpathians. Mahel' (1978) assumes that the West Carpathians were cratonized and designates the landmass formed in this process as the Slovak Block. According to Roth (1980) the Subhercynian phase came to an end by reconsolidation, and an Epipaleoalpine quasiplatform was formed inside the Carpathians. The beginning of the reconsolidation or cratonization in southern zones of the West Carpathians, however, probably antedated the Subhercynian phase.

In the course of the cratonization or reconsolidation, which can be regarded only as partial and temporary one, there was formed a basement, i.e. lower storey of the quasiplatform

(Činčura, 1988). This quasiplatform basement was covered with deposits of the Central Carpathian and/or Buda Paleogene.

The overall development in the Inner and Central West Carpathians controlled by structurally dominant phases of Paleoalpine folding should be denominated as quasiplatform and the period of the Upper (Middle) Cretaceous, Paleocene and part of the Eocene should also be designated by the adjective quasiplatform (compare Činčura, 1988). In the course of this distinct spell of subaerial development, the surface of the quasiplatform basement was formed not only on the Slovak Block but probably also on the adjacent areas of the Pannonian Block.

The subaerial development of the basement in the Inner West Carpathians continued despite the fact that transgressions in the Lower and Upper Cenomanian belonged among the most extensive Cretaceous transgressions in Europe (Cooper, 1977). In spite of the Coniacian transgressive cycle, in the Myjava upland Inner as well as Central Carpathian landmass remained emerged.

Cretaceous marine sediments are scarce in the West Carpathians. They include the occurrence of the Gosau Cretaceous near Šumiac which is thought to have been laid down in a channel of the Upper Cretaceous sea (occurrence near Dobšinská Ľudová Jaskyňa is probably of the same origin) trending north-south across the Carpathians and a small occurrence of the Gosau Cretaceous limestone in Miglinc Valley, Slovak karst (Mello – Salaj, 1982). The Gosau development near Šumiac suggests an archipelago character of the Kreios during the Upper Cretaceous rather than the existence of extensive Senonian basins in the Inner and/or Central West Carpathians.

Nevertheless, we cannot rule out the possibility that during the Upper Cretaceous the basement surface was invaded by local ingressions due to eustatic changes in sea level or tectonic movements. No Senonian marine fills of karstified carbonate complexes have yet been found in the basement rocks (Eocene neptunic dykes are known), which could suggest denudation of sediments of extensive Cretaceous basins in the Inner and Central West Carpathians. On the other hand, there exist exceptional subaerial fills of Upper Cretaceous age in karst depressions of the Slovak karst (Mello – Snopková, 1973).

During the basement formation in the Inner and Central West Carpathians there were no major vertical movements and therefore we designate this period as the so-called phase of quiescence (Činčura, 1988). The Eastern Alps also experienced a period of relative tectonic quiescence during the Laramian phase which was active elsewhere (Tollmann, 1976; Oberhauser, 1978).

From the paleogeographic point of view, the Paleoalpine development resulted in individualization of the Slovak and probably also Pannonian Block in the form of basement and subsequently also in the geocratic character of this unit which persisted, on a large part of the basement, until the Lower Eocene and in places which were not invaded by the Paleogene transgression as late as until the Miocene.

The northern coast of the Tethys Ocean, in whose tropical and/or subequatorial waters was situated the quasiplatform basement as part of the Kreios, was represented by the oscillating shoreline in the south of the Eurasian plate. The southern coastline of the Tethys Ocean changed its position in response to various stages of individual transgressions onto the African plate.

The surficial water layers of the Upper Cretaceous ocean, whose temperature properties were described by Lowenstam (1964), are characterized by decreasing temperatures from the equator towards the pole. It means that thermal latitudinal zoning existed in the ocean. This justifies the assumption that during the Cretaceous a latitudinal zoning existed also above the landmass adjacent to ocean areas.

Despite the fact that temperature and also pressure gradients between the Tethys Ocean and northern landmass of the Eurasian plate were lower than the present-day ones with glaciated poles, they were sufficient to cause seasonal air movements between the continent and ocean which were different in summer and winter, bearing signs of monsoons.

The Upper Cretaceous monsoons penetrated above the basement, which was part of the Kreios, deep into the interior of the northern landmass. This was probably allowed by the considerably levelled surface. Humid warm climate in some parts of the Eurasian plate is indicated, for example, by tropical karst of Cretaceous age in Poland (Gilewska, 1971) or lateritic and kaolinic weathering products in the Bohemian Massif.

Intensive and deep weathering on the surface of the basement and possibly also on the surface of exotic cordilleras emerging from the northern oceanic branch of the Tethys Ocean is indirectly suggested by the red colour of pelites of interturbidity currents in the Cretaceous flysch (Roth, 1980) and red colour in Cenomanian, Turonian and Senonian marls of the Czorsztyn unit as well as by the red coloration of the Senonian and Paleogene Gosau developments in the Myjava upland and elsewhere (Mišík et al., 1985; Salaj-–Priechodská, 1987).

Subaerial development of basement and development of karst phenomena

Important knowledge on rocks forming the near-surface parts of the basement during the Paleoalpine and Epipaleoalpine stages currently results from information obtained by deep drilling and its generalization by means of geophysical methods. This knowledge is illustrated in the map of buried areas of the Inner Carpathians (Fusán et al., 1972, 1987). The map shows the supposed denudation level of the basement prior to Paleogene transgression, but with the basement relief reflecting deformations of the basement and its Paleogene cover during the neotectonic stage.

Areas where Paleogene sequences have been mapped in detail provide good information on the composition of the basement of the Paleogene basal transgressive lithofacies, i.e. rocks forming near-surface parts of the basement. An example of such an area is the Liptov Basin. The Paleogene basal transgressive lithofacies is immediately underlain by a fairly thin complex of Triassic sediments of the Choč nappe in the south or by Lower Cretaceous marly limestones and Upper Triassic sediments of the Krížna nappe (Biely in Gross – Köhler, et al., 1980). The situation is almost identical also at the northern margin of the Liptov Basin.

In the northern part of the West Carpathians, Tertiary series rest predominantly on carbonate complexes belonging mainly to the Fatricum and Hronicum (compare Fusán et al., 1987). In the southern parts of the West Carpathians, the Tertiary series are underlain by granitoids and crystalline schists of the Tatricum and Veporicum as well as Paleozoic and Mesozoic rocks of the Tisa Block and in extensive areas by Mesozoic complexes of the Tatricum or Gemericum (Fusán et al., l. c.).

From the above facts it results that during the Paleoalpine and Epipaleoalpine stages, prior to Paleogene transgression, the basement surface was made predominantly of carbonate complexes. We assume that the extent of carbonate rocks exposed on the basement surface in the initial phases of subaerial development was even larger than that after 50-million-year-long dry-land development. The fact that in the period before the Paleogene transgression, crystalline cores in many places were not exposed on the surface is suggested by predominantly carbonate material constituting basal transgressive lithofacies in various localities of the West Carpathians (Andrusov, 1965; Chmelík in Buday et al., 1967; Gross – Köhler et al., 1980; Gross, 1978).

Large areal extent of carbonate rocks on the basement surface, tropical monsoon and/or humid subequatorial climate as well as long-lasting continuous subaerial development controlled the character of exogene modelling of the basement surface.

The formation of the basement surface during the Paleoalpine and Epipaleoalpine stages was therefore dominated, in our opinion, by karst processes.

The oldest so-far proved manifestations of karst processes in the West Carpathians are Upper Santonian–Campanian fills of karst hollows in the Wetterstein Limestones of the Slovak karst (Mello – Snopková, 1973). Nevertheless, we assume the existence of even older karst forms on the basement of the Inner as well as Central West Carpathians.

Upper Turonian–Coniacian nonmarine limestones have been described in the Stratená upland and Spišsko-gemerské rudohorie Mts. Mišík – Sýkora (1980) assume that these limestones were laid down in extensive lacustrine depressions on the levelled territory. The Upper Turonian subaerial development and carbonate rocks exposed on the basement surface therefore indicate karst processes older than the Senonian.

The fact that it was not only a local subaerial development on a small isolated karst plateau in the eastern part of the basement is suggested by similar finds in younger pebble material from the Čachtické pohorie Mts. (Mišík, 1986). The Upper Turonian–Coniacian nonmarine limestones covered also a fairly extensive area near the north-eastern end of the Malé Karpaty Mts. Occurrences of these fresh-water limestones, which are also at present hundreds of kilometres apart, indicate not only an extensive basement landmass as early as in the beginning of the Senonian and/or in the end of the Middle Cretaceous but also similar processes of exogene modelling on the basement surface. These processes probably gave rise to a wide range of karst forms, surficial as well as underground, most probably dating from the pre-Senonian period.

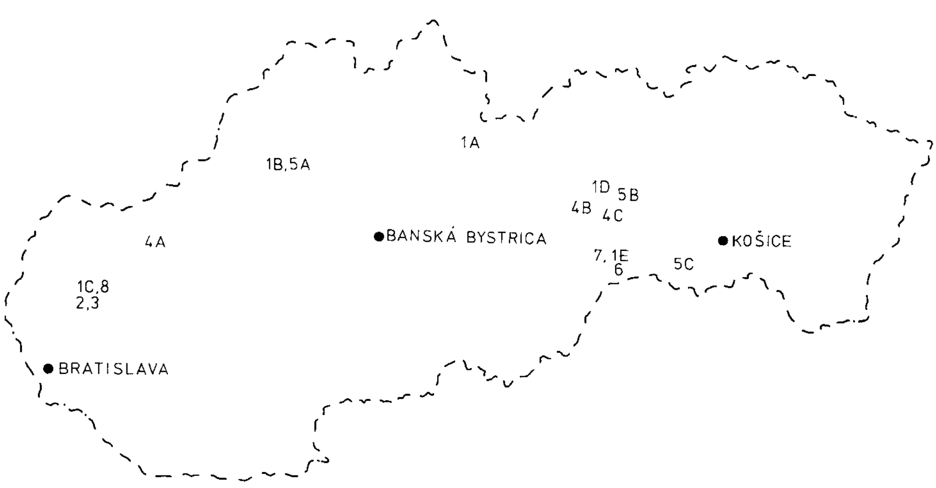

Fig. 1. Distribution of Paleoalpine and Epipaleoalpine karst forms and deposits on the basement.

1 – karst forms: A – Liptov Basin, B – Mojtín, C – Sološnica, D – Kľuknava, E – Slovak karst. 2 – karst breccias of Malé Karpaty Mts; 3 – speleothems of Malé Karpaty Mts; 4 – fresh-water limestones: A – Čachtice Mts., B – Stratená upland, C – Slovenské rudohorie Mts.; 5 – bauxites: A – Mojtín, B – Markušovce, C – Drienovec; 6 – bauxitic iron ores of Silica upland; 7 – residual iron ores of Plešivec plain; 8 – red soils of Malé Karpaty Mts.

There are no doubts the existence of Paleoalpine and Epipaleoalpine karst on the basement. At present, however, sufficient evidence to date individual paleokarst phenomena within this long period is not available. We cannot rule out that the karst phenomena on the basement developed continuously throughout this long period. Nevertheless, intensity of karstification processes most probably changed, mainly because of eustatic changes in sea level, predominantly during individual Cretaceous transgressions and regressions.

Distribution of Paleoalpine and Epipaleoalpine karst forms and sediments in the Inner and Central West Carpthians makes it possible to determine the areal extent of the basement. The basement landmass stretched from the southernmost known paleokarst occurrence in the Slovak karst (Mello – Snopková, 1973) towads the north to the Liptov Basin where is known a number of deepened karst forms – various pockets and hollows filled in the lower part by brown-yellow loams overlain by deposits of basal Paleogene transgressive lithofacies (Gross – Köhler et al., 1980).

Remnants of positive paleokarst forms in the eastern part of the basement probably include also remnants of a karst tower overlain by the transgressive Paleogene of Kľuknava development. Much more distinct karst towers, however, are known in plateaux of the Slovak karst. Nevertheless, nowhere was it possible, for the time being, to prove their relationship to Paleogene transgression and therefore their Paleoalpine and/or Epipaleoalpine age can only be assumed.

In the western part of the basement there occur paleokarst forms and deposits in the Malé Karpaty Mts. Their Paleoalpine to Epipaleoalpine age is proved by rock's superposition in a quarry at Sološnica where dark-gray brecciated Annaberg Limestone interlaced with red-soil-filled fissures and/or karst breccia whose matrix consists of red soils underlies basal Eocene limestones (Cuisian). In contrast to the underlying rocks, the Eocene limestones are neither karstified, nor contain red soils.

In the Malé Karpaty Mts. there are extensive complexes of carbonate breccias overlying the subtatric nappes. On the basis of the relationship between these breccias and Paleogene sediments, the former are regarded as Upper Cretaceous to Paleocene (Michalík, 1984). The breccias are characterized by large irregularly arranged poorly rounded clasts containing easily disintegrating rocks. In some localities, lenticular beds of laminated red marl with poorly rounded gravels occur amidst the breccia mass (Michalík, l. c.).

Composition of the breccias, their poorly rounded fragments as well as arrangement of their predominantly large blocks suggest that these rocks originated in the course of destruction of underground spaces, mainly by gravitational falling of their ceilings and walls onto the floor of underground karst spaces. Nevertheless, we cannot totally rule out the possibility that some of the breccias were formed on the surface, by destruction of positive karst forms. The origin of the breccias in underground karst spaces, however, is indicated not only by the arrangement mainly of their large blocks roughly parallel to the base, but also by the presence of lenticular beds of laminated red marls with gravels surrounded by the breccia mass. We assume that these marls with gravels are remnants of cave sediments transported by underground water streams.

In addition to the above-described forms and sediments which fairly unequivocally indicate intensive karst processes during the Paleoalpine and/or Epipaleoalpine stage, the existence of underground cave spaces in this period is also suggested by numerous finds of speleothems in the karst breccias.

Pedosphere of the basement

Pedosphere of the Paleoalpine and Epipaleoalpine stages was formed simultaneously with the formation of the karst forms. Its remnants are represented not only by red soils in fissures in Middle Triassic limestones or in breccia matrix but also by West Carpathian bauxites. These are typical karst bauxites in the sense of Bárdossy (1982). The pedosphere of the Paleoalpine and Epipaleoalpine stages which developed on the basement surface most probably includes also exceptional occurrences of bauxitic iron ores (Borza – Pospíšil, 1959) as well as residual iron ores (Kováčik, 1955) sporadically exposed on the surface of extensive levelled plains of the Slovak karst. Our opinion on the Paleoalpine and/or Epipaleoalpine age of these ferricretes or paleosoils is supported also by their joint occurrence on the plains along with Upper Santonian–Campanian karst (Mello – Snopková, 1973).

With respect to the ferricrete, bauxitic iron ore and bauxite occurrences in the West Carpathians it is noteworthy that the basement landmass passed through southward, from the Slovak Block to the Pannonian Block of Hungary. This fact is suggested by abundant bauxite deposits in the Transdanubian Mts. These deposits, except for one of Middle Cretaceous age, are bound to the Lower Eocene or Senonian–Paleocene and Paleocene–Lower Eocene (Bárdossy, 1982), which means that the formation of Hungarian bauxites in Transdanubia, is also essentially restricted to the Paleoalpine and Epipaleoalpine stages in the development of the quasiplatform basement.

Eastern Alpine bauxites were probably formed under similar conditions on the Kreios plate. Upper Cretaceous pisolitic bauxite in the Grosse Einöd Valley fills pockets in the Norian Hauptdolomite (Plöchinger, 1979), and bauxite at Unter-Laussa occurs at the base of the Gosau Cretaceous (Oberhauser, 1978).

One of significant preconditions to bauxite formation is that redeposition of bauxite into karst depressions should not be accompanied by deposition of extraneous constituents. Such conditions can only occur on a considerably levelled relief, such as a not very rugged karst in the vicinity of a seashore or an island without high mountains, from which rivers would carry clastic material into the forming bauxites (compare Bárdossy, 1982).

On the Pannonian Block, all bauxite occurrences are associated with levelled surface (Pécsi, 1984, 1985). On the Slovak Block, such association with a fairly levelled besement surface has been noted by Činčura (1987, 1988).

Distinct individualization and cratonization of the basement are suggested also by the fact that it remained emerged during one of the most extensive Upper Cretaceous transgressions which took place during the uppermost Maestrichtian (Cooper, 1977). Nevertheless, we have to take into account indirect effects of the Upper Cretaceous eustatic changes in sea level on the development of the basement.

Rising sea level resulted in the elevation of erosion level thus presumably restricting and slowing down karstification processes on the basement. Eustatic regressions led to a lower erosion level and rejuvenization of karst processes. Karstification processes on the basement during the tectonically fairly quiet phase (Tollmann, 1976; Oberhauser, 1978; Činčura, 1988) were several times renewed and interrupted due to eustatic changes in sea level and not because of vertical tectonic movements.

In our opinion, phases associated with eustatic regressions, lowering erosion level and increased fluvial activity on the basement are likely to have been also periods when karst bauxites and red soils were redeposited into places of their present-day occurrence – predominantly into near-shore karst plains. Transgressive phases marked by the uplift of erosion level resulted not only in slowing down of fluvial activity, karstification processes and bauxite transport, but also in some cases – in the Transdanubian Mts. – in deposition of marine sediments on the bauxites.

Conclusion

1. Present-day knowledge on Cretaceous and Paleogene development of the Central and Inner West Carpathians suggests that the Paleoalpine and Epipaleoalpine dry land on the basement has, because of its long duration, a special position in the paleogeographic and paleotectonic picture of the West Carpathians and represents a linkage between older periods of Alpine tectogenesis and Neotectonic orogenic stage.

2. Owing to large extent of carbonate rocks exposed on the basement surface, monsoon and/or humid subequatorial climate and prolonged subaerial development, the exogene modelling of the basement was dominated by karst processes.

3. Distribution of Paleoalpine and Epipaleoalpine surficial as well as underground karst forms and sediments makes it possible to determine approximate extent of the basement.

4. During the Paleoalpine and Epipaleoalpine stages, montmorillonite-kaolinite-illite red soils, ferricretes and/or bauxite were formed in the basement pedosphere.

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REVIEW

H. Postma – J. J Zijlstra (eds.), 1988: **Ecosystems of the world 27: Continental shelves.** Elsevier, Amsterdam – Oxford – New York – Tokyo, 421 pp., 207 figs., 36 tabs.

Authors engaged in the ecology of fossil organisms and reconstruction of relationships in ancient animal and plant assemblages frequently complain that inadequate interest is paid to recent marine ecosystems in comparison with terrestrial ones. This is one of the reasons why the reviewed work attracts considerable attention of the broad geological public.

Present-day shelf seas make up less than 7 % of the surface and only 0.2 % of the volume of the oceans. In the geological history of the Earth there were even periods when there was no continuous shelf fringe around the continents, or it was very limited. An extensive glaciation 17 000 years ago lowered the level of the world seas by 135 m and turned shelf-floors dry land for the last time. Over most of the Earth's history, however, the shelf seas were broader than the present-day Hudson or Persian Gulf, North or Yellow Sea. The importance of today's shelves is underlined by the fact that they account for 90 % of the world fishing. It is probably not by chance that sea shelves are thought to have been birthplace of life on the Earth...

The book by eighteen authors, divided into eleven chapters, submits a modern multisided, thorough look at the nature of sea shelves. Postma deals with physico-chemical aspects of shelf oceanography, Eisma introduces problems regarding their geological structure and development. Smetacek characterizes plankton, its diversification in relation to the distance from the seashore, climatic zones, upwelling and other streams. McLusky – McIntyre describe benthos, Sharp deals with nekton, whereas Cushing defines energy flow in marine ecosystems of continental shelves. The last four chapters deal with particular models of ecosystems from diverse shelf seas of the world. Zijlstra analyses the North Sea, Sherman's team the northeast coast of the U.S.A., Dragosund – Gjøsaeter the Barents Sea and Menasveta – Hongskul deal with Thai Straits. As regards the application of these data in the geology of belt mountains and paleoecology of organisms from their sediments, the third and fifth chapter deserve special attention.

Most sediments forming orogenic belts were laid down in environments similar to present-day shelves, i.e. on outer margins of continental blocks invaded by sea. In an instructive review of the shelf geology, Eisma discusses views on the role and position of shelves in geotectonic models, on theories regarding development stages of shelves, models of shelf sedimentation. He pais attention to the morphology and structure of submarine canyons, fans of deposited sediments, prograding shelf/continental-slope boundary. He also analyses the relationship of transgressive and regressive events of the sealevel to oceanfloor spreading and climatic cycles culminating in glacials (repeating approximately each 250 m. y.). He defines regularities in lithotype distribution relative to climatic conditions, importance of relict and palimpsest sediments for the interpretation of environment as well as significance of individual types of transport (gliding, rolling, jumping, suspension) for the distribution of sediments. He characterizes in detail the main sources of sediments (coastal erosion, river transport) which are usually located near the coast.

McLusky – McIntyre deal with the characteristics of shelf benthic organisms which affect not only the sediment character but also water chemistry and thus also the environment in the whole neritic zone. The authors describe study methods of benthos and deal with the principal regularities in ecosystem dynamics and formation of assemblages. They divide the ecosystem into four main trophic groups (suspension feeders, collecting deposit feeders, swallowing deposit feeders, predators) and on the basis of several examples characterize the properties of ecosystems in various environments (highly productive arctic zones, upwelling zones, polluted zones of port bays etc.). By this the authors generalize the knowledge into comprehensive conclusions, models and schemes of food webs as well as outline regularities and relationships between the members of individual trophic levels. These conclusions, however, do not deal with details, they just outline the topic (biomass and productivity of benthos in higher latitudes are much larger because of smaller amount of food consumed by zooplankton etc.)

The book is richly illustrated, many of the illustrations (maps, schemes) are very easy to understand and well explain the text, often revealing new aspects and ideas for further speculations. I recommend the book to all those interested in paleobiogeography, paleoecology, paleobiology as well as sedimentology.

Translated by L. Bohmer

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