NEOGENE CLIMATIC CHANGES AND GEODYNAMICS OF THE CENTRAL PARATETHYS

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The Neogene development of the Western Carpathians as a part of the Alpine-Carpathian suture zone is characterized as follows:

In the area of the Western Carpathian outer units —

— gradual extinction of the former flysch throughs accompanied by a change of flysch sedimentation into molasse one (e. g. during the Egerian in the Ždánice unit, during the Eggenburgian in the Skola unit);
— extension of the foredeep over the platform and from the area of former flysch throughs on the fronts of the overriding nappes (e. g. basins in position of "piggy back" type);
— folding and thrusting of the outer Western Carpathian flysch nappes over the foredeep and gradual uplift of the Western Carpathian outer units;
— overthrust movements in the Carpathian collision zone fading out from the inner units toward the outer ones and from the west to the east (Buday, Cicha, Seneš, 1965).

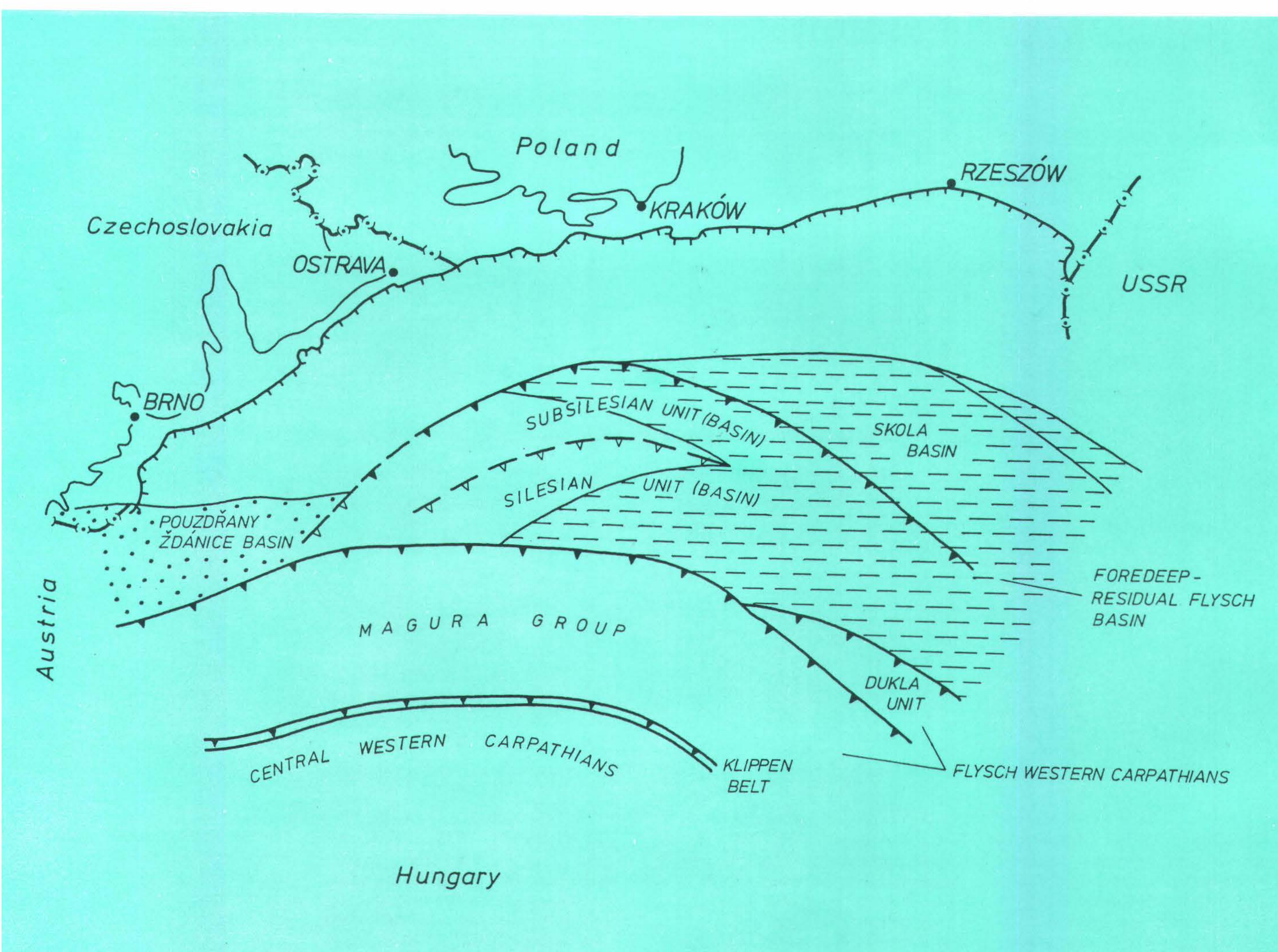
In the area of the Central Western Carpathians —

— formation of the arc-shape of the Western Carpathians associated with formation and development of shear zones;
— horizontal displacement and rotation of individual blocks inside the Western Carpathian segment;
— formation and development of the Pannonian mantle diapir (mantle astenolith) (Stegena, Geczy, Horváth, 1975);
— Neogene volcanism resulting from subduction, formation and development of the mantle diapir (Lexa, Konečný, 1974).

It should be pointed out that in the Lower Oligocene a separate sedimentary area was formed in the Tethys northern branch which markedly differed both from the older, mostly flysch, and the younger molasse basins (Cicha, Krystek, 1986). This period ranges within the new regional stage — the Kiscellian (Baldi, 1979). Contrary to the Eocene, it gets colder, several anoxic phases accompanied by deposition of menilitic beds repeate, and during the Kiscellian marl deposition it gets warmer again. This fact based on the study of marine assemblages corresponds even to the character of floras and faunas from the continental basins deposits of the Bohemian Massif (e. g. Fejfar, personal communication).

At the end of the Oligocene and onset of the Miocene considerable changes in the development of the Western Carpathian sedimentary areas took place. The space reduction in the outer units was manifested by further folding

Fig. 1: Palinspastic reconstruction of the Western Carpathians during the Egerian.



and thrusting of Alpine and Western Carpathian flysch units. In the northern Alps, the main overthrust on the foreland took place in the Egerian (Tolmann, 1978). In this period, the flysch deposition in the Pouzdřany and Ždánice sedimentary areas in the front of the Magura Group of nappes changed into molasse one (Cicha, Pícha, 1964). Eastwards, in the sedimentary basins of the Subsilesian, Silesian, Skola and Fore-Magura units the flysch deposition of the Krosno Fm. continued till the Eggenburgian. The basin extended eastwards, to the Eastern Carpathians.

Folding and overthrust of the nappes in the front of the folded belt was in the backland area of the Western Carpathians compensated by movement along the transform faults (fault zones) Rába-Rožňava, Balaton-Darnó, Zagreb-Zemplín, according to Hungarian geologists by dextral strike-slip displacement toward the NE (Baldi, 1986). By the end of the Oligocene these displacements led to disintegration of the Paleogene Buda Basin in the backland of the Western Carpathians and to their uplift.

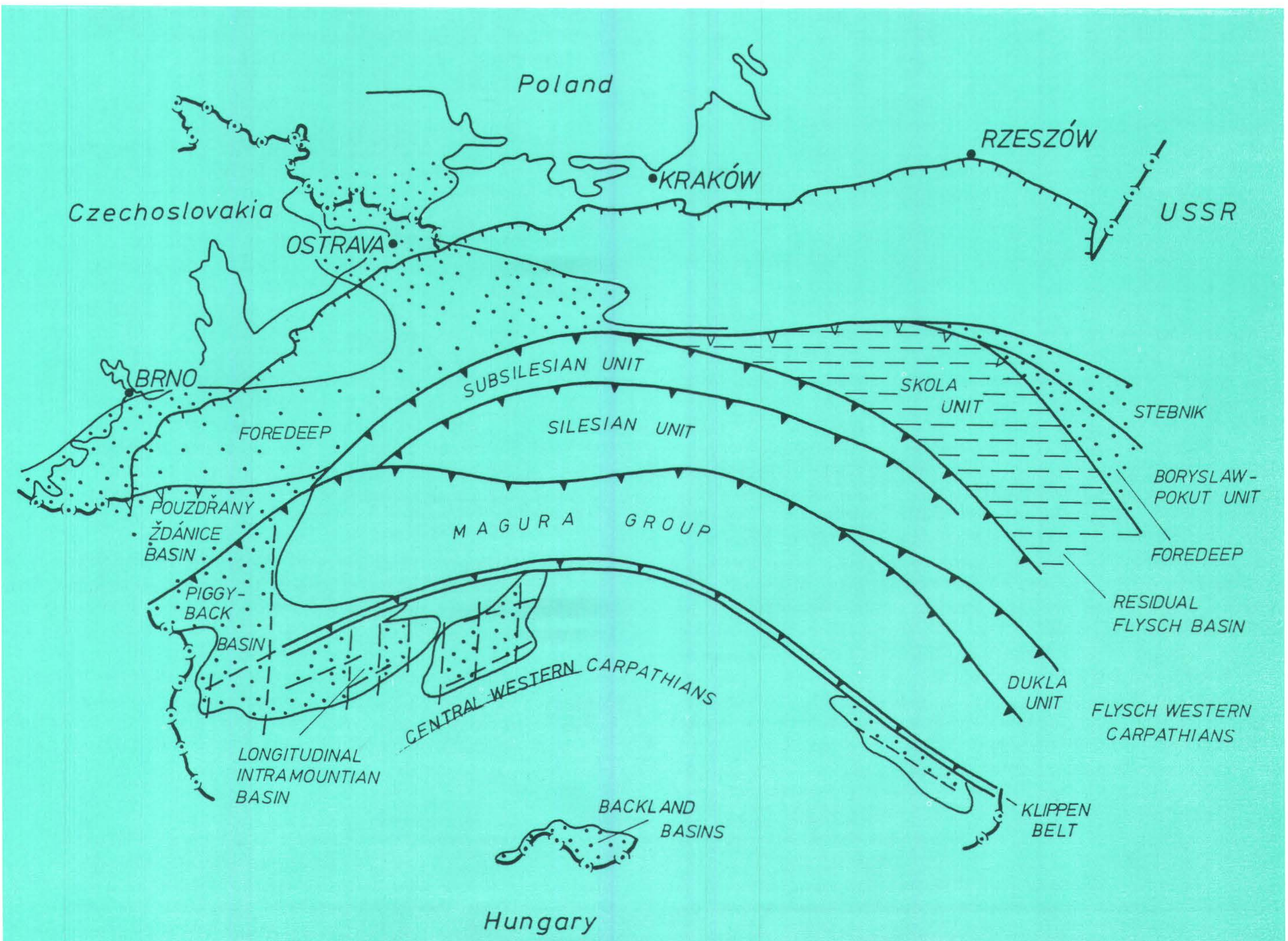
In the Egerian (Bůžek, Kvaček, 1985) the flora of the Central Paratethys region was changing due to numerous factors both of global and local character — it was not only the prevailing wind direction or precipitation spread that played a role. The Egerian floras and faunas occurring more southerly comprised more thermophillous elements than those occurring northerly (e. g. at Bechlejovice — the Bohemian Massif, Krumvíř-Ždánice unit, Verőcemaros-Csörög — the Buda Basin). It was caused by former position of the Buda Basin which was at least 100—150 km more to the south than we find it today.

Based on the macro- and microflora study (Planderová, 1975) in the Egerian the lower and middle subtropic parts and the upper part indicating a certain drop of temperature, as it contains "Arctic-Tertiary" elements, can be distinguished. This cooling was probably of Miocene date, when the Western Carpathian sedimentary basins underwent structural changes (sea regression, uplift of the internides). The cooling, however, might not coincide with the Oligocene-Miocene boundary in the Upper Egerian — in the opinion of Bůžek and Kvaček (1985) the Miocene set on with a short-term climatic optimum favouring perennially green wood species. The fauna from the Miogypsina tanigunteri Zone signalises a warmer climate as well. Penetration of warm-water indicators — the foraminifers — into northern parts of the Buda Basin and the Carpathian Foredeep in the Egerian also evidences the warming. The mollusc fauna found at many localities in Western Carpathian basins exhibits both boreal and Mediterranean elements. (Seneš, 1958).

Eggenburgian — Ottnangian

During the Eggenburgian, the southern margin of the sedimentary area in the front of the Western Carpathians shifted due to compression northwards. Deposition took place both in the foredeep and in the residual flysch basins. In the western part, the Silesian and Subsilesian units

Fig. 2: Palinspastic reconstruction of the Western Carpathians during the Eggenburgian.



emerged, while in the eastern part the flysch deposited in the Skola and molasse in the Boryslaw-Pokuty Basin. By the end of the Eggenburgian, sediments of molasse character containing evaporites (Vorotyshche Fm.) were deposited in the Boryslaw-Pokuty Basin.

During the Ottnangian the Eggenburgian foredeep deposits from central and north Moravia underwent denudation. The sedimentation continued in southern Moravia and in Poland, Sucha Fm. was deposited in the west and in the east sedimentation in the area of the Stebnik unit took place the eastern continuation of the Stebnik unit in the Western Carpathians is the Sambor-Rozniatov unit. Due to compression, by the end of the Ottnangian the Skola unit was thrust over the Borislaw-Pokuty unit (Oszczypko, Slaczka, 1986).

In the Eggenburgian a shear zone was formed in the periklippen belt area on the central Western Carpathian basement in which by sinistral strike-slip displacement a longitudinal intramountain basin was opened. This sedimentary area followed the boundary between the outer flysch and central Western Carpathians from where it penetrated along the rejuvenated mobile zones into Paleoalpine consolidated inner units.

In the Ottnangian the marine sedimentary areas of the central Western Carpathians were reduced, in the backland they were replaced by terrestrial deposition.

In the Eggenburgian the first temperature optimum of the Miocene comparable to the Lower Badenian — the Moravian one appeared. Beside the large foraminifers (Miogypsina) known also from the Alpine foredeep from the "Hall schlier" sediments the association of large pectinides considerably evolved. The mollusc fauna showed affinity either to the Atlantic or the Mediterranean bioprovince. Both the flora and fauna recorded brand-new elements. However, we point out that there was not much difference between the Lower Eggenburgian and the Upper Egerian flora. In the Tertiary basins of the Bohemian Massif and on the area of the today's G. D. R. (Bůžek, Kvaček, 1985) there were mixed forests in the Egerian with frequent deciduous wood species. Overwhelming part of the Eggenburgian belonged to the most varied, prevailingly evergreen forest formations of the Neogene.

Palynological investigations (Planderová, 1978) have revealed that the Eggenburgian had overwhelmingly subtropic to tropic climate. The presence of "Arctic-Tertiary" forms by the end of the Eggenburgian indicated a gradual decrease of temperature. However, this can be connected with sea regression in the area of the Western Carpathians. The Ottnangian palynological spectra point to a warm period with a certain extension of "Arctic-Tertiary" elements. The Ottnangian floras of the Central Paratethys were very close to the Eggenburgian. But new species of deciduous plants start to appear (Bůžek, Kvaček, 1985) which may signalize cooling, aggravation of climatic conditions. From the viewpoint of the development of the Paratethys sedimentary areas, the Ottnangian stage represents an important Miocene period. During it the connection between the Western Paratethys and the Rhone basin was interrupted and the Paratethys was getting still more isolated from the marine regime of the Mediterranean region s. s. This process culminated by formation of a sedimentary area extending from the molasse zone in Switzerland as far as the Caspian region (including Ustjurt) with brackish fauna of Rzehakia association strongly reduced as to the species variety. During the Ottnangian the coal seams of the Salgótarján Fm. were formed in the Western Carpathian backland area. The coal deposition was reported also from the marginal parts of the Alpine-Carpathian foredeep Langau-Šafov, south Moravia, from the underlier of the Rzehakia beds in Braunau "schlier" of the molasse zone in Austria (Rögl 1971) and in the underlier of the Salgótarján Fm. (Vass et al. 1987) a rudimentary foraminiferal fauna with Uvigerina was detected being later on typical of the Karpatian. The movements associated with a gradual isolation of the Paratethys from the Mediterranean s. s. were the reason of a short-lasting activation of the marine regime, with penetration of marine fauna which later in the Karpatian, under fully euhaline conditions, creates the assemblages of Acme-zones. The data on an extremely close relation between the Eggenburgian and Ottnangian floras to a certain degree contradict the world-wide cooling supposed for this period by Barron 1985, Rögl, Steininger, 1984.

Within the Ottnangian humudity gradually lowered and climate became drier with continental features (Bůžek, Kvaček, 1985). The activation of tectonic movements and uplift of sedimentary areas led to reduction of the swamp system typical of the Lower Ottnangian. Even higher temperatures cannot be excluded as indicated by the evaporite deposition in the Lower Karpatian in the East Slovakian Basin.

Karpatian

Styrian orogenetic movements resulted in further space reduction in the frontal part of the orogene in the Karpatian. The sedimentary area of the foredeep extended along the whole front of the Western Carpathians. The preserved remains of the foredeep deposits (Krystek, 1983) prove the transgression reaching the Bohemian Massif. The tectonic reduction of the foredeep sedimentary fill supposed later on is indicated also by a considerable thickness of the sediments in the basin "schlier" facies — from the area between Mikulov and Vranovice trench in southern Moravia (1 200 m), where the thick "schlier" sequence is cut off by the nappes front. Gradual overthrust of the nappes into the foredeep area during the Karpatian is documented by flysch material found in conglomerates ahead the nappe front (Krystek, 1983) and olistolithes in the Polish Zamarov Fm. (Oszczypko, Tomáš, 1985). At the end of the Karpatian the foredeep was overriden by the Pouzdřany and Ždánice units in southern Moravia and the Silesian and Subsilesian units in northern Moravia and Poland. In the northeastern part of the Western Carpathian front (in today's Poland) part of the foredeep sediments was detached and created the nappe of the Stebnik unit (Ney et al. 1974).

In the central Western Carpathians formation of orogene arc-shape was completed. (Styrian orogenetic movements.) In the western part in a sinistral strike-slip zone intramountain basins opened in the area of the present Vienna Basin and northern part of the Danube lowland. Namely the area of the Vienna Basin with the central Carpathian basement display an increased sedimentation rate. In the eastern part of the Western Carpathians the uplift in the beginning of the Karpatian contributed to the shallowing of the East Slovakian Basin. Evaporites were deposited. In the Upper Karpatian the basin formation was controlled by a dextral strike-slip displacement. Rapid deposition of the variegated shales documents an increase of terrigenous input.

Lower Miocene basin formation culminated at the end of the Karpatian and new Middle Miocene cycle started. The Karpatian can be considered a turning point in the evolution of fauna and flora. It was stressed in the paper by Cicha et al. 1975 that from the Eggenburgian-Ottnangian, the Karpatian flora and fauna markedly changed. The "Middle-Miocene" type of organisms' evolution coincides with this period chronostratigraphically assigned to the terminal part of the Burdigalian s. l. of the global Miocene time scale.

Badenian

Compared with the Lower Badenian (Moravian) — Langhian the basic difference was the appearance of the planktonic foraminifers association Praeorbulina-Orbulina. However, from the phylogenetical viewpoint the organisms are the closest in the Karpatian sequence with the appearance of Globigerinoides bisphaericus.

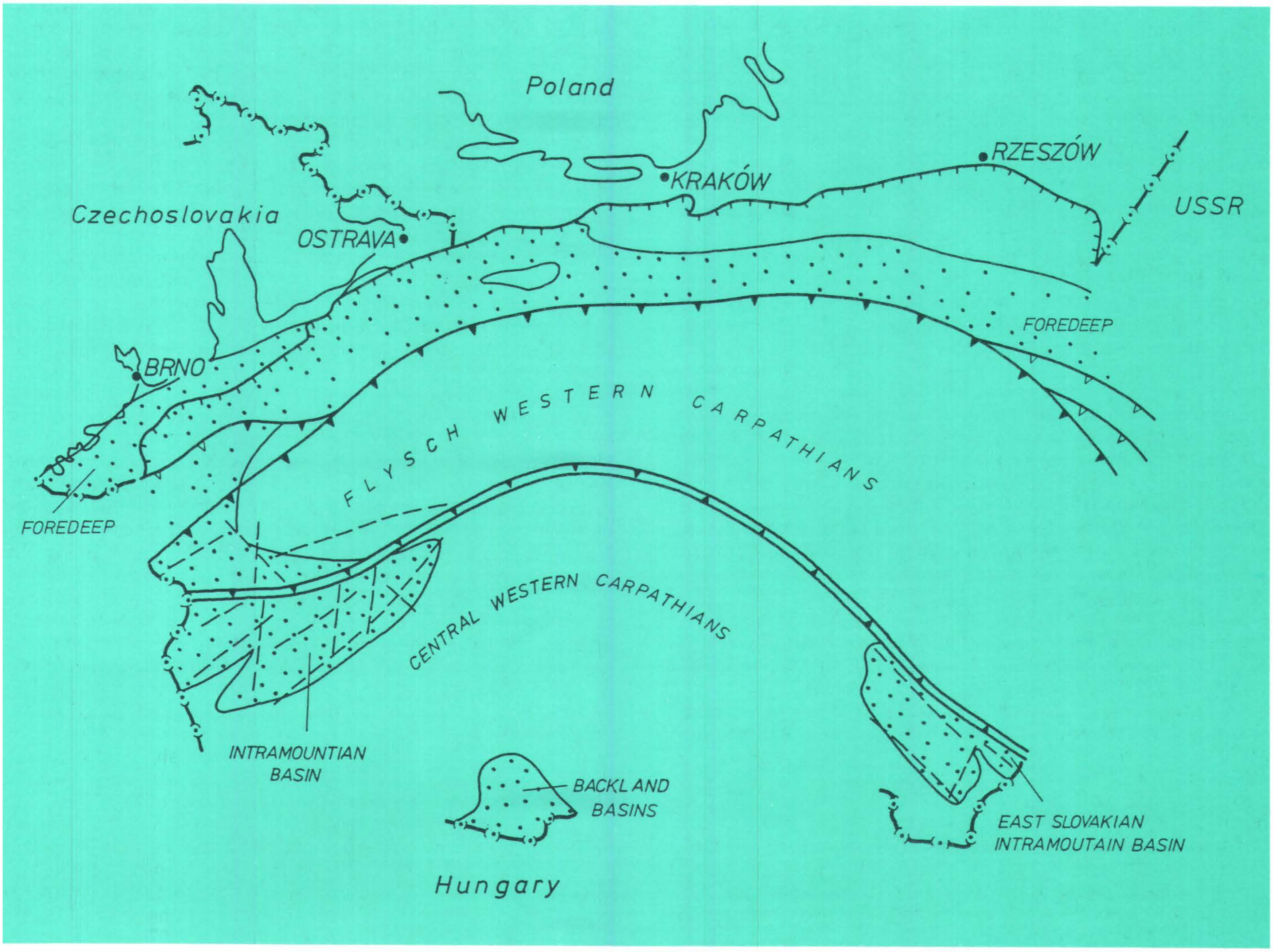


Fig. 3: Palinspastic reconstruction of the Western Carpathians during the Karpatian.

The mollusc fauna and the benthic foraminifers (Cicha, Seneš, Tejkal, 1967) document the subtropic climate. According to Planderová (1978) the Karpatian flora is rich in humid and thermophilous elements; southwards (the North Hungarian Basin) even in the tropic elements. The salinity crisis indicates a drier climate with equivalents even in the Vienna Basin. We cannot exclude that e. g. in the Carpathian foredeep this phase of the Karpatian development was accompanied by faunal reduction and prevalence of sponges which can be documented by predominance of megascleres in fossil association of these sediments. Knobloch 1969 and particularly Bůžek, Kvaček 1985 suppose that a certain change in the general character of flora, namely reduction of thermophilous wood species in the northernmost part of the Central Paratethys in the Karpatian may be attributed to regressions with the following radical change in the basin configuration. However, the Karpatian climate was for the most part subtropic and the evolution of benthic faunas points to warming toward the Badenian. Strong orogenetic movements caused an extensive break in sedimentation in the Upper Karpatian. The G. bisphericus Zone occurs only in the southern part of the Central Paratethys, not in its northern part. Here the Lower Badenian has prominently transgressive character.

The Lower Badenian sea transgression extended from the foredeep far to the Bohemian Massif. The highest subsidence in the foredeep was between the rivers Danube and Odra. Sinking of the platform margin was connected with the nappes overthrust. The overthrust on the area of the ČSSR in the Badenian was not so long as that in the Karpatian. Probably due to transverse tectonics (as a result of oblique collision) the overthrust of the flysch nappes front was restricted only to the northern Moravia region (NM of the Maliník horst) with anti-clockwise rotation (in fact "en block" — Jurková 1976). After deposition of the Balice Fm. Sambor-Rozniatov unit was overthrust with the Boryslaw-Pokuty unit in the outer Carpathians (Oszczypko, Slaczka, 1986).

After the end of nappes overthrust movements, in the Middle Badenian, the marine deposition in the foredeep on the territory of ČSSR was finished maintaining only in the Opava region. Eastwards, the Silesian and Subsilesian nappes overriden the Slavkov-Těšín Ridge and the last overthrust of the Magura Group was documented in Poland (Oszczypko, Tomáš, 1985). The compression in frontal part of the Carpathian orogene was associated with a regional uplift of the mountain chain. This is evidenced also by an increased supply of detritus from the Carpathian front into the foredeep. In the foredeep evaporite crisis took place. By the end of the salinity crisis the northern Carpathian margin was uplifted and eroded, this resulted in redeposition of eroded clastic material to the foredeep in the Wieliczka region in Poland.

In the Upper Badenian the flysch front had overriden the NE part of the foredeep partly due to gravity tectonics evoked by the uplift of the Western Carpathians (Poltovitz, 1978). The foredeep deposits were folded and detached forming the Vojnice unit (Badenian) in the front of the Carpathians.

In the Middle Miocene regional uplift of the Western Carpathians started. Intramountain basin formation was accompanied mainly by the shear zones development. The basin opening in the orogene and the maximum sedimentation rate in them, migrating from W to the E, can be well correlated with the last overthrusts in the front of the Western Carpathians.

In the course of synsedimentary activity of faults in the Lower and Middle Badenian the today's Vienna Basin was opened. In the contrary to the Lower Miocene depocentres, the Badenian ones migrated southwestwards. The Vienna Basin was formed in a sinistral strike-slip zone (Roth 1980, Kováč 1985, Royden 1985), in the same way the Middle and Upper Badenian basins were opened in the northern margin of the Danube lowland – the Trnava-Dubník depressions. In the eastern part of the Western Carpathians the East Slovakian Basin was opened in a dextral strike-slip zone (Vass et al. 1988). Here, in the Lower Badenian the connection with the foredeep through the today uplifted flysch nappe units is supposed. Middle Badenian salinity crisis can be here a consequence of partial areal uplift. The subsidence in the East Slovakian Basin culminated in the Upper Badenian (Kolčov Fm. 2 000 m thick)) to the Lower Sarmatian. In the western part of the orogene in this time the subsidence decreased. In central part of the Western Carpathians small intramountain basins with lacustrine and river deposition were formed in the Badenian.

The backland area of the Western Carpathians had since the Badenian a similar development as the Pannonian intermountain region, controlled by origin and formation of the mantle diapir (Vass 1979, Stegena et al. 1985).

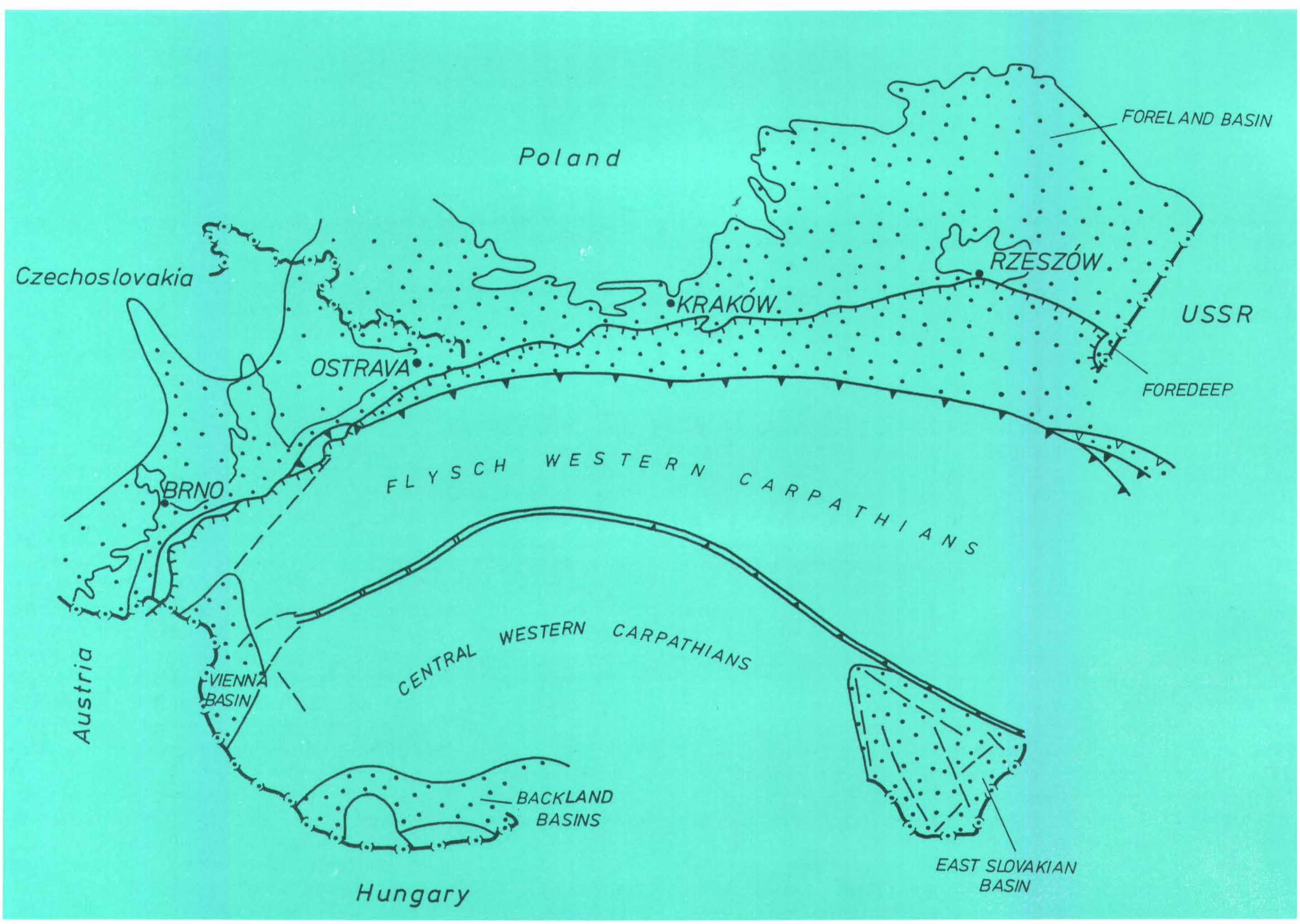
As to the species diversity (of mollusc and other assemblages), the Lower Badenian represents the optimum phase in the evolution of Neogene marine faunas. Benthic faunas are virtually identical with the Lower Karpatian ones.

The evolution of foraminiferal plankton indicates the prevalence of subtropic to tropic climate accompanied by formation of minor reefs even in more northernly situated parts of the Carpathian foredeep.

As to the flora evolution, in the northern part of the Central Paratethys, the period of the last extension of mastixioid floras sets on. Perennially green wood species gradually recede (Bůžek, Kvaček, 1985). In the Middle and Upper Badenian the annual average temperature lowers. The evaluation of conditions of evaporite deposition reveals that it was passing on in mild climate of the Opava region whereas in the Polish part of the foredeep xerophilous elements dominated – the halophyte genus Limnocarpus (Knobloch in Cicha et al. 1975). In the Kosov cooler oscillations prevailed already.

The palynological analysis (Planderová 1978) indicates that a very hot and humid Lower Badenian period in the Middle and Upper Badenian changes into cooler and drier. Warming up is recorded by the end of the Badenian and the onset of the Sarmatian. Warm and humid climate with low occurrence of tropic and subtropic flora species was suitable for coal deposition, e. g. in the area of the Nitra Valley Basin and the western part of the Opava Basin. In the south of the Carpathian foredeep in Moravia the deposition of the so called Brno basal sands and their equivalents was followed by deposition of thin evaporite layers, shortly before another transgression phase accompanied by deepening and "tegl" deposition. Comparing the devel-

Fig. 4: Palinspastic reconstruction of the Western Carpathians during the Lower Badenian.

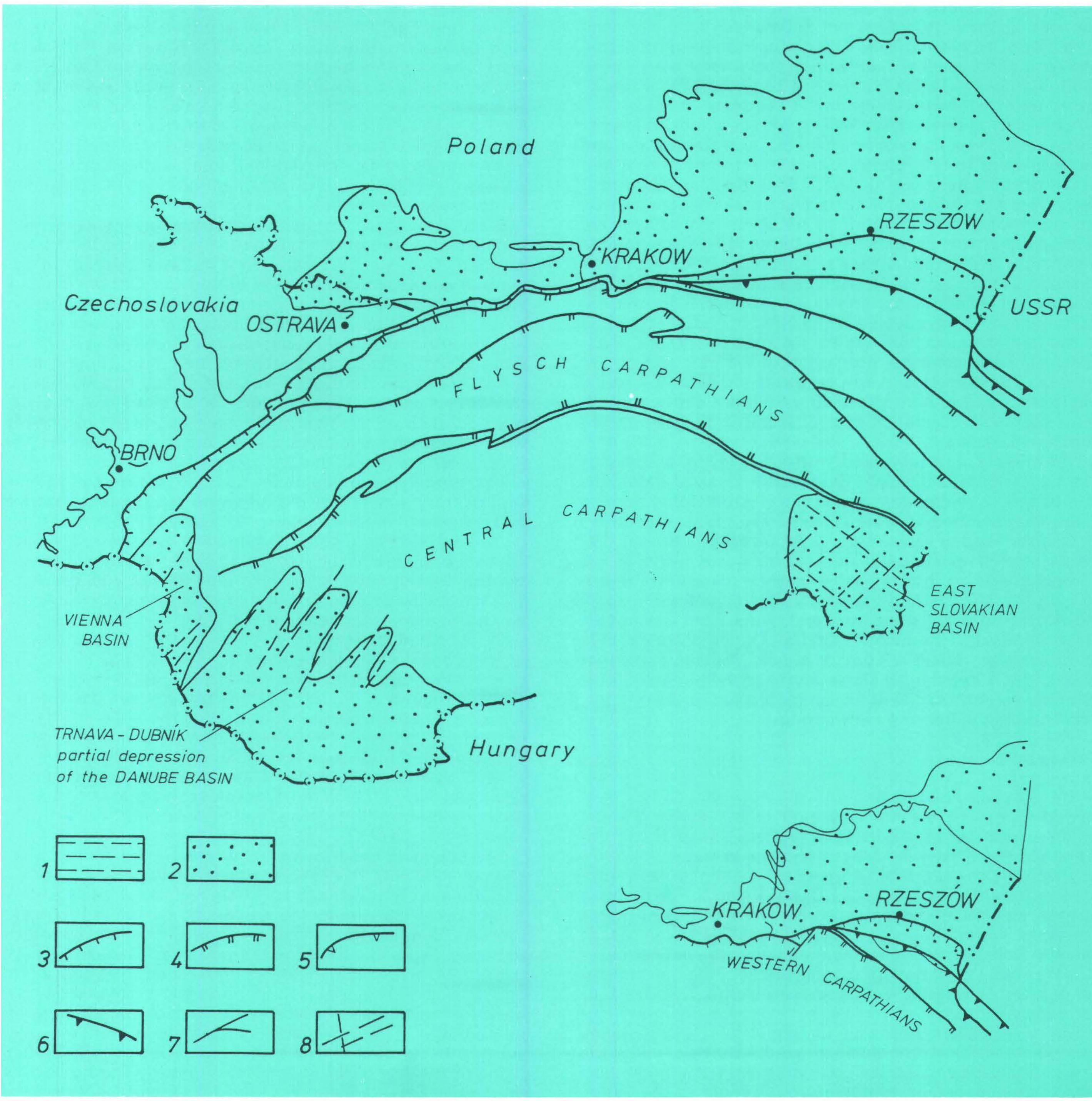


opment in the front of the Western Carpathian mountain chain with that inside and in the backland area, differences in the Badenian are obvious. In the backland area on the Hungarian territory elements of tropic flora were represented throughout the Badenian, in the intramountain basins tropic elements occurred only in the Lower Badenian, whereas in the front of the Carpathians the Lower Badenian is characterized by elements typical prevailingly only of the subtropic climate. Gradual cooling of the climate from the Lower till the Middle Miocene is probably associated with the Western Carpathians shifting to the N and NE.

Fig. 5: Palinspastic reconstruction of the Western Carpathians during the Upper Badenian
1 — Flysch sedimentation; 2 — Molasse sedimentation; 3 — Present front of the Western Carpathian nappes; 4 — Passive fronts of individual groups of the Western Carpathian nappes; 5 — Border of folded autochthonous sediments; 6 — Active thrust front of the Western Carpathian nappes; 7 — Boundary of basins (subbasins); 8 — Faults.
Fig. 6: Palinspastic reconstruction of the Western Carpathians during the Sarmatian.

Sarmatian

At the and of the Lower Sarmatian, development and sedimentation of the northeastern section of the Western Carpathian foredeep in Poland terminated. The last overthrust of the nappe front on the Lower Sarmatian sediments east of Rzeszow was already influenced by the development of the Eastern Carpathians. In the mountain chain the development of intramountain basins came to the end. The Sarmatian sediments are known from the area of the Vienna Basin, the Danube lowland and the numerous small intramountain basins. In the East Slovakian Basin, where the Lower Sarmatian sediments reach maximum



thickness, the centre of deposition moves toward the SE. The axis of the basin was NW-SE oriented, i. e. along the Eastern Carpathian segment.

The Sarmatian flora evolved from that of the Badenian. In Central Europe the environmental differentiation was still more marked. At the beginning of the Sarmatian, the climate had humide, subtropic character, whereas it was much cooler at its upper part. The climate at the end of the Sarmatian becomes drier. At the Sarmatian/Pannonian boundary the climatic conditions were aggravated showing further temperature fall (Planderová 1978).

Upper Miocene — Pliocene

In the Upper Miocene and Pliocene the compression manifestations in the orogene front faded out, the Western Carpathian uplift became slowlier than the Mid-Miocene, the fault activity weakened. Intensive subsidence was focussed in the backland area. The Pannonian region was influenced here by the collapse of the mantle diapir (Stegena et al. 1975, Horváth 1984). The Carpathian intramountain and backland basins in fact formed systems of bays of the Pannonian basin. In the Pontian the basin became more isolated and freshwater environment prevailed.

According to Kovar-Eder 1987, mixed mesophytic forests dominated in the Pannonian while the evergreen trees and conifers were in full retreat. There is no unequivocal evidence on the presence of xerophilous flora of Mediterranean type, nor the steppe or savanna assemblages can be proved. Herbs, on the other hand, were common in the Pannonian. A humid phase with formation of brown-coal seams falls within the Lower Pannonian, i. e. the time of the Hipparion fauna onset. Mild climate free from utterly dry seasons prevailed. According to Kovar-Eder 1985, the extinction of yew-tree species in the Pontian meant reduction of the coal-forming flora. As to the Pontian climate, Planderová (1978) supposes alternation of warmer and cooler periods. Comparatively warm period is indicated by kaolin weathering in southern Slovakia, a humide and warm climate supported formation of coal seams in the Vienna and Gabčíkovo Basins.

The present data obtained from the Pleistocene of the Central Paratethys (Dacian, Rumanian) speak of extension of mesophyte deciduous woods. Phases of global cooling in the Pliocene had their equivalents also in the Rumanian of Central Europe (e. g. Nyssa, Ampelepsis). Boreal elements started to appear. The occurrence of loess of the Rumanian age at Stranzendorf along the margin of the Bohemian Massif signified extremely cool climatic phases in the Alpine-Carpathian arc foreland. Data from the uppermost Rumanian (Reuverian) of the Upper Moravia Vale bring evidence about a humide phase. We can state that namely the Rumanian was characterized by numerous pronounced climatic oscillations signalizing the onset of enormous cooling within the Pleistocene.

Conclusion

The Pyrenean orogenetic movements united the sedimentary areas of the northern part of the Tethys Realm, which was under the influence of a global phase of cool climate. On the Bohemian Massif and the Western Carpathians territory the regional influences did not manifest. Activation of marine regime in the Upper Kiscellian and Lower Egerian was accompanied by prominent warming of global character, without climatic zoning, in the Bohemian Massif and the Western Carpathians. Similarly, the influence of global cooling of the world ocean (Müller 1985) in the Upper Egerian is well documented even in the Western Carpathians.

The onset of temperature optimum in the marine regime observable in the world ocean since the Burdigalian till the Lower Serravallian can be correlated with the Eggenburgian-Middle Badenian temperature optimum in the Western Carpathians. The regional influence of Savian and Styrian orogenetic movements in the Alpine-Carpathian region is documented by the relation between the large Miocene transgressions and their climatic optima. The Eggenburgian transgression caused by the Savian orogenetic movements took place in tropic to subtropic climate. The onset of Styrian orogenetic movements is associated with the Karpatian transgression with a new climatic optimum culminating in the Lower Badenian with regime of subtropic to tropic character.

Unlike the drastic cooling of the world ocean in the Upper Serravallian lasting till the Lower Tortonian (Müller 1985), in the Western Carpathian basins since the Middle Badenian till the Panonnian, the temperature lowers only gradually devoid of distinctive temperature boundaries.

The deposition of evaporites accompanied tectonic activity during the orogenetic movements in the area of the forming orogene of the Western Carpathians. Activation of a marine regime in the sedimentary areas of the Upper Kiscellian and Egerian was in the marginal parts associated with evaporites formation (southern Slovakia, Pouzdřany unit). The separation of the eastern part of the Carpathian foredeep in the Eggenburgian conditioned by Savian orogenetic movements resulted in the deposition of evaporites. Similarly, the Styrian movements in the Karpatian led to isolation of the sedimentary basin with evaporites deposition in eastern Slovakia. The Middle Badenian origin of the evaporites coincides with the culmination of Styrian orogenetic movements.

Disintegration of large sedimentary areas into individual basins by the end of the sedimentary cycles led to coal deposition. This is well documented by disintegration of Eggenburgian sedimentary areas during the Ottnangian (the Eggenburgian-Ottnangian sedimentary cycle) accompanied by coal deposition. The Styrian orogenetic movements initially caused changes in extension and sea ways connections of the Badenian sedimentary area, later, during their disintegration in the Upper Badenian, they caused formation of coal seams in the Western Carpathians. The coal deposition at the Sarmatian/Pannonian boundary associated with formation of a brachyhaline facies, and that at the Pannonian/Pontian boundary had similar reasons.

The orogenetic movements in the Western Carpathian sedimentary areas have the following consequence on the marine environment changes: the anoxic regime in Oligocene basins following the Pyrenean movements, the brachyhaline regime of the Rzehakia sea in the Ottnangian after the Savian orogenetic movements and the onset of a brachyhaline regime in Sarmatian sedimentary areas after the Styrian orogenetic movements.

The Miocene development of the Western Carpathian orogene considerably influenced the morphological division of the mountain chain area. During the Eggenburgian the climatic regime in the front of the orogene still did not differ from that in its backland area. With the onset of Styrian orogenetic movements in the Karpatian the N-S climatic zoning started to be manifested. Since the Badenian zoning caused by the uplift of the Western Carpathian mountain chain, forming a climatic barrier between the sedimentary areas in the front, inside and in the backland of the mountains was expressive.

The sea level changes of the world ocean (Müller 1985) still coincide with the Egerian transgression in the Western Carpathians. Marine regime of the Miocene sedimentary areas was influenced by the orogenetic movements. An expressive Eggenburgian transgression in the Western Carpathians (from the Rhone Basin to the Caspean region) does not correspond to the supposed drop of the world ocean level. A regional isolation and sea regression within the Ottnangian in the Paratethys area is, on the other hand, in the frame of the world ocean manifested by rising sea level (the uplift of the Alpine-Carpathian orogene). Gradual rising of the world ocean sea level from the Burdigalian till the Upper Serravallian can be in the Western Carpathians

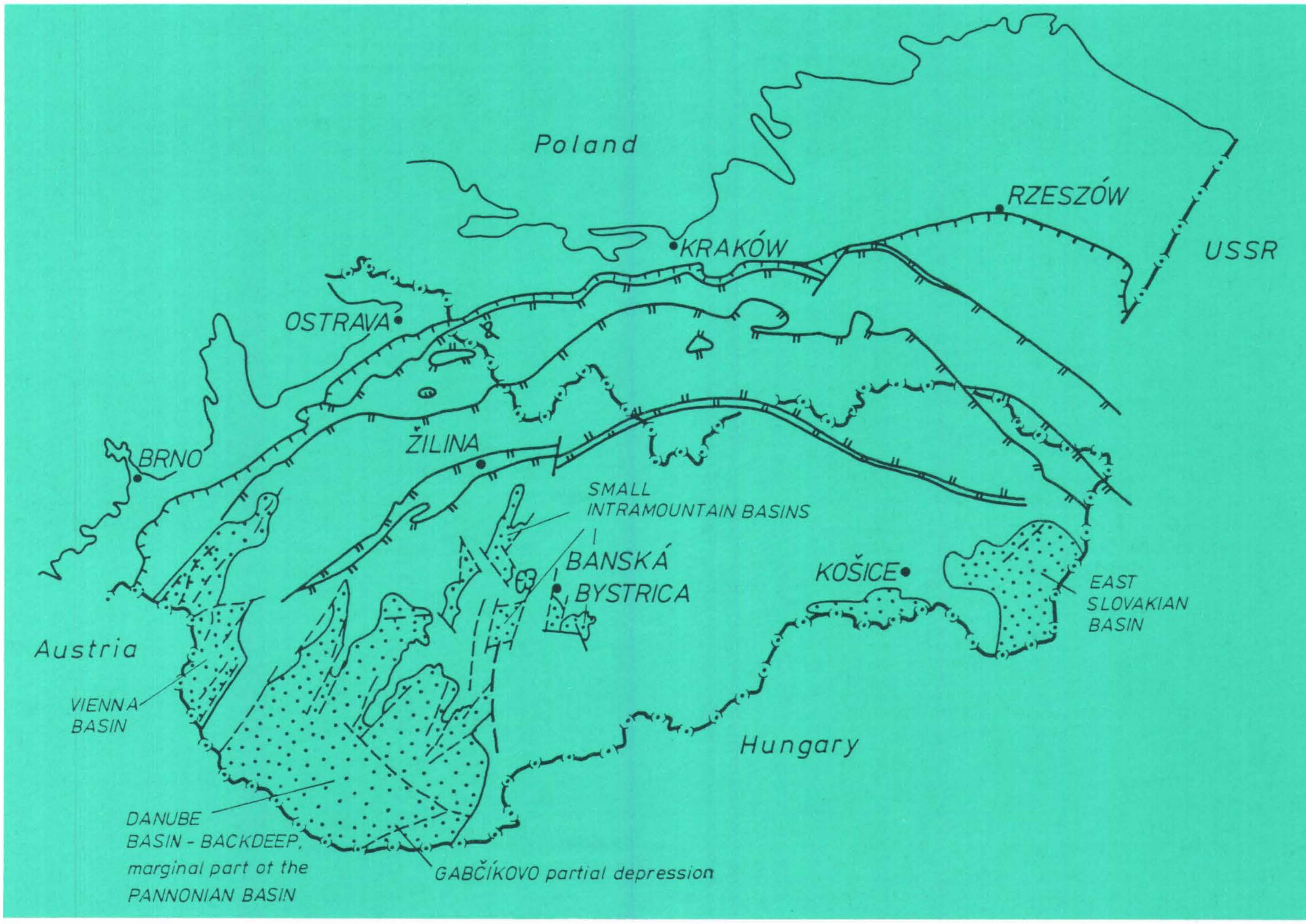


Fig. 7: Palinspastic reconstruction of the Western Carpathians during the Pannonian.

identified with the regional transgressions of the Karpatian and Lower Badenian induced by orogenetic movements. The global drop of the world ocean level in the Upper Serravallian coincides with eustatic changes in the Upper Badenian in the Western Carpathian region. The activation of the world ocean sea regime in the Meotian has its equivalent in the Euxinic-Caspean region.

The sedimentary record of the Western Carpathians Neogene shows, besides the global changes, also a large number of regional ones. The changes reflect the geodynamics of the orogene. The global changes took place especially in the earlier period of orogene development, while the role of regional changes increased in the later period of mountain chain formation.

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Abstrakt

Pyrenejské horotvorné pohyby sjednotily sedimentační prostory v severní části tethydní oblasti, která byla pod vlivem globální fáze chladného klimatu. Na území Českého masívu a Západních Karpat se v oligocénu neuplatnily regionální vlivy.

Nástup teplotního optima v mořském režimu, pozorovatelný od burdigalu do staršího serravallu ve světovém oceánu, můžeme korelovat s teplotním optimem eggenburg—střední baden v Záp. Karpatech. Regionální vliv sávských a štýrských horotvorných pohybů v alpsko-karpatské oblasti dokládá vztah velkých miocenních transgresí a jejich klimatických optim.

Na rozdíl od výrazného ochlazení světového oceánu v mladším serravallu, trvajícího do staršího tortonu, sledujeme v pánvích Západních Karpat od středního badenu do panonu jen postupné ochlazování, bez výrazných teplotních rozhraní.

Důsledkem horotvorných pohybů v Západních Karpatech byly: anoxický režim oligocenních pánví po doznění pyrenejských pohybů, brachyhalinní režim rzehakiového moře v ottnangu po doznění sávských horotvorných pohybů a nástup brachyhalinního režimu sarmatských sedimentačních prostorů po ukončení štýrských horotvorných pohybů.

V eggenburgu se ještě klimatický režim čela orogénu neliší od jeho týlových částí. S nástupem štýrských horotvorných pohybů v karpatu začíná S-J zonace, která je už v badenu velmi výrazná.

Zusammenfassung

Durch die pyrenäischen gebirgsbildenden Bewegungen wurden Sedimentationsräume im Nordteil der Tethys vereinigt, die von einer globalen kalten Klimaperiode beeinflußt wurden. Im Bereich der Böhmischen Masse und der Westkarpaten kamen im Oligozän keine regionalen Einflüsse zum Vorschein.

Der Beginn des Temperaturoptimums im marinen Regime, das vom Burdigal bis zum älteren Serravall im Weltozean zu beobachten ist, kann mit dem Temperaturoptimum vom Eggenburg bis zum mittleren Baden in den Westkarpaten korreliert werden. Der regionale Einfluß der savischen und steirischen gebirgsbildenden Bewegungen im Alpen-Karpaten-Bereich wird durch die Beziehung großer miozäner Transgressionen zu den Klimaoptima bezeugt.

Zum Unterschied von einer ausgeprägten Erkaltung des Weltozeans im jüngeren Serravall, die bis zum älteren Torton andauerte, ist in den westkarpatischen Becken vom mittleren Baden bis zum Pannon nur eine allmähliche Erkaltung, ohne einen ausgeprägten Temperaturwechsel, zu verzeichnen.

Die gebirgsbildenden Bewegungen in den Westkarpaten hatten ein sauerstoffarmes Regime in den Oligozänbecken nach dem Abklingen der pyrenäischen Bewegungen, ein brachyhalines Regime im Rzehakia-Meer im Ottnang nach dem Abklingen der savischen Bewegungen und den Beginn eines brachyhalinen Regimes in den sarmatischen Sedimentationsräumen nach dem Abschluß der steirischen Bewegungen zur Folge.

Im Eggenburg unterschied sich das Klimaregime der Orogenfront noch nicht von dem der Rückteile des Orogens. Mit dem Beginn der steirischen gebirgsbildenden Bewegungen im Karpat begann eine nördlich-südliche Zonenanordnung, die im Baden bereits sehr ausgeprägt war.

THE AUTOCHTHONOUS MESOZOIC ON THE EASTERN FLANK OF THE BOHEMIAN MASSIF — AN OBJECT OF MUTUAL GEOLOGICAL EFFORTS BETWEEN AUSTRIA AND ČSSR

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Introduction

The exploration of the Autochthonous Mesozoic along the Eastern flank of the Bohemian Massif led to contacts between ÖMV and ÚÚG Praha and later MND Hodonín as well as Geofyzika Brno in order to investigate the stratigraphy, paleogeography and structure of this geological unit, which was unknown until the early sixties.

It became evident soon, that the encountered Pretertiary deposits on both sides of the state boundaries belong to the same basin and form nearly the same vertical and horizontal sequences. The industrial results of the exploration in the basement of the foredeep and of the frontal part of the Alpine-Carpatian nappes are manifested by the discoveries of Dolní Dunajovice, Pottenhofen, Roseldorf, Höflein etc. Up to this activity only the outer, western part of an area prospective for hydrocarbons has been explored. There is to be expected, that in case of more apt economical situation for the future the exploration will advance into deeper positions, where larger accumulations of hydrocarbons may be possible because of more favourable maturity conditions of a very potential source rock.

The results of deep wells in the Carpathian frontal areas (for example Němčičky 1, Sedlec 1, Falkenstein 1) as well as in underground of the Vienna basin (Zistersdorf ÜT2, Maustrenk ÜT1, Aderklaa ÜT1) give evidence of the importance of a further cooperation.

1. History of exploration and investigation

Before the Autochthonous Mesozoic was explored by wells indications of a Jurassic-Cretaceous basin on the southeastern flank of the Bohemian Massif already existed in form of Jurassic carbonates in the vicinity of Brno (Eliáš 1962) and of klippen tectonically shorn off from this basin