GEOLOGICKÝ ZBORNÍK — GEOLOGICA CARPATHICA, 34, 4, BRATISLAVA, AUGUST 1983, Pp. 399—410

ZDENĚK ROTH+

TECTONIC RELATIONS BETWEEN THE INNER WEST CARPATHIANS AND EAST CARPATHIANS ACCORDING TO LATEST INVESTIGATIONS IN THE UKRAINIAN CARPATHIANS

(*Fig.* 1)

Abstract: At the front of the zone of the Upper Cretaceous nappes of the Eastern Alps, West and East Carpathians a zone of older Aptian—Albian (Austrian) nappes of the vanished (ultra) Pieninic Cordiller and Marmaroš zone (with crystalline rocks of the Inner-Carpathian Paleozoids) was extending. The axis of the North Penninic + Kysuca—Pieniny + Rachovo—Ceahlău geosyncline was running in its northern fore-land. To the fundamental differences between the structure of the West and East Carpathians the intense Priabonian—Lower Oligocene (Pyreneic) deformations in the West Carpathians belong, called forth by dextral twisting of the Tertiary Apuseni—Transylvanian partial block (Fig. 1).

Резюме: В передней части зоны верхнемеловых покровов Восточных Альп, Западных и Восточных Карпат простиралась зона старших апт-альбских (австрийских) покровов ушедшей (ультра) пьенинской кордильеры и мармарошской зоны (с кристаллиникумом внутрикарпатских палеозоид). Ось северопеннинской + кисуцко-пьенинской + раховско-цеглавской геосинклинали проходила в ее северном форланде. К основным отличиям в строении Западных и Восточных Карпат относятся интенсивные приабонско-нижнеолигоценовые (пиренейские) деформации в Западных Карпатах вызваны декстральным поворотнем третичного апусенско-трансильванского частичного блока (рис. 1).

The Ukrainian section of the East Carpathians is a key region of the Carpathian regional tectonics. In it ends the Magura group of nappes as one of specific large West Carpathian tectonic units and begin some specific more inner East Carpathian elements (Marmaroš group of nappes, Rachov—Ceahlău nappe).

An essential question, important for the geology of the Czechoslovak, Polish and Roumanian Carpathians, are mutual relations between the tectonic units of the East Carpathians and West Carpathians at the Ukrainian territory. The questions of these relations were systematically cleared up in preparation of the Tectonic map of CBGA (Maheľ et al., 1973). However, by far, all is not clear (see for example the analysis of Kruglov and Smirnov, 1980) and increasing regional knowledge and new global tectonic opinions throw a new light on relations between the West and East Carpathians. As to the Ukrainian Carpathians, besides older comprehensive works, I set out from the materials of the CBGA Congress published in Kiev (1980), where the fundamental questions of the geological structures of the Ukrainian Carpathians are discussed by Soviet specialists. They analyse also the causes of difficulties and insecurities (Kruglov—Smirnov, 1980; Vjalov, 1980). It can be said, that the opinions of Czechoslovak, Polish, Sowiet and Rumanian geologists are mutually approaching.

+ Doc. RNDr. Z. Roth, DrSc., Central Geological Institute, Malostranské nám. 19, 121 00 Praha.

Connection of tectonic Polish, Ukrainian and Roumanian Carpathian zones

Also in the Ukrainian Carpathians is reckoned with domination of the nappe structure. In the first place there are no doubts of it at the outer margin of the Carpathians (Skole—Tarcău nappe) and in the inner zones of the Ukrainian Carpathians (Marmaroš, Rachovo—Ceahlău, Porkulec—Suchov, Dukla and Černá hora—Audia zones). Kruglov and Smirnov (l. c.) write about the Krosno zone, however as about "a large autochthonous depression", lying in SE continuation of the Silesian and Skole—Tarcău nappes, to the rear part of which it belongs. The autochthonity of the Krosno zone (i. e. the autochthonity of the rear part of the Skole—Tarcău nappe), is however, not proved by Kruglov and Smirnov. The narrowed Krosno zone continues according to Soviet investigations (Robinson in Kruglov—Smirnov, 1980) un-interrupted into Roumania before the front of the Černá hora—Audia nappe.

Connection of the tectonic zones of the Czechoslovak, Ukrainian and Roumanian Carpathians

Kruglov and Smirnov (1980) consider not only the Marmaroš zone (i. e. the Marmaroš massif+zone of the Marmaroš klippes), but also the Rachovo—Ceahlău nappe, on which the Marmaroš zone (= Marmaroš group of nappes) is thrust from SW, similarly as the fore-land of this nappe, i. e. the zone Porkulec-Suchovo and Hoverla subzone in the Černá hora—Audia nappe (which at surface to SE appears of Jasina) as an area already folded in the Aptian—Albian (Austrian phase).

As far as younger nappe movements in the inner part of the Ukrainian Carpathians (Martynov, 1980) are concerned the Lamaride frontal boundary of the Rachovo—Ceahlău nappe separates the system of older nappes (Austrian—Lamaride) from the more northern Neogene (Savian, Styrian to Moldavian) nappe structures. The Laramide overthrusting of the Rachovo—Ceahlău nappe is proved by Dumitrescu and Săndulescu (1974).

When we compare according to intense Cretaceous (Austrian) to Paleocene (Laramide) movements tectonic units of the Czechoslovak and Ukrainian Carpathians, we observe pre-Albian (Austrian) intense movements as oldest in the hypothetic Pieniny (according to Tollmann, 1975 Ultrapieninic) Cordiller of the Pieniny Klippen-Belt of the West Carpathians and easternmost Alps. These movements are distinctly older than the Turonian (Subhercynian) thrusting of nappes of the Inner West Carpathians and Eastern Alps (Mišík, 1980). In the Pieniny Klippen Belt zone indeed even manifestations of the Subhercynian folding as well as of younger (including Late Styrian movements from the end of Miocene) are not missing. It can be stated, that the essential nappe structure of the Marmaroš zone of the Ukrainian and Roumanian Carpathians is of equal (i. e. Austrian) age as the origin and structure of the hypothetic Pieniny Cordiller of the easternmost Alps and West Carpathians.

A regionally tectonic parallel between the hypothetic Pieniny Cordiller of the Eastern Alps and West Carpathians and likewise Austrian-folded Dacides of the East Carpathians (Săndulescu, 1975) is also confirmed by the extension of Laramide intensive tectonics, which according to Martynov (1980) and Rumanian geologists does not exceed to NE the front of the Rachovo—Ceahlău

nappe and in the West Carpathians it characterizes with its lithological manifestations the Pieniny Klippen-Belt east of its Zázriva sigmoid (R o t h—L e š k o, 1974 and others). It can also be said, that the tectonic position of the Marmaroš zone of the Eastern Carpathians in the Aptian and Albian was coincident with the position of the hypothetic Pieniny Cordiller of the West Carpathians and Eastern Alps and the position of the Marmaroš zone + Rachovo —Ceahlău nappe in the Paleocene with the position of the form of the Pieniny Klippen Belt of that time in eastern Slovakia. [The present-day tectonic position of the Marmaroš and Rachovo—Ceahlău zones (i. e. its tectonic position after L a t e-S t y r i a n movements) can be compared to the position of the Magura group of nappes in Slovakia, its structure has dominant features of Pyreneic age and is accompanied by zones of intense younger Miocene tectonics on the side of the foreland as well as on the side of the hinderland. Inside the arc of the Outer Carpathians it is the intense (dominant) Late Styrian tectonics of the Pieniny Klippen Belt, on the outer side the dominating Late-Styrian-Moldavian structure of the middle and outer marginal groups of the Outer-Carpathian nappes].

Connection of tectonic zones inside the Carpathian arc

The dominant Late Styrian structure of the Pieniny Klippen Belt continues from eastern Slovakia to SE. It extends from Svaljava S of the Marmaroš zone into the upper Tisa river basin in Rumania, where the Klippen Belt ends in a complicated arc bowing to E (S ă n d u l e s c u, 1975), and is linked with the Pyreneic-Late Styrian (T r u n k ó, 1969; B a l o g h—K ö r ö s y, 1974; V j a l o v, 1974) N and NW delimitation of the partial Tertiary Apuseni-Transylvanian block (R o t h 1970; K r s—R o t h, 1979; R o t h, 1980) against the trough with the Szolnok flysch. This tectonic delimitation of the trough is directed to SW, to Szeged.

Simplified speaking, SE from the river Latorica the Austrian and Laramide structures (i. e. the Marmaroš Rachovo—Ceahlău zone) are getting gradually "unpacked" in direction to E from Miocene (Late Styrian) structures of the Pieniny Klippen Belt, which completely swallowed the more western Austrian and Laramide structure. In the upper Tisa river basin the young tectonics is definitively leaving the area of the Austrian structure of "Klippen" sequences. The Laramide and Austrian structures, which W of Svaljava are completely swallowed by the Late Styrian structure of the Pieniny Klippen Belt, have preserved independently till now E from Svaljava in the East Carpathians and are extending to SE into the crystalline-Mesozoic zone (Dacides) of the East Carpathians.

We have mentioned that the W continuation of the Marmaroš group of nappes (zone) was the hypothetic Pieniny Cordiller. The width of the Austrian nappe structure of the Marmaroš group attains in the S part of the East Carpathians about 30 Km (M a h e ľ et al., 1973). The narrowing of the Pieniny Klippen Belt connected with swallowing of the Pieniny Cordiller is estimated by Ś i k o r a (1974) to 100 Km and by M i š í k (1980, including the reduction of width of the cordiller by the Austrian nappe structure) to 230 km. In narrowing gradually also Subhercynian, Laramide, Pyreneic, Savian and Styrian movements took part, in which the movement of the Tatraveporide block was dominating (and

their hinter-land) at the front with the Dacides to the N, to the present-day platform. The front of the Austrian (Aptian—Albian) nappe structure ("Dacides") was the front of the block. It was the outer margin of the Marmaroš zone + Pieniny Cordiller.

Mišík (1980) attests that also the Pieniny Cordiller reached with its width and dissection of its terrestrial relief the present-day dimensions of the East Carpathian crystalline complex. Its polyphase narrowing (up to its total swallowing) brought in the West Carpathians in places also the Subhercynian nappes into the Klippen Belt already before the Late Styrian movements (Manín unit). In the East Carpathians, however, the zone of Aptian—Albian (Austrian) nappes preserved at surface till now and the Subhercynian units lagged behind, restricted to the Apuseni area (Fig. 1).

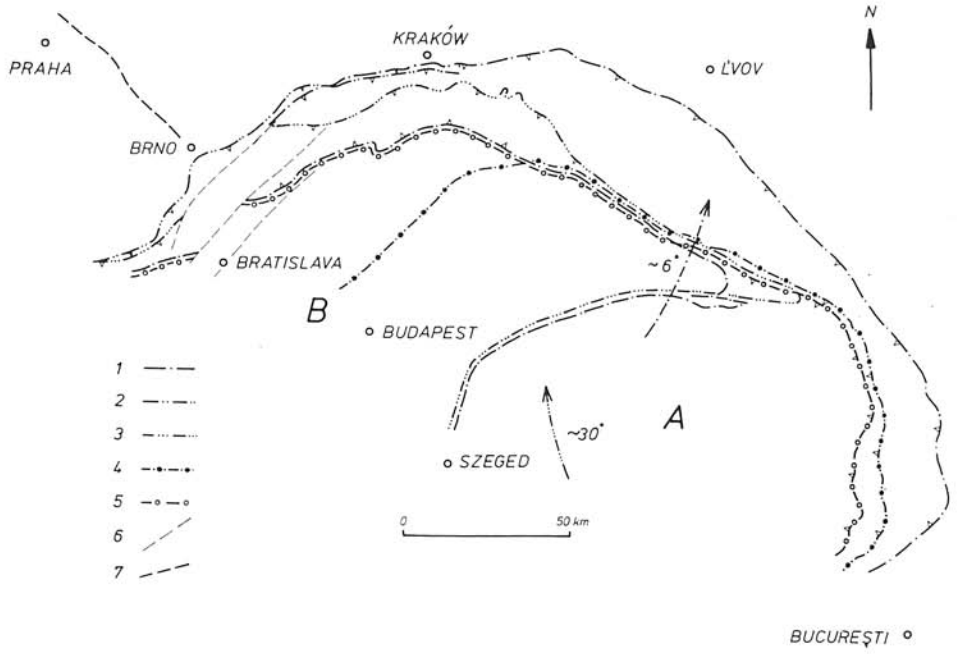

Fig. 1. Present-day Carpathian framework of the main structural effects of Outer Carpathian tectonic phases.

Explanations: 1 — Late Styrian (to Moldavian) phase; 2 — Early Styrian phase (only in the W); 3 — Pyreneic phase; 4 — Laramide phase; 5 — Austrian phase; 6 — main zones of Early Styrian sinistral shifting; 7 — axis of the Labe—Upper Moravian system of faults; A — Tertiary Apuseni—Transylvanian partial block; B — Tertiary Carpathian—Pannonian partial block. The relative movement of blocks in the competent tectonic phase is indicated by arrows.

The cause of the later surficial suppression of the Western Dacides (Pieniny Cordiller) and persistence of the Eastern Dacides in the surficial structure of the East Carpathians can be sought in different intensity of the Pyreneic and younger movements in the West and East Carpathians. After a shorter prepa-

ration during the Pyreneic phase (to the end of the Eocene) in the frame of the Austrian—Subhercynian-consolidated basement the partial Apuseni—Transylvanian block was released and somewhat (dextrally) rotated in relation to it (see Fig. 1). This movement (Roth, 1970; Krs—Roth, 1979) resulted in folding of the flysch filling of the Szolnok trough (Balogh—Körössy, 1974; Vjalov, 1974), but kept the E. Dacides, East Carpathians and South Carpathians away from Pyreneic rebuilding (Fig. 1).

The Marmaroš crystalline massif is, according to Roumanian and Soviet investigations, inside affected by Austrian northvergent nappe tectonics. For this Cretaceous tectonics it belongs till now (so as also the Pieniny Cordiller belonged before its incorporation in the Late Tertiary Outer West Carpathians) to the Inner Carpathian block, the basement of which is the Paleozoic In agreement with this fact the Marmaroš crystalline massif does not belong to the Bajkalides as the Moravian (Brunovistulicum, Dudek, 1980), Polish (with the essential part), Ukrainian and Roumanian margin of the platform, but to the Paleozoic. Between the Marmaroš massif and platform fore-land of the Carpathians considerable Alpine approaching took place (Chain et al., 1980) The Carpathian relation of the pre-Alpine basement of the Pieniny Cordiller, which is an analogy to the Marmaroš massif, is also indicated by the presence of marine Triassic, which was missing in the sedimentation area of the Outer Carpathians (see Mišík, 1980).

Mutual relations of development between the Carpathian tectonic zones

From the relation of crystalline rocks of the Pieniny Cordiller and crystalline rocks of the Marmaroš zone to the basement of the block of the Tatraveporides—Dacides and from their secondary essential approaching to the present-day platform fore-land of the Carpathians is evident, that the outer Jurassic—Cretaceous Carpathian geosyncline was lying in the northern foreground of the Pieniny Cordiller and Marmaroš zone. According to the mostly spread opinions this geosyncline originated inside the Afro—European Epivariscan table — land Pangea by secondary sinking (with basification of crust, Aubouin et al. 1977) as a considerably wide quasioceanic region (Bejer—Ščukin, 1980; Sviridenko, 1980; Chain et al., 1980; Roth, 1980). In the West Carpathian section with this Outer Carpathian Jurassic Lower-Cretaceous geosyncline can approximately be idenfitied the hypothetic Kysuca—Pieniny through, about the deep-marine character of which in the Jurassic—Lower Cretaceous speak Maheľ (1980) and Mišík (1980). Maheľ, nevertheless, considers as the main Jurassic—Lower-Cretaceous quasi-oceanic region the unproved (longitudinal) "wide oceanic Magura trough", situated between the Czorsztyn and Silesian source areas. Neither the older, nor the later investigations, however, have provided from this paleographic region indisputable documents for abyssopelagic developments known from the Kysuca—Pieniny trough (Matějka—Roth, 1956; Roth, 1961; Began—Salaj, 1978). The Czorsztyn—Magura region was rather an elevated one, where only the Senonian transgreded on the basement.

In the East Carpathian section as continuation of the Kysuca—Pieniny trough and as quasioceanic geosyncline, separating the present-day platform fore-land of the Carpathians, from the Carpathian region to the end of the Jurassic and

at the beginning of the Cretaceous, according to the mentioned criterion can be considered the Rachovo—Ceahlău sedimentation area. In accordance with T o l l m a n n (1975 et al.), who considers the Pieniny sedimentation area as E continuation of the North Penninic (Valaisian) geosyncline of the Alps, I consider as E continuation of the North Penninic geosyncline of the Alps the Kysuca—Pieniny + Rachovo—Ceahlău sedimentation area in the Carpathians.

If the Marmaroš zone + Pieniny Cordiller was the frontal margin of the Tatraveporide + Dacide block, the margin, which began to form (according to extension of glaucophanite rock in the Pieniny Klippen Belt, M i š í k, 1980) by collision of the frontal margin with the N fore-land during the Barremian, after further movements only its sedimentary cover remained in the West Carpathian section of the front. The basement was disappearing at depth. In the East Carpathian section of the front, which essentially corresponds to the late (Pyreneic) more mobile Apuseni—Transylvanian Tertiary block (Fig. 1), a major part of the Paleozoic, Austrian Alpine type refolded crystalline complex (= of the Dacides) occurs at surface till now.

The lithological character of the clastic lower members of the outer units of the Magura flysch or crystalline rocks, Devonian and Carboniferous of their source area (Silesian "Cordiller") is one of the proofs of the generally recognized inner-platform character of the more northerly situated sedimentation area of the Cretaceous and Paleogene of the Silesian and Subsilesian nappe (S t i l l e, 1951, 1953 a. o.). The fundamental lithofacial features of the Cretaceous sequences of the Silesian nappe are in conformity not only with the features of the Cretaceous sequences of the Dukla, Porkulec—Suchov nappes and Hoverla subzone in the Černa hora—Audia nappe, but in the Lower Cretaceous also with features of the Cretaceous in the platform Lower-Saxonian basin in the Federal Republic of Germany (R o t h, 1957; R o t h—H a n z l í k o v á, 1967; R o t h, 1975, 1980; B o i g k, 1981). To the mentioned fundamental characters according to K r u g l o v and S m i r n o v (1980) black pelites in the Lower-Cretaceous, variegated pelites in the Albian—Turonian and in the Carpathian part the dark grey fine rhythmical Coniacian—Campanian flysch and sandy Campanian—Eocene flysch belong. Under platform conditions flyschoid and flysch developments of the Outer Carpathian sedimentation area originating gradually on a new collision margin of the platform are replaced by marly-limestone and marly-sandy sediments (B o i g k, 1981; Z i e g l e r, 1982). Besides the fundamental Lower Cretaceous lithofacies belong to common features (inner-platform in that time) of the Lower Saxonian—Silesian—Porkulec sedimentation (=Beskyd trough; R o t h, 1961, 1974, 1980) also penetration of Tethyan macrofauna and microfauna to the NW on the platform and of platform fauna to SE to the present-day Carpathians see for example R o t h, 1962; R o t h—H a n z l í k o v á, 1967 a. o.). The occurrences of Lower-Cretaceous basic magmatites from the Brams localith in Lower Saxonian through the Beskyd teschenites to basic of the Porkulec (and neighbouring Rachovo) zones also belong to them (C h a i n et al., 1980 a. o.; V o l o š i n, 1980; B o i g k, 1981). Also in the more southern Penninic—Pieniny —Rachovo = quasioceanic zone (i. e. from the Silesian "Cordiller" in the Lower) also Upper-Cretaceous) are present basic rocks (M i š í k, 1980 et al.). The occurrence of basics testifies to extension (and "basification") of the platform basement present in these zone still in that time (A u b o u i n et al., 1977).

From wedging out of the Magura flysch to the E (it ends NE of Užhorod,

V j a l o v, 1980) it may inferred (that the innerplatform) Silesian source area ("Cordiller"), situated between the Beskyd trough to the N and the Kysuca—Pieniny—Rachovo geosyncline in the S, did not continue to the E. According to inversion manifested in sediments of the group of the Krosno—Menilite napes near Val. Meziříčí the Silesian inner-platform source area can be connected to NW with the Labe—Upper Moravian system of faults inside the platform (R o t h, 1960, 1980 a. o.). A manifestation of inverse sinking in this (and contemporaneously also in the transversal, paired) system of faults is obviously also sedimentation of the Magura flysch and uplifting of the Silesian source area (as forming continental slope of the platform) (R o t h, 1960, 1962, 1963). In the Labe—Upper Moravian system of faults, which is the tectonic framework of the Beskyd trough and its NW connection with the Lower Saxonian basin, these inversions were manifested at the boundary of the Cretaceous and Paleogene also in the region of the Bohemian massif and Lower Saxonian basin (movements of the Pompecký block, R o t h, 1957, 1961; Z i e g l e r, 1982 a. o.). The inverse relative upheaval of the Silesian "Cordiller" against the Magura sedimentation area is of similar age, Laramide.

It was mentioned, that E of Svaljava in the Ukrainian Carpathians the main source of the Magura flysch, the Silesian "Cordiller" was not manifested in the Cretaceous and Paleogene paleographically. Overthrusting of the Rachovo—Ceahlău nappe on the Porkulec—Suchov zone is also Laramide (M a r t y n o v, 1980), but its N vergency is opposite to the sense of relative uplifting of the Silesian source area against the Magura sedimentation area in the same time. Moreover, there is considerable lithofacial, biofacial and volcanological approaching between the Porkulec—Suchov E ending of the Beskyd trough and the section of the Penninic—Pieniny—Rachovo geosyncline in the Ukrainian Carpathians already in the Lower Cretaceous, when between them to the W the (denudation) Czorsztyn—Magura region was elevated (R o t h, 1961; B e g a n—S a l a j, 1978). We conclude from the above mentioned that the inner-platform structure of NE delimitation of the Czorsztyn—Magura region and later Silesian "Cordiller" continued neither in the Cretaceous nor in the Paleogene from the Svaljava area to E and there was free communication between the Beskyd trough and the Penninic—Pieniny—Rachovo geosyncline. The Penninic—Pieniny—Rachovo geosyncline developed in the forefront of the Dacides as a newly formed Carpathian structure, bordering the platform, the Beskyd trough remained an inner-platform structure.

The Laramide nappe structure was limited to the East Carpathians. Its front was the front of the Rachovo—Ceahlău nappe and has remained (similarly as the Austrian nappes of the Dacides) preserved in the original state till now (by the influence of the Pyreneic relative "retreat" of the Tertiary Apuseni—Transylvanian block). W of the river Boržava it is (by Pyreneic movement, as a consequence of which also the Magura group of nappes formed?), covered by the Marmaroš zone at present and W of the Latorica it was swallowed by the Neogene (Late-Styrian) structure of the Pieniny Klippen Belt. The post-Laramide conglomerates can be traced in the Šariš section of the Pieniny Klippen Belt (S c h e i b n e r, 1967; S t r á n i k et al., 1967). They are linked with the wide zone with erosion remnants of the variegated terrestrial molasse of the uppermost Cretaceous and Paleocene (accumulated from SE, M a r s c h a l k o, 1978; R o t h, 1981) in the Branisko, Low Tatra, Hron valley, in the Hungarian moun-

tains of Bükk—Upony, Gerecse, Vertés and Bakony (Trunkó, 1969; Semenovič et al., 1981). The remnants testify to the Lamaride rising of an extensive block inside of the Tertiary Carpathian—Transylvanian block, the NW margin of which followed in Slovakia approximately the front of the Gemericum. The Carpathian and close platform NW forland of the rising block began to sink (including W Hungary and the platform Magura sedimentation area, Fig. 1).

The front of the Pyreneic structure followed in the Eastern Alps and Carpathians the outer periphery of the Magura group (Roth, 1980). Preparation of the Pyreneic movements was the Upper Lutetian upheaval of the wide "Orava ridge" (Marschalko, 1978) along the N margin of the partial Carpathian—Pannonian Tertiary block, which in the Inner—Carpathians and partly also in the Pieniny Klippen Belt (Kňaža, Hanušovce) resulted in sedimentation of the Súľov conglomerates between Žilina and Humenné and at the inner periphery of the Magura flysch (in the same section) in synchronous psammitic-psephitic developments (Matějka – Roth, 1956; Stránik, et al., 1967 a. o.). From the SE termination of the Magura group the front of Pyreneic deformations continued first perhaps along the front and then in the interior of the Marmaroš zone, in the upper Tisa and Mureš river basins where it was connected with the rear boundary of Pyreneic deformations near Borsa (see Mahel et al., 1973), which was the N and NW boundary of the partial Apuseni—Transsylvanian Tertiary block. This boundary is directed from Borsa to W and SW and borders between Baia Mare and Szeged the Szolnok flysch trough (Fig. 1). Not only conservation of the Austrian and Laramide nappe structures in the East Carpathians, but also extension of intensive Pyreneic deformations in Hungary and Transcarpathian Ukraine (Trunkó, 1969; Balogh—Körössy, 1974; Vjalov, 1974) can also be cleared up by the above mentioned "retreating" rotation of the partial Apuseni—Transylvanian block during Pyreneic and later (up to Late—Styrian) movements (see Roth, 1970, 1980).

Wider relations of development of the Carpathian region to its fore-land

Formation of the Aptian—Albian (Austrian) folds and nappes of the Dacides (including the hypothetic Pieniny Cordiller) narrowed the sedimentation area of the Cretaceous in the East Carpathians, but the communication between the North Sea and Tethys in the Beskyd trough retained. The North-Penninic—Pieniny—Rachovo geosyncline in the West Carpathians was almost closed by collision, the marine communication retained in the time of the uppermost Cretaceous mainly in the Czorsztyn—Magura zone as preparation of Paleocene onset of bulky sedimentation of the Magura flysch. As the erosion remnants of Jurassic limestones in Bohemia and W Moravia testify, the latest Austrian movements (Aptian—Albian) interrupted temporarily direct communication between the Lower-Saxonian basin near Hannover and the Beskyd trough (through the region of the present-day Bohemian massif) along the Labe-Upper Moravian system of tectonic faults. This direct communication was restored in the Cenomanian, as indicated by biofacial and lithofacial similarities between the Bohemian Cretaceous tableband and marginal (Baška) facies of the Beskyd trough filling (Hanzlíková—Roth, 1963; Roth—Hanzlíková, 1967). The presence of the Austrian-folded Pieniny Cordiller between

the present-day block of the Inner Carpathians (with Subhercynian nappes formed already in the Turonian) clears up also the apparent exceeding of the tectonic effect of the originating Alpides on the platform fore-land (pre-Cenomanian interruption of communication along the Labe-Upper Moravian system of faults in the region of the Bohemian massif).

The diagonal course of the inner-platform Jurassic—Cretaceous Beskyd trough from NW to SE through the sedimentation area of the Tertiary of Neoalpine nappes of the Krosno—Menilite group (R o t h, 1975) is indirectly supported in the discussion also by K r u g l o v and S m i r n o v (1980). They point out that for delimitation of the fundamental tectonic units building up the Outer Carpathians (i. e. units originated mainly in the Miocene) also in the Ukrainian Carpathians (on the contrary to the Carpathians of Roumania, where the diagonal Beskyd nappe as independent structure, as mentioned above, already did not continue) we cannot use the detailled lithostratigraphy of the Cretaceous, because the Cretaceous lithofacial zones of the Krosno—Menilite group were directed by the older structural plan of the platform foreland, not by the plan of the present-day Carpathian structure. In classiffication of the fundamental (i. e. Tertiary) units of the Outer Carpathians, it is necessary to follow structural facial zones of the Tertiary sequences, also when these sequences are frequently of little extension. The platform structures of NW—SE direction are used by B e j e r and Š č u k i n (1980 — "Subsilesian Cordiller"), also by C h a i n et al. (1980) in their reconstructions of the sedimentation area of the Outer Carpathians. An important role of the plat-form structure in formation of marginal units of the Outer Carpathians in Poland is confirmed by N e y (1968). It is one of the regularities of tectonics of the Czechoslovak, Polish and Ukrainian Carpathians (on the contrary to the Roumanian Carpathians), on which the geologists are coming to terms more and more distinctly.

Conclusions

1. The Aptian—Albian (Austrian) structure of the hypothetic (ultra) Pieniny cordiller of the easternmost Alps and West Carpathians was the W continuation of the equally old structure of the Marmaroš zone of the East Carpathians. The common Cretaceous structure of the West and East Carpathians locates the Austrian-folded Dacides to the front of the Tatraveporide core of the Inner Carpathians.

2. The E continuation of the Jurassic—Lower Cretaceous North Penninic (Valaisian) geosyncline of the Alps forms (according to Austrian tectonics of the Pieniny cordiller and Marmaroš zone and according to Paleozoide structure of the West Carpathian and East Carpathian crystalline rocks) in the West Carpathians the Kysuca—Pieniny trough and in the East Carpathians the Rachovo—Ceahlău trough. It was a quasioceanic, originally intraplatform geosyncline inside the Epivariscan Afro—European table-land. The width of this geosyncline attained about several hundreds of km on an average. The geosyncline was closed in the Barremian—Aptian by collision of Dacides with the more northern Bajkalide region of the platform basement.

3. The Austrian-, Subhercynian-, Laramide-Pyreneic- and Styrian- to Moldavian-folded areas of the Carpathians originated in fore-front of blocks of the continental crust, which as parts of the field of blocks, shifting to the N, were

variously grouped, split and mutually slightly rotated. The folded area in fore-front of the corresponding frontal block was formed by detached parts of the cover of the fore-land as nappes in all the mentioned cases. The Laramide-folded area of the Carpathians had the superficial Rachovo-Cehlău nappe at the front and included that part of the Inner Carpathians, which is situated SE perhaps from the Muráň (or Darńo?) — Balaton line. The Pyreneic-folded area of the Carpathians had the Magura group of nappes at the front and included the NW part of the Inner Carpathians to the SE as far as the fracture zone Baia Mare—Szeged. The Miocene folding affected (with unequal intensity) the whole present-day region of the Carpathians including the whole Carpathian—Transylvanian Tertiary block. In the main phases of Tertiary development of the Carpathians the nappes originated at the N periphery of the respective block shifting in the front of the block field.

4. Survival of the little disturbed Aptian—Albian (Austrian) and Lamaride nappe structure inside the crystalline-Mesozoic zone of the East Carpathians, equally as extension of the Pyreneic folding in the Carpathians, are a result of Eocene releasing and Pyreneic dextral rotation of the partial Apuseni—Transylvanian Tertiary block at the beginning of the N shifting of the whole Tertiary Carpathian—Transylvanian block (Fig. 1). Releasing and rotation were possibly evoked by the movement of the Moesian "platform".

5. Under the influence of independent movement of the Apuseni—Transylvanian Tertiary block (on the contrary to the East Carpathians) the Alpine-type Pyreneic West Carpathian tectonics of Priabonian—Lower Oligocene age was distinctly produced. An equivalent of the Outer West Carpathians as Late-Styrian megastructure are the whole. East Carpathians including the Tertiary Apuseni—Transylvanian block. The structural boundary between the West and East Carpathians can be placed to the junction Satu Mare—Iasi on the basis of different reverberation of Pyreneic structures (see the map of M a h e l' et al., 1973).

Translated by J. Pevný

REFERENCES

AUBOUIN, J. et al., 1977: Téthys (Mésogée) et l' Atlantique, données de la géologie. C. R. hebd. Séanc. Acad. Sci., Sér. D, Sci. natur. (Paris), 285, pp. 1025—1028.

BALOGH, K. — KÖRÖSSY, L., 1974: Hungarian Midd-Mountains and adjacent areas. In: Tectonics of the Carpathian-Balkan regions. (Edit. M. Maheľ). Geol. ústav D. Štúra, Bratislava, pp. 391—403.

BEGAN, A. — SALAJ, J., 1978: Nové paleogeografické poznatky vo vrchnej kriede a v paleogéne západného a stredného Slovenska. In: Paleogeografický vývoj Západných Karpát. (Edit. J. Vozár). Geol. ústav D. Štúra, Bratislava, pp. 161—174.

BEJER, M. A. — ŠČUKIN, J. K., 1980: Evoljucija Karpato-Dinarskoj sistemy s pozicii tektoniki plit. In: Materiály XI. Kongressa Karpato-Balkanskoj geologičeskoj associacii. Tektonika (Kiev), pp. 40—50.

BOIGK, H., 1981: Erdöl und Erdölgas in der Bundesrepublik Deutschland. F. Enke. Stuttgart.

DUDEK, A., 1980: The crystalline basement block of the Outer Carpathians in Moravia: Bruno-Vistulicum. Rozpr. Čs. Akad. Věd, Ř. mat. přír. Věd, (Praha), 90, 8 pp.

DUMITRESCU, I. — SĂNDULESCU, M., 1974: Flysch zone. In: Tectonics of the Carpathian-Balkan regions. (Edit. M. Maheľ). Geol. ústav D. Štúra, Bratislava, pp. 253—264.

HANZLÍKOVÁ, E. — ROTH, Z., 1963: Lithofacies, biofacies and sedimentary conditions in the Cretaceous beds of the Flysch zone in the Czechoslovak Carpathians. Geol. Sbor. (Bratislava), 14, 1, pp. 83—108.

CHAIN, V. E. et al., 1980: Tektoničeskoe razvitie Vostočnych Karpat v svete novych predstavlenij o prirode geosinklinalej. In: Materialy XI. Kongressa Karpato-Balkanskoj geologičeskoj associacii. Tektonika (Kiev), pp. 214—225.

KRS, M. — ROTH, Z., 1979: Insubric-Carpathian Tertiary block-system, its origin and disintegrations. Geol. Zborn. — Geol. carpath. (Bratislava), 30, 1, pp. 3—17.

KRUGLOV, S. S. — SMIRNOV, S. E., 1980: Nekotorye problemnye voprosy tektoničeskogo rajonirovanija Ukrainskich Karpat. In: Materialy XI. Kongressa Karpato-Balkanskoj geologičeskoj associacii. Tektonika (Kiev), pp. 112—123.

MAHEĽ, M. (edit.) et al., 1973: Tectonic map of the Carpathian-Balkan mountain system and adjacent areas, 1:1 000 000. Geol. ústav D. Štúra — UNESCO. Bratislava.

MAHEĽ, M. (edit.) 1974: Tectonics of the Carpathian-Balkan regions. Geol. ústav D. Štúra, Bratislava.

MAHEĽ, M., 1980: Strukturno-faciaľnoe rasčlenenije Karpat s točki zrenija novoj globaľnoj tektoniki. In: Materialy XI. Kongressa Karpato-Balkanskoj geologičeskoj associacii. Tektonika (Kiev), pp. 124—138.

MARSCHALKO, R., 1978: Vývoj sedimentárnych bazénov a paleotektonické rekonštrukcie Západných Karpát. In: Paleogeografický vývoj Západných Karpát. (Edit. J. Vozár). Geol. ústav D. Štúra, Bratislava, pp. 49—80.

MATĚJKA, A. — ROTH, Z., 1956: Geologie magurského flyše v severnom povodí Váhu mezi Bytčou a Trenčínem. Rozpr. Ústř. Úst. geol. Čs. akad. věd, (Praha), T. 22.

MIŠÍK, M., 1980: Evidences of strong albian tectonic phase and new interpretation of the Pennines cordillera in the Carpathian Klippen Belt. In: Materialy XI. Kongressa Karpato-Balkanskoj geologičeskoj associacii. Tektonika (Kiev), pp. 147—153.

NEY, R., 1968: Rola rygla krakowskiego w geologii zapadliska przedkarpackiego i rozmieszczeniu złoz ropy i gazu. Prace geol. Pol. Akad. Nauk (Warszawa), 45 pp.

ROTH, Z., 1957: L' état actuel de nos connaissances de l' édifice de la zone du flysch des Carpathes tchécoslovaques. Congreso geologico international, 20a Sesión, Sec. 5, 1, (Mexico), pp. 253—265.

ROTH, Z., 1960: Vztah sedimentačního prostoru flyšového pásma v sz. části čs. Karpat k Českému masívu. Věst. Ústř. Úst. geol. (Praha), 35, 5, pp. 383—386.

ROTH, Z., 1961: Structure and geological position of Moravo-Silesian Beskyds (ČSSR). Geol. Práce, Zoš. (Bratislava), 60, pp. 65—85.

ROTH, Z., 1962: Geologický vývoj. Perm; trias; jura; křída; paleogén. In: Vysvětlivky k Přehledné geol. mapě ČSSR 1:200 000, M-33-XXIV Olomouc (Edit. Z. Roth). Geofond, Praha, pp. 21—34.

ROTH, Z., 1963: Strukturbeziehungen des Sedimentationsgebietes der Flyschzone der Westkarpaten zum Karpatenvorland und den Zentralkarpaten. Geol. Práce, Spr. (Bratislava), 28, pp. 5—22.

ROTH, Z., 1970: Alpine remobilization in the West Carpathians of Czechoslovakia. Věst. Ústř. Úst. geol. (Praha), 45, 6, pp. 331—338.

ROTH, Z., 1974 a: The Laramide phase in the Carpathian Klippen Belt and its interpretation in the book of O. Samuel, K. Borza and E. Köhler. Věst. Ústř. Úst. geol. (Praha), 49, 4, pp. 247—249.

ROTH, Z., 1974 b: Paleotektonická klasifikace geosynklinální výplně vnějších Karpat. Sbor. geol. Věd, Geologie (Praha), 26, pp. 95—100.

ROTH, Z., 1975: Die vorneogenen Strukturen und paläotektonische Gliederung der alpinen Füllung der Geosynklinale der Äusseren Westkarpaten. In: Tectonic Problems of the Alpine system (Edit. M. Maheľ). VEDA, vyd. SAV, Bratislava, pp. 23—34.

ROTH, Z., 1980: Západní Karpaty — terciérní struktura střední Evropy. Knih. Ústř. Úst. geol. Praha, 55 pp.

ROTH, Z., 1981: Paleogeografie vnitřních Západních Karpat. Věst. Ústř. Úst. geol. (Praha), 56, 1, pp. 47—52.

ROTH, Z. — HANZLÍKOVÁ, E., 1967: Západní úsek flyšového pásma Československých Karpát. In: Regionální geologie ČSSR, II 2. (T. Buday et al.). Praha, pp. 109—200.

ROTH, Z. — LEŠKO, B., 1974: The Outer Carpathian Flysch Belt in Czechoslovakia. In: Tectonics of the Carpathian-Balkan regions. (Edit. M. Maheľ). Geol. ústav D. Štúra, Bratislava, pp. 158—163.

SĂNDULESCU, M., 1975: Essai de synthèse structurale des Carpathes. Bull. Soc. géol. France (Paris), 7, 17, 3, pp. 299—358.
SEMENOVIČ, V. V. (edit.) et al., 1981: Neftegazonosnye bassejny socialističeskich stran Evropy i Respubliky Kuba. SEV. Moskva, 1981.
SCHEIBNER, E., 1967: Karpatské pásmo bradlové. In: Regionální geologie ČSSR, II/2. (Edit. T. Buday et al.). Praha, pp. 7—105.
SIKORA, W., 1974: The Pieniny Klippen Belt. In: Tectonics of the Carpathian-Balkan regions. (Edit. M. Maheľ). Geol. ústav D. Štúra, Bratislava, pp. 177—180.
STRÁNIK, Z. et al., 1967: Východní úsek flyšového pásma Československých Karpát. In: Regionální geologie ČSSR, II 2. (Edit. T. Buday et al.). Praha, pp. 203—283.
SVIRIDENKO, V. G., 1980: Kvaziplatformennyj etap razvitija i tektonika Karpato--Pannono-Dinarskogo regiona. In: Materialy XI. Kongressa Karpato-Balkanskoj geologičeskoj associacii. Tektonika (Kiev), pp. 198—201.
STILLE, H., 1951: Das mitteleuropäische variszische Grundgebirge im gesamteuropäischen. Geol. Jb., Beih. (Hannover), 2
STILLE, H., 1953: Der tektonische Werdegang der Karpaten. Geol. Jb., Beih. (Hannover), 8
TOLLMANN, A., 1975: Karpatische Züge in Fazies und Tektonik der Ostalpen sowie Anmerkungen zur Grossgliederung des Subtatrikums. In: Tectonic Problems of the Alpine System (Edit. M. Maheľ). VEDA, vyd. SAV, Bratislava, pp. 109—120.
TRUNKÓ, L., 1969: Geologie von Ungarn. Beiträge zur region. Geol. d. Erde — Bornträger. (Berlin, Stuttgart), 8
VJALOV, O. S., 1974: Transcarpathian depression. In: Tectonics of the Carpathian Balkan regions (Edit. M. Maheľ), Geol. ústav D. Štúra, Bratislava.
VJALOV, O. S., 1980: Osnovnye problemy geologii Sovetskich Karpat. In: Materialy XI. Kongressa Karpato-Balkanskoj geologičeskoj associacii. Tektonika (Kiev), pp. 5—25.
VOLOŠIN, A. A., 1980: Osnovnye čerty geologičeskogo stroenija oblasti sočlenenija Vnutrennich i Vnešnich Sovetskich Karpat i vozmožnyj mechanizm formirovanija struktury rajona. In: Materialy XI. Kongressa Karpato-Balkanskoj geologičeskoj associacii. Tektonika (Kiev), pp. 82—91.
ZIEGLER, P. A., 1982: Geological Atlas of Western and Central Europe. Shell. Den Haag.

Review by M. MAHEĽ

Manuscript received November 23, 1982