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ON RELATIONSHIP OF THE CENTRAL WEST CARPATHIANS AND THE NORTHERN APUSENI MTS.

Abstract: Mesozoic complexes from the Central West Carpathian section of 300 km in length and from apparently equivalent units of the Northern Apuseni section of 100 km in length display over 60 different features. There are no equivalents of Tatricum and the Krížna nappe in the Northern Apuseni Mts.; partial similarity of the Choč and Dieva-Ferice nappes facies, as well as of the Silica and Vaşcau nappes in only of accidental character. Important differences are also in the crystalline complex, Permian complex, in tectonic nature of the nappes and in the Alpine metamorphism. The Central West Carpathians and the Northern Apuseni Mts. cannot be joined together into a common unit of the West Dacides (or Internal Dacides).

Резюме: Мезозойские комплексы участка Центральных Западных Карпат 300 км-вой длины и вероятно эквивалентных единиц участка Северных Апусенов 100 км-вой длины обнаруживают больше 60 разных признаков. Татрикум и крижнянский покров не имеют эквивалентов в Северных Апусенах; частичное сходство фаций хочского покрова и покрова Дьева-Ферице, а также силицкого покрова и покрова Васкау является только случайным. Серьезные отличия также в кристаллическом комплексе, пермском комплексе, в тектоническом характере покровов и в альпийском метаморфизме. Центральные Западные Карпаты и Северные Апусены нельзя соединить в одну единицу Западных Дацидов (или же Внутренних Дацидов).

Introduction

Sandulescu (1975) included in his synthesis the Central West Carpathians and the Northern Apuseni Mts. into a common unit called the West Dacides. Tatric "autochthone" has to correspond to Bihor "autochthone" and subtatric nappes — to system of Codru nappes. This conception was repeated also in significant summarizing works on Alpine system of Europe (Sandulescu in Lemoine, 1978; Debelmas et al., 1980), so that it might be assumed that it is a generally accepted fact, although inclusion of the Central West Carpathians into the West Dacides was not accepted by any of the Slovak geologists. Maheľ (1983 b, p. 561) expressed himself against this. In the earlier works (Maheľ, 1978, 1983 a), he pointed out some distinctions of the West Carpathians and the Northern Apuseni Mts. As a main difference he stated considerable representation of limestones in the pre-Mesozoic complexes and low portion of the Jurassic and Lower Cretaceous trough facies in the Northern Apuseni Mts. Owing to the fact that views on the West Carpathians and Northern Apuseni forming one unit are always repeated in the foreign litera-

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ture, detailed comparison from which impossibility of the conception results is presented in this paper.

When comparing the orogenic belts we, unfortunately, cannot come out from quantitative expression to what degree a certain section of the mountain range resembles or does not resemble another. The features that are compared are ascribed different importance, whereby tectonic features (period of folding, important hiatuses, onset of flysch, etc.) are usually highly valued in "anatomy" of the mountain range, and then bioprovincial relations are applied. Facial comparisons provide, however, a highest number of data and, therefore, we shall be dealing particularly with them.

Change of facies is, to a certain degree, a function of distance. Tectonic--morphological division of sedimentary area of orogenic belts causes zoning — their most striking feature. We can express it approximately in the following way: ratio of average distances in which change of the facies in transversal (radial) and longitudinal direction of orogenic belts occurs is sometimes as much as 1 : 10. It is natural that accidental accordance of the facies on a certain temporal level may take place also in two remote regions. But if we compare the facies of two permanently remote sedimentary areas on several temporal levels, probability of incorrect result based on accidental accordances is practically eliminated.

Comparison of the Central West Carpathians and the Northern Apuseni Mts.

The term Central West Carpathians (CWC) has been lately started to be used in narrowed sense, whereby Gemericum, Meliata unit, Silica nappe and Bükk have been distinguished as the Inner West Carpathians. As the problem of location of the Choč and Silica nappes sedimentary areas has not been definitely solved out yet, I shall use the term CWC in older, broader sense in the present paper. Comparing the above-mentioned mountain range with the Northern Apuseni I came out from the following works: Patrulius et al. (1968), Patrulius (1976), Bleahu in Maheľ (1974), Bleahu et al. (1981). From the comparison of the sequences it follows that there are no equivalents of Tatricum and Krížna nappe in the Northern Apuseni Mts. and comparison of higher nappes is problematic.

Tatricum versus Bihor "autochthone"

Their equivalence was postulated besides Rumanian authors also by e.g. Kováčs (1982, 1983) and Michalík — Kováč (1982). Triassic successions of Tatricum and Bihor "autochthone" have nothing in common, except generally distributed facies of the Werfenian schists and Anisian Gutenstein limestones. Thickness of the Bihor Triassic complex is 1500—2000 m, of Tatricum Triassic sequence — 350—600 m. While the Bihor autochthone almost totally mises the Upper Triassic sediments, in Tatricum only Rhaetian part is missing (only in some mountain ranges, whereby e.g. in the Malé Karpaty Mts. it may be proved that it was present and removed by erosion during the Hettangian). Lower Ladinian clayey shales (Bihor "Peştiş Shales") are missing in Tatricum, nowhere in Tatricum Wetterstein limestone occurs (its thickness in Bihor is 400 m and it is accompanied with corals). On the other hand, in Tatricum there are

Ladinian clayey shales (Bihor "Peştiş Shales") are missing in Tatricum, no-sediments (sporadically also of continental ones, e.g. in the High Tatra). Though Carnian red shales and sandstones which might resemble the Keuper are mentioned in the Bihor autochthone, this term is not used for them. In Tatricum Keuper we shall never meet with limestone (pelletal, laminated) intercalations as in Scarița and Ordinușa Formations of Bihor. On the contrary, there are dolomite intercalations missing in the Apuseni Mts.

There are certain accordances in the Lias successions, but black shales facies is largely spread in Tatricum, whereas in Bihor it is only rudimentary (Toarcian and 3 m of the Upper Aalenian Fleckenmergel). Phosphate nodules occur there in Toarcian—Lower Aalenian sediments. They do not occur in Tatricum (they are sporadically known from the Sinemurian horizons). Bajocian oolitic limestones occur in the Bihor autochthone (Dogger oolitic limestone occurs nowhere in Tatricum), coral limestones are present in the Oxfordian—Kimmeridgian sequence of Bihor (never in Tatricum), Tithonian limestones of Štramberk type are present in the Bihor autochthone (never in Tatricum). The Upper Malm limestone of Albioara is characterized by oncolites; Tithonian mocroscopic oncolites occur in the West Carpathians only in the Ždánice unit of externides. Three hiatuses (in the middle of the Sinemurian, Bajocian and Callovian) are mentioned in the Bihor Jurassic sequence, in Tatricum they are not known except interruption of sedimentation in the Bathonian of the High Tatra.

Valanginian bauxites occurring in the Bihor autochthone are not known anywhere in Tatricum, sedimentation was not interrupted between the Tithonian and Lower Cretaceous sequences. In the Bihor autochthone there are Lower Cretaceous black lacustrine limestones with *Characeae* (nowhere in Tatricum), Upper Hauterivian limestones with *Nerinea* (there is nowhere *Nerinea* nor any organodetrital facies in the Hauterivian sediments of Tatricum). The Upper Aptian and Albian reef limestones are present in Bihor (the Albian limestones are never of biohermal nature in Tatricum and not even in the West Carpathians as a whole). Barremian to Turonian Bihor succession has a thickness of 2500 m (thickness of the Tithonian—Lower Turonian sequence of the most complete High Tatra succession is lower than 250 m). Vraconian to Lower Turonian red clayey and marly shales occur in Bihor, they are never of red colour in Tatricum.

Krížna nappe versus Valani and Finiș-Girda nappes

Triassic succession of the Krížna nappe has no analogue in the nappes of Codru. Presence of "Keuper" in the lowermost Valani nappe and in the part of Finiș-Girda nappe might be the only common feature. Geometric equivalent of the Krížna nappe should be represented by the Valani nappe; according to the published stratigraphic tables of the Valani nappe not even Anisian Gutenstein limestones and Ladinian—Carnian dolomites are present, whereas these two members occur in all sections of the Krížna nappe. Instead of them there are dark limestones with cherts (Roșia Formation) of Reifling type, whereby Reifling limestones never occur in the Krížna nappe. They might be perhaps partly analogous to the so-called Podhradie limestones of the Krížna nappe, though the latter are not accompanied with cherts and they contain the Upper Fassanian conodonts, whereas Roșia limestones contain the Lower Carnian co-

nodonts belonging even to the southern Tethyan province (K o z u r, fide B l e a h u et al., 1981). In the higher part of the Carnian complex of the Valani nappe there are limestones similar to the Wetterstein ones, in the Krížna nappe of all nine core mountains they are absolutely unknown. Consequently, the only accordance is occurrence of "Keuper", but identity of clastic material with the Carpathian Keuper has not been verified. Rhaetian sediments are missing in the Valani nappe, whereas they are developed in all sections of the Krížna nappe. Rhaetian "Kössen facies" is present in the Finiş-Girda nappe, but below the Keuper there are Dachstein limestones with megalodonts absolutely unknown in the Krížna unit. Below them there are dark shales of Codru Formation with intercalations of sandstones and limestones containing Norian conodonts. Such succession is unknown not only in the Krížna nappe, but in the whole West Carpathians as well.

Variability of the Lias facies of the Krížna nappe enables certain accordances with Valani and Finiş, but Hettangian—Sinemurian red nodular limestones (Moneasa marble) have no analogues in the Krížna nappe, not even in the whole West Carpathians. Lias facies of the Codru nappes are deepening from north to south, in the Krížna nappe they are shallowing from north to south (e.g. Veľká Fatra Mts.). The Upper Dogger—Lower Malm radiolarites which are a typical feature of Zliechov development of the Krížna unit are not known in the Codru nappes. As to absence of the Middle Jurassic part of the sequence (Toarcian to Oxfordian) in the Finiş nappe, it should be noted that there is nowhere such hiatus in the Krížna nappe (sporadic hiatuses involve not even one stage). Kimmeridgian—Lower Tithonian nodular limestones usually occur in the Krížna nappe, they are absent in Finiş-Girda. In the Valani nappe which should correspond the best to the Krížna nappe there are Malm coral limestones of 250 m in thickness (absent in the Krížna nappe). Here is rather an analogy with *Calpionella* marls of the Finiş nappe, but they contain intercalations of sandstones froming a flysch-like complex which deos not occur on equivalent level of the Krížna unit succession. In the Krížna nappe there are no Valanginian bauxites as in Valani and there are nowhere traces of shallowing in the Valanginian.

Only the Finiş nappe contains higher members of Cretaceous for the comparison purposes. It is the Lower Cretaceous flysch complex similar to the Sinaia bers. In the Krížna nappe, the Lower Cretaceous succession is pelagic and only the Albian sequences have sporadically a flysch character. Numerous small bodies of Barremian, Aptian and Albian basic volcanic rocks of the Krížna nappe have no analogues in the Valani and Finiş nappes.

Choč nappe versus Dieva-Ferice nappe

There are some agreements between the Triassic of Biely Váh development of the Choč and Dieva-Ferice nappes: Werfenian schists, Anisian dolomites, Reifling limestones (Roşia Formation), Dachstein limestones. Carnian Claptescu Dolomite might be a partial equivalent of Hauptdolomit, but it containts intercalations of red and white limestones and lumachelles with *Perihalobia styriaca* what is not known in the Choč nappe (Norian Hauptdolomit is mentioned only in the highest nappe of Arieşeni — B l e a h u et al., 1981). In the Choč

nappe there are marls with *Costatoria costata* instead of Campil dolomites with *C. costata;* in addition, here are Gutenstein limestone and especially the Lunz beds. This Middle Carnian flysch-like sequence with *Carnites floridus* represents a typical, 300 m thick member of Biely Váh development of the Choč nappe. Only in the Finiş-Girda and Ferice nappes there is something similar — the Codru Formation from dark marly and clayey shales with intercalations of sandstones. It is Norian, its age is proved by Norian conodonts from the uppermost part of the underlying Roşia Formation. It contains also intercalations of black limestones which also exclude analogy with the Lunz beds. In Carnian succession of the Choč nappe there are, in addition, Raming limestones (dark biohermal limestones with *Sphinctozoa* and *Tubiphytes*).

Besides the Biely Váh development, also Čierny Váh development with continuous development of the Middle and Upper Triassic dolomites is considerably spread in the Choč nappe. It has no equivalent in Dieva-Ferice-Batrinescu. Bebrava development with Wetterstein limestones has no equivalent here too. Presence of Longobardian—Julian hiatus not known from the whole CWC is an important difference.

As the Jurassic and Cretaceous sediments were almost totally removed by erosion, their correlation is problematic. Only the Tithonian—Lower Cretaceous flysch-like formation is mentioned, whereas the Tithonian—Neocomian sequence of the Choč nappe is represented by pelagic limestones with entirely sporadic allodapic intercalations of Barmstein limestones in the Tithonian or intercalations of sandstones in the Hauterivian.

Important difference is, however, in composition of the Permian complex of the Dieva nappe where lower rhyolites, basalts and upper rhyolites are present, whereas the Permian complex of the Choč nappe is characterized exclusively by basalts (melaphyres) along the whole length, and rhyolites (quartz porphyries) are totally missing in it.

Silica nappe versus Vaşcau nappe

The highest from the hitherto mentioned nappes — Vaşcau nappe is considered an equivalent of the Silica nappe of the Slovak Karst. The both nappes contain Steinalm, Schreyeralm and Hallstatt limestones and Upper Norian to Rhaetian massive limestones (in our country called Furmanec limestones and limestones of Bleskový prameň). However, absence of Ladinian—Cordevolian Wetterstein limestones in Vascau represents a significant difference. They are a main member of the Silica nappe of 1200 m in thickness and also a bearing member of the Silicicum of the highest subtatric nappes. In Vascau, there are Schreyeralm limestones instead of them, in the Silica nappe they are only secondarily represented. Hallstatt limestones of the Silica unit are almost exclusively of Norian age, whereas in Vascau they are of Carnian—Lower Norian age. B l e a h u et al. (1981) do not call them Hallstatt, but again the Roşia Formation (analogy will be rather with Aflenz beds of the Silicicum of the Stratenská hornatina Mts.).

Lower Lias pink crinoidal limestones are identical with the Silica nappes facies. But Adneth limestones and Fleckenmergel are missing in Vascau; the Lias complex is penetrated there by lamprophyries unknown in the Silicicum. The higher members were not preserved.

Other criteria

Just one case will be mentioned from the comparison of the crystalline complexes. Complex of green schists from the Arieşeni nappe is compared with the Rakovec Group of Gemericum (B l e a h u et al., 1981); Palaeozoic complex from higher Baia de Aries nappe is compared with Hladomorná dolina Group of Veporicum. But in the West Carpathians, particularly Gemericum unit represents a higher nappe overthrust on Veporicum. We have not mentioned the fact that Mesozoic sequences of the Arieşeni nappe do not correspond with sequences of Gemericum (which includes a part of Meliata succession), e.g. the Arieşeni nappe contains especially Hauptdolomit.

Inclusion of the CWC and the Northern Apuseni into a common unit of the West Dacides was based mainly on the fact that the both regions were tectonically affected by pre-Gosau folding. But in the map No. 5 from the work of D e b e l m a s et al. (1980), age of folding of the CWC is denoted as "anté--Gosau précoce (Aptien—Albien)" and folding of the Northern Apuseni as "anté--Gosau tardif (Crétacé supérieur)". Structure of the CWC is different from that of the Northern Apuseni primarily by its division into the core mountains. Essential difference lies in the fact that nappes of the Northern Apuseni are mostly the nappes of basement with substantial representation of the crystalline complex, whereas the subtatric nappes are superficial. No metamorphism of Mesozoic rocks is mentioned in the Northern Apuseni, whereas a part of Tatricum sequences, proximal part of the Krížna nappe in "homeland" region and especially Veporicum and Gemericum Mesozoic complexes (Meliata succession s.l.) display a distinct metamorphism.

The Central West Carpathians join the Pieniny Klippen Belt, whereas margin of the Northern Apuseni is remote from it by more than 100 km. According to some authors, e.g. K o v á c s (1982, Fig. 3; 1983, Fig. 2), sedimentary area of the Bihor autochthone, Mecsek and Villány neighboured the Klippen Belt, and only during the end of the Jurassic — beginning of the Cretaceous it was transferred to the present position (K o v á c s, 1983, Fig. 3). But if ophiolite suture of the southern part of the Klippen Belt (M i š í k, 1978; M i š í k — S ý k o r a, 1981) continues to Transylvanian suture (S a n d u l e s c u in L e m o i n e, 1978; D e b e l m a s et al., 1980; M a h e l', 1983 c, Fig. 5), we cannot place the Bucovinian and sub-Bucovinian nappes into one sedimentary zone with the above--mentioned units, as done by K o v á c s. The Northern Apuseni were situated in more internal position in relation to the units, they might eventually represent their missing internides. Complexes of the facies show that sedimentary area of the Northern Apuseni was in the Mesozoic much nearer to the sedimentary area of the East and South Carpathians than to the sedimentary area of the Central West Carpathians. For the time being, it has not been palaeomagnetically proved whether the Northern Apuseni were rotated; in such case, relics of Mureş oceanic trough would not obstruct such conception.

Conclusion

The Central West Carpathians represent perfectly individualized unit which cannot be connected with the Northern Apuseni as the West Dacides. Their original distance in the sedimentary area had to be larger than the present

200—400 km, as expressed in the palaeogeographic sketches of Kozur—Mock (1986). After analysis of the facies it may be stated that no equivalents of Tatricum and the Krížna nappe exist. Some accordances between the Choč and Silica nappes and their presupposed equivalents may be rather ascribed to large areal distribution of the facies of the southern (inner) units. If we compare about 100 km long section of the Northern Apuseni with three times longer section (300 km) of the Central West Carpathians and if we establish over sixty different facial features (formations), these differences should be considered to be proved. The Central West Carpathians preserve on the whole territory many specific features (e.g. melaphyre zone and Lunz beds of the Choč unit) which are missing in the Apuseni.

Though the sedimentary area of the Central East Carpathian nappes ("median Dacides") did not lie in the same zone as the Northern Apuseni, their "radial" neighbourhood was manifested by several facial agreements, such as Hettangian—Sinemurian red nodular limestones (Bihor, Rarau), Bajocian oolitic limestones (Bihor, Rarau), Malm coral limestones (Valani, Rarau), Tithonian flysch (Finiş, Bucovinian nappe). Only the features totally missing in the Central West Carpathians have been mentioned. The Northern Apuseni are closely connected with the East and South Carpathians by tectonic history (numerous basement nappes) concluded by specific banatite volcanism.

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