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MICHAL MAHEĽ*

HERITAGE AND ITS BEARERS IN GEOLOGICAL DEVELOPMENT OF THE ALPIDES

Abstract: The causes of differences in dissection of the individual segments of the Alpides have their historical anchoring in unequal pre—Alpine consolidation of crust, mainly, however, in unequal distribution of massifs of granitoids and zones with basic and ultrabasic rocks. These are together with transcrustal faults the bearers and regulators of heritage in development of earth crust and so antagonistic counter—players of global manifestations of the trend of development.

Резюме: Причины разниц расчленения индивидуальных частей альпид находятся в их историческом якорнении различной передальнийской консолидации коры, а главным образом в разчленении гранитоидовых массивов и зон с основными и ультраосновными породами. Они вместе с транскрустальными разломами носительми и регуляторми наследства развивания земной коры и таким образом являются антагонистическими контрастами общего направления развития.

Introduction

It is commonly known that the trend of development of the Alpides is a result of more global manifestations of fundamental geological processes. It concerns mainly folding with cyclic, periodical and phase formation of tectonic structures, with changes of the paleogeographical picture. The new tectonics raised the importance of manifestations of more regional, more global character with focusing attention on periods of rifting, extending and thinning of crust, on the character of its changes, on changes of granitization type, on types of formations characteristic of individual periods of development; stressing the importance of ophiolites and deep—water Jurassic and Lower Cretaceous sequences in the Alpides.

Knowledge from the Carpathians, Balkans and Dinarides, also Alps, has led us to the view that for individual cycles of development of the Alpides certain manifestations of fundamental processes are particularly characteristic (M. Maheľ, 1978): — The Assyntian cycle was marked by extensive migmatization and intensive high-thermal metamorphism and only weak mountain-building morphostructural manifestations (lacking molasses) but paleotectonic differentiation of crust into throughs with thinner crust, with abundant basic rocks (diabases, spilite—keratophyres), island zones with manifestations of intermediate to acid volcanism and into central massifs with reductional sedimentation. — Characteristic of the Hercynian cycle is the origin of extensive granitoid bodies, regional metamorphism of lower grade (epi), distinct orogenetic morphostructural manifestations with formation of longitudinal troughs filled up with oldest molasse. Particularly distinct are the differences in the type and degree of crust consolidation in the individual areas and zones, including unequal intensity of folding.

* Acad. Prof. Dr. M. Maheľ, DrSc., Geological Institute of the Slovak Academy of Sciences, Dúbravská cesta 9, 886 25 Bratislava.

The Alpine cycle is characterized by distinct stage-character: with overgrowing of Permian molasse troughs into structural facial zones of the carbonate stage in the Triassic; with manifestations of general oceanization in the Jurassic and Lower Cretaceous; with predominating flysch sequences in the Cretaceous and Paleogene; with three—periodical folding (Paleo-, Meso—and Neoalpine), with distinct orogenetic polarity; with formation of basins in several stages. The extent of granitization was relatively small, bound to narrow zones; on the other hand, extent of late—geosynclinal volcanics was considerable, with alkalic basalts appearing in the post—tectonic stage. To features characteristic of more global importance also the near—surface character of folding with extensive nappes, but with restricted extent of metamorphism belongs.

A consequence of the global character of folding manifestations and a result of a homogenous trend of development is homogeneity of the Alpine system with the existence of connections zones passing through several segments of the Alpides. Such ones are mainly the units folded out from oceanic or paraoceanic troughs, characterized by ophiolites or ophiolitoids. Their running through course is also supposed in those segments, in which they are not occurring directly at surface, on the basis of indirect evidence. An example of it is tracing of the Penninic through the Alps, but also through the whole Carpathians, Balkans, to the region of the Pontides (J. Aubouin — J. Debelmas, 1980; J. Debelmas et al., 1980). In segments where they do not occur at surface, they are identified with zones of tectonic melanges or sutures, e.g. the Klippen Belt of the West Carpathians.

Each of the Alpide segments displays a whole series of particularities of structure and development.

To search for the causes of these particularities is the objective of our contribution. We are particularly directed to the importance of unequal intensity of folding — one of the significant factors in consolidation of crust,

— to the importance of deep—seated faults, with which the differences in development and structure of the individual blocks are put into connection and

— to dissection of the geosyncline in relation to heterogeneity of crust.

1. Differences in intensity of folding

Between the individual segments of the Alpides there are more distinct differences in the intensity and extent of the individual Alpine periods of folding and in manifestations of polarity. A clear case is the conspicuously smaller extent of folding of the Mesoalpine period in the West Carpathians with more intense manifestations in the narrow zone of the Klippen Belt and Periklippen region only. The dominating manifestation of only one period of Paleoalpine folding in the essential part of the Inner Carpathians and of the Neoalpine folding in the Flysch Carpathians is the cause that we look at the Carpathians as a double mountain system with the belts of the Inner and Outer Carpathians. In the independence of both belts it is by far much greater than e.g. in the Eastern Alps, where besides the Paleoalpine folding a much more important rôle was played by the Mesoalpine folding, which overalps and links up closer the inner and outer zones (M. M a h e ľ, 1973, 1974).

As a matter of fact, the folding should be unterstood in a complex way and from many sides. The function of folding cannot be restricted only as structure—building factor and to see the differences between the segments of the Alpides, e.g. between the Eastern Alps and West Carpathians, in structural differences caused by the changes of intensity of folding only (B. L e š k o — J. V a r g a, 1980). The folding is one of the formers of crust type. With folding re—building of the paleotectonic and paleogeographical plan is connected. The extent of the intensity and type is of particular importance for further development of the individual regions. It gives the impulse to activation of new zones of intensive sedimentation.

Comparison of the West Carpathians and Eastern Alps can serve as an example of the difference of results of the major Paleoalpine folding. Also with considerable stratigraphic, but also structural conformities development in the essential part of the region of the Alps and Carpathians was partly different in the following Mesoalpine stage. In the Eastern Alps, on Paleoalpine units a very wide basin of the Gosau Cretaceous and Paleocene formed, affected later by Mesoalpine folding. In the Carpathians the extent of such a basin was restricted to the Periklippen zone, i.e. to the marginal part of the Inner-Carpathians only. In the Carpathians, however, basins of the Intracarpathian flysch formed later in the Lutetian as a consequence of subduction.

The differences of orogenetic polarity, distinct between the West Carpathians — Eastern Carpathians — Balkans (M. M a h e ľ, 1974) as reflection of heterogeneity of thickness and different dissection of crust in the individual segments are also prevailingly a consequence of unequal intensity of folding. A result is also a whole series of tectonic units typical of one or another segment. We should seek for, for instance, the Krížná nappe or only an analogue of the nappes of the Veporide crystalline — Krakľová, Kráľova hoľa nappes, analogues of the nappes of the Tatrides: Bratislava, Baďurka nappes of the Little Carpathians (M. M a h e ľ, 1980), or nappes of Giewont and Červené vrchy in the High Tatra in vain elsewhere than in the West Carpathians.

The basis of differences in thickness of crust between the individual segments of the Alpides is necessary to search already in unequal stabilization of the foundations of the Alpine geosyncline, formed by Hercynian foldings. Since longer ago have been known the differences between the Balkans and Dinarides. Still more distinct are the differences in the extent and areal distribution of accompanying granitization between these and other Alpide segments (M. M a h e ľ, 1978).

The changes in consequences of foldings are often apparent from segment to segment, in some places from one block to the adjacent block, as far as they are separated by transcrustal faults.

2. *The rôle of deep—seated faults in formation of particularities*

Between the segments of the Alpides are distinct differences in the number and so also in the influence of deep—seated faults on formations of particularities. Conspicuous is the difference in extent of younger superimposed structures, Tertiary basins and their accompanying neovolcanics. The differences are especially visible between the Eastern Alps with a low portion of superimposed structures and the inner morphostructurally dissected West Carpathians with numerous basins and extensive neovolcanics. Differences are between the West and East Carpathians. Whilst in the East Carpathians superimposed linear structures predominate, more or less parallel with older structural plans, in the West Carpathians are mostly basins of transversal orientation.

In the recent past the abundance and function of faults was almost exclusively put into connection with the period of desintegration of crust in the late—geosynclinal and post—geosynclinal stages of the development of the Alpine geosyncline. At present, however, it is accepted that in the West Carpathians the faults, which played a decisive rôle in development of Neogene basins, have their foundation at least already in the Mesozoic and many are older (M. M a h e ľ, 1972). A clear example is the Jastrabie fault system of NW-SE to W-E direction, which separates blocks with differences also in the structure of the pre-Mesozoic basement. They separate even two blocks with a different model of structure. The more western of the blocks called Danubian (O. F u s á n et al., 1980) is shown in the greater content and structural affinity to the Eastern Alps than in the remaining part of the West Carpathians; a greater extent of the Gosau Cretaceous, a more extensive overthrust of the Inner Carpathians on the Outer Carpathians a model of development and structure close to the East Alpine; (M. M a h e ľ, 1980).

Not a less important rôle in formation of particularities of the structure player the Hornád diagonal fault, accompanied also by sudden turning of the more western blocks to SE. Until lately is was put into connection with the boundary of the West Carpathians — East Carpathians. Our latest knowledge leads to the opinion that the substratum of the East Elovakian block has West Carpathians fundamental units but in other morpho—structural order with structural and content differences / almost complete covering of the southern zone of the Tatrides, a greater extent of more upper elements of the Veporides, a great extent of the Vysoká unit, a little extent of the Central Carpathian Paleogene — different model of the structure.

The mentioned faults, boundaries of blocks, are linked up with the lines of regional importance, they are their branches or younger manifestations: the Hornád line with the system Darnó—Balatón, the Jastrabie fault with upper Moravian fault system.

Of particular importance for the development and stressing of particularity are faults, which separate the individual segments of the Alpides. The Szolnok trough separates Apusins from the West Carpathians; the Vienna basin, which separates the West Carpathians from the Eastern Alps, is bound to a transversal structural element, with which also then the turning of the East Alpine structures from W-E to SW-NE direction should be put into connection (A. T o l l m a n n, 1976).

In the Dinarides are even four segments, which differ also in the character of ophiolites and flysch basins separated between the faults Skutari — Peč; Sarajevo, Banja luka, Zahreb-Balaton. Each of the blocks has its own facial features of Mesozoic development. The differences concern even also peridotites and associated rocks. The faults obviously reached at least the uppermost part of the mantle (J. Panič, 1977).

In the Balkans are distinct three segments with differences, beside others, also in the extent of flysch, banalites and granitoids, caused by two cryptoruptures (Tvardica and Etropole), obviously deep of old foundation (E. Bončev, 1974).

The deep—seated faults were functioning as the boundaries of zones of different crust thickness, different intensity of folding, as surfaces of discontinuity or weakening. They were in places sensitive to manifestation of processes of extension but also shortening, compression, subduction, but served also as ways of communication, securing linking of the paleogeographical environment with deep process. Connected with them are surficial manifestations of endogenic forces, geodynamic activity, but also kinematic changes. They are directing paleogeographical, content, structural and morphostructural dissection. The deep—seated faults played a significant rôle during development of the geosynclinal system and took a large part in formation of the particularity of each segment, often separate blocks of different crust type, are boundaries of different dissection of adjacent segments.

3. The dissection of the Alpine geosyncline-a consequence of heterogeneity of the crust

Each segment of the Alpides displays differences in dissection of the geosyncline and particularities of individual geotectonic zones. This is valid even also for zones with oceanic or paraoceanic type of crust, thus in those ones the origin of which is mostly a consequence of global manifestations. The ophiolite troughs are also of different dissection in various segments. The differences concern the extent and dissection of their island zones with thicker but dissected crust but also dissection and the content of ophiolitic sequences. An example of this are the changes of the Middle Penninic zone olang the Alps (R. Trűmpy et al., 1980). Unequivocal is the difference between the Penninic and its analogue, the eastern continuation of the Transylvanic (J. Debelmas et al., 1980). In the Penninic of the Alps the features characteristic of ophiolite zones, a thick ophiolite group, transition through the pre—flysch into thick flysch complexes and a distinct high—pressure metamorphism are prevailing. In the Transylvanides only some members (Upper Triassic, Liassic) display features of formation of the paraoceanic type (M. Sandulescu, 1980); the Upper Jurassic has even several shallow—water facies and the extent of the following flysch complexes is small.

In the West Carpathians the ophiolite zone proper — interlink between the Penninic and Transylvanic, may be supposed and located according to indirect features only, as follows:

a) analogy of tectonic conditions in the Little Carpathians with the area of the aesternmost tectonic inlier of Rechnitzer (M. Mahel', 1980 b).

b) abundance of minerals and fragments coming from ultrabasics (M. Mišík et al., 1980).

c) Paleogeographic relations of flysch sequences, which show more extensive amputations of sedimentation areas (R. Marschalko, 1978);

d) Basin with active sedimentation of the Upper Cretaceous and Eocene above the supposed zone of subduction — Periklippen zone (M. M a h e ľ, 1980), formed structurally in two periods of folding: Paleoalpine and Mesoalpine — equally as the Penninic and its analogues.

In the West Carpathians an indisputable example of particularity of troughs with oceanic and paraoceanic crust type are: the Klippen Belt and Bűkkides south of the Austroalpine-Gemeride. To the particularities belongs also the wide dissected Flysch Belt at the outer margins of the Pienides and the existence of the distinct Jurassic-Lower-Cretaceous Zliechov trough with main members analogous to those accompanying ophiolitic series everywhere without associated ophiolites: Fleckenmergel, radiolarites, pelitomorph, calpionel and nannocone limestones.

The differences between individual segments of the Alpides in dissection of shelf zones are not lesser. The number of zones with facies of basin type is already in the Triassic in the Eastern Alps different from the West Carpathians and different in the Dinarides.

The consequence of differences in the paleogeographical dissection and in the dissection of crust of individual segments of Alpides is the different number of tectonic units and also the fact that the units mostly as tectonic bodies do not exceed the extent of several segments.

In what, however, lie the causes of paleogeographic dissection of the Alpine geosyncline and its differences in individual segments of the Alpides?

In the West Carpathians we have distinctly advanced in the last years in the knowledge of paleogeographical distribution but also in dissection of the crystalline substratum of the Inner Carpathians from the original three types (Tatric, Veporide, Gemeride) to seven zones, of mutually different type of crust (M. M a h e ľ, 1980). An interesting spatial linking of Mesozoic paleotectonic zones to certain types of the pre—Mesozoic substratum has shown there. Conspicuous is spatial linking of zones with more deep—water type of trough sequences to the zones without granitoids with a considerable share of basics in the pre-Permian complexes. On the contrary, the Alpine zones of ridge type display linking to zones with large bodies of granitoids. We have concluded that the foundation of the structural—facial dissection of the Carpathian geosyncline has historical conditions, its basis in the heterogeneity of crust formed already in the Hercynian stage (M. M a h e ľ, 1978, 1980). This heterogeneity began to be manifested already in the Permian with foundation of longitudinal troughs, which became the basis of the later geosyncline. Their distribution is bound to the margins of zones with a thicker crust with granitoids.

In the beginnings of formation of the Alpine geosyncline in the Triassic rifts and basins — channels amidst the shelf sea originated in the southern zones, in zones without granitoid substratum. In the West Carpathians we put into connection with that period formation of the ophiolite zone of the Bűkkides and protrusions of ultrabasics in the North-Gemeride zone.

In the period of distinct oceanization of the Alpides in the Jurassic and Lower Cretaceous troughs formed mainly in the more northern zones: the Zliechov trough overlying the North Veporide granite-free zone; the Fatric trough at the northern margins of the Tatride zone with gradual transition into the Penninic, without granites in the substratum (M. M a h e ľ, 1980a). The

Pezinok — Pernek group and to the north — Inovec crystalline represented the sou.hern margin of the wider zone without granitoid substratum, which in its essential part formed the substratum of the dissected zone of the Penninic.

The units of ridge type: Tatride, Struženík are linked-up with the crystalline charactedized by large granitoid massifs (Tatride and Kráľova hoľa).

The connection of the Mesozoic trough with a thinner crust on the zone „without granites" and zones with thicker crust, ridges on zones with thicker granitoids puts the question of causal dependences of dissection of the geosyncline and so of particularity of the individual segments.

4. The particulities of manifestations of hereditary factors and heterogeneity of crust

It resulted from the above mentioned that the global factors, the fundamental features of the trend of development with periods of contractions-folding but also the rift-genesis, thinning and expansion of the crust, transcurrent faults, orientation of the major fault system, equally as some tectonic units, running trough several segments ensure the homogeneity of the Alpide system.

Each segment and also the individual blocks in it display particularities of development, which at last result in distinct morphostructural and structural differences.

In formation of the particularities the differences in intensity and extent of the individual periods of folding, the number and distribution of deep—seating faults take part. The firs trate rôle in forming of the differences of the dissection of the geosyncline have areal differences of the thickness and type of crust and the influence of deep processes on its changes. In dissection of the crust the historical linking of the paleogeographic antagonistic zones of the Alpine geosyncline, its troughs and ridges plays an important rôle there with the pre-Mesozoic zones of different composition, different crust type. Such a connection or manifestation of crust heritage is a regulator of particularities of individual segments and blocks, at the same time i. is a „counter—player", antithesis, somewhere complementary component of global manifestations. A mark of manifestations of heritage is the fact that zones with granitoid and migmatite massifs and zones with numerous eugesync'inal magmatites (of diabase and spilite-keratophyre formations equally as also ophiolite zones) „avoid" one another, dissect the pre-Alpine basement into blocks with different type of crust. They were manifested each in a particular way with Hercynian consolidation (M. M a h e ľ, 1980).

The areal distribution of zones with granitoids and migmatites and zones with eugesynclinal type of magmatites is the foundation of dissection of the pre-Alpine basement. The share of these fundamental indicators of crust type and their distribution are unequal in the individual segments of the Alpides. The East Carpathians, for instance, display a less share of granitoids. The majority of the pre-Alpine groups is rich in basics, in other ones quartz porphyries or volcanics of intermediate type (insular type) play a determining rôle. In the Alps granitoid massifs are characteristic of the Helvetic, par.ly also of the zone of the Middle Penninic and they are particularly abundant in the Unterostalpine, also in the Mittelostalpine. Characteristic of the zone of Southern Penninic (typical Alpine ophiolite zone) is the small share or missing of pre-Alpine granitoids.

In the West Carpathians we distinguish even seven zones of the pre-Alpine basement according to present-day stage of knowledge. Two of them (the South Veporide and South Tatride) are characterized by massifs of granitoids and migmatites. The accompanying three zones (Periklippen, North--Veporide and North Gemeride) are characterized by numerous bodies of amphibolites; the southernmost by diabases accompanied by gabbros and sporadical ultrabasics. Characteristic of the sixth zone in order, the Volovec zone, are quartz porphyries and Late Hercynian-Alpine granites. The southernmost zone, the Bűkkides, has no granitoids and displays weaker effects of Hercynian folding (M. M a h e ľ, 1978).

Of particular importance in formation of the crust type are granitoids. Their massifs were manifested as factors of uplifting tendencies. Conspicuous is radiometrical confirming of several ages of granitoid bodies with changes of the type of granitization: with manifestations of extensive synkinematic migmatization, mainly during the pre-Hercynian stages, with formation of large bodies in the Hercynian period and formation of smaller marginal bodies at margins of older massifs in the Alpine period. The several stages of formation of plutonite bodies proved radiometrically in the last years even also in such bodies, which up to lately were considered as typical Alpine Eisenkappel, Adamello, Gemeride granites) and on the contrary, proving of the Paleoalpine age of a part of „typically" Hercynian granitoid bodies (Southern Veporides, south Bulgarian) indicate, that just the granitoids are the most distinct bearers of historical linking of the Alpine stage with the preceding ones. Activation of granitoid bodies proves there that together with deep——seated transcrustal faults they are the main communicators between deep processes und upper parts of crust. This leads us to the idea to see in them the bearers of crustal „genes", which are regulators of heritage, in development of the earth crust. There is not persistency, outlasting or permanent manifestations of thinner and thicker crust but manifestation of its type in development in periods of distinct changes of kinematic conditions of global character.

We understand the manifestations of global factors so in unity with the particularities of individual segments, which result from hereditary dispositions, mainly from distribution of zones of various crust types with particular importance of distribution of granitoid bodies.

Thus we see the cause of difference in dissection of the individual Alpide segments, in the unequal extent and distribution of granitoids and basics or ultrabasics in individual segments of the Alpides. Both these indicators of crust type have their historical anchorage. Spatially they usually avoid. Ophiolites are linked with zones of deep-water troughs and usually connected with zones, which displayed a thinner type of crust in the preceding period, characterized by abundant basics and smaller accompanying bodies of ultrabasic rocks. The ophiolite zones of the Alpides do not represent „new forms" independent on preceding development but have their „ancestors". This is equally valid for Jurassic-Lower Cretaceous troughs with deep—water limestones and marls (Fleckenmergel, nannocone and calpionel limestones; radiolarites), which are accompanying ophiolites or part of their melanges.

An antagonistic type are larger bodies of granitoids and accompanying migmatites, prevailingly Hercynian, which played a particular rôle in formation of the Alpine zones with thicker crust. More often Hercynian granitoids display manifestations of rejuvenization. The process of further formation of granitoid massifs reaches over to the Alpine stage in zones of intensive shortening, mainly in root zones of nappes.

The importance of granitoid massifs in development of folded mountains is reinforced by their rôle in formation of volcanoplutonic and volcano—sedimentary formations bound to zones of activation at the margins of granitoids.

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