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DEEP STRUCTURE OR THE VIENNA AND DANUBE BASINS IN RELATION TO CRUST TYPES

(Figs. 1—2)

Abstract: The Vienna basin is a type of interblock-intermontane depression, which displays an anomalous structure in relation to the fore-deep and to intramontane basins. In deep structure the Vienna basin has integrating elements with the Danube basin. Both basins are divided by the Nesvačilka-Trnava fault into more stable NE and more mobile SW blocks. The basins are divided by the Peripieninic lineament, accompanied by an elevation belt prognostic for combustible depostits. So the deep rissection integrates two basins different genetically and in position. I put the origin of basins into connection with endogenic subcrustal processes.

Резюме: Венский бассейн является типом межблоковой-межгорной депрессии, у которой, в отношении к передовой впадине и внутригорским бассейнам, аномальная структура. В глубинной структуре имеет Венский бассейн интегрирующие элементы с Дунайским бассейном. Оба бассейна разделены Несвачилско-Трнавским разломом на СВ более стабильные и ЮЗ более мобильные блоки. Бассейны разделены перипиенинским линеаментом сопровождаемым поясом поднятия, прогнозным на горючих ископаемых. Таким образом, глубинное расчленение интегрует два отличающихся генетически и что касается положения, бассейна. Возникновение басейнов связываю с эндогенными подкоровыми процессами.

The Vienna basin extends at the contact of the West Carpathians and Bohemian massif and is a type of interblock-intermontane basin. The composition of the fundament of basin has not been known so far. Regionally it belongs to the Bohemian massif (F. Němec — G. Kocák, 1976), to the Brunnia block with simatic crust according to J. Zeman (1978), the autonomous block of J. Weiss (1978), mainly defined according to geophysical data (B. Beránek, 1978). According to H. D. Klemm (1978) the Vienna basin was founded on a crust of transitional type and should be a basin at the contact of continental and oceanic crust. In my opinion this definition is not precise. I suppose that there is a continental type of crust, however, weakly consolidated-prevailingly basified type of crust. According to my assumption, the granodiorite Brno massif terminates approximately at the Lednice line or does not reach very far to the east. Farther, in eastern direction granodiorites are replaced by basic rocks. I am basing this hypothetic assumption on different mobility of the basement of basin in the Tertiary. The gravimetric data, however, do not correlate with this assumption, which fact I attribute to lower crustal effects (serpentinization of crust?) and the influences of thick sedimentary filling.

The Cadomian consolidation was already terminated in the Devonian, sinking renewed, continuing in the Carboniferous and Mesozoic. There is a longdated mobile section of crust. Its thickness attains 32—34 km according to

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seismics, if we subtract 3 to 4 km thickness of sedimentary filling and 3 to 4 km thickness of nappes, the original crust was 26—28 km thick.

The deepest boreholes in the Slovak part of the Vienna basin, Šaštín-12 (6505 m) and Lakšárska Nová Ves-7(6405 m) ended in the Triassic, probably of the Choč nappe. F. Němec — G. Kocák (1976) place here the nappes of the Eastern Alps, sunken nappes of the Magura flysch and slices of the Klippen Belt.

On the basis of reflection-seismic profiles the basement of the Vienna basin is at depth 7 km. According to the DSS VI profile the autonomous crustal block on the mantle elevation slopes is inclined to west. In interpretation of B. Beránek et al. (1972) the crustal block forms a large graben. An open problem remains explanation of the largest negative gravity anomaly known by us and positive magnetic anomaly in this region. Recently Č. Tomek et al. (1979) interpret the source of anomaly by the existence of porous sediments of the fore-deep, which could be possible collectors of carbohydrates.

In the Vienna basin faults penetrating the fundament are crosing:

a) From the Bohemian massif in ENE—WSW, W—E directions (Leváre—Sološnica partial graben) and NW—SE direction obviously running out from the Nesvačilka—Vranovice graben (A. Dudek — V. Špička, 1975). M. Mahel' (1978b) extrapolates these faults as far as the Pannonian region.

b) From the Outer Carpathians, faults of NE—SW direction. T. Buday (1961) connects location of the basin with the area of crossing of the Peripieninic and Labe lineaments (the so called Sudetic dislocation of the Hornomoravský úval depression). Latest geophysical and geological works, however, proved that of greatest importance — as to location of the Vienna basin — were the deep-seated Lednice and Peripieninic faults. The Labe fault system was manifested subordinately at the northern border of the basin only.

Thickness of Neogene filling in the deepest blocks (Leváre graben, Kúty graben) attains more than 5 500 m and the Vienna basin together with the Danube basin is ranged to the most mobile basins. From the view-point of the deep structure is interesting that both most mobile parts of the Vienna and Danube basins are contiguous to the belt of the Peripieninic lineament, bordered in NW by the Lednice and in SE by the Rába line (Fig. 1). From crustal view-point the belt is heterogeneous as contrastness and uncorrelability of gravity and magnetic anomalies show. Both depressions, i.e. the Leváre and Gabčikovo depressions are separated by an elevation zone of the basement in the belt of the Peripieninic lineament, occurring at the the surface as the Malé Karpaty Mts.

In the tectonic structure of the Vienna basin faults of NW—SE direction take part, parallel, but not identical with the Labe sysem, linked with the Nesvačilka and Vranovice grabens SE of Brno (A. Dudek — V. Špička, 1975). Continuation of faults of this direction is mentioned by O. Fusán et al. (1979) in the Trnava — Nové Zámky line and other two parallel faults in the Danube lowland (see Fig. 1). According to up to present DSS data about the crust — mantle boundary in the place of occurrence of these faults is a change at depth and the margin of mantle elevation takes its course here.

Up to present solving of deep tectonics did not take into account relations of the tectonic regime to crust types. Setting out from the synthetic work by

M. M a h e ľ (1978b) I tried to work out this new approach to solving the deep structure. With extrapolation I completed Moho depth lines in the Vienna region and SW part of the Danube basin with application of the data of J. K v i t k o v i č — J. P l a n č á r (1975), taking into regard geophysical interpretation of relations established, from which a rapidly lessening extent of sinking of the Neogene basement in the belt of increasing crust thickness results — see the Danube block.

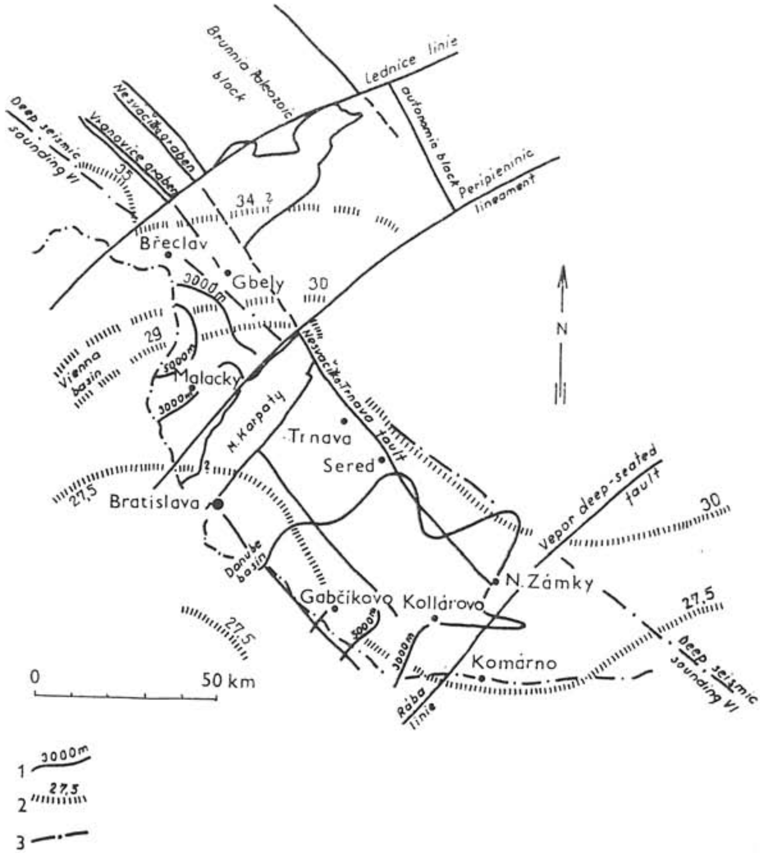

Fig. 1. Tectonic sketch-map of most mobile parts of the Vienna and Danube basins.

1 — depth of Neogene base (modified without faults according to F. N ě m e c — G. K o c á k, 1976 and O. F u s á n et al., 1971), 2 — depth to Moho in km (modified according to B. B e r á n e k 1978), 3 — DSS VI profile.

Geological knowledge about the deep structure of the Danube basin was worked out by T. B u d a y — V. Š p i č k a (1964) and O. F u s á n et al. (1971). The Danube basin, similarly as the Vienna basin, is lying at the boundary of geologically different units — the West Carpathian and Pannonian — characteristic of which is a various degree of attained consolidation.

The tectonic structure of the Danube basin displays mixed features and according to B u d a y's classification, the southern part of the basin belongs to the type of superposed basins, the northern part to the type of longitudinal basins with inherited structures (three „bays" of NE—SW direction, conditioned by elevations of the Považský Inovec and Thíbeč Mts.). The Carpathian crystalline units, occurring in the basement elevation, were deeply drawn in sinking, to depth of 5 km, at the margin with the Pannonian block.

The basement of the South-Slovakian basin is better known when compared with the fundament of the Vienna basin because it was encountered in several boreholes. On the basis of data from deep boreholes I tried to clear up nearer the geological-petrographic character of this submerged crystalline and to correlate these data with gravimetric anomalies, which alternate in direction NW—SE here. The axes of these anomalies correspond to structural directions of the basement.

The negative gravity anomaly in the Trnava area is of regional character and its source, judging from maps of regional anomalies for depths 12 — 20 km (O. F u s á n et al., 1971), is lying very deep. Foundation of the extensive depression was preceded by partial sinking and formation of basins N and S of present-day basin. The integration of heterogeneous units to basin downwarping was caused by Pliocene sinking movements.

The crystalline encountered by boreholes NW of the Vepor deep-seated fault (Danube block) is formed in the northern part by mica schists and phyllites, making up the mantle of the Tríbeč granite massif, in the NW part by granitoids of the Malé Karpaty Mts. These — equally as the Tríbeč Mts., are lying in the belt of positive anomalies and interpreted as massifs without deeper roots (B. B e r á n e k, 1979). On the contrary, the negative anomaly along the Rába line linked with the Central Slovakian neovolcanic region, in my opinion, can indicate hidden acid intrusive masses, which brought fort stabilization or slight uplift of the block between Komárno and Štúrovo where also coal-bearing strata deposited (Štúrovo deposit).

In composition of the crystalline we do not find an explanation of these deeper rooted anomalies. From the view-point of crust types the statement is important that granitoids are not of deep reach and obviously there are particular bodies, which are not connected by a coherent thick granite layer (B. B e r á n e k, 1979). In this sense I should not agree with the interpretation of O. F u s á n et al. (1971) about connection of granitoids drilled near Dedina Mládeže and Pozba into one continuous body. I should prefer the conception of small bodies, possibly connected by hypothetic Miocene acid magmatites at depth (possibly linear intrusions) into a body with lesser gravity effects (Fig. 2). It could be evident from the map of B e r á n e k that the depth of the lighter body is not more than 15 km. There could be anatexites, which did not reach the surface under the influence of compression at the Vepor fault.

In areas with no occurrences of granitoids the crystalline is prevailingly formed by mica schits and two-mica paragneisses. Only in the area of Sereď — Sládkovičovo phyllites, in places brecciaed, were drilled. I consider them as remnant of tectonic depression in the crystalline, in NNE — SSW to N—S direction (Fig. 2). As a further old depression zone I consider the area between Levice and Šurany where mica schists and abundant amphibolites have been found (borehole Šurany—1). This depression was separated by a zone of diorites and smaller granodiorite massifs from the Komárno—Šahy depression, in which greatest thicknesses of metabasites were found (Fig. 2).

On the contrary to elevation units of the crystalline with granitoids, with rising tendency, in the South Slovakian region the crystalline is submerged with lacking granitoids and vice versa with predominanting metabasites (ori-

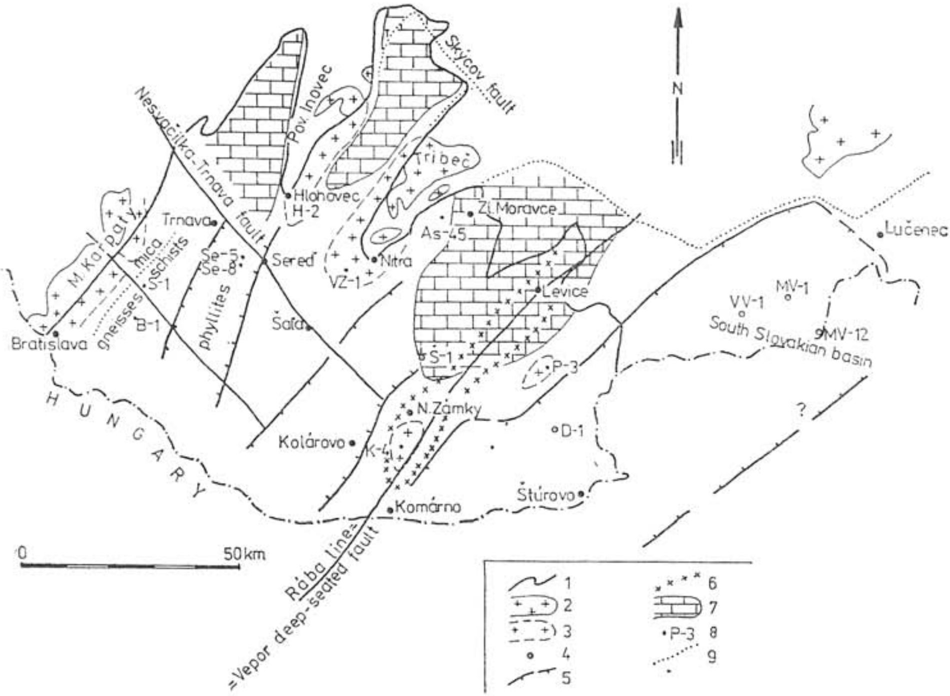

Fig. 2. Reconstruction of crust types in the crystalline basement of the Danube basin (model solution).
1 — margin of the Neogene basin, 2 — granitoids at surface, 3 — granitoids at depth (supposed extension), 4 — drilled amphibolites, 5 — depression zones, 6 — hypothetic Neogene intrusion, 7 — pre-Neogene depressions filled up with nappes, 8 — boreholes, 9 — supposed boundary of the continental and suboceanic crust before Hercynian metamorphism.

ginally the sedimentary-volcanogenic complex more than 600 m thick encountered by borehole MV —12 SV of Bušince). The prevalence of metapelites only indicated the original type of thin mobile crust with thin granite layer of originally suboceanic type. In this regard I should not extrapolate a highly granitized belt from the Inovec and Tríbeč Mts. to SW as performed by M. M a h e ľ (1978b).

From the masses of piled up nappes and at depths more than 2 000 m I conclude that they accumulated in depressions of primary simatic character, with heavier crust (densities of metapelites 2,71 — 2,72 . 10^3 kg. m^{-3}, A. B i e l a 1978) and thus more liable to sinking. An indirect evidence are also mica schists drilled west of Zlaté Moravce by borehole As—45 (Fig. 2).

As approximate boundary of this crust, closer to oceanic crust in its character, I consider northern delimitation of the positive gravitational field. The mobility of this crust increased in eastern direction where it persisted to the Late Paleozoic. M. M a h e ľ (1978a, b), I. V a r g a (1978) and R. M o c k (1978) call attention to unmaturity of continental crust in this unit by the influence of weak Hercynian tectogenesis (unterminated cycle) and its liability to mobility. A weak or missing granitization was also proved by boreholes sunk so far, which have neither encountered migmatites nor orthogneisses.

The data about composition of underlying rocks in the adjacent part of Hungary (G. W e i n 1969; B. J a n t s k ý, 1976) show that beside the Šoproň granitoids also here the substratum of Neogene basins is formed by the crystalline or Early Paleozoic groups indicating sedimentation on a crust of rather suboceanic type, with weak Hercynian consolidation (M. M a h e ľ, 1978b). Further on, I should stress the conspicuous accordance of indications of premetamorphic depressions with repeating sinking in the time of nappe overthrust. The inheritance of mobility would be caused by a different type of crust. On the contrary, it is surprising that besides formation of partial flysch depressions on both sides of the Považský Inovec Mts. already no deepening took place in the Neogene. This fact confirms that the influence of even heavy nappe masses (carbonate densities 2,7 — 2,8 . 10^3kg.m^{-3}) without the effect of deep processes cannot be the cause of basin sinking. The dissection into depression and elevation belts running out from the Inovec and Tríbeč Mts. inherits the old dissection of the crystalline when the elevation belts corresponded to the presence of lighter granitoid rocks. It may be concluded from the example of the Danube basin that the crust preserved different mobility also in the time of its Neogene rebuilding, as a consequence of its differentiation into more and less granitized crust.

On the basis of complex valuation of geological and geophysical data a tectonic structure may be concluded, from which results:

a) The Vienna and Danube basins have common features in relation of the deepest sunken blocks to the belt of great crust thickness change with great horizontal gradient of change 60 m/km (in the central part of the West Carpathians this gradient attains 80 m/km, in the Pannonian basin 50—90 m/km).

b) The most mobile blocks are delimited by longitudinal deep-seated faults and transveral deeper faults of NW — SE direction, the NE boundary of mobile blocks is the Nesvačilka — Trnava fault zone. This zone borders the elongated mobile Záhorie — Danube sector and separates it from the higher block in NE.

c) Transversal dissection into mobile and stable blocks is surely in connection with the course of the elevation margin at depth.

d) The Malé Karpaty Mts. elevation separating both basins, longitudinal to their boundaries and transversal to the mobile belt is kinetically bound to the Peripieninic lineament and neotectonic movements of elevation character in this lineament sector.

On the basis of the basement structure analysis of the Vienna and Danube basins and on the basis of correlation of the basement structure of these basins with geophysical data I succeeded to find out so far unknown regional — tectonic relations and dissection integrating development and deeper structure of two apparently genetically different basins, lying at the contact of two Neoid megablocks — the Bohemian massif and West Carpathians. The above mentioned knowledge stresses still more the importance of Neogene structural rebuilding in the sphere of the effects of the mantle diapir of the Pannonian basin.

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