

Relation of fuel deposits to the deep structure and development of the Pannonian basin

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Отношение месторождений угля к глубинному строению и развитию панонской впадины

Панонская впадина в своих периферийных структурах является комплексной мегаструктурой для месторождений горючих ископаемых. Её фундамент представляет гетерогенная кора под отдельными депрессиями субокеанического характера с наследственной мобильностью. Эта кора была уже примарно утончена. В конце терциера произошла интеграция блоков на панонский мегаблок с новым планом структурных разломов. Глубинные причины её развития связываем, в согласии с другими авторами, с термодинамическим развитием панонского покровного диапира. Поднятие диапира способствовало стагнации, погружению впадин и для возникновения угольных месторождений. Коллапсовая стадия диапира приводит к освобождению углеводородов и к их миграции в новые структуры. На их распределении приняли участие районы с различно высокими теплотными потоками. Месторождения угля находятся в хорошей корреляции с блоковым строением фундамента впадины. Для месторождений углеводородов корреляция замечается. В общем, для аккумуляции горючих полезных ископаемых являются подходящими периферийные части диапира. Положительную роль при этом имели перипанонские и инсубрические линияменты на контактах с диапиром. С точки зрения развития коры указаны корреляционные феномены характерные и для чешских угольных бассейнов.

Relation of fuel deposits to the deep structure and development of the Pannonian basin

In its marginal structures, the Pannonian basin represents a complex megastructure containing deposits of natural fuels. Its basement is built by heterogeneous type of crust where, beneath partial depressions, the crust has suboceanic nature

with inherited mobility. In these parts, the presence of primary attenuated crust is supposed. At the end of the Cenozoic, single crustal blocks participating on the structure of the recent Pannonian basin became integrated into the Pannonian megablock structure and a new structural framework of faults has been imposed. Concordantly with other authors, we relate the deep-seated sources of the development to the thermodynamic development of the Pannonian mantle diapir. The uprise of the diapir imposed stagnation onto depressional movements of partial basins and created by that favourable conditions for the generation of coal seams. The subsequent stage of collapse of the diapir led to squeezing out and migration of hydrocarbons into new structural traps. Several areas with different heat-flow values participated in the distribution of hydrocarbon accumulations. Deposits of coal reveal good correlation with the block structure of the basement. To the contrary, any relation may be proved in the case of hydrocarbons. Generally, the most favourable conditions for the accumulation of deposits of natural fuels occur along the periphery of the diapir where the Peripieninic and Insubric lineaments played positive role being located along the margin of the diapir. Common features of development with Bohemian coal-bearing basins are indicated as well.

The Pannonian basin is girdled by the orogenic belt of the folded Eastern Alps, Carpathians and Dinarides, the structures of which do not continue inside of the basin and emphasize its autonomy mainly during the neotectonic epoch of the development. Both geological and geophysical knowledge prove the pre-Cenozoic block structure of the basin basement which appears mostly discordant to the block structure within the sedimentary basin filling of Neogene age. The distribution of deposits of coal and accumulations of oil and natural gas are influenced by this structure. Considerable significance for the generation of these fuel deposits is ascribed to tectonic reconstruction of Neogene age caused by deepseated processes.

Geological knowledge of the deep structure

A pronounced positive gravitational field characterizes the Pannonian basin extending into the inner units of the orogenic girdle around the basin. The gravitational field correlates well with seismologically proved crust attenuated over the upper mantle diapir in the area (L. Stegena et al. 1975). From the basinal margin towards the orogenic girdle, crustal thicknesses become doubled. The contact between the thick and thin crust is of tectonic nature and, in the Carpathian arc, it runs along the Peripieninic lineament. Similarly, at the eastern margin of the Eastern Alps, a jump in crustal thickness has been stated from 63 km in

Central Tauern Mts. to 30 km in the Semmering area (K. Arik — R. Gutdeutsch 1975). The crustal contact in the Alpine-Carpathian girdle is seismically active whereas the Pannonian basin is considered to represent an aseismic unit (G. Schneider 1978). Dynamical analysis of earthquakes proved that strain axes rotate along the W and SW margin of the Pannonian basin (G. Gangl 1975). The seismicity indicates also a deep-seated origin of its arched shape.

P-wave velocities reveal decrease of upper mantle velocities by $0.5 \text{ km} \cdot \text{s}^{-1}$ beneath the Pannonian basin and the Southern Carpathians when comparing with those beneath Western and Eastern Carpathians (L. P. Vinnik et al. 1975) in the latter correlating with mantle velocities of the platform foreland. Velocity data point to block structure of the upper mantle around the mantle diapir assigned by us as the Pannonian (mantle) diapir. The geophysical picture but even the tectonic structure and also the geological setting are correlatable with features of the Afghanian — Tadzhik depression girdled by the Southern Tien-Shan and Pamir Mts.

The seismotectonic activity along the Peripieninic lineament which runs in tangential direction to the mantle diapir is caused by shear movements where the tectonic strain cumulates in the more rigid

mantle of low heat-flow values girdling the higher tempered one (L. P. Vinnik et al. 1975). The tangential strain relation along marginal shear fault belts towards the mantle diapir resembles relations around other similar deep structures: the Great Basin (C. H. Scholz et al. 1971) or the Red Sea (J. D. Lowell et al. 1978). The distribution of tectonic strain is in accordance even with the simulated diapir by modelling which caused belts of tangential strain along the margins of the diapir summit (M. V. Gzovskiy 1960).

The gravitative effect of the Pannonian diapir conceals the original gravimetric heterogeneity deduced from derived gravimetric maps (B. Beránek 1979). The latter correlates well with the geological experience upon the block structure proved in the northern part of the Pannonian basin. Investigations of block structure remodelling are promoted by data on seismic activity along the limits of recent block units as well (V. Kárník 1975).

Geophysical data from the Transylvanian and East Slovakian basins, where partial gravimetric anomalies of regional extent and of oval shape were found, may be interpreted in the sense of mantle diapir differentiation into partial elevations. The distribution of deep-seated faults in these basins points to their similar tangential relations around the partial diapir as it is

the case with the Peripieninic lineament to the Pannonian diapir. Recent knowledge on the deep structure and on the relation of marginal intra-Carpathian basins led us to assimilate the Danube basin, the South Slovakian and East Slovakian basins among peripheral partial basins of the Pannonian basin proper. We suppose similar deep connections to the endogenous development of the Pannonian megastructure also in the case of the Vienna basin.

Type of crust in the Pannonian basin basement

The basement of the Pannonian basin is assumed to represent a central massif (E. Bonchev 1978). Contrary to other central massifs, any sufficient crustal consolidation may be assumed here. It follows from data by Gy. Wein (1969), B. Jantsky (1976) and M. Mahel (1978) that the Pannonian crust achieved only insufficient uniformity and pronounced substantial inhomogenities occur within the area. Hence, partial mobile depressions developed here during the Mesozoic as well, being situated above slightly consolidated crustal segments of, likely, even oceanic nature: the Mureş trough and the Igal — Bükk trough (M. Mahel 1978). The small share of granitoids in the basement together with the appearance of tholeiitic

and, on the other hand, of alkaline basites as well as elevations alternating with depressions and the repeating mobility of depressions, this all points to the existence of slightly consolidated crust beside belts of more intensively sialitized portions. The mass development of andesite and rhyolite suite in the northern part of the basin during the Neogene may be assumed to reflect increase of continental crustal thickness along a pre-Cenozoic mobile belt situated above suboceanic type of crust. This crustal type occurred mostly also in the basement of South Slovakian basins (F. Čech 1978, 1979).

We consider the Pannonian megastructure to represent an unevenly consolidated and heterogenous crustal segment which constituted originally part of the Paleotethys and where likely, during the Jurassic, relics of oceanic crust still survived. The small amount of basalts does not fit the supposition of L. Stegena et al. (1975) on extensive deep erosion of the basaltic crustal layer as the sole process that caused crustal attenuation. We assume that the crust has been of primarily thinner nature as from the Paleozoic and, supposing that single crustal segments became thicker in belts of granitization, the crust became attenuated mainly due to basification imposed by the mantle diapir during the Cenozoic. A basin with such crustal type is favourable site for the ge-

neration and preservation of a variety of fuel deposits. Therefore the Pannonian basin represents a complex megastructure of fuel deposits.

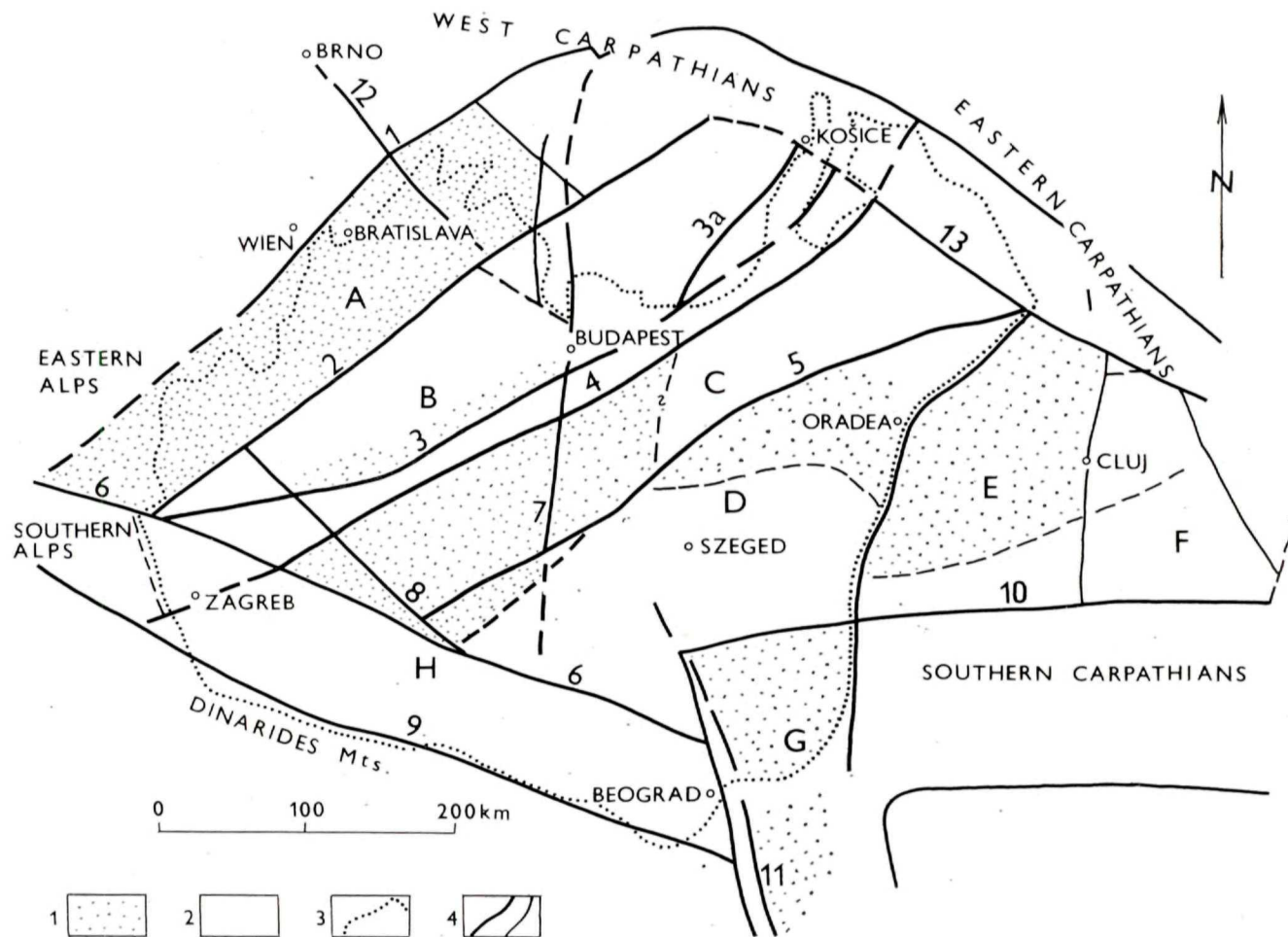
The block structure and its development

We interpret (cf. F. Čech — J. Zeman 1979) here deep-seated faults of NE-SW course (Gy. Wein 1969) delimiting crustal blocks stretching in the same directions. As we delimit and call them according to crustal types present, the new names do not respect the until used ones. Other limits and names are found in D. Hovorka (1979), M. Maheľ (1978) and P. Grečula — I. Varga (1979). From the tectonic viewpoint, the most important deep-seated fault in the area was the Zagreb — Kulcs one with almost parallel Balaton deep-seated fault. Subparallel orientation to the former has the Rába line delimiting together with the Peripieninic lineament the Sopron block of sialic crust. On the Slovakian territory, this block continues into the Danubian block defined by O. Fusán et al. (1971) which became separated from the former most probably but during the post-Badenian time.

The Rába and Zagreb — Kulcs deep-seated faults delimit the Balaton block of highest mobility within the Pannonian megastructure and of simatic nature. The

presence of basic rock masses along linear structures (indicated by extensive magnetic anomaly along the Rába line as well) and the overwhelming metapelites present are in accordance with our knowledge about long-lasting subsidence within the block as from the Paleozoic (Gy. Wein 1969) at the same time indicating suboceanic type of crust (Fig. 1.). The mobility of the block survived till to the Pliocene. Before the Neogene, the Balaton block stretched as far as Southern Slovakia when the Gemeride crystalline beneath the South Slovakian basin constituted its part as well. It is likely that the Darnó line deviating from the Balaton deep-seated fault separated the former unitary block into the East and South Slovakian blocks but during the Neogene. The similar type of crust may point to the common relation of the East Slovakian area with the crustal type present within the Balaton block proved also by basic and ultrabasic rocks uncovered by drilling in the basement of the East Slovakian basin (F. Čech 1980).

Southeasternly from the Balaton block, a crustal segment of linear shape and containing granitoids reflected repeated elevational tendencies during the evolution of the Pannonian crust. According to our interpretation, this sialic block has been limited on the SE by a tectonic line that determined the site of the Szolnok deep-seated fault.



The high mobility in the Szolnok trough has been likely influenced by partial remobilization of the block itself as well. We assign this block as the Paleopannonian block s. s. assuming it to create the sialic remnant of an originally more extensive structure, the Paleopannonian block s. l. which originated by the end of the Paleogene joining the originally simatic Tisza block structure. The Tisza block does not cover the original Tisza of Gy. Princz (1922 in Gy. Wein 1969). Its geological development was of complex nature and remains until insufficiently known (cf. M. MaheI 1978). The Tisza block has been bordered by the Apuseni block structure of heterogenous nature and of various type of crust. This block became probably separated from

more southern sialic blocks by crustal segment of suboceanic and even possibly of oceanic type indicated in the Mureş trough (M. MaheI 1978) still during the Jurassic. The structural segmentation occurred here mostly in E—W direction as it is indicated by the strike of single tectonic units, for example in the Moesia platform or in the southern arc of the Carpathians. Similar strikes are interpreted also in the eastern margin of the Dinarides and in the Vardar zone by B. Šikšek (1976) for the time before the Upper Paleozoic. The original limits of the Tisza block have had likely also E—W course running along a belt of continental crust that joined the recent Mecsek Mts. with the Serbo-Macedonian massif (M. MaheI 1978), but mainly

Fig. 1. Block structure of the Pannonian basin. Explanations: Deep-seated faults and lineaments: 1 — Peripieninic lineament, 2 — the Rába and Vepor deep-seated faults, 3 — the Balaton (3a — Darnó) deep-seated fault, 4 — the Zagreb — Kulcs deep-seated fault, 5 — the Szolnok deep-seated fault, 6 — Periadriatic (Insubric) lineament, 7 — Danubian (Central Carpathian) fault, 8 — the Drava deep-seated fault, 9 — the Sava (Peridinarian) deep-seated fault, 10 — the Mureş deep-seated fault, 11 — Vardar lineament, 12 — the Nesvačily — Trnava deep-seated fault, 13 — the Szamos lineament. Blocks: A — the Sopron and Danubian blocks, B — the Balaton block, C — the Paleopannonian block s. s., D — the Tisza block (C + D — the Paleopannonian block s. l.), E — the Apuseni block, F — the Transylvanian block, G — the Serbo-Macedonian block, H — the Fore-Dinarian block, I — the East Carpathian block. Hachure: 1 — sialic blocks more consolidated during the Variscan epoch and sialitized belts, 2 — simatic blocks and segments consolidated at the end of Cretaceous and during the Cenozoic, 3 — limits of the Pannonian basin, 4 — main deep-seated faults and lineaments

Obr. 1. Bloková stavba panónskej panvy. Vysvetlivky: Hlbinné zlomy a lineamenty: 1 — peripieninský, 2 — rábsky, + veporický, 3 — balatonský (3a — darnóvský), 4 — záhrebsko-kulčský, 5 — szolnocký, 6 — periadriatický (insubrický), 7 — dunajský (centrálno-karpatský), 8 — drávsky, 9 — sávsky (peridinársky), 10 — murešský, 11 — vardarský, 12 — nesvačilsko-trnavský, 13 — samošký. Bloky: A — šopronský s podunajským, B — balatonský, C — paleopanónsky s. s., D — tiský (C + D paleopanónsky s. l.), E — apusenský, F — transylvánsky, G — srbsko-macedónsky, H — predinársky, I — východokarpatský. 1 — sialické bloky, varisky viac konsolidované a sializované zóny, 2 — simatické bloky a kryhy konsolidované koncom kriedy a v terciéri, 3 — hranice panónskej panvy, 4 — hlavné hlbinné zlomy a lineamenty

with the continental crust present in the Apuseni Mts. We place recent limits of the Paleopannonian block s. l. (assimilating also parts of the granitic crust which continues towards the E into the Serbo-Macedonian massif) along the Insubric line or on the Drava deep-seated fault. The latter splitted away to create an independent structure probably but during the Neogene predisposing the graben-like Drava depression.

All these structures, the Apuseni and Transylvanian blocks including, were limited from NE by the Szamos line representing originally a significant lineament assumed already by H. Stille (1953).

Mesozoic sedimentary basins still inherited the structural dissection of the Paleozoic development and the latter became modified at places during folding phases of the Cretaceous. As from the Cretaceous, the former mobile belts disintegrated and single new blocks originated incorporating the folded units or areas of active magmatism. During the Paleogene, the northern part of the Pannonian basin still inherited the old structural pattern whereas further segmentations and adaptations of Carpathian directions occurred in its SE portion. The Balaton block retained its autonomy even during the Miocene and it became, as one of most mobile blocks, the site of highest rate of subsidence. Also areas limited by the Szamos and Insubric lineaments

were active at this time. A pronounced reorganization of the whole area occurred but during the Pliocene when both the Sopron and Paleopannonian s. l. blocks were mobilized. Contrary to the formers, the Balaton block stabilized at this time.

As from the end of the Miocene, single blocks in the Pannonian basin disintegrated into eastern and western portions along a N—S line followed by the recent Danube flow. The line was still not of deep-seated nature along its whole strike-length as it was in the recent Czechoslovak territory within the Štiavnica neovolcanic centre. In the Pannonian basin, the line appears as a crustal fracture covering the Zázrivá — Budapest line of D. Kubiny (1962) or the Central Carpathian lineament of J. Štolh (1976). Along this young line of until upper crustal extent, the block structure of the Pannonian basin basement disintegrated into the more mobile eastern portion and the more stable western one. The similar differentiation of crustal mobility is indicated by the difference of Quaternary sediments (cf. L. Stegena et al. 1975). Recent seismoactive lines delimit contours of the Pannonian basin (V. Kárník 1975). Within the basin proper, the highest activity concentrates along the N—S striking Central Carpathian lineament only northernly from the Balaton line. Hence, with regard to its not

deep-seated nature, we assign this line in the full extent as the Danube fault. Another seismoactive line represents the NW continuation of the Vardar zone which extends further, as an active fault, towards the NW followed by the Tisza river lower course. The inversion in block movements influenced the distribution of coal deposits and also of deposits of hydrocarbons.

Coal deposits occur over stabilized block units or over their parts whereas accumulations of hydrocarbons are confined to subsiding blocks. The development of the Pannonian block during the Neogene and Quaternary reveals that the basin does not represent a sole unitary block unit (massif) but, even after structural reorganization that occurred at the Miocene — Pliocene boundary, it preserved the heterogenous dissection despite processes of integration of old participating block units. We relate this development to the uprise and subsequent collapse of the mantle diapir that governed the generation of young sedimentary basins (D. Vass 1979). The origin and development of the diapir imposed changes upon the regional yield strain field in the area and changed also the disposition of maximally subsiding centres. In the central portion of the basin over the diapir, the strain was of tensional nature whereas shear strain forces occurred at the periphery. This led to strong tectonic segmentation in the Vien-

na, East Slovakian, Transcarpathian and Drava basins. In these peripheral basins the subsidence stabilized as from the end of the Miocene changing from previous 3—4 km to lesser values from. Contrary, an acceleration of subsidence occurred in the Pannonian basin proper with a total value of 5 km.

Relation of coal deposits to the block structure

Coal deposits along the inner side of the Carpathian arc create four belts which appear as centres of main coal accumulation. These belts occur on the Balaton block in NW Hungary, at the transition from the East Carpathian arc into the South Carpathian one, mainly upon the Serbo-Macedonian block and within the Fore-Dinarian block. Reflected by persistent tendency for coal generation, the Vardar zone, the Serbo-Macedonian massif and the Kraishtide zone acquire specific position. Conditions for coal generation persisted here from the Upper Carboniferous to Neogene time; 7 mineable coal deposits occur in Carboniferous beds, 2 in Permian, 11 in Jurassic, 6 in Cretaceous, 7 in Paleogene and 14 deposits are confined to beds of Neogene age. We assign this extensive coal-bearing structure as the Vardar — Kraishtide coal-bearing lineament. Deep-seated faults fixed here basin structures and denuda-

tion areas. For example, between the Carboniferous and Jurassic, coal deposits originated along the line connecting Lupacu (Rumania) and Pirot (Greece). Later, the coal generating activity migrated in the strike and also across the lineament.

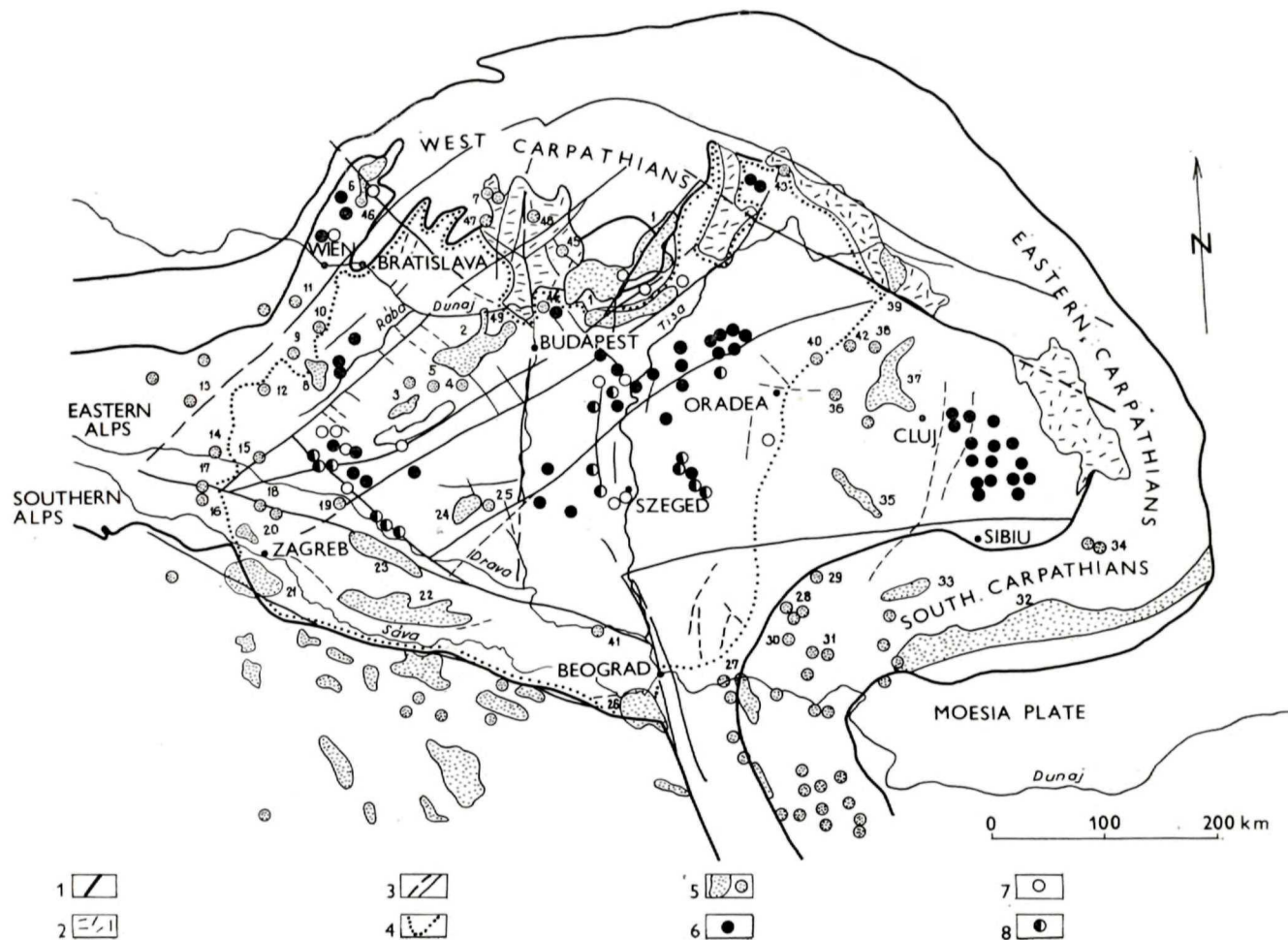
Among other deep-seated faults, the Peripieninic lineament played positive role for the generation of coal deposits not only along the limit of the basin towards the Eastern Alps but also towards the Eastern Carpathians. Another area with favourable conditions for coal

generation occurs at the margin of the Paleopannonian block unit facing the Apuseni Mts. and along the Insubric line. The central portion of the basin is not of coal-bearing nature (Fig. 2).

Coal deposits originated in tectonically dissected areas where places of denudation alternated with sedimentary basins. However, the extent of deposits is here small. Great deposits are confined to mobile blocks with supposed suboceanic crust. The most important block is the Balaton one where the

Fig. 2. Relation of fuel deposits to the structure of the Pannonian basin. Explanations: Coal-bearing basins and smaller deposits: 1 — Northeastern basin (Nógrád, Borsodnádassd, Mátravidék), 2 — Northwestern basin, 3 — Ajka, 4 — Várpalota, 5 — Szentgál, 6 — Hodonín — Dubňany, 7 — the Handlová — Nováky basin, 8 — Torony — Szombathely, 9 — Tauchen, 10 — Brennbeg, 11 — Wiener Neustadt, 12 — Ilz, 13 — Köflach — Voitsberg, 14 — Lavanttal basin, 15 — Wiess, 16 — Zasavski basin, 17 — Velenje basin, 18 — Hrvatsko — Zagorje basin, 19 — Ludbreg — Koprivnice basin, 20 — Krško Polje, 21 — Pokupsko — Vukomerički basin, 22 — Posavski basin, 23 — Bilogorsko — Podravski basin, 24 — Mecsek basin, 25 — Hidas, 26 — Kolubarski basin, 27 — Mlavski — Pečki and Podunavski basins, 28 — Lupac, Secul, Doman, 29 — Rusca-Montăna, 30 — Anina, 31 — Rudăria, Mehădia, 32 — Subcarpații basin, 33 — Petroșani basin, 34 — Codlea, Cristian, 35 — Brad, 36 — Ip — Zăuani basin, 37 — Almașului basin, 38 — Sărmășag, 39 — Bicsad, 40 — Popești, 41 — Vrdnički basin, 42 — Bratca, 43 — Vihorlat Mts. piedmont basin, 44 — Nagyszál, 45 — Modrý Kameň basin, 46 — Kúty — Gbely basin, 47 — Obyce, 48 — Badin, 49 — Štúrovo. Hachure: 1 — limits of the Central Carpathians, 2 — neovolcanite, 3 — deep-seated faults, lineaments and other faults, 4 — limits of the Pannonian basin, 5 — coal-bearing basins and smaller deposits, 6 — deposits of natural gas, 7 — oil deposits, 8 — deposits of oil and natural gas

Obr. 2. Vzťah ložísk palív k štruktúre panónskej panvy. Uhoľné panvy a menšie ložíská: 1 — severovýchodná (Nógrád, Borsodnádassd, Mátravidék), 2 — severozápadná, 3 — Ajka, 4 — Várpalota, 5 — Szentgál, 6 — Hodonín, Dubňany, 7 — Handlová — Nováky, 8 — Torony — Szombathely, 9 — Tauchen, 10 — Brennbeg, 11 — Wiener-Neustadt, 12 — Ilz, Köflach — Voitsberg, 14 — Lavanttal, 15 — Wiess, 16 — Zasavská, 17 — Velenje, 18 — Hrvatsko — Zagorje, 19 — Ludbreg — Koprivnice, 20 — Krško Polje, 21 — pokupsko — vukomeričská, 22 — posavská, 23 — bilogorsko — pečovská, 24 — mecsekská, 25 — hidasská, 26 — kolubarská, 27 — mlavsko — pečská, podunavská, 28 — Lupac, Secul, Doman, 29 — Rusca — Montăna, 30 — Aninská, 31 — Rudăria, Mehădia, 32 — Subcarpații, 33 — Petroșani, 34 — Codlea, Cristian, 35 — Brad, 36 — Ip — Zăuani, 37 — Almașului, 38 — Sărmășag, 39 — Bicsad, 40 — Popești, 41 — Vrdnički, 42 — Bratca, 43 — podvihorlatská, 44 — Nagyszál, 45 — modrokamenská, 46 — Kúty — Gbely, 47 — Obyce, 48 — Badin, 49 — Štúrovo. 1 — hranice Vnútorých Karpát, 2 — neovulkanity, 3 — hlbinné zlomy, lineamenty a zlomy, 4 — hranice panónskej panvy, 5 — uhoľné panvy a menšie ložíská, 6 — ložíská zemného plynu, 7 — ložíská ropy, 8 — ložíská ropy a zemného plynu



oldest coal basin originated already during the Upper Cretaceous (Ajka). Conditions for coal accumulation renewed during the Eocene westernly from the Danube fault whereas conditions for coal deposition moved to the E from this line during the Miocene and Pliocene. During the Pliocene, even the Balaton deep-seated fault became important for the generation of coal deposits. A mobile depression developed along this fault at the southern piedmont of the Mátra and Bükk Mts., where up to 17 coal seams occur.

The disposition of coal deposits within the Balaton block proves its disintegration along the N—S stretching Danube fault. Contrary, the generation of coal deposits points to the stabilization related to the increase of continental crustal thickness that resulted from the neovolcanic activity.

Coal deposits along the margin of the Pannonian basin and at the limits of the Pannonian diapir occur along the Peripieninic lineament at the inner side. At the boundary of Alps and Carpathians, coal deposits of Neogene age indicate the stabilization of subsidence (coal deposits in Austria and W. Hungary, e. g. the Szombathely basin).

In the East Carpathian sector of the Peripieninic lineament, beside the coal basin at the Vihorlat Mts. piedmont area, several coal deposits occur mainly in Rumania (Bicsad, Borsec, Fălticeni, Riscă, Comănești,

Baraolt-Căpeni).

Several coal-bearing basins occur along the margin of the Paleopannonian block: Petroșani, Rusca-Montăna, Lupac, Doman, Secul, Anina a. o. Mainly faults of W—E strike were active at the time of basin foundation here. For the amount of coal deposits located along, basins confined to the Insubric line at the SW margin of the Paleopannonian and Balaton blocks are significant. Coal deposits originated upon the margin of continental and suboceanic crustal blocks of the Dinarides.

The most discussion provokes the position of the Mecsek Mts. and that of the coal-bearing basin of Jurassic age. It follows from the knowledge upon reconstitution of blocks that the discussed coal basin, which occurs within the Paleopannonian block s. s., generated originally at the boundary of sialic and simatic blocks extending here from the Tisza block. Coal seams wedge out towards the NE into the marine basin of the Szolnok trough. However, it is not excluded the possibility of marine communication with the contemporaneous Mureș belt. Continental conditions were likely determined by a belt of sialic crust deviating from the Serbo-Macedonian massif. A such connection is supposed by M. MaheI (1978) on the base of other phenomena.

The considerable part of coal seams in the Pannonian basin is

weakly coalified and belongs to haemitypes of brown coal. An exception represents the coal of Paleogene age and some seams of Lower Miocene age constituting metatypes of brown coal (the coalification in the Mecsek Mts. is caused by other kind of tectonic processes). Coal seams of Paleogene to Lower Miocene age became not buried into considerable depths and we ascribe the relative high coalification of these seams to the high heat-flow in areas of their occurrence. It is possible to pose the question why does not ameliorate the Pannonian heat-flow the quality (coalification degree) of all coal seams present? There are three possible explanations.

a) Weak coalification characterizes the most of deposits confined to the margins of the basin where thermal effects of the diapir were weak as well.

b) More intensively coalified deposits of pre-Upper-Miocene age were affected by thermal effects as these have been not protected from the underlier by isolating beds. Younger coal seams follow upon thick sediment pile protecting them against thermal influence.

c) Thermal flux changed with time and the recent thermal flow is lower than the one during pre-Miocene time. The recent geothermal gradient ($50\text{--}70^\circ \text{C} \cdot \text{km}^{-1}$) is insufficient to cause more intense coalification in depths above 2,000 m in basins as proved by D. Ďurica

et al. (1979) for the East Slovakian basin. Hence, the most probable explanation to us appears the case under b).

Summarizing the knowledge upon relations between coal deposits and the type of crust, we conclude that the largest coal deposits occur within the Balaton block with original suboceanic crust. The highest number of deposits is confined to the margins of basins at the borders of single blocks or along faults limiting single blocks. Favourable conditions for coal generation were created by tectonic dissection into elevational structures, denudation areas and depressional ones where the density of dissection influenced also the areal extent of deposits.

The Balaton block created a belt of depression of rift nature with some features common with the North Bohemian coal basin along the Ohře rift structure. The volcanic activity created positive conditions for the development of vegetation and for the connection with elevational structures of denudation areas. Hence, another rich coal-bearing belt occurs along the depression zone of the Insubric and Drava lines situated at the backside of the Dinarides.

The position of deposits over mobile crustal blocks and the sinking of post-Miocene age within the Pannonian basin proper or along its margins promoted the preservation of coal deposits against denudation. The distribution of depo-

sits in space and time reflects the general trend in coal-bearing basin locations along the arched margin of the basin gradually from the W to E. The coal-bearing sedimentation predominated during the Lower Miocene in the SW part of the basin along the peri-Dinaride area. Maximal concentration of deposits of Upper Miocene age occurs within the Balaton block whereas the site of the most intensive coal deposition moved to the backside of the Eastern Carpathians during the Pliocene. This move of maximal coal generation along the margin of the Pannonian basin is in accordance with the migration of single basins and it obviously reflects the dynamic evolution of the Pannonian diapir. The older dissection by faults, which is oriented mostly radially to the diapir, modified the general tendency of migration towards the outer and inner side of the Pannonian basin in partial belts (as it follows from the stratigraphical position of single coal seams in the map of A. K. Matveyev 1975).

Coal deposits older than the Pliocene complete our knowledge upon the block structure of the area with heterogenous crustal types. Ensialitic basins are mostly of superposed type whereas ensimatic ones bear inherited structures (the Balaton block and the peri-Dinaride zone). Basins of Pliocene age reveal weak dependence on the older block structure reflecting already new

tectonic conditions imposed by the integration of the Pannonian megablock dissected anew along young structural directions.

Relation of hydrocarbon deposits to the deep structure

Gas deposits exceeding quantitatively the number of oil deposits are confined to structures in the basement of the Neogene or to porous horizons of the Neogene proper (Gy. Kertai 1968). From the point of view of the deep structure, we may discern hydrocarbon deposits located in peripheral portions of the Pannonian basin along the Peripieninic lineament and those confined to central areas of the basin. Also deposits of the Vienna basin may be included among accumulations governed by peripheral structures along the Peripieninic lineament together with ones within the Sopron block structure. Deposits in the Drava and Sava depressions concentrate along the Insubric line.

The majority of deposits occurs in the central part of the basin. The lowest number of deposits is related structurally to the Balaton block eastwards from the Danube fault. Higher number of deposits concentrates along the foreland of the Balaton block towards the Dinarides. The highest areal concentration characterizes the Paleo-

pannonian block eastward from the Danube fault namely in the space of the mobile Paleopannonian block s. s. Sites of deposits correlate well with the regions of thinner crust and with the apical parts of the Pannonian diapir. Moreover, the highest thermal flow appears here according to data by L. Stegena et al. (1975). From the viewpoint of hydrocarbon migration, this area appears as unfavourable when comparing it with the regions of highest accumulation of deposits.

Tectonic lines created favourable conditions for migration by increasing the porosity of the rock mass until they were oriented diagonally or at right angle to supposed E—W yield tensional strain orientation away from the apical parts of the expanding diapir (e. g. the Drava or Szolnok lines). On the other hand, sealing along the Zagreb — Kulcs and Rába lines during the Pliocene inversion moved migration directions for hydrocarbons into the stabilized Balaton block (where, moreover, negative influences prevailed due to decreasing volcanic activity). The dynamic role of the Peripieninic lineament remains unclear. However, we may assume from the distribution of gas deposits that shear movements and compressive stresses limited the possibility of hydrocarbon migration across the lineament. In the case of the Vienna basin, the Peripieninic lineament played, probably, even a protective function acting as barrier

against strain effects coming from the inner side of the Carpathians. Favourable conditions prevailed mainly to the SW from the Nesvačily — Trnava line (F. Čech 1980). This area located outwards from the extent of flysch nappes became less influenced by stresses.

Relieved from stresses at its SE half, the Pannonian basin reveals favourable tectonic conditions for the preservation of hydrocarbon deposits. The presence of old structural blocks unified into the Pannonian megablock imposed partial differentiation on the distribution of deposits into blocks of maximal subsidence during the Pliocene. Therefore an explanation offers that this subsidence caused squeezing out of hydrocarbons to being preserved in traps. From the point of view of the crustal type, the relation is not a dominating one and several deposits concentrate in blocks consolidated in pre-Neogene time but also in those regenerated during the Neogene (the type of regenerated platforms) or upon slightly consolidated crustal segments. The more advanced consolidation had positive influence in that it prevented the intensity of tectonic shattering.

Hence, it appears that any clear relation exists between the block structure and the distribution of hydrocarbon deposits. There is evident only a correlation caused by paleogeography and tectonic conditions that promoted the concentra-

tion of hydrocarbon deposits mainly in blocks or segments of the Pannonian basin which are devoid of considerable concentration of coal deposits. Existing exceptions are ruled by inversional movements of relative block structures (the Mátra and Bükk Mts.).

It is likely that for the distribution of hydrocarbons, the main importance from deep-seated phenomena played the development of the Pannonian diapir by its thermal field generated during uprise along contacts of the rigid basement in single sedimentary basins with their filling. Gas deposits concentrate mainly along the flanks of apical portions of the diapir being confined to areas devoid of thinner crust. The shape of the diapir together with heterogeneous crustal block structure modified the distribution of strain within the crust. As the possible model one may assume a scheme where the apical portion of the diapir imposes tensional strain transforming into stress along the limbs of the diapir in sites of thicker crust. This phenomenon probably promoted the hydrocarbon migration and the increase of deposit pressure. It may be not excluded even that the different depth of productive horizons, which is less above the diapir and more along the margins, has been imposed by the predominating strain regime of endogenous origin.

Elliptical areas with thinner crust

are usually accompanied by elevated thermal flow regime. The latter, besides the supposed tensional strain, may have resulted in areas devoid of hydrocarbon accumulations originated in the axial portion of the Pannonian diapir.

Conclusions

The Pannonian basin appears, in its marginal structures, as a complex megastructure of fuel deposits. Its basement is built by heterogeneous and primarily attenuated crust segmented by deep-seated faults into single block units. The orientation of these blocks points to the autonomous position of the whole structure in comparison with neighbour orogenic belts surrounding the Pannonian basin. At the end of the Cenozoic, single blocks became integrated into the Pannonian megablock dissected subsequently along old faults or by N—S stretching faults oriented along the Danube and Tisza rivers.

At the Miocene — Pliocene boundary, besides structural inversion of the area, the velocity of subsidential movements changed in partial basins along the periphery and also in the centre of the basin proper. We assume deep-seated causes of this reorganization in the development of the Pannonian diapir which generated at the participation of asthenospheric mass mo-

vement oriented from peripheral portions (considerable and rapid subsidence in marginal partial basins during the Miocene) towards the centre of the Pannonian crustal segment. Hence, a stagnation of movements occurred in the central area. The collapse of Pliocene age following after the discharge of magmatic chambers changed also the distribution pattern of maximal subsidential centres.

The uprise of the diapir created favourable conditions for stagnation within Cenozoic basins and by that even for the development of coal deposits. These originated mainly upon crust of suboceanic type being strongly differentiated tectonically and of pre-Cenozoic age. Sialitization occurred by pronounced intensity mostly already as from the end of the Paleogene and led to increase of crustal thickness in the Balaton block. The development of coal deposits in the time of sialitization represents an analogous process to the development of coal basins during the Upper Carboniferous in Middle Bohemia. Both processes acquire the same historical and tectonic position in crustal development of the respective regions.

Hydrocarbon deposits are devoid of clear correlation with the pre-Neogene block structure. The accumulation of hydrocarbons falls into the period of Pliocene inversion and block reorganization. Hydrocarbon deposits concentrate upon

large block units with rapid subsidence rates during the post-inversional period of the Pannonian megablock. Single segments do not respect then the older block structure and acquire the renewed structural pattern imposed mainly by the dynamics of the Pannonian diapir during the Pliocene.

The analysis of the deep structure of the Pannonian basin leads us to the conclusion that single intra-Carpathian basins (the Danube, South Slovakian and East Slovakian basin) represent marginal parts of the former and that they underwent the same evolution as did the Pannonian basin. This development has been caused by the same endogenous processes.

For prognostics, the knowledge deduced from the deep structure is in accordance with until negative results of hydrocarbon exploration in intra-Carpathian basins. More perspectives seem to appear in the belt along the Peripieninic lineament. The NW continuation of the Szamos line beneath the Levoča flysch basement may deserve attention as well. From the viewpoint of prognoses for coal deposits, it is impossible to propose any prognose for hidden coal deposits without complex paleogeographical and paleotectonic analysis of the area. It follows from the analytical treatment of the deep structure that most perspectives yield generally the margins of elevational sialic blocks facing the simatic ones

where depressional movements concentrated and mainly the uprising partial block structures within the latter. Coal deposits of lesser extent may occur along the Rába line in the Danube basin and at the NE

part of the Balaton block along the NW side of the Darnó line.

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Vzťah ložísk palív k hlbínnej stavbe a vývoju panónskej panvy

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Panónsku panvu lemuje orogénne pásmo, ktoré do stredu panvy nepokračujú. To zdôrazňuje jej štruktúrnú autonómiu. Geologické a geofyzikálne poznatky potvrdzujú jej predterciérnu blokovú stavbu nesúhlasnú s blokovou stavbou neogénnej sedimentárnej výplne.

Geofyzikálne poznatky o hlbínnej stavbe

Panónska panva sa vyznačuje výrazným kladným tiažovým poľom, ktoré dobre koreluje so seizmicky zistenou kôrou nad plášťovým diapírom (L. Stegena et al. 1975). Styk tejto kôry s hrubšou kôrou, pre ktorú sú charakteristické orogénne prejavy, prebieha v zásade na peripieninskom lineamente, ktorý je aktívnou seizmickou líniou. Vlastná panónska panva je asezimická (G. Schneider 1978). Z rýchlosti šírenia seizmických vln pod panvou vychádza, že rýchlosť P-vln v plášti je až o 0,5 km/s nižšia ako pod Západnými a Východnými Karpatmi. Rýchlostný obraz (L. P. Vinnik et al. 1969) naznačuje blokovú stavbu vrchného plášťa okolo panónskeho plášťového diapíru. Panva má analogickú hlbinnú stavbu a pozíciu ako napr. afgansko-tadžická depresia obklopená Pamírom a Južným Tanšanom. Existencia tangenciálne orientova-

nej strižnozlomovej zóny peripieninského lineamentu na okraji plášťového diapíru sa podobá hlbínnej stavbe Great Basin (CH. H. Scholz et al. 1971) alebo Červeného mora (J. D. Lowell et al. 1978). Je aj dobrá zhoda s modelovaným strižným napätím nad stúpajúcim diapírom (M. V. Gzovskij 1960).

Bloková stavba sa geofyzikálne prejavuje v odvodených tiažových mapách, ktoré zo severnej časti panvy urobil B. Beránek (1979). Kladné tiažové anomálie, čiastočne oválneho tvaru, a tangenciálny vzťah okrajových zlomov k anomáliám vo východoslovenskej a transylvánskej panve vedie k hľadaniu analógií v hlbínnej stavbe s panónskou panvou a k interpretácii čiastkových plášťových diapírov.

Typy kôry v podloží panónskej panvy

Kôra podložia panvy nie je porovnateľná s vnútornými masívmi, za aké sa panónsky megablok pokladá. Ako ukazujú aj poznatky G. Weina (1969), B. Jantského (1976), a najmä M. Maheľa (1978), je menej konsolidovaná a látkovo silne heterogénna. Existencia čiastkových depresí vznikajúcich už v mezozoiku dokladá slabo konsolidovanú kôru skôr oceánskeho typu, akú

súborne označujeme ako suboceánsku. Terciérny vulkanizmus pokladáme za akreciu kontinentálnej kôry. Suboceánsku kôru v depresiách, najmä v murešskom trogu, pokladáme za zvyšky pôvodnej slabo sializovanej oceánskej kôry.

Kôra panónskej panvy je heterogénym nerovnomerne sializovaným segmentom, patriacim pôvodne kôre Paleotetydy. Dnešná tenká kôra je teda buď zvyškom pôvodnej tenkej, prevažne suboceánskej kôry, alebo čiastočne stenčenou kôrou predovšetkým pod vplyvom bazifikácie plášťovou eleváciou. Mobilita tenkej kôry bola priaznivá pre vznik sedimentárnych panví a tvorbu ložísk palivových surovín.

Bloková stavba a jej vývoj

V podloží panvy prevažujú hlbinné zlomy smeru SV—JZ, ktoré oddeľujú pretiahnuté bloky s rozličným typom kôry. Ich vymedzenie a názov sú pôvodné (obr. 1). Iné označenie je v prácach D. Hovorku (1979), M. Mahela (1978) a P. Greculu — I. Vargu (1979). Tektonicky najvýznamnejší bol záhrebsko-kulčský hlbinný zlom so subparalelným balatonským zlomom a vzdialenejšou rábskou liniou. Táto línia oddeľuje šopronský blok od balatonského. Ich ekvivalentmi na československom území sú pobádensky oddelené bloky — podunajský a juhoslovenský, ktoré definoval O. Fusán et al. (1971). Balatonský blok simatického charakteru bol mobilný najdlhšie. Asi v neogéne ho rozdelila darnóovská línia, oddeľujúca sa od balatonského zlomu, na východoslovenský a juhoslovenský. Obidva bloky majú pôvodne zhodný simatický typ kôry.

Smerom na JV od balatonského bloku prebieha lineárne granitoidové pásmo tvoriace základ sialického bloku, ktorý označujeme ako paleopanónsky blok s. s. Jeho juhovýchodný okraj tvoril szolnokský flyšový trog, vzniknuvší v okolí hlbinného szolnokského zlomu. Paleopanónsky blok s. s. bol jadrom konsolidácie terciérne stmeleného paleopanónskeho bloku s. l., a to s pôvodne simatickým tiským blokom. Tiský blok nezodpovedá

Tisii v zmysle Princza (1922 — in G. Wein 1969). Vývoj bloku nie je ešte dostatočne známy (pozri M. Mahel 1978). Východné obmedzenie tiského bloku (a paleopanónskeho bloku s. l.) tvorí apusenský blok, ktorý má heterogénnu vnútornú stavbu a sialický aj simanický (murešský trog) typ kôry. Simatická kôra v jure oddeľovala pôvodne sialické jadro od južného kryštalinického masívu vystupujúceho v srbsko-macedónskom masíve a genetickej jednotke Južných Karpát. Tektonické obmedzenie apusenského bloku na J kladíme na zlom označený ako murešský. Pod transylvánskou panvou vymedzujeme transylvánsky blok. Severné obmedzenie obidvoch blokov tvorí samošská línia, ktorá oddeľovala panónsku mobilnú kôru od skôr šelfového vývoja predterciérnych Východných Karpát.

Štruktúrne smery v juhovýchodnej časti podložja panónskej panvy prebrali smer Z—V, vychádzajúci z rozhrania apusenského a transylvánskeho bloku so srbsko-macedónskym blokom. Pôvodná kontinentálna kôra sa mohla rozprestierať ďalej na Z až po Mecsek (M. Mahel 1978). Na prevahu smerov Z—V v predvariskom vývoji aj vo vardarskej zóne upozornil B. Sikošek (1976).

Prestavba blokov a ich integrácia na panónsky megablok nastala pravdepodobne koncom miocénu, keď sa zmenil aj štruktúrny plán panónskej panvy. V jej štruktúre sú potlačené smery SV—JZ a objavujú sa smery S—J, zdôraznené dunajským zlomovým systémom vystupujúcim v linii pretínajúcej Západné Karpaty: zázrivsko-budapeštianska línia D. Kubínyho (1962), centrálno-karpatský lineament J. Štohl (1976). Pozdĺž tejto línie sa panónska panva rozčlenila na stabilnejšiu západnú a mobilnejšiu východnú časť, ako to ukazuje aj mocnosť kvartérnych sedimentov (L. Stegena et al. 1975). Uvedená severojužná línia sa v priestore balatonského bloku prejavuje aj ako seizmoaktívna zóna (V. Kárník 1975).

Vývoj blokovej stavby bol endogénne ovplyvnený vývojom a kolapsom panónskeho diapíru, ktorý viedol aj ku vzniku pliocénnych panví (D. Vass 1979).

Jeho výstup a následný kolaps zmenili regionálne napäťové pole a rozloženie centier subsidencie. Šmykové napätia pri okraji diapíru vyvolali tektonickú segmentáciu viedenskej, východoslovenskej, zakarpatskej a drávskej panvy. V periférnych panvách sa od konca miocénu klesanie stabilizovalo. Naopak v panónskej panve sa klesanie zrýchlilo a dosiahlo celkovú hodnotu až 5 km.

Vzťah uhoľných ložísk k blokovej stavbe

Uhoľné ložiská tvoria na vnútornej strane karpatského oblúka štyri pásma — centrá akumulácie uhlia: na balatonskom, apusenskom, srbsko-macedónskom a na preddinárskom bloku. Vo vardarskej a krajštidnej zóne, ktoré od seba oddeľuje pásmo srbsko-macedónskeho masívu, vznikli dlhodobé priaznivé uhoľtvorné podmienky od karbónu do neogénu s množstvom dobývacích ložísk. Túto štruktúru označujeme ako vardarsko-krajštidný uhoľtvorný lineament.

Pri akumulácii uhlia sa pozitívne uplatnil aj peripieninský lineament na styku panónskej panvy s Východnými Alpami a Východnými Karpatmi, ako aj insubrická línia s drávsym zlomom v juhozápadnej časti panónskej panvy. Ak sú periférne časti panónskej panvy bohaté na ložiská uhlia, centrálna časť panvy je na ložiská uhlia chudobná. Veľké ložiská sa viažu na mobilné bloky s predpokladanou predterciálnou suboceánskou kôrou, pričom najvýznamnejším bol balatonský blok. Uhoľtvorné podmienky tu vznikli už vo vrchnej kriede (panva Ajka). V ďalšom období mal na distribúciu uhoľných ložísk veľký vplyv najmä dunajský zlomový systém: pred miocénom vznikli ložiská najmä západne od tohto systému, od miocénu naopak v oblasti východne od tohto systému. Existencia uhoľtvornej sedimentácie indikuje stabilizáciu balatonského bloku v dôsledku narastania kontinentálnej kôry v neovulkanickom období.

Často sa uvažuje o pozícii Meceku a jurskej mobilnej uhľonosnej panvy. Z vývoja blokovej stavby vychádza, že táto panva leží na paleopanónskom bloku s. s. a vznikla na hranici sialickej

kôry (patriacej pôvodne do srbsko-macedónskeho masívu) a simatickej kôry zasahujúcej do tohto priestoru z tiského bloku. Uhoľné sloje vyklíňujú smerom na SV, teda na jurskú morskú panvu, ležiacu v pásme szolnockého trogu.

Nedoriešeným problémom je slabé preuhoľnenie uhoľných slojov miocénneho a pliocénneho veku, aj keď ležia v značnej hĺbke. Naproti tomu paleogénne a niektoré spodnomiocénne sloje ležiace v malej hĺbke sú silne preuhoľnené (hnedouhoľné metatypy). Slabé preuhoľnenie nekoreluje dobre s vysokým tepelným tokom v panónskej panve. Vysvetlenie môže byť trojaké:

a) Slabé preuhoľnenie je charakteristické väčšinou pre ložiská pri okraji panvy, kde bol tepelný vplyv slabší.

b) Predvrchnomiocénne viac preuhoľnené uhoľné sloje boli vystavené tepelnému žiareniu, pretože ich od podložia nechránil izolátor, napr. mocné sedimenty. Mladšie ložiská ležiace na mocnom sedimentárnom podloží boli tepelne dobre izolované.

c) Tepelný tok sa historicky menil a recentný tepelný tok bol nižší ako pred miocénom. Recentný geotermický gradient $50-70\text{ }^{\circ}\text{C km}^{-1}$ hĺbky nestačil na vyššie preuhoľnenie v hĺbke menšej ako 2000 m, čo z východoslovenskej panvy preukazuje D. Ďurica et al. (1979). Zatiaľ najpravdepodobnejšie sa nám javí vysvetlenie z bodu b.

Z tektonickej stavby podložia panvy vychádza:

— Najväčší počet ložísk je pri okraji panónskej panvy, najmä na balatonskom bloku a pri okrajoch ďalších blokov alebo krýh.

— Priaznivý vplyv na tvorbu uhlia malo striedanie elevačných a depresných zón, pričom plošná rozloha ložísk závisí od stupňa tektonického členenia.

Balatonský blok má charakter depresnej riftovej zóny s niektorými znakmi spoločnými so severočeskou uhoľnou panvou na oháreckom rifte. Umiestnenie obidvoch typov ložísk na mobilnej kôre prispelo k ich zachovaniu pred denudáciou. Spojitosť s masovým vulkanizmom pripomína stredočeské permokarbónske panvy. V obidvoch prípadoch sú uhoľné

panvy časovo späté s akreáciou kontinentálnej kôry.

Časovo-priestorové rozmiestnenie ložísk ukazuje na postupnú migráciu uhoľných panví po oblúkovitom okraji panónskej depresie, a to od Z na V. Toto sťahovanie súvisí s migráciou sedimentárnych panví a dynamicky ho možno spájať s vývojom panónskeho diapíru. Staršie zlomové členenie radiálne orientované na diapír modifikovalo v čiastkových zónach tendenciu migrácie smerom na vonkajšiu stranu a do vnútra panónskej panvy (ako to vyplýva zo stratigrafickej pozície uhoľných slojov v mape A. K. Matvejeva 1975).

Rozdielny typ kôry mal vplyv aj na charakter vývoja panví a na ich stavbu. Ensialické panvy majú vo vzťahu k mobilite kôry väčšinou charakter superponovaných panví, zatiaľ čo ensimatické panvy sú typom štruktúr, ktoré dedia priestorovo subsidenčnú mobilitu (balatonský blok, peridinarické pásmo).

Vzťah ložísk uhľovodíkov k hlbínnej stavbe

Ložiská uhľovodíkov sa všeobecne viažu na periférnu časť panónskej panvy, kde vykazujú vzťah k peripieninskému lineamentu, a na centrálnu časť panvy. Pozdĺž insubrickej línie a drávskeho zlomu sa koncentrujú ložiská drávskej a sávskej panvy. Najväčší počet známych ložísk je v centrálnej časti panónskej panvy východne od dunajského zlomu. Ďalšou oblasťou koncentrácie je peridinarické pásmo.

Oblasti bez ložísk uhľovodíkov dobre korelujú s najtenšou kôrou v panónskej panve a s maximálnym tepelným tokom (L. Stegena et al. 1975). Z hľadiska migrácie uhľovodíkov je táto zóna nepriaznivá a môže predstavovať zónu úniku uhľovodíkov. Na ich migráciu mohli byť priaznivé zlomy orientované kolmo alebo diagonálne na severojužnú os roztiahnutia kôry nad diapírom v mieste dunajského zlomu. Z rozmiestnenia ložísk uhľovodíkov možno usudzovať, že záhrebsko-kulčská a rábska línia ekranovali cestu uhľovodíkom do balatonského bloku, kde mal navyše negatívny

vplyv aj vulkanizmus. Peripieninský lineament pod vplyvom existujúcich strižných napätí limitoval migráciu uhľovodíkov z oboch strán a v prípade vytvorenia vhodných štruktúrnych pascí môže byť perspektívny na akumuláciu uhľovodíkov.

Rozmiestnenie ložísk uhľovodíkov nekoreluje s predterciálnou blokovou stavbou, aj keď čiastočný miestny vplyv možno pozorovať. Rozmiestnenie ložísk závisí od pliocénnej etapy tektonického vývoja panvy, ktorá vyvolala migráciu a novú distribúciu uhľovodíkov. Pri migrácii sa uplatnil aj termodynamický vývoj panónskeho diapíru. Pritom možno pozorovať tendenciu hromadenia sa ložísk uhľovodíkov do periférnych častí diapíru.

Záver

Panónska panva je vo svojich okrajových štruktúrach komplexnou palivo-vo-ložiskovou megaštruktúrou s heterogénnym podložím a už primárne stenčenou kôrou. Kôra má predmiocennú blokovanú stavbu, integrovanú v pliocéne do panónskeho megabloku. Hlbinné príčiny vývoja v zhode s inými geológmi spájame s vývojom panónskeho diapíru. Výstup diapíru bol priaznivý pre stagnáciu pohybov v panvách a na tvorbu uhoľných ložísk. Kolapsové štádium viedlo k vytláčaniu uhľovodíkov a ich migrácii do vhodných novovznikajúcich pascí. Ak ložiská uhľia vcelku dobre korelujú s blokovou stavbou podložia panvy, ložiská uhľovodíkov nevykazujú nijakú koreláciu. Ich rozmiestnenie je skôr podriadené novému, pliocénemu štruktúrnemu plánu.

Analýza hlbínnej stavby panónskej panvy zdôrazňuje spätosť veľkých vnútrokarpatských panví s periférnou časťou panónskej panvy a ich spoločný endogénny vývoj. Poznatky odvodené z hlbínnej stavby sú z prognózneho hľadiska v súlade s doterajšími negatívnymi výsledkami vyhľadávania uhľovodíkov na južnom Slovensku. Perspektívnym sa ukazuje peripieninský lineament a severozápadné pokračovanie samošskej

línie do podložia flyšu v Levočských vrchoch.

Bez komplexnej paleogeografickej a paleotektonickej analýzy plytkých štruktúr nemožno urobiť prognózy na výskyt skrytých ložísk uhlia. Z analýzy hlbínnej stavby vychodí, že perspektívne sú sprava

vidla okraje elevačných sialických a depresných simatických blokov, najmä stúpajúce kryhy v nich. Menšie ložiská uhlia by sa mohli vyskytovať pozdĺž rábskej línie v podunajskej panve a v severozápadnej časti balatonského bloku, severozápadne od darnóvskej línie.

ZO ŽIVOTA SPOLOČNOSTI

M. Pulec: **Metodika a výsledky šlichovacích prác** (Košice 7. 4. 1980)

V západnej časti Nízkych Tatier vykonáva Geologický ústav D. Štúra šlichovacie práce od roku 1975. Šlichová prospekcia bola aj súčasťou ložiskového výskumu v súvislosti so zostavovaním nových geologických máp v mierke 1 : 25 000.

Odber šlichov v regionálnom meradle sme začali robiť podľa metodiky, ktorú na základe prác z oblasti východoslovenských neovulkanitov rozpracoval a opísal J. Slávik (1965) a ďalej rozpracoval a pre územie budované kryštalinikom prispôbil P. Hvožďara (1971). Využili sme aj metodiku a skúsenosti zo šlichovacích prác z Českého masívu (Geindustria Jihlava).

Podľa uvedených metodík a skúseností z regionálnych prác z kryštalinika Nízkych Tatier zameraných na scheelitové zrudnenie a vymedzenie rudonosnej zóny sme v miestach anomálneho výskytu scheelitu v šlichoch krok odberu skrátili na 50–100 m. Okrem toho sme na spresnenie rudonosnej scheelitovej zóny odoberali šlichy z výplavových kužeľov, dočasných potokov a sutiny rozličného charakteru. Hneď na mieste odberu sme UV lampou orientačne hodnotili každý šlich z hľadiska obsahu scheelitu. Rovnakým spôsobom sme zisťovali, či nadsitová frakcia neobsahuje úlomky so scheelitovým zrudnením.

Šlichy sme odoberali z miest najvhodnejších na akumuláciu ťažkých minerálov, a to výkopom z hĺbky 20–30 cm. Odoberal sa vždy rovnaký objem štrkopieskového materiálu a ten sa za mokra preosial na site s okami s priemerom 3 mm. Dbali sme na to, aby podsitová frakcia bola aspoň v objeme jednej banickej misy. Šlichy sme doryžovali v tzv. čínskom klobúku.

Šlichovou prospekciou sme zhodnotili všetky minerály, ale najmä rudné, osobitne zlato a scheelit. Prospekcia zahŕňala územia mapových listov Korytnica, Jasenie, Horná Lehota a Mýto pod Ďumbierom, detailná oblasť listu Jasenie a Vrbické pleso.

Dovedna sa identifikovalo 36 minerálov. Niektoré z nich sa na tomto území zistili prvý raz. Z najzaujímavejších rudných minerálov sa identifikoval kassiterit, galenit, sfalerit, volframit, scheelit a zlato. Kassiterit sa na území mapového listu Mýto pod Ďumbierom zistil prvýkrát. Identifikoval sa v 64 šlichoch v tatrickej aj veporickej časti kryštalinika, vo veporickej v 42 šlichoch v stopách. Vo vyššej koncentrácii bol v Beňušskej doline, a to v Hlbokej doline pri Braväcove a v ľavých prítokoch potoka Bystrá (Jasenák a vyššie v bezmennom prítoku východne od Jarabej).

V hronskej sérii veporského kryštalinika severne od Bujakova a v Bacúšskej doline kassiterit obdobne zistili M. Linkešová — I. Čillík (1979). Na základe geochemickej asociácie Sn—W—Li hovoria o novej neznámej rudnej formácii kassiteritu periplutonického typu.