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New morphostructural division of Slovakia

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Abstract. This contribution offers a new morphostructural division of the Slovak Republic area accepting new geomorphological and geological facts. It is different to the older Mazúr's division (1979 and 1980) and the geological regionalisation made by Vass et al. (1988). The morphostructural units have been divided according to tectonical movement tendency, relation to the neighbouring units and inner morphostructural dissection.

The Slovak Republic area are divided into following morphostructures:

A. Carpathians: 1. West Carpathians, 1.1 Central morphostructures of the West Carpathian dome, 1.2 Transitive morphostructures of the West Carpathian dome, 1.3 Marginal morphostructures of the West Carpathian dome, 1.4 Southern depressed morphostructures, 1.5 Southern elevational morphostructures, 2. East Carpathians: 2.1 Outer zone morphostructures of the East Carpathians, 2.2 Inner zone morphostructures of the East Carpathians;

B. Pannonian Basin: 1. West Pannonian Basin, 1.1 Záhorie morphostructures of the Pannonian Basin, 1.2 Danube morphostructures of the Pannonian Basin; 2. East Pannonian Basin: 2.1 East Slovakian morphostructures of the Pannonian Basin.

The West Carpathians is a megamorphostructure which has acquired a form of a large dome. This dome has an ecliptical ground plane and an asymetrical shape. Its centre is situated to NE. There are six mountains and two intramontane basins in the centre. They are Central morphostructures of the West Carpathians. The most extensive are Transitive morphostructures of the West Carpathians between centre and margin of the West Carpathians dome. They are very various from geological and geomorphological point of view. It consists more or less dissected horsts and grabens. The Marginal morphostructures of the West Carpathians border on the Panonian Basin or the South morphostructural depression. The West Carpathian dome is limited by the South morphostructural elevation in the South.

The East Carpathians has a zonal composition. There are Outher zone morphostructures in the North and Inner morphostructures in the South.

The Pannonian Basin is divided into the West and East Pannonian Basin. This morphostructures have developed as large subsided blocks.

Key words: morphostructure, morphotectonics, Carpathians, Slovakia

Introduction

The Slovak geomorphologists used the morphostructural regionalisation of Slovakia worked out by Emil Mazúr for about three decades. The first of his two modifications was presented in a form of a scientific article (Mazúr, 1979), the second was included in several geomorphologic maps in the Atlas of the SSR, the chapter IV - Povrch (Mazúr - Jakál, eds.,1980). This contribution is an attempt to create a new morphostructural regionalisation of the Slovakia ´s territory, with an ambition to finalise the conceptual plan only indicated in Mazúrs's work and at the same time to include new geomorphologic and geological knowledge unknown three decades ago.

Methods and terminology

This work applied a multilevel morphostructure regionalisation with accepted principles of individual and typological regionalisation. It prefers individual regionalisation on the high levels, the lower levels have a character of typology.

Morphostructure is a key term of this contribution. It has been introduced to the literature by a prominent Russian geomorphologist Gerasimov in 1946. He defined it as an relief element which rises in the consequence of the historically developing mutual activities of the endogenous and exogenous processes with dominance of the endogenous factor. This term spread to the Central and Eastern Europe (including Slovakia) of former Soviet Union, while the western geomorphologists prefer an equivalent term the morphotectonic unit. Mazúr (in: Mazúr - Jakál, eds., 1980) defined morphostructure as a geomorphologic form, basic shapes and structural individualisation of which are generated by the direct active (mobile) tectonics. Some scientists accepted a wider conception of morphostructure as a land form affected by the properties of the passive (static) component of

the geological structure. The land forms created by an active component of the geological structure are regarded as active morphostructures (for instance uplifted horsts). The passive components of a geological structure take part in creation of the passive morphostructures (for instance an erosionally destroyed volcano).

Mazúr´s morphostructural regionalisation

The presented individual morphostructural regionalisation (Fig. 3) corresponds to the Mazúr´s division of the Slovakia's territory (Fig. 1) on the highest hierarchical level only. The first level discerns the Carpathians and the Pannonian Basin within Slovakia and the second level dissects the Carpathians to the Western Carpathians and Eastern Carpathians. This morphostructural regionalisation uses different criterion from that of Mazúr´s on the lower levels, therefore there is an absence of the more expressive intersection between the selected morphostructural units.

The passive structure (folded, flysch, klippen and volcanic etc.) occurred as too vulnerable forms which does not correspond to their present task in the relief forming act. The present morphostructures are developing more in the direction of the active (fault) structures, which causes gradual and irreversible destruction of the passive structure. The task of the passive structure in present morphogenesis of the Slovakia's territory consists entirely of the regulation of the selective erosion and denudation. Therefore the utilisation of the passive structure attributes as classification criterion was reduced at high level of the regionalisation and emphasised or kept at lower levels.

We hold on using of regional terminology of the divided individual units unlike the Mazúr´s morphostructural division (to observe the principle of not confusing the components of the individual and typological regions at the same level. The individual morphostructural units used by this regionalisation of the Slovakian territory are delimited to the level of units (celok - in Slovak) and less frequently to subunits (podcelok - in Slovak) and they have their own names (for instance. morphostructure of the Malé Karpaty Mts., morphostructure of the Žiarska kotlina Basin etc.). They are morphostructures of the fifth hierarchical level.

Comparison of the morphostructural and geological regionalisations

The geological and morphostructural maps project the same thing. It is the geological structure. In spite of it there is only little agreement as far as the contents is concerned. The cause are the different geological and geomorphologic views of the matter. The interest of an geologists is considerably wider in the vertical and temporal dimensions. They study the geological structure starting by the surface and ending by the positions under the earth mantle, on the other hand geomorphologists limit their research only to the superficial or shallow underground Earth sections which take part in relief modelling. Old structural units are often presented by the geological maps, the development of which was finished, i.e. they are passive at the present time. Morphostructural maps are focused on considerably younger structural active units, the development of which is yet incomplete.

Little agreement of the comparable hierarchy regions in the map of the morphostructures (Fig. 3) and the map which interpretes the geology of the regional units of the Slovakia"s territory (Fig. 2) is obvious. The geological map (Vass et al., 1988) does not define the high hierarchy regional units, for instance the Carpathians, the Pannonian Basin, the Eastern Carpathians, etc. The highest unit was the region (oblasť - in Slovak) or zone (pásmo - in Slovak) in the four level regionalisation (for instance, Jadrové pohoria area, Gemerské pásmo zone). The units between the 3rd and the 4th hierarchy in new morphostructural map (lower than for instance Central morphostructure of the West Carpathian dome and higher than for instance the Tatra central morphostructure in Fig. 3) are roughly comparable to the highest hierarchy of the geological units in Fig 2.

The first of the comparing maps (Fig. 3) illustrates the result of the relief-forming process in the youngest phase of development, named by the geomorphologists the neotectonical phase as it depicts the active morphostructures of block-like type. Exogenous geomorphologic processes selected by differentiated tectonic block movements influenced destructively the structural units shown on the second map (Fig 2). They change the quality of the passive structures, for instance the klippen zone or the neovolcanic compounds. Comparison of figs 2 and 3 shows that geological and morphostructure frontiers agree only at the interface between the Carpathians and the Pannonian Basin. The boundaries of the majority of the intracarpathian basins is similar in both maps. The older the geological units, the lower similarity to morphostructures.

The basic characteristics of morphostructures

1. The Carpathians

The Slovak Carpathians are represented by the western part of a massive of the Carpathians arch, which is a part of the Alpine-Himalayan system. The Slovak Carpathians belong to the West Carpathians, except its easternmost area, which is a part of the East Carpathians.

1.1 The West Carpathians

The overall shape of the West Carpathians is that of a large dome. Its ground-plan is close to ellipse (Mazúr, 1979). The top of the dome is not precisely centred. It is shifted towards its north-eastern border. This megamorphostructure inclines from its asymmetrically situated centre to its circumferential and peripheral parts towards the lowland area of the Pannonian Basin on the southwest and south-east and towards the longitudinal Juhoslovenská depression in the south. This depression is limited in the opposite side by the elevation zone of Matra morphostructure.

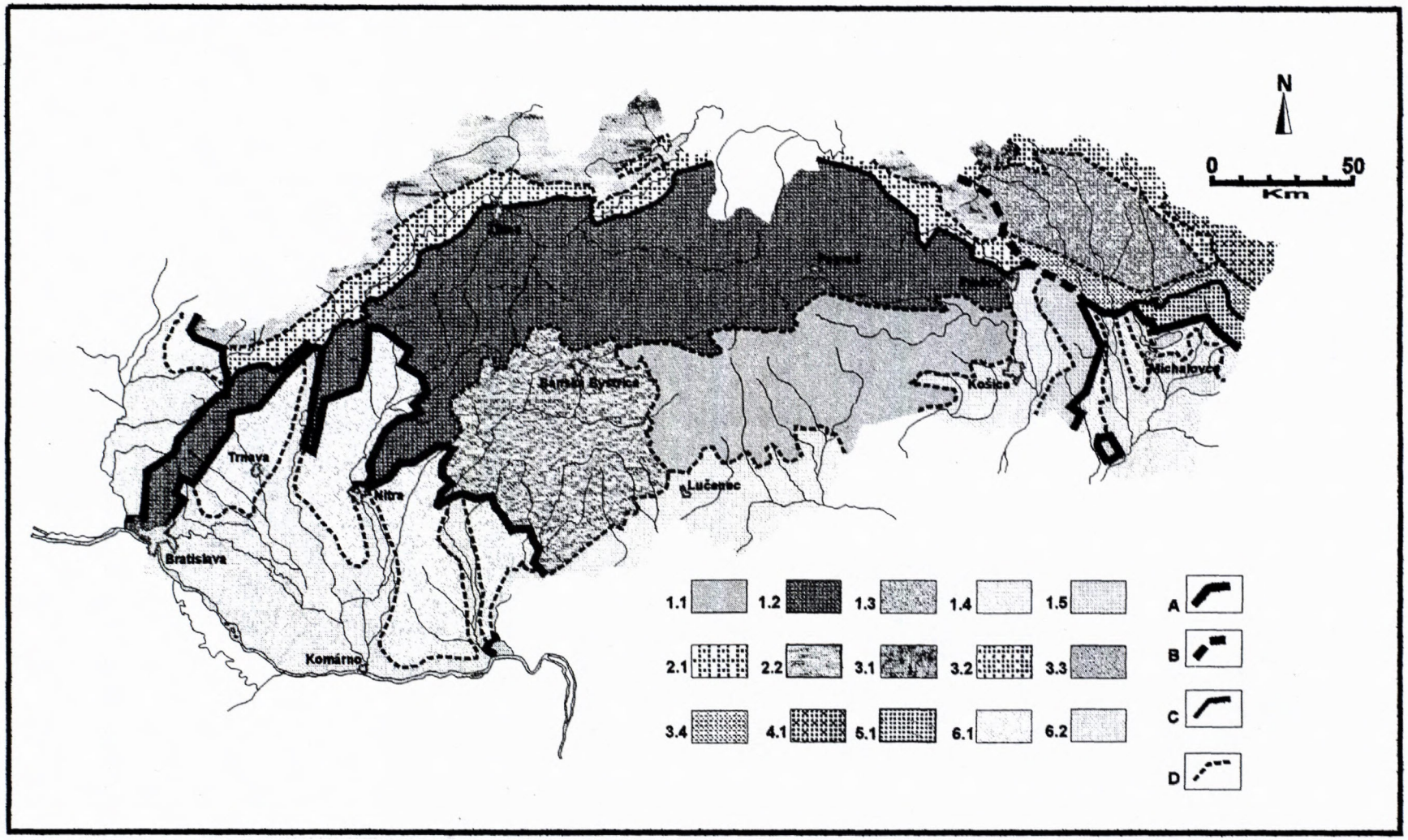

Fig. 1 Morphostructural division of Slovakia according to Mazúr (1980).
1. Morphostructures of the Inner West Carpathians; 1.1 Semi-massive morphostructure of the Slovenské Rudohorie Mts., 1.2 Folded-block Fatra - Tatra morphostructure, 1.3 volcanic block structure of the Slovenské Stredohorie Mts. 1.4 Lučenec - Košice depression, 1.5 Matra - Slaná block morphostructure; 2. Morphostructures of the Outer West Carpathians, 2.1 morphostructural depression of the peri-pieniny (Klippen) lineament, 2.2 fault-folded structures of the flysch Carpathians, 3. Morphostructures of the transitional zone - transversal depression of the Nizke Beskydy Mts., 3.1 partial positive morphostructures, 3.2 transitional morphostructures: uplands, 3.3 transversal depression proper - hilly land, 3.4 structure of the peri-Pieniny lineament, 4. Morphostructures of the Outher West Carpathians, 4.1 block-folded positive morphostructure of the flysh zone, 5. Morphostructure of the Inner East Carpathians, 5.1 block Vihorlat-Gutin structure, 6. Morphostructure of the Pannonian Basin, 6.1 sightly elevated morphostructures within the Pannonian depression,6.2 recent susiding morphostructures with aggradation; Morphostructural boundaries: A. Carpathians-Pannonian Basin boundary; B. West and East Carpathian boundary; C. Inner and Outer Carpathian boundary; D. morphostructural regions boundary

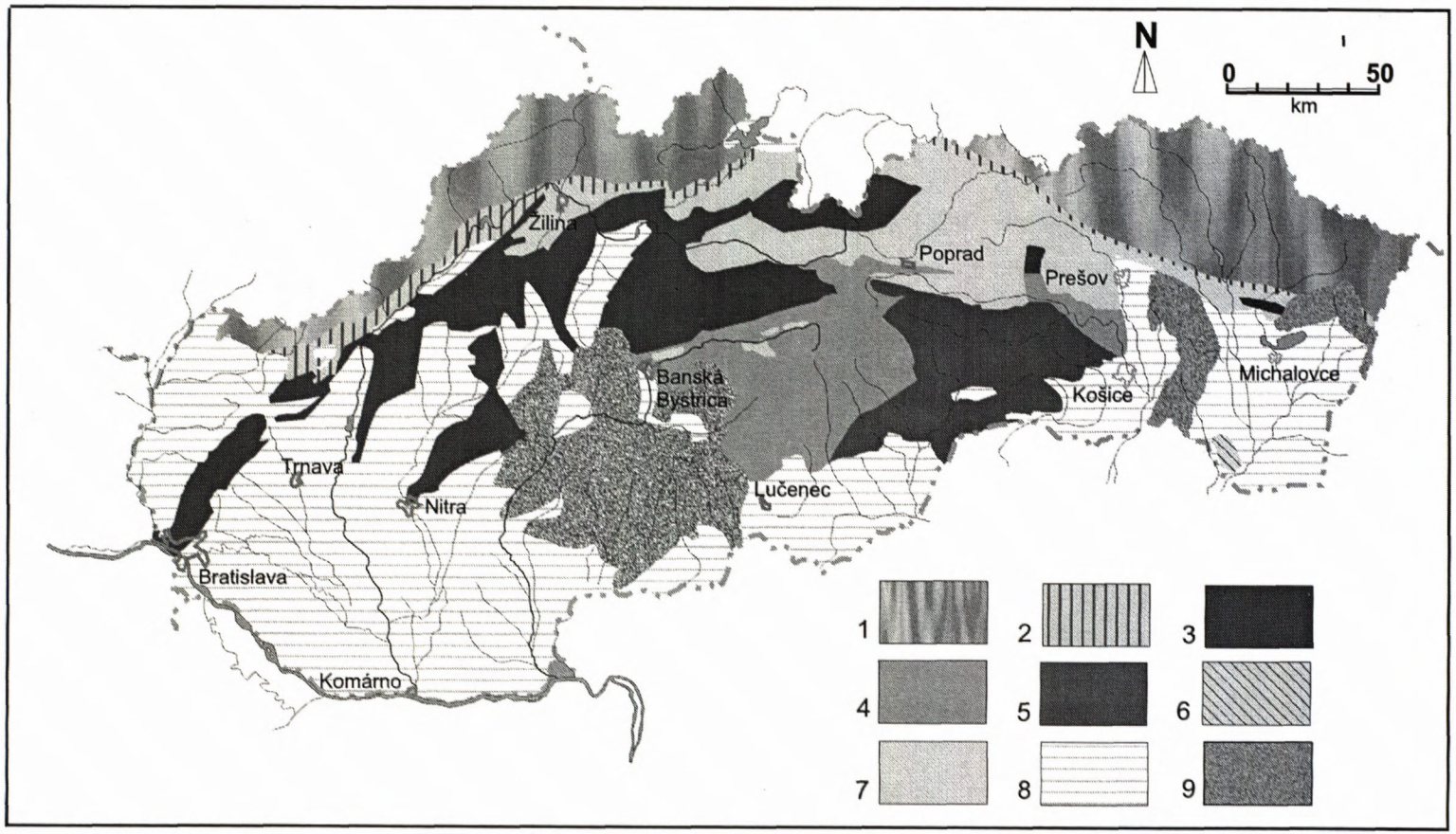

Fig. 2 Regional geological division of the West Carpathians and northern protuberances of the Pannonian Basin in the territory of Slovakia according to Vass et al. (1988)
1. Flysh zone, 2 Klippen zone and sub-klippen areas, 3. Core mountains, 4. Veporik zone, 5. Gemeride zone,. Zemplínske vrchy Mts., 7. Inner Carpathian Paleogene, 8. Inner Carpathian basins, 9. Neovolcanic areas

1.1.1 The central morphostructures of the West Carpathian dome

The central morphostructures represent the most uplifted part of the West Carpathians and whole Carpathian arch. Their mountains reach the highest altitude and also their basins are in the highest position in Slovakia. This unit is at the same time the most internally differentiated and the most contrasting one. The differences between mountains and basins in central part of the dome reach the highest values (max. almost 2 000 m). Two units of the 4th hierarchy level are distinguished within the central morphostructure.

a) The Tatra central morphostructure

The main geomorphologic axes of the morphostructure situated east of the dome centre are running in the west-eastern direction. It is the highest morphostructure in Slovakia, surpassing the altitude of 2 000 metres. There are two expressive elevations: *the Vysoké Tatry Mts.* and *the Nízke Tatry Mts.* bordered by a relatively subsided longitudinal depression *the Podtatranská kotlina basin.* Its eastern part (the Popradská kotlina basin) is almost by 2 000 metres lower than the Tatra mts. Also less uplifted submontane morphostructural unit runs in the same direction as Podtatranská kotlina basin. The borders between the partial units are considerably faulted and they manifested themselves during the Quaternary very dynamically. Likewise, the external borders of the central morphostructure are morphologically very pronounced. In the north it drops markedly towards *the Podtatranská brázda depression,* in the south the corresponding depressed marginal unit represents *the Horehronské podolie valley* (except the Breznianska kotlina basin).

b) Fatra central morphostructure

It is the lower one of two central morphostructures lying west of the dome centre of the West Carpathians. It is characterised by the north-south or diagonal orientation of the relief. It consists of by equally uplifted *the Veľká Fatra Mts.* and *the Malá Fatra Mts.* bordering on the relatively subsided *the Turčianska kotlina basin.* Both uplifted mountain ranges decline towards the basin by steep fault scarp with facets. We have included also *the Žiar Mts. and the Starohorské vrchy Mts.* into the Fatra central morphostructure. The nature of these morphostructures (except the massif Veľký Choč Mt) is that of less uplifted units joining higher central morphostructure. Their lower position is the result of stronger effect of the transversal fault tectonics (Lacika - Gajdoš, 1997).

1.1.2 Transitive morphostructures of the West Carpathian dome

The transitive part of the West Carpathian dome is less uplifted than the central and more uplifted than the peripheral one. Amplitude of the uplifts of the partial morphostructures is less pronounced, i.e their relief is less contrasting than in the central part of dome. This unit consists of five lower structures, which differ from each other by the composition of elevation and depression and by the properties of the passive structures expressed in relief. In other words, the mosaic of mountains and basins varies.

a) the Beskydy transitive morphostructure

There is Beskydy flysch morphostructure in the north of Slovakia and south of Poland. The Polish part of morphostructure passes the boundary northerly of the Tatra Mts. and joins the western and eastern Slovak parts to one entity. The western and eastern parts of the Beskydy flysch morphostructure are symmetrical (for instance the Skorušinské vrchy Mts. and the Spišská Magura Mts.). This unit is characterised by a distinct zonation with arch-shaped zones concentrically arranged around the centre of the West Carpathians. The zones are prevailingly identical with the axes of the flysch and klippen passive morphostructures. The contemporary valley network is based in the young generation of faults often not oriented in direction of the old structural axes.

There are partial morphostructures dominantly arranged in south-west -- north-east strike on the western wing of the West Carpathian dome. They are characterised by a distinct two-level composition of blocks. The elevation zones regularly alternate with depression zones. The higher level is formed by massive plateau-like uplands (*the Vysoké Javorníky Mts, the Turzovská vrchovina Mts., the Kysucké Beskydy Mts, the Oravské Beskydy Mts, the Oravská Magura Mts.* and *the Skorušinské vrchy Mts.)* locally containing well-preserved remains of the middle planation surface in the altitude 900-1 000 metres. Mountain ridges usually decline by faceted slopes towards the submotane forms and basins. The highest uplifted blocks are situated on the massif Babia Hora and Pilsko areas, altitudes of which are comparable for instance to both, Veľká and Malá Fatra Mts. The lower units are represented by a zone of subsided blocks (valleys, submotane, intermontane forms and basins) starting by the narrow *the Považské podolie valley passing the Nízke Javorníky Mts, the Kysucká vrchovina Mts., the Podbeskydská vrchovina Mts.* and ending by *the Oravská kotlina basin.*

The territory of the eastern flysch transitive morphostructures is expressively differentiated into a high uplifted group of blocks (*the Spišská Magura Mts., the Levočské vrchy Mts. and the Čergov Mts.)* and a relatively subsided group of blocks (*the Ľubovnianska kotlina basin* and *the Spišsko-šarišské medzihorie foreland).* The system of less uplifted morphostructures - intermontane forms *(the Pieniny Mts, the Ľubovnianska vrchovina Mts.* and *the Bachureň Mts.)* is also rather extensive. The highest mountains are sharply individualised, they have a distinct central ridge and submontane blocks. Two-level composition (the Levočské vrchy Mts.) and asymmetry (the Spišská Magura Mts.) occur in these units. General relief shapes are similar to the Central Slovakian volcanic mountains. There are well-preserved remains of the middle planation surface in the mountains. The depressions in this area are bordered by faults and underlined by selectively acting erosion.

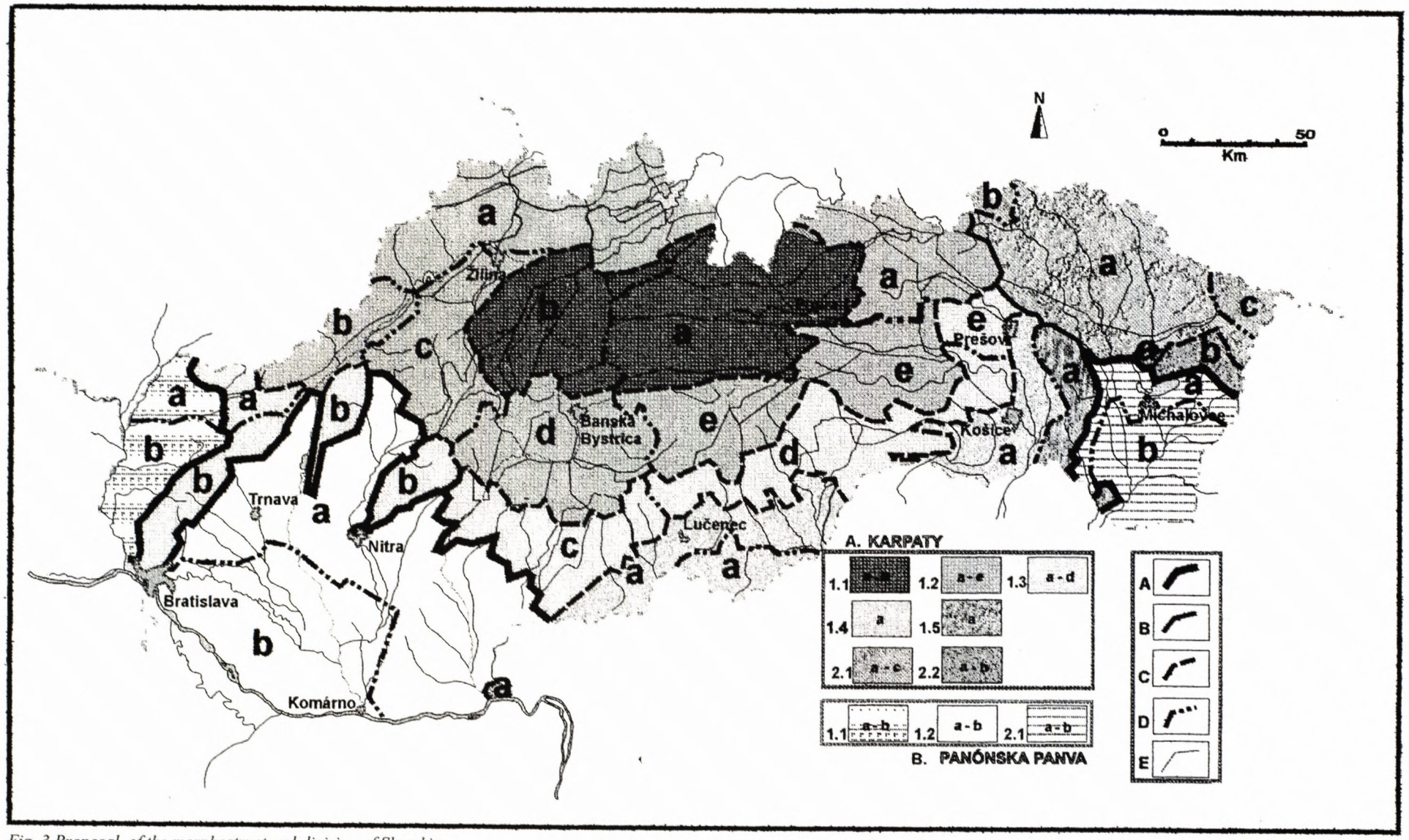

Fig. 3 Proposal of the morphostructural division of Slovakia

A. Carpathians: 1. West Carpathians, 1,1 Central morphostructures of the West Carpathian dome,a. Tatra central morphostructure, b.Fatra central morphostructure; 1.2 Transitive morphostructures of the West Carpathian dome, a. Beskydy transitive morphostructure, b. Moravian-Slovak transitive morphostructure, c. Strážov transitive morphostructure, d. Central Slovak transitive morphostructure, e. Rudohorie transitive morphostructure; 1.3 Marginal morphostructures of the West Carpathian dome, a. Myjava marginal morphostructure, b. West Carpathian marginal morphostructures, c. Central Slovak marginal morphostructure, d. Rudohorie marginal morphostructure, e. Šariš marginal morphostructure; 1.4 Southern depressed morphostructures, a. Lučenec-Košice morphostructural depression; 1.5 Southern elevational morphostructures, b. Matra-Slaná morphostructural elevation

b) the Slovak-Moravian transitive morphostructure

This morphostructure is the westernmost unit of the 4th hierarchical level within the transitive part of the West Carpathian megamorphostructure. Its larger part lies in the Moravian territory. It includes a larger northern part of *the Biele Karpaty Mts.* and also larger southern part of *the Považské podolie valley* (the Ilavská kotlina basin and Trenčianska kotlina basin). The morphostructure has a notable two-level composition. Upper horst-like Biele Karpaty Mts is built-up by flysch rock, lower level is represented by a system of relatively subsided blocks of Považské podolie valley. The narrow zone of the limestone mountains represents an interference between the mountains and basins. But the active component structure (active faults) appear as a dominant relief-forming factor.

c) the Strážov transitive morphostructure

This morphostructure includes a group of mountains and basins in the central Považie and Horné Ponitrie regions. The tectonically less differentiated *Strážovské vrchy Mts.* represent the heart of the area. Notable passive structures (klippens, basins etc.) are evident in these mountains and in the neighbouring *Súľovské vrchy Mts.* Relatively subsided morphostructures in the periphery of unit are in minority (*the Považské podolie valley, the Žilinská kotlina basin* and *the Hornonitrianska kotlina basin).*

d) The Central Slovakian transitive morphostructure

There is a transitive morphostructure SW of the West Carpathian dome, which includes the northern area of the volcanic Slovenské Stredohorie. Its geological structure was analysed in detail by Konečný, Lexa & Planderová (1984) and Kalinčiak, Konečný & Lexa (1989). This territory is very expressively differentiated into uplifted group of blocks (mountains) and a relatively subsided group of blocks (basins). The primary volcanic land forms were almost completely destroyed in this part of the Slovenské Stredohorie, with the exception of *the Poľana Mts.* and *the Javorie Mts.,* where some traits of the original Neogenic stratovolcanoes are recognisable (Lacika 1993 and 1997a). Recent mountains of this unit are horst-like morphostructures dissected into a multidirectional system of ridges and valleys, especially *the Vtáčnik Mts., the Kremnické vrchy Mts.* and the northern part of *the Štiavnické vrchy Mts.* (Lacika 1997b). The north-southern orientation of the geomorphologic networks in this area is prevailing (from the area Veľká Fatra Mts. north of the Danube valley in the south). Structural cascades formed in the consequence of different rock resistance of the destroyed stratovolcanic structure, are evident in a more detailed scale, Some remains of the Neogene planation occur, for instance in the foreland of the Vtáčnik Mts otherwise these land forms are relatively rare in this area (with the exception of Kunešovská Planina plateau in the Kremnické vrchy Mts). Asymmetry of the uplifted blocks is relatively frequent (for instance Kremnické vrchy Mts). *The Zvolenská kotlina basin* is the internally most complicated structure in the area with several partial elevations and depressions. On the other hand, *the Žiarska kotlina basin* is simple, though very dynamically developed. *The Pliešovská kotlina basin* is particular for the absence of sedimentary filling.

e) the Rudohorie transitive morphostructure

This massive morphostructure lies south of the centre of the West Carpathian dome. It includes *the Veporské vrchy Mts., the Stolické vrchy Mts., the Volovské vrchy Mts. and the Spišsko-gemerský kras* area. Uplifted blocks are relatively expressively individualised in its northern side compared to the longitudinal depression of the Horehronské podolie valley or the Hornádska kotlina basin. They decline little by little and in a step-like manner towards the peripheral foreland in the south except the steep fault contact on the border of the Rožnavská kotlina basin in the south and the Košická kotlina basin in the south-east. Tectonic lines are manifested in the Rudohorie morphostructure in ground-plan only, less in the vertical dissection of relief. The central part of the unit carries extensive remains of the Neogenic planation surfaces in the altitude above 1 000 m. The western and eastern parts of this morphostructure are relatively wide in north-southern direction. On the other hand, the middle part of it (in the Dobšiná town area) with its visible reduction of width allows the immediate contact between the centre and periphery of the West Carpathian dome. The system of the linear geomorphologic network related to Murán faults is an important morphostructural element.

1.1.3 The marginal morphostructures of the West Carpathian dome

Except the Juhoslovenská depression, this marginal morphostructure is the least uplifted part of the West Car-

Fig. 3 – continuation

2. East Carpathians: 2.1 Outer zone morphostructures of the East Carpathians, a. Beskydy transversal flysh morphostructure, b. Busov flysh morphostructure, c. Poloniny flysh morphostructure; 2.2 Inner zone morphostructures of the East Carpathians, a. Humenné non-volcanic morphostructure, b. Vihorlat volcanic morphostructure

B. Pannonian Basin: 1. West Pannonian Basin, 1.1 Záhorie morphostructures of the Pannonian Basin, a. Chvojnice morphostructure, b.Bor morphostructure; 1.2 Danube morphostructures of the Pannonian Basin, a. Outer Danube morphostructure, b. Inner Danube morphostructure, 2. East Pannonian Basin, 2.1 East Slovakian morphostructures of the Pannonian Basin, a. Outer East Slovak morphostructure, b Inner East Slovakia morphostructure

Morphostructural borders: A. 1st level morphostructural boundaries, B. 2nd level morphostructural boundaries, C. 3rd level morphostructural boundaries, D. 4th level morphostructural boundaries, E. 5th level morphostructural boundaries

pathian dome. There is more or less uplifted and subsided mosaic of block within this unit. The mountains decline straight towards wide lowland protuberances between the peripheral elevations or towards the longitudinal Juhoslovenská depression. We have discerned five morphostructural units of the fourth hierarchical level in the periphery of the dome.

a) The Myjava marginal morphostructure

This morphostructure belongs to the smallest ones. It continues on the Moravian side of the boundary and represents the group of less uplifted marginal blocks on the south-west margin of the Beskydy transitive zone. There are *the Žalostinská vrchovina Mts.* (SW of the Biele Karpaty Mts.) and the Myjavská pahorkatina hilly land in this unit.

b) The West Slovakian marginal morphostructure

This uplifted group of blocks in the West Slovakia are arranged into the three mountain ranges: *the Malé Karpaty Mts., the Považský Inovec Mts.* and *the Tribeč Mts.*. They decline towards lowlands, usually by fault scarps. The two-level composition and asymmetry occur there. There are well-preserved remains of the Neogene planation in several places. The lowland protuberances originated in the Neogene, They are tectonic subsided blocks. The Malé Karpaty Mts were investigated by Jakál, Lacika, Stankoviansky & Urbánek, 1988 and 1990.

c) The Central Slovak marginal morphostructure

The dome periphery farther eastward of the previous unit makes up a group of the plateau-like mountains built by the volcanic rock studied by Konečný, Lexa & Planderová (1984) and Kalinčiak, Konečný & Lexa (1989). They belong to less uplifted and less differentiated mountains: *the Pohronský Inovec Mts.,* southern part of *the Štiavnické vrchy Mts., the Krupinská planina plateau, the Ostrôžky Mts. and small Novobanská kotlina basin.* The extensive plateaus of this morphostructure gradually decline southwards. More uplifted marginal blocks than the central ones can be found only in the south of the Krupinská Planina plateau (Lacika, 1994 and 1997a).

d) The Rudohorie marginal morphostructure

Southwards of Rudohorie morphostructure lies a group of less uplifted blocks of *the Revúcka vrchovina Mts.* researched by Hochmuth (1996). Its tectonic differentiation is more dense than the internal massive part of the Slovenské Rudohorie Mts. Individual step-like blocks are separated by valleys tracing the tectonic lines, which are directed of the Slovenské Rudohorie Mts. in the north to the Juhoslovenská depression in the south. There is a group of morphostructures in the eastern part of dome periphery, which includes *the Slovenský Kras plateau, the Holička Mts.* (part of the Volovské vrchy Mts.) and the *Čierna Hora Mts.* The Slovenský Kras plateau is the karstic area depending on its geological structure, a superficial plateau karst prevails (Mazúr & Jakál, 1969, Jakál, 1975, 1978 and 1983). Each of the three partial morphostructures is bordered by very sharp fault scarps declined towards the Juhoslovenská depression. The Slovenský Kras plateau declines towards *the Rožňavská kotlina basin* on the opposite side. This basin is the only negatively developed unit in the Rudohorie marginal morphostructure.

e) The Šariš marginal morphostructure

This morphostructure is represented by a group of less uplifted blocks built by flysch rock. It is a very dynamic unit, because it lies in an area of the shortest distance between the centre and the borders of the West Carpathians dome. There is *the Šarišská vrchovina Mts.* in the south. It is a mosaic of step-like blocks without central ridge (Harčár, 1962). The south-eastern ending of *the Spišsko-šarišské medzihorie foreland* lies more to north. This morphostructure is characterised by the Neogenic volcanic exots eroded to distinct isolated elevations. This morphostructure passes continuously to the Košická kotlina basin in the south-east .

1.1.4 The Southuthern depressed morphostructures

These morphostructures are considered a part of the tectonic deformation of the southern wing of the West Carpathian dome (Mazúr, 1979). They consist of the chain of basins arching around the unit 1.1.3. The creation and development of this longitudinal depression is evidently the result of the tectonic block-like movements and selective erosion and denudation. Subject of the ongoing discussion is which of these two groups of relief-forming processes was the dominating one.

a) The Lučenec-Košice depression morphostructure.

The continuous zone of four basins (interconnected over Hungary) two hilly lands *(the Bodvianska pahorkatina hilly land* and *the Abovská pahorkatina hilly land*) are situated in an area between Šahy and Prešov towns. The three basins are neighbouring with each other, but they are not part of the same draining area. *The Ipeľská kotlina basin* is morphologically sharply delimited by the steep southern slopes of the Krupinská Planina plateau. It is divided by the system of parallel symmetrical valleys passive faults. The valleys are directed towards the main Ipel valley in the south-east. *The Lučenská kotlina basin* and *the Rimavská kotlina basin* have a more complicated composition. Their north and south fault bordering are notable (with zigzag course). The asymmetry of the valley indicates their internal morphostructural heterogeneity, which is manifested by tectonic tilting of the individual blocks. A very young and dynamic morphostructure *the Cerová vrchovina Mts.* in the south was individualised in the Pontian (Lukniš, 1972), but its contemporary morphostructural composition originated in the Upper Pliocene - Holocene periods. This unit is built by relatively extensive basalt volcanic complex, activity of which began in the Pliocene and continued till the Quaternary (Vass - Elečko, 1992). The original volcanic land forms of this mountain were erosionally destroyed and got into inverse

position. The Cerová vrchovina Mts. was uplifted into combined dome-horst type morphostructure (Vass - Pristaš - Elečko, 1992 and Lacika, 1989). The study of the river planation surface indicates high values of its Quaternary uplifts locally higher than 300 metres (Lacika, 1990). Frequent asymmetry and appearance of the tectonic intramontane basins suggest an intensive morphostructural differentiation of these young mountains. The ground plant of *The Košická kotlina basin* is complicated with several protuberances to the Slovenské Rudohorie Mts. This basin is bordered and segmented by a few active fault lines in various directions. The west-east fault system dominates in the southern part of basin, the north-southern faults, which predetermine the direction of the principal basin river, dominate in the north. The Turnianska kotlina basin in the south-west represents an inverse valley bordered in the South and North by the longitudinal fault, which had been active during the Pliocene and Pleistocene. This faults controlled the uplifting of the Slovenský Kras plateau and subsidence of the proper depression (Vass et al., 1994).

1.1.5 The southern elevational morphostructures

This elevation morphostructure represents southern border West Carpathian dome, which myself individualised tectonic uplifts.

a) the Matra-Slaná elevation morphostructure

The longitudinal system of mountains culminates in its north-east termination formed by less tectonically differentiated volcanic-fault morphostructure *Slanské vrchy Mts.* According to Dzurovčin (1990) the morphology of the meridionally oriented morphostructure is given more by accumulation volcanics than by block upliftings along the system of faults. These mountains formed on north-south fault system, which are delimited by much higher blocks of the Košická kotlina basin and much lower blocks of the Východoslovenská Nížina lowland. Volcanics of the linearly arranged Neogene volcanoes covered a tectonic step-like blocks declined eastward. Their fault bordering is less expressive towards the Košická kotlina basin than towards the other side. *The Zemplínske vrchy Mts.* represent a horst-like morphostructure with unusual position. The system of uplifted blocks is enclosed from three sides by subsided blocks of the Východoslovenská nížina lowland. *The Burda Mts.* are by faults bordered morphostructure structurally connected with Hungarian volcanic mountain range Borsszony behind the fault of the Ipeľ valley. These mountains represent the west limitation of the south Slovakian elevation morphostructure. The Hungarian mountain range beginning by the Pilis Mts which spread farther to the south-west is not considered by the Hungarian geomorphologists as a part of the West Carpathians (Pésci, 1970). According to Mazúr (1979) they should be included in the West Carpathians.

1.2 The East Carpathians

The East Carpathians reach the territory of Slovakia by only by their western border only. They consist of two parts and their arrangement is zonal.

1.2.1 Outer zone morphostructures of the East Carpathians

The character of this unit is a transversally widely opening depression (intermontane type) between the West Carpathians and higher eastern part of the East Carpathians. The axis of this depression is north-south oriented. It follows the Ondava river valley. The Nízke Beskydy Mts appear as a northern continuation of the Východoslovenská Nízina lowland (its tectonic subsidence). The is a more uplifted group of blocks of the Bukovské vrchy Mts north-east of the Nízke Beskydy Mts. The upper blocks of the Busov Mts. are situated in the north-west.

a) The Nízke Beskydy depression morphostructure

This morphostructure is consists of three geomorphologic units: *the Ondavská vrchovina Mts., the Laborecká vrchovina Mts* and *the Beskydské predhorie foreland.* The shape of the Nízke Beskydy morphostructure is that of a wide shallow transversal depression, lower than the Čergov Mts, the Bukovské vrchy and the Slanské vrchy Mts. The Východoslovenská nížina lowland lies in lower position only. Morphostructure was analysed by Harčár (1995 and 1997). It is differentiated into a great amount of small blocks. The blocks are not organised into a well-marked hierarchically arranged system. There is not any central ridge or central depression in this morphostructure, only monotonous alternating of low ridges and valleys. The NW-SE and N-S lines dominate in the geomorphologic ground-plan. The NW-SE lines belong to the Paleogene geological structure, N-S lines are linked to younger faults. An expressive inverse relief occurs in some areas. The Beskydské predhorie foreland represents a zonally arranged less uplifted morphostructure. It looks as a foreland of the Ondavská vrchovina Mts. and the Laborecká vrchovina Mts. in the West and as wide valley between the Bukovské vrchy Mts. and the Vihorlat Mts. in the east. This morphostructure is differentiated by transversal faults.

b) the Busov elevation morphostructure

There is one partial morphostructure in the Busov elevation morphostructure. The are *the Busov Mts.* This less differentiated, massive mountainous unit like near Čergov Mts. is build by rock outer flysch, dominantly by sandstone, lithology of which emphasizes the elevation shape of morphostructure and relief inversion.

c) the Poloniny elevation morphostructure

This unit comprises only one partial morphostructure - *the Bukovské vrchy Mts.* This expressive elevation rises above the Nízke Beskydy Mts. The massive active morphostructure has a central ridge which reaches its

highest altitude in the territory of Poland and Ukraine (over 1 300 m above the sea level). It has a two-level composition with vast foreland.

1.2.2 Inner zone morphostructures of the East Carpathians

This morphostructure includes the whole of the Vihorlatské vrchy Mts divided into two units of the 4th hierarchical level.

a) The Humenné morphostructure

This small morphostructure is identical to *the Humenské vrchy Mts.* in the western part of the Vihorlatské vrchy Mts. It is not volcanic or massive. Its blocks are built by the Mesozoic rock in an expressively isolated position. Morphostructure is less uplifted than the surrounding volcanic Vihorlat Mts. The group of blocks is limited by the longitudinal faults and differentiated by a transversal one. The Laborec river valley traces one of them.

b) The Vihorlat volcanic morphostructure

This volcanic and relatively massive morphostructure is divided into *the Vihorlat Mts.* and *the Popriečny Mts.* (the eastern part of the Vihorlatské vrchy Mts.) Kalinčiak, Konečný & Lexa (1989) studied its volcanic structure. The system of transversal tectonic divides the morphostructure by a transversal depression in two massifs. The Vihorlat Mts. group of blocks is individualised by expressive NE-SW faults. The transversal NW-SE faults in the Vihorlat Mts. become longitudinal in the Popriečny Mts. This different tectonic ground-plan changes orientation of the main ridge of the eastern part of the morphostructure.

2. The Pannonian Basin

The Pannonian Basin consists of three Slovak lowlands. Each of them is a part of bigger lowland unit, and their bigger parts lye out of Slovakia. The lowlands are bounded and divided by elements of the fault tectonics. The West Pannonian Basin consist of the Záhorská nížina lowland and Podunajská Nížina lowland. Východoslovenská nížina lowland belongs to the East Pannonian basin.

2.1 The West Pannonian Basin

2.1.1 The Záhorie morphostructures of the Pannonian Basin

The Záhorská nížina lowland belong to bigger lowland unit, which continues over the boundary of the river Morava to the Austria and the Czech Republic. Its boundaries with neighbouring elevation morphostructures follows mostly an active fault (more expressive with the Malé Karpaty Mts, less with the Myjavská pahorkatina hilly land).

a) The Chvojnícka morphostructure

The Chvojnícka morphostructure lies in the northern part of the Zahorská nížina lowland. It consists of *the Chvojnícka pahorkatina hilly land, the Gbelský Bor* and *the Slovak part of the Dolnomoravský úval lowland.* It has a mosaic of high lowland type blocks, which are massive, less differentiated and plateau-like. Plateaus reach the altitude above the sea level over 400 m in the Zámčisko area. The subsided blocks during the Quaternary are situated in the West (near Holič town).

b) The Bor morphostructure

Borská morphostructure stretches over *the Borská Nížina lowland* excluding the Gbelský Bor area. It has been studied by Škvarček (1971). The Malé Karpaty Mts. are bordered by a narrow longitudinal Podmalokarpatská Znízenina depression, which is dissected by transversal faults into less uplifted and more subsided system of blocks. An intense Quaternary subsidence of this depression has accelerated their filling by alluvium of the brooks from the Malé Karpaty Mts. The western part of Záhorská nížina lowland appears as relatively stable morphostructure. Its very moderate tectonic mobility is indicated by asymmetry of the terracing system of the Morava river, which is well developed in the left (Slovak) side. Probably the effect of a westward tectonic tilting caused gradual migration of the Morava in the same direction during the Quaternary.

2.1.2 The Danube morphostructures of the Pannonian Basin

The Podunajská morphostructure is bordered by faults with neighbouring elevation morphostructures of the West Carpathians. It is divided into two partial morphostructures.

a) The Danube outer morphostructure

This morphostructure includes *the Podunajská pahorkatina hilly land* only. It has a position of the transitive morphostructure between strongly subsided centre of lowland and surrounding positively developed mountainous morphostructure. The lowlands protuberances reach northwards between the mountain ranges of the West and Central Slovak external volcanic morphostructure. One of them (near the Bánovce town) directly contacts with the transitive morphostructures of the West Carpathian dome. The Podunajská pahorkatina hilly land is arranged into a system of alternating wide valleys and the lowland hills. The Váh river very intensively agrades in its valley between the Nové Mesto nad Váhom and Sereď towns, suggesting the Quaternary subsidence. This depression neighbours with the second subsided block in the southeast with recent tectonic tilting (Stankovinansky, 1993) There is also longitudinal depression at the foot of the Malé Karpaty Mts. analogue to depression in the opposite side of this horst morphostructure. This depression is cut by several active transverse faults. Some of them break the depression between the Modra town and Častá village (Feranec - Lacika, 1991). Geomorphologic development of entire morphostructure was influenced by intensive subsidence in the south lying neighbouring central blocks of the Podunajská nížina lowland. Large alluvial fan of

the Danube river pushes back the lower Váh river. This geomorphologic process causes a bend of Váh river towards south-east close to Sereď town. Other considerable change of a hydrological and structural networks of the Podunajská nížina lowland developed on an the area of the lower Nitra and Zitava rivers. They flew directly down the old Žitava valley across the Hronská pahorkatina hilly land towards the Hron river valley as recently as in the Middle Pleistocene (Harčár, 1975 and 1981). There are several land forms related to the tectonic movements in the Podunajská pahorkatina hilly land, for instance rectangular and asymmetrical valley texture in the Hronská pahorkatina and Nitrianska pahorkatina hillylands (wide surroundings of the Vráble town).

b) the Danube inner morphostructure

This morphostructure is the deepest Quaternary tectonic depression in Slovakia .It includes the Žitný ostrov area and adjacent less subsided blocks of *the Podunajská rovina plain.* The Danube river looses its transport energy leaving the Malé Karpaty Mts Danube and its alluvial material is deposited into an intensively subsided central depression. Maximum thickness of the alluvial accumulation is more than 500 meters in the central part of depression (Halouzka, 1994). Man has entered into this natural relief-forming story by construction of dike systems and water works and stopped the process of depression. That is why in the territory of Žitný ostrov several shallow depressions originated, named by Lukniš & Mazúr (1959) "mokrade".

2.2 The East Pannonian Basin

2.2.1 The East Slovakian morphostructures of the Pannonian Basin

This morphostructure has a complicated ground-plan. This lowland has no centre of subsidence. The plains are more typical here than hills in it is a trait that distinguishes it from the Podunajská nížina lowland.

a) The East Slovakian outer morphostructure

The Východoslovenská pahorkatina hilly land is situated in the circumferential part of the Východoslovenská nížina lowland. The edge of the lowland consists of a group of upper blocks higher than internal morphostructure and lower than the surrounding mountainous blocks of the Slanské vrchy Mts. and Vihorlatské vrchy Mts. They are very close to centre of the West Carpathians dome in the north-west. This fact causes the maximum dynamism of the local fluvial geomorphologic systems. The Pozdišovský chrbát lowland ridge reaches farthest in the Východoslovenská nížina lowland, between the Ondava and Laborec river valleys. There is a complicate system of blocks under the Vihorlatské vrchy Mts (surroundings of the Sobrance town).

b) The East Slovakian inner morphostructure

This morphostructure consists of *the Východoslovenská rrovina plain.* It is a complicated system of the blocks that subsided in the Neogene and Quaternary mobility of which causes frequent changes of the hydrological and geomorphologic networks (Borsy - Felefyházy, 1983). Subsided blocks are mostly bordered by N-S and W-E fault systems. There are flat and badly drained land forms, their rivers often agrade. Water-logged territory is unsuitable for agricultural use.

Conclusion

The basic morphostructural units of Slovakia surpass its state borders and some of its parts part lie in the territories of the neighbouring states. In other words, the morphostructural regionalization has an international dimension. The Carpatho-Balkanic Geomorphologic Commission is starting a multilateral research project. It will co-ordinate the morphostructural research in several Central-European and Balkan countries including Slovakia. This contribution is a part of the project.

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