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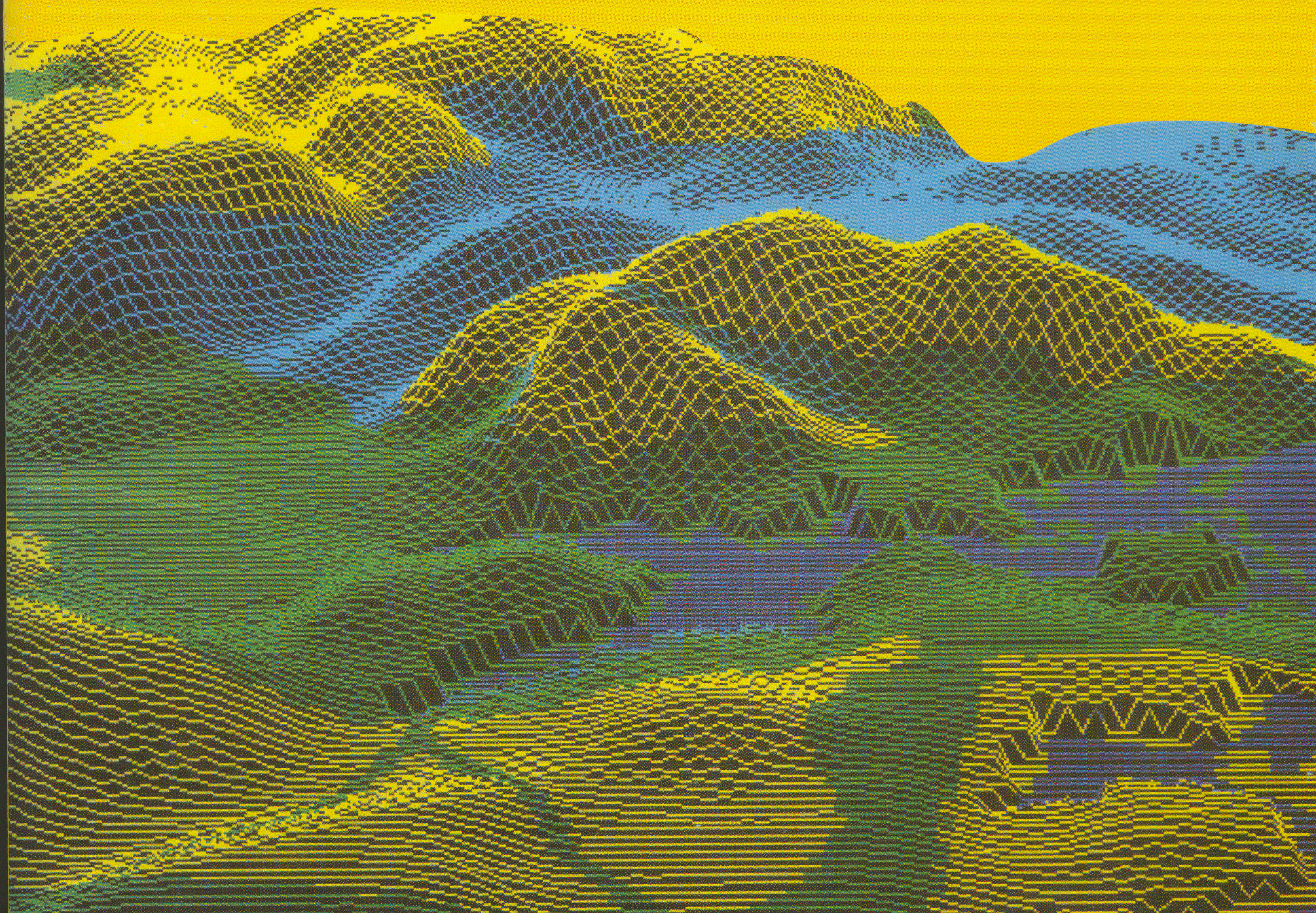

PODYJÍ NATONAL PARK WITH CANYON-LIKE VALLEY OF DYJE RIVER

Deep valley of Dyje river with the wooded rocky steep slopes was the one of reasons for constitution of the Podyjí National Park. View from the Fox rock on the part of the incised meander Dyje river in the eastern section of national park.

Photo: Vítězslav Nováček

Granite tor forms on the upper part of left valley slope Dyje river (locality of Fox rock) their origin is conditioned by rock structure and activity of cryogenic and gravitational processes.

Photo: Karel Kirchner

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Morphotectonics of SE margin of the Bohemian Cretaceous Basin, two half-grabens and their surroundings north of Brno (Moravia)

Antonín Ivan

Abstract

In the paper, morphotectonics of the SE marginal part of the Bohemian Cretaceous Basin as well as of two half-grabens and their surroundings north of the town of Brno is discussed. The pre-Variscan basement in the SE part of the Bohemian Massif, between the Carpathian Foredeep and the Bohemian Cretaceous Basin was strongly affected by Young-Saxon germanotype tectonics. North of Brno, relics of the downfaulted Upper Cretaceous sediments are preserved mainly in tectonic depressions and owing to the relief inversion, also at some divides. Relations among the half-grabens and Saxon structures in the Bohemian Cretaceous Basin are also discussed. Other problems are denudation chronology (including the Moravian Karst) and river pattern development.

Abstrakt

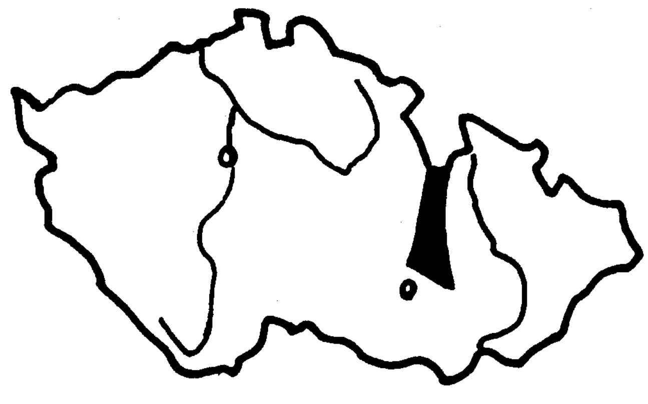
V článku je diskutována morfotektonika jv.okraje České křídové pánve, dvou polopříkopů a jejich okolí severně od Brna. Předvariský fundament jv.části Českého masívu mezi čelní karpatskou hlubinou a Českou křídovou pánví byl silně porušen mladosaxonskou germanotypní tektonikou. Zbytky svrchnokřídových sedimentů se uchovaly nejen v depresích, ale v důsledku inverze reliéfu jsou také na rozvodích.Je diskutován vztah polopříkopů k saxonským strukturám v České křídové pánvi. Blanenský prolom je jjz. pokračovánín ústecké synklinály. Dalšími diskutovanými problémy jsou denudační chronologie (včetně Moravského krasu) a vývoj říční sítě.

Key words: geomorphology of the SE part of the Bohemian Massif, Saxon tectonics, half-grabens, Bohemian Cretaceous Basin

1. Introduction

The post-Hercynian (Saxon) germanotype tectonics, characterized by intensive block-faulting both of the pre-Mesozoic basement and its sedimentary cover, resulted in horsts and grabens topography in the eastern part of the Bohemian Massif. North of the town of Brno, between the Bohemian Cretaceous Basin on the NW and the Carpathian Foredeep on the SE, two synclinal structures of half-graben type originated, in which the Upper Cretaceous sediments are preserved. At present, after the longterm subaerial denudation interrupted by marine transgression in the Miocene (Lower Badenian 16,5 - 15,5 m.y.) and complications caused by younger phases of tectonism, we found the relics of the Upper Cretaceous sediments and of the Miocene deposits in two narrow discontinuous zones of the NW and NNW directions in very different topographic positions and altitudes (Fig.1). A larger and more distinct structure in the surroundings of towns of Blansko and Kunštát is referred here to as the Blansko-Kunštát zone; the less striking zone in the sourroundings of Boskovice and the village of Valchov is referred to as the Boskovice - Valchov zone. However, only the SE parts of the zones are well-defined structures and topographic depressions known as the Blansko and Valchov Grabens (Zapletal, 1932; Kettner, 1960). In the NW parts of the structures, the Upper Cretaceous sediments are in higher altitudes, in some cases forming conspicuous buttes. Their position resulted from tectonic tilting of graben fillings along their long axes as well as from antithetic nature of major faults. At present, the Upper Cretaceous sediments are found in the rather complicated and dissected landscape in the altitude of 230-580 m.

Lithological and paleogeographical relations between the Upper Cretaceous sediments of the two zones and the Bohemian Cretaceous Basin are apparent especially in the Blansko - Kunštát zone. This also



applies for several large isolated remnants of the Upper Cretaceous sediments north of the Boskovice - Valchov zone. They are called "islets" (e.g.Vachtl et al., 1968), and are not analysed here, however.

The relics of the Upper Cretaceous sediments of both zones are 20-30 km from the contact of the SE margin of the Bohemian Massif with the Carpathian Foredeep. Towards the SE, in the adjacent part of the Western Flysch Carpathians, the Upper Cretaceous sediments occur e.g. in the Pavlovské vrchy (Hills), about 40 km from the SE margin of the Bohemian Massif.

2. *Relationship between half-grabens and basement structure*

The half-grabens north of Brno are located in the contact area of three important terranes or crystalline blocks of the eastern part of the Bohemian Massif (see e.g. Mísař and Dudek, 1993). The western block, Moravosilesicum, consists partly of the Svratka dome, a complex nappe structure with gneiss core mantled by two-mica schists, phyllites, limestones and amphibolites. The block is bordered on the NE by metabasites of the Letovice and Polička Units belonging to the block of the Bohemicum. On the SE, the Moravosilesicum is bordered by the Brunovistulicum, consisting of granitoid rocks of the Brno Massif (mainly by granodiorites and metabasites). Towards the E and N, the Brno Massif is hidden by the Devonian and Lower Carboniferous (Culm) sediments of the Drahanská vrchovina (Highland). The sediments were folded intensely during the Variscan tectogenesis.

The contacts among blocks were modified and masked by late Variscan structure of the Boskovice Furrow originated along the Boskovice - Diendorf fault. The furrow, trending NNE, is in fact also the half-graben about 70 km long, filled with the moderately deformed Upper Carboniferous and Lower Permian (Stephanian - Autunian) continental deposits. The sediments are classified as posttectonic molasse (e.g. Katzung, 1988). The present topographic nature of the depression resulted both from differential erosion of weak sediments and neotectonic reactivation of some of the faults. The largest, not remobilized part of the furrow dividing the structure into two parts belongs to the Českomoravská vrchovina (Highland). Some margins both of the Českomoravská vrchovina and Drahanská vrchovina (Higlands) are also composed by sediments of the furrow (Fig.1).

Thus, the term Boskovice Furrow, as used by geologists and geomorphologists, is not unambiguous. As a downfaulted structure, the furrow is larger than the present topographic depression. The Boskovice Furrow originated after the climax of Variscan tectogenesis. However, episodic tendencies to sinking in the whole contact area of three crustal blocks repeated during the post-Paleozoic platform regime. This is exemplified by remnants of the Jurassic and traces of the Lower Cretaceous sediments between the towns of Brno and Svitavy (Eliáš, 1981; Krystek and Samuel, 1978). Later, the Bohemian Cretaceous Basin originated as an intracratonic depression trending generally ESE. Its general trend turns to the SSE in western Moravia and not only the N part of the Boskovice Furrow, but also the supposed area of Jurassic sedimentation was affected. This direction change was predisposed by the trend of Variscan structures in the Moravosilesicum. Owing to the direction change, the Bohemian Cretaceous Basin extended towards the S, probably as far as to Brno, where it linked up with the sea in the area of the present Carpathians (Malkovský, 1979). This is supported by the Upper Cretaceous sediments in the northern vicinity of Brno, e.g. in the Svinošice Graben (Demek - Novák et al., 1993) and perhaps also by problematic gravels at Soběšice (the northern suburb of Brno), interpreted by Krejčí and Štelcl (1987) as possible remnants of the Lower Cretaceous sediments assigned in the Moravian Karst to the Rudice Formation (Fig.1).

The N-S direction was important during the Variscan tectogenesis in the northern surroundings of Brno as demonstrated e.g. by downfaulting of Lower Devonian sediments of the Old Red type in the Babí lom tectonic zone N of Brno (Dvořák, Karásek and Netopil, 1975; Roupec, 1994). Many faults were reactivated during young-Saxon movements (Krejčí, 1964; Ivan, 1992). The Upper Cretaceous sediments were deposited on tropical weathering planation surface with a thick mantle of saprolite. The Cenomanian and Turonian sediments are less than 200 m thick in the half-grabens, whereas in adjacent parts of the Bohemian Cretaceous Basin their thickness is almost 400 m and also younger formations are preserved. The sediments are intensely mined for ceramic and building purposes, especially in the Blansko - Kunštát zone.

After regression of the Upper Cretaceous sea, the young Saxon tectonic movements took place mainly in subaerial environment and denudation regime. Numerous faults, flexures, assymetric folds and high-angle thrusts originated (Malkovský, 1979, 1980). Amplitudes of the most intensive movements in the eastern part of the Bohemian Cretaceous Basin which partly overlaps sediments of the Boskovice Furrow exceeded 1000 m (Malkovský, 1977).

In the pre-Variscan basement of the eastern part of the Bohemian Massif, downfaulted blocks of the Upper Cretaceous sediments of both zones are cross structures. From the NW to the SE, the Blansko - Kunštát zone crosses the eastern part of the Svratka Dome, the Boskovice Furrow and partly also the Brno Massif. In the Boskovice - Valchov zone the Boskovice Furrow and Brno Massif are also dislocated. At its NW end, however, the relation to metamorphic rocks of the Svratka

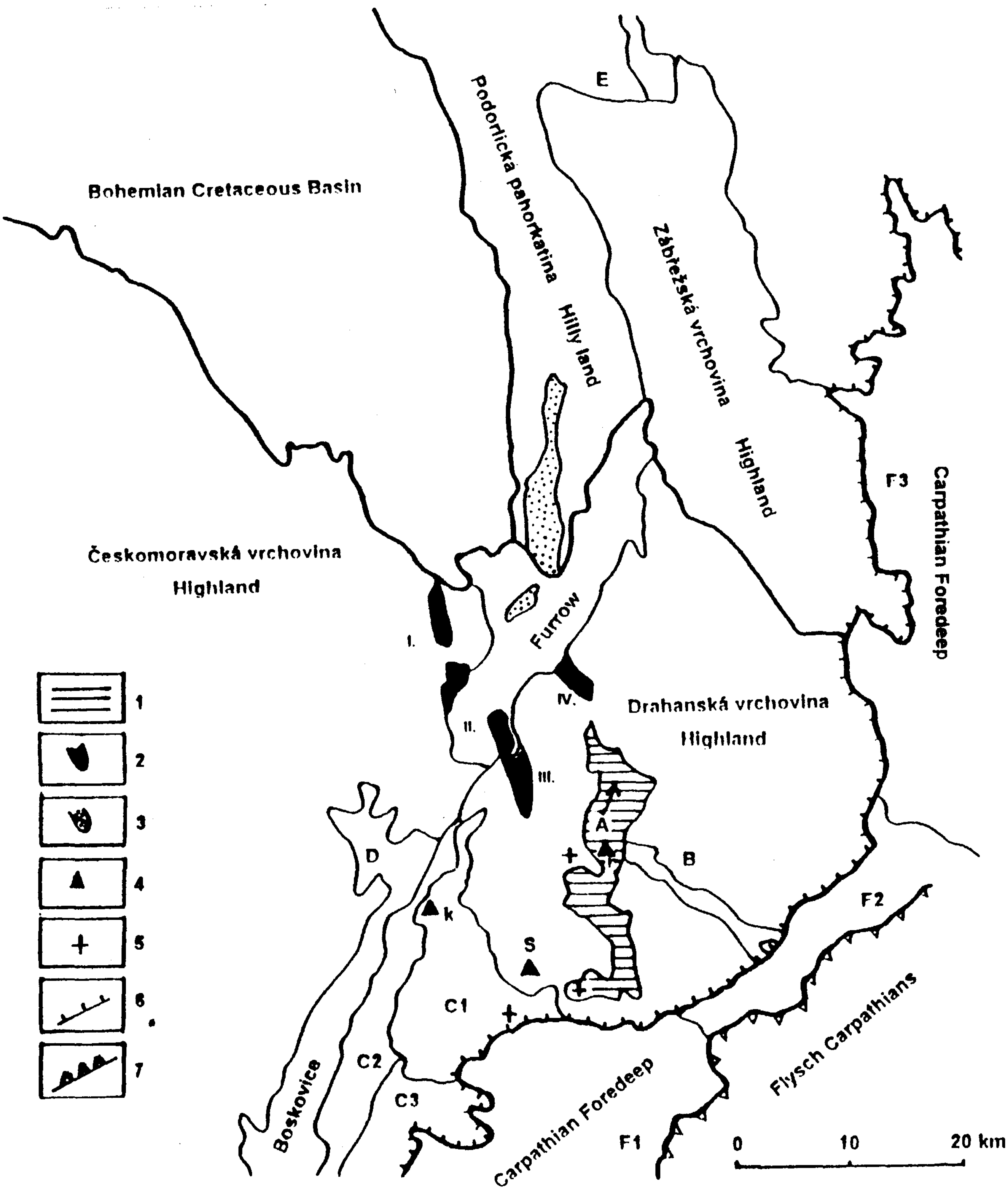


Fig.1. Main occurences of Mesozoic sediments in the northern surroundings of Brno: 1.Devonian limestones, 2.Upper Cretaceous sediments of the Blansko - Kunštát a Boskovice-Valchov zone. I-III Northern, middle and southern segments of Blansko - Kunštát zone. IV Valchov Graben. 3.Upper Cretaceous sediments in the "islets" of the Bohemian Cretaceous Basin. 4. Isolated relics of the Cretaceous sediments in the northern surroundings of Brno: k-Kuřim, s -Soběšice, r-Rudice. 5.Relics of the Jurassic sediments. 6. Marginal slope of the Bohemian Massif. 7. Front of the West Carpathians. Symbols of geomorphological units: A-Moravian Karst, B-Jedovnice - Račice Graben, C1- Brno Basin, C2 - Lipovská vrchovina (Highland), C3- Pršticka pahorkatina (Hilly land), D -Tišnov Basin, E -Králíky Graeben, F -Outer Carpathian Depressions (Carpathian Foredeep), F1- Dyjsko-svratecký úval (Graben), F2- Vyškovská brána (Gate), F3 Hornomoravský úval (Graben).

Dome is not clear, because of complete denudation of the Upper Cretaceous sediments. Accordingly, although the two zones are crossing three very different geological a geomorphological units, the half-grabens as distinct topographic depressions are developed only in granitoid rocks of the Brno Massif. On the SE, the half-grabens are closed at the contact of the granitoid rocks with the folded Devonian and Culm sediments of the Drahanská vrchovina (Highland).

3. *The Blansko - Kunštát zone*

The Blansko-Kunštát zone is 26 km long and 1-5 km wide. It extends from the valley of the Křetínka river on the NNW to the junction of the rivers Svitava and Punkva on the SSE. The original continuity with the Bohemian Cretaceous Basin in the NNW was lost due to entire denudation of the Upper Cretaceous sediments in the valley of the Křetínka. On the SSE, at Blansko, the zone ends on a diagonal fault trending SE. In this place, the Svitava R. enters a deep tranversal gorge. The Blansko - Kunštát zone can be divided into three segments (I- III in Fig.1) according to their topography, position of the Upper Cretaceous deposits and basement structure (see also Vachtl et al., 1968). Although the whole zone is bordered by the Semanín fault on the SW, a distinct scarp related to this fracture is only in the southern segment. The Semanín fault is a complicated step-like fracture with the Upper Cretaceous sediments on the downthrown block only. From the upthrown block, the Upper Cretaceous sediments were denuded entirely.

3.1 The northern segment in the Českomoravská vrchovina (Highland)

From the geomorphological viewpoint, the segment is situated in the NE marginal part of a huge elevation of the Českomoravská vrchovina (Highland). The segment is about 10 km long and its downfaulted blocks are not well-defined neither structurally nor topographically. In the segment, the Upper Cretaceous sediments attain the highest elevation (up to 580m). Owing to denudation as well as antithetic nature of the Semanín fault, the Upper Cretaceous sediments are preserved only as a narrow strip along the fault trace.

Denudation of the Upper Cretaceous sediments resulted in the formation of a small depression, the Křetín Basin, at the NNW end of the segment (Fig.12). The exhumed pre-Upper Cretaceous planation surface on its bottom truncates metabasites of the Letovice Unit at the altitude of 400-420 m (Fig. 7). The planation surface is flat, only with sporadic residual hills (Zvejška, 1948, Fig.1).

Structure of crystalline basement is very complex in the segment. The Semanín fault coincides with ancient fracture along which metabasites of the Letovice Unit were thrusted over schists of the Svratka Dome (Jenček, 1963). The present position of the Upper Cretaceous deposits is owing to the post-Upper Cretaceous rejuvenation of the Semanín fault. However, not only the Semanín fault, but also the whole Svratka Dome were remobilized (Hrádek, 1982) and even the marginal part of the Lower Permian sediments of the Boskovice Furrow was partly involved in the process.

Remobilization of the Svratka Dome is demonstrated by a dome-like deformation of the buried pre-Upper Cretaceous planation surface (angular unconformity), apparent mainly along the long axis of the segment (Fig.2, see also Zvejška, 1944). In the Křetín Basin the exhumed surface is at the altitude of 400- 420 m, on the quer axis of the dome at Kunštát at the altitude of 500 m. Further southward, the planation surface descends to the altitude of about 350 m at Lysice. On metabasites, the rests of lateritic weathering crust on the exhumed planation surface were found (Vachtl et al.,1968; Bezvodová, 1988). Several cross faults trending NW (Röhlich, 1958) were important in the remobilization, too. As it will be shown later, the highest part of the segment is at the same time a threshold between the Blansko - Kunštát zone and the Ústí syncline, a very important structure of the Bohemian Cretaceous Basin.

Several conspicuous buttes, (Brablecův kopec 546 m, Křib 583 m, Milenka 580 m and Chlum 512 m), standing above the partly exhumed pre-Upper Creta-

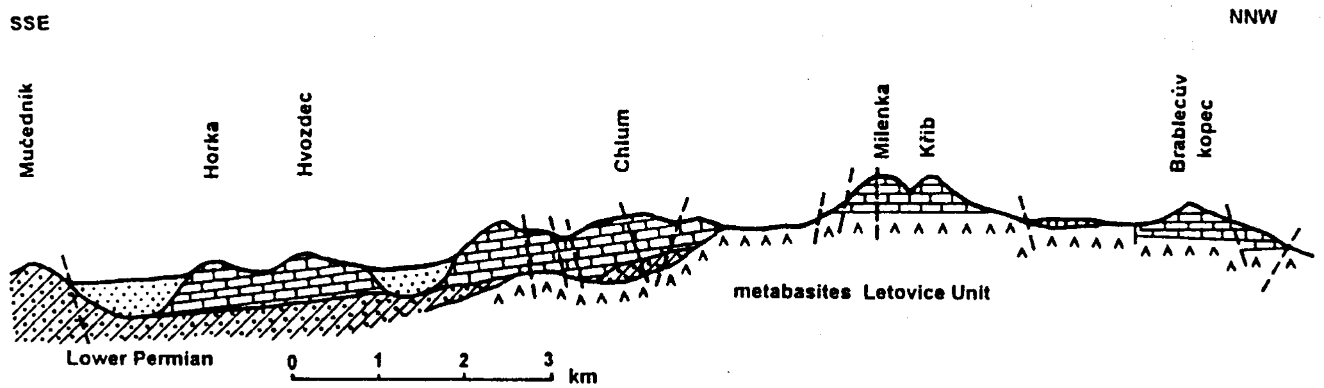


Fig.2. Profile along the long axis of the northern segment of the Blansko - Kunštát zone (according to J.Vachtl et al.1968). The dome-like deformation of buried pre-Upper Cretaceous planation surface is conspicuous.

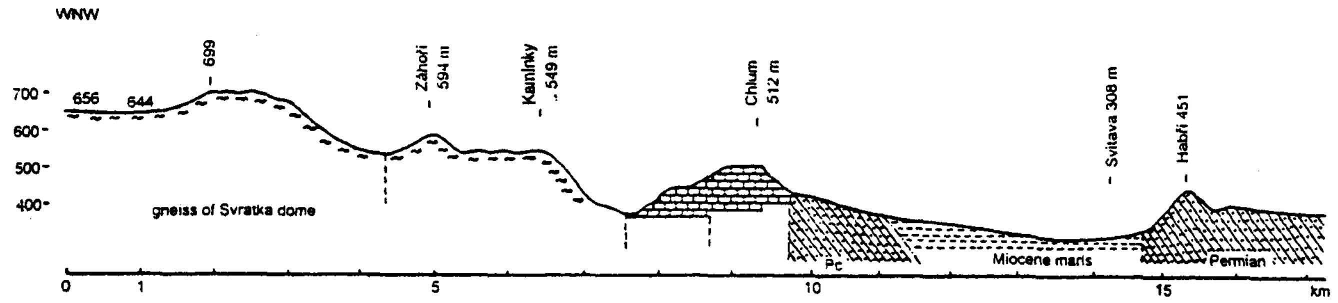


Fig.3.Profile across the western part of the Českomoravská vrchovina (Highland), the Svratka Dome and northern segment of the Boskovice - Kunštát zone and the Boskovice Furrow (northern part of the Lysice Depression filled partly by Miocene deposits).

ceous planation surface, are the only denudational remnants of originally thicker and more extensive cover of the Cenomanian and Turonian deposits (Figs. 2,3, and 13). Some of them, especially the Milenka and Chlum are flat-topped mesas.

South of Kunštát, the Semanín fault is followed by a small water course of the Umoří trending SSE (towards the Boskovice Furrow). The striking fault-line valley developed along the water course with the high steep western slope built of schists and the low gentle eastern slope of the Upper Cretaceous deposits.

3.2 The middle segment in the Boskovice Furrow

The middle segment of the Blansko - Kunštát zone crosses the old tectonic structure of the Boskovice Furrow trending NNE (Fig.1), filled by the Upper Paleozoic sediments perhaps more than a thousand meters thick. The structures cross each other at the angle of 45°. Geomorphologically, the middle segment presents a part of the intramontane depression of the Boskovická brázda (Furrow). In the segment, the furrow is only 5 km wide.

Similarly as in the northern segment, the structure of the downfaulted Upper Cretaceous sediments is assymetric (Fig.3, 4). The structure of the Boskovice Furrow is also assymetric, however in the opposite direction. Its major disturbance, the Boskovice-Diendorf fault is bounding the furrow on its eastern side. This originally normal fault was transformed into a high-angle thrust (Jaroš, 1958a) dipping to the ESE. The Permian sediments dip gently to the ENE owing to rotation. Thus, the Upper Cretaceous deposits of the Blansko - Kunštát zone and underlying the Permian sediments of the Boskovice Furrow are dipping in the opposite direction.

The base of the Upper Cretaceous sediments at the Semanín fault in the West is at lower altitude (perhaps about 100 - 200 m) than in the northern segment. Besides this, the Cenomanian and Turonian sediments occur both in the western and eastern parts of the segment.

The very different topography of the middle segment corresponds with complex geologic structure. Generally, two contrasting relief types were recognized in the segment (see Demek et al., 1987). The lower and more uniform part in the W was designated as the Lysice Depression, while the higher and more dissected one in the E as the Krhov Ridge.

The Lysice Depression, adjacent to the Semanín fault, presents a shallow flat-bottomed basin about 4 km wide. Both in the N and S, the depression is closed by thresholds built of Permian sediments. The higher southern threshold, was named Žernovník Horst. Although composed of the Permian sediments, it belongs geomorphologically to the Českomoravská vrchovina (Highland). The planation surface in its summit parts truncates the Permian sediments and towards the W also the gneiss of the Svratka Dome. The northern

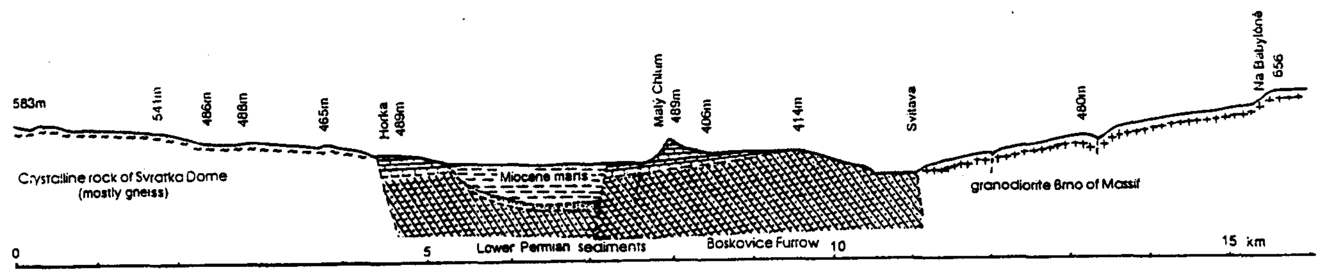


Fig.4.Profile across the E part of Českomoravská vrchovina (Highland), middle part of the Blansko - Kunštát zone (Lysice Depression and Krhov Ridge) and W part of the Drahanská vrchovina (Highland). The Malý Chlum is example of relief inversion.

threshold (Chrudichromy Hilly land) is lower and it separates the Lysice Depression from the northernmost part of the Boskovice Furrow called the Malá Haná. In our opinion, the Lysice Depression and Malá Haná form together a unit which we designate as the Lanškroun - Černá Hora Depression. Its main part developed in structure of the Orlice Permian, that is the NNW continuation of the structure of the Boskovice Furrow.

The eastern slope of the Českomoravská vrchovina (Highland) facing the Lysice Depression is complicated by several small embayments, especially at mouths of small watercourses.There are two low buttes in front of the slope, the Hvozdec (418 m) and Horka (482 m), built by the Turonian deposits. They are situated along the trace of the Semanín fault and present the only remnants of the Upper Cretaceous sediments in the western part of the segment.

The unusual bow-shaped planform of the Lysice Depression conforms with the direction of the Boskovice Furrow only partly (Fig.2). The bottom of the Lysice Depression slopes down towards the E from the foot of the Českomoravská vrchovina (Highland) at the altitude of about 380 m. At the village of Skalice nad Svitavou, the bottom passes into the wide floodplain of Svitava at the altitude of 305 m. Towards the S, between the villages of Jabloňov and Bořitov, the slope encounters the western slope of the Krhov Ridge.

The Lysice Depression is crossed by small right tributaries of Svitava R., Úmoří and Býkovka, which circumfluent the Krhov Ridge. The broad valley of the lowermost Býkovka is cut in the Upper Cretaceous sediments and interconnects the southern part of the Lysice Depression with the Blansko graben.

The bottom of the Lysice Depression is composed of Lower Badenian sediments covered by the Quaternary loess. Marine sands and marls (with thin tuff intercalations) are known for long time already. Their great thickness (about 200 m), however, was demostrated only recently. Surprisingly, they are underlained by Lower Permian deposits (Jurková, 1975). Absence of the expected Upper Cretaceous sediments in boreholes is an evidence of intensive pre-Badenian denudation. Thus, with the exception of Hvozdec and Horka (hills), the Upper Cretaceous sediments on the downfaulted block adjoing to the Semanín fault were eroded. It is possible, that a water course existed in the Boskovice Furrow before the Miocene marine transgression (see chap. 8). The Semanín fault was not active in this segment after the Lower Badenian and this is also the reason, why it is difficult to determine its course across the Boskovice Furrow.

The eastern part of the middle segment, the Krhov Ridge,is an oval elevation of the N-S direction, situated between the Lysice Depression in the W and the gorge-like valley of the Svitava R. in the E. The valley separates the Krhov Ridge from the Drahanská vrchovina (Highland).

In the ridge, the area composed of the Upper Cretaceous sediments is larger than in the Lysice Depression (Dvořák,1953; Dvořák and Havlena, 1957). The most prominent forms are two high mesas, the sharp-topped Velký Chlum (464 m) and the flat-topped Malý Chlum (489 m).The mesas are beautiful examples of relief inversion. The summit flat of the Malý Chlum is gently inclined to the SW, towards the Lysice Depression. The mesas are surrounded by a flat erosion surface at the altitude of 380-420 m sloping to the S. The surface truncates both the Cenomanian and Lower Permian sediments at the same level. Towards the E, the surface rises to the narrow structural ridge (390 - 450 m) built by more resistant Permian beds. The steep eastern slope of ridge faces the gorge-like valley of the Svitava River.

In our opinion, the oval groundplan of the Krhov Ridge, the high position of the Lower Permian sediments at its eastern margin above the assymetric gorge-like valley of the Svitava R. suggest possible involvement of the ridge in dome-like uplift of the adjoining part of the Drahanská vrchovina (Highland). The uplift was probably younger than downfaulting of the Upper Cretaceous deposits along the Semanín fault.

The southern part of the Krhov Ridge is somewhat narrower and it is crossed by the Boskovice-Diendorf fault. During the downfaulting of the Upper Cretaceous sediments, this short section of the Boskovice - Diendorf fault (here with the local name the Klemov fault; Zvejška, 1944) was reactivated and functioned in the Blansko - Kunštát zone as a cross fault. However, the movements had the opposite direction in this episode than movements in the Upper Paleozoic (Jaroš, 1958a). The topographic effects of the post-Cretaceous (Saxon) movements, however, are not apparent in the present topography.

3.3 The southern segment - the Blansko Graben in the eastern part of Drahanská vrchovina (Highland)

In the Blansko Graben, the most distinct part of the zone, the Upper Cretaceous sediments are underlained by granitoid rocks of the Brno Massif. The graben penetrates as a wedge-shaped depression towards the SSE into the elevated part of the Drahanská vrchovina (Highland). In the S, the graben ends as a faulted brachysynclinal closure, only 0,5 km thick.

These adjacent uplifted blocks are the Hořice Horst in the W, and the more complicate but less uniform elevated area of the Adamovská vrchovina (Highland) and Moravian Karst in the E. The latter are discussed in chapter 7. The Hořice Horst is a relatively small morphostructure elongated in the N-S direction, composed

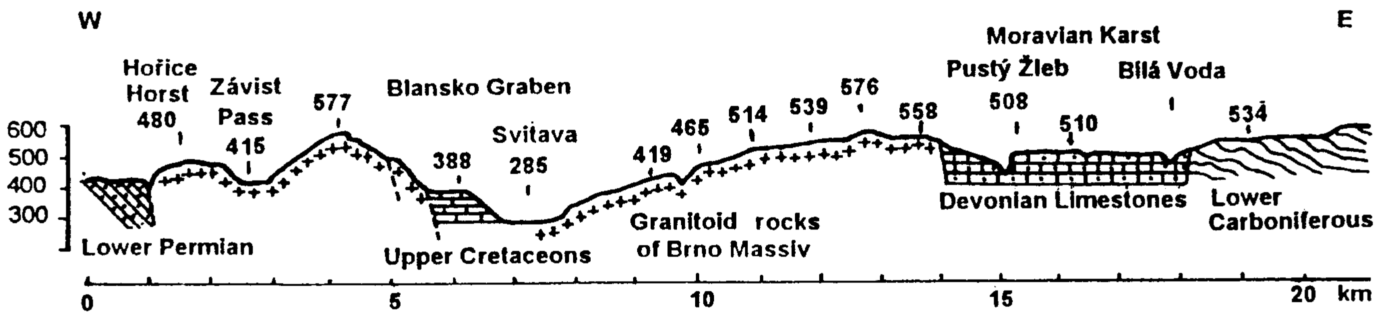


Fig.5 Profile across the Hořice Horst, Blansko Graben and Moravian Karst.

of granodiorites and metabasites. The flat summit parts at the altitude of about 550 m are slightly inclined to the S. The horst is assymetric in cross profile with a steeper eastern slope on the Semanín fault (Figs. 5 and 11).

The Adamovská vrchovina (Highland) adjoining to the graben is also built of granodiorites. Towards the E, it passes into the Moravian Karst composed of Devonian limestones. The two units are parts of a large dome-like morphostructure in the core of the Drahanská vrchovina (Highland)(Hrádek and Ivan, 1974).

The steeper eastern slope of the Hořice Horst facing the Blansko Graben is 7 km long and maintains the original NNW-SSE direction of the Semanín fault. The horst slope is beginning in the NNW, at place, where the Semanín fault crosses the Boskovice - Diendorf fault. The amplitude of fault movements is about 300 m (based on the thickness of the Upper Cretaceous sediments and the height of the fault scarp). On the SSE, the slope ends on the diagonal fault trending SE. The Semanín fault was classified by Zapletal (1932) and Zvejška (1944, 1953a) as high-angle thrust. The profile of Zvejška suggests also some collapse structures. In the opinion of Demek (1956), the slope is a composite fault scarp according to Cotton s classification (1950).

The opposite longer and gentle eastern slope of the Blansko Graben is thought to be an exhumed pre-Upper Cretaceous planation surface (e.g. Štelcl, 1964). It is composed of granodiorite and participates in the dome-like deformation of the Drahanská vrchovina (Highland).

There are several interesting features connected with this eastern slope of the graben:

1) Unusual N-S direction characteristic just of the Brno Massif.
2) Lenght of the slope is 13 km, in comparison with only 7 km of the western slope of the graben. But only the southern part of the slope faces the graben, while the northern one faces the gorge-like valley of the Svitava R. between the villages of Skalice n. Svitavou and Rájec.
3) Height of the slope is decreasing in the N - S direction from 350 m (above the confluence of the rivers of Svitava and Bělá) to a less than 200 m at Blansko. The slope passes upwards into a broad flat ridge with remnants of a younger planation surface (Musil at al., 1993). Inclination of this younger Paleogene (?) surface in top parts of the ridge to the S, from 650 m to 450 m corresponds with inclination of the top parts of the Hořice Horst. Consequently, the two planation surfaces intersect above the eastern graben slope.
4) The slope is dissected by short left tributary valleys of the Svitava R. The valley pattern is a combination of rectangular and fan-like features. The valleys are mostly assymeric in cross profile, the slope facing the graben beeing higher. In our opinion, the pattern suggests combination of a dome-like deformation and fault movements. The prevailing direction of the valleys is NE-SW. The NW-SE trend perpendicular to the major one occurs only between Rájec and Doubravice nad Svitavou.
5) The Miocene marine transgression was also important and resulted in the deposition of basal clastics, sands and marls and at last of the Litothamnion limestones. Neubauer (1969) found the Miocene (Lower Badenian) sediments even in several small valleys in the lower part of the slope. In addition, the Miocene sediments occur also under the floodplain of Svitava R. in the graben, and even in the more than 100 m deep karst valley of Punkva R. (left tributary of the Svitava). Occurence of the Miocene sediments also in a part of the valley cut in granodiorite (Schütznerová - Havelková, 1957, 1958) introduced many difficult problems, especially as regards erosional history of the Moravian Karst (see chap. 6).

The Blansko Graben is used by the Svitava River, but its N-S direction shows that the Semanín fault was of secondary importance for the location of its course. The valley of Svitava R. was cut already before the Lower Badenian.

The Upper Cretaceous sediments are in the deepest position below the bottom of the Svitava valley in the northern part of the graben at Rájec. Southwards, the graben becomes gradually narrower and the base of the Upper Cretaceous sediments on its bottom rises. In the abandoned quarry at the railway station in Blansko, the remnants of the Upper Cenomanian sediments only a few meters thick are resting with angular unconformity on deeply weathered granodiorite (some tens a meters above the Svitava floodplain).

Maximum thickness of Cenomanian and Turonian sediments in the Blansko Graben is more than 160 m (Vachtl et al., 1968). Except for a small remnant east of Rájec, the deposits are present only in the western part of the graben on the right side of the Svitava valley (again near the Semanín fault). At Rájec, the Upper Cretaceous sediments are known also below the floodplain of Svitava R.

The erosional surface, developed on the Upper Cretaceous sediments at the foot of western granodiorite slope of the Hořice Horst, is at the altitude of 380 m, about 100 m above the floodplain of Svitava. The surface is built of the Turonian sandstones and is probably partly structural.

4. The Boskovice - Valchov zone and the Valchov Graben

In the zone, not only the area of Upper Cretaceous sediments is lesser and thickness of deposits reduced by denudation to only some tens of meters, but characteristic forms such as buttes present in the Blansko - Kunštát zone are lacking. Remnants of the Upper Cretaceous sediments are preserved mainly in the SE part of zone. Relics of the Badenian marls, clays and Litothamnion limestones (Zvejška, 1953b) suggest, that most of the Upper Cretaceous sediments was denuded before the Miocene marine transgression.

The Boskovice - Valchov zone is only 7 km long and about 3 km wide. Its NW-SE trend crosses perpendicularly the Boskovice Furrow, just at the eastern margin of Boskovice, probably near the Boskovice - Diendorf fault. The fault is not distinct in the present topography (this is the same situation as in the middle segment of the Blansko - Kunštát zone).

The only occurence of the Upper Cretaceous sediments resting on the Permian deposits (and corresponding therefore to the middle segment of the Blansko - Kunštát zone) is preserved at the village of Chrudichromy, about 2 km NW of Boskovice. The Cenomanian and probably also Turonian sediments (Vachtl et al., 1968) crop out on the top of broad rounded ridge at the altitude of about 420 m. The WNW slope of the ridge composed of Permian claystones and sandstones trends NNE, as well as the whole of the Boskovice Furrow. The slope is more than 100 m high, facing the northern part of the Lysice Depression.

The eastern part of the zone, the Valchov Graben, is both the structural and topographic depression (Fig.1). The Valchov Graben penetrates wedge-like towards the SE into higher parts of the Drahanská vrchovina (Highland). The graben is underlained with granodiorite of the Brno Massif. The bottom of the graben rises from the altitude of 380 m in the NW to 520 m at Valchov in the SE. The high elevation of the Upper Cretaceous sediments at Valchov is owing to uplift in a broad faulted brachysynclinal closure of the graben. The graben is assymetric in cross profile (Fig.6A). The higher and steeper slope on the SW originated on the Bělá fault. The fault scarp or fault-line scarp composed of granodiorite is up to 200 m high (Fig.6A). Towards the SE, however, it passes into folded Culm sediments and its height diminishes rapidly.

The graben bottom inclined to the SW towards the base of the higher slope suggests an antithetic dip. The graben is drained transversally by the Bělá R., left tributary of Svitava R. The Bělá is incised below the base of the Upper Cretaceous sediments in the graben. The combined rectangular and fan-like features of the drainage pattern of the Bělá suggest an influence of faults and dome-like deformations in their development. In Boskovice, the Bělá R. crosses the graben and enters a gorge about 3 km long and more than 250 m deep. The gorge crosses the uplifted marginal part of the Drahanská vrchovina (Highland) (Fig.6B). Towards the SE, the graben is closed by a step-like slope of the N-S direction, forming a brachysynclinal closure. In it, granodiorite is in tectonic contact with the Culm sediments. The importance of Variscan fault tectonics in the formation of brachysynclinal closure is indicated by vertical dip of the strata of Devonian limestones (forming the Němčice - Vratíkov zone, Dvořák et al., 1984) sandwiched between the granodiorite and Culm sediments (Fig.6C). In the limestones, the Neogene tropical karst phenomena were studied by Panoš (1964a). East of the brachysynclinal closure, the highest parts of the Drahanská vrchovina (Highland) with an extensive planation surface at the altitude of 700 -735 m are present.

5. Saxon fold structures at the E margin of the Bohemian Cretaceous Basin adjoining to the half-grabens

The major fold structures of the southeastern part of the Bohemian Cretaceous Basin, the Ústí syncline and Potštejn anticline were been recognized relatively early. In the present landscape, the Ústí syncline is more conspicuous than the Potštejn anticline. The two structures are several ten km long, but only their southern parts are discussed here.

5.1 The Semanín fault and Saxon tectonics along the southern margin of the Bohemian Cretaceous Basin

The Semanín fault is one of the most important fractures in the eastern part of the Bohemian Cretaceous Basin (Malkovský, 1979). The fault affected the eastern steeper limb of the Potštejn anticline near its contact with the Ústí syncline. The Upper Cretaceous sediments of the Potštejn anticline on the upthrown block are at the higher altitude and they are also more denuded than those of the Ústí syncline.

Between the town of Česká Třebová and the village of Svojanov, the Semanín fault runs to the S and the Upper Cretaceous deposits are present both on the upthrown and downthrown blocks. The fault is the most distinct where the Upper Cretaceous sediments are underlained with granodiorite of the Polička Unit (Vachtl et al., 1968). In the less rigid crystalline schists the, fault is not clean-cut and probably flexure deformation prevails. This seems to be the case in the surroundings of the vilage of Radiměř, where the Upper Cretaceous sediments of the Potštejn anticline are not faulted and some authors characterize the structure as a flexure or homocline (Radiměř flexure; Frejková, 1960; Fajst, 1969). The Semanín fault consists of two branches (Fig.9). Together with bending of the Potštejn anticline, the total displacement is more than 200 m (Vachtl et al., 1968; Malkovský, 1977, 1979).

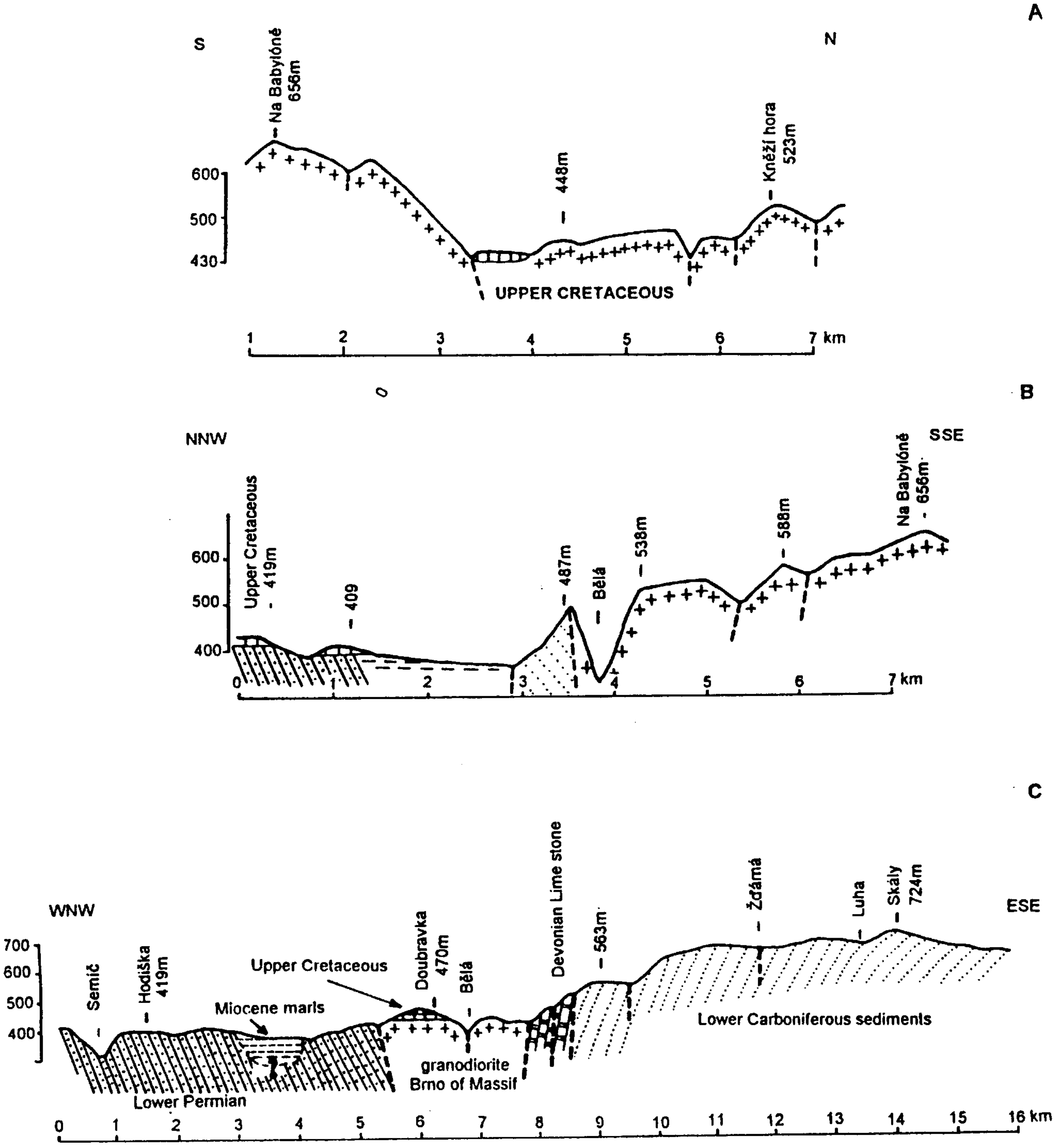


Fig.6 Profiles across the Valchov Graben and adjacent part of the Drahanská vrchovina (Highland).

Below deposits of the Bohemian Cretaceous Basin relations between the fault tectonics (including the Semanín fault) and the crystalline basement are very complex, especially at the contact of the Letovice and Polička Units. Metabasites of the Letovice Unit trend southwards and they were interpreted as a fissure feeding channels governed by tectonics (Mísař, 1974). Importance of the N-S direction is supported also by magnetic anomaly in the surroundings of Svitavy (Kopecký, 1992).

The contact between the Polička and Letovice Units is partly hidden by Permian sediments. Nonetheless, it seems that the Semanín fault and contact of the Letovice and Polička Units do not coincide. Northwest of the village of Svojanov, the Upper Cretaceous deposits were partly denuded from the upthrown block of the Semanín fault and the ancient tectonic zone between the Letovice and Polička Units (the Svojanov mylonite zone) was exposed (see Mísař, 1962). Between Svojanov and Rohozná, the Semanín fault and Svojanov mylonite zone are about 2-3 km apart. The two fracture zones run almost parallel towards the S or SSW, used by the uppermost courses of the Křetínka R. (along the Svojanov mylonite zone) and its left tributary, the Rohozenský potok Brook (along the Semanín fault). The rocks of the Svojanov mylonite zone, as described by Mísař (1962), are resistant to physical and chemical weathering, but in the quarry at the village of Stašov, some roots of the pre-Upper Cretaceous weathering are visible. The Svojanov mylonite zone was not active in the post-Cretaceous period. This is evidenced by parts of the exhumed pre-Upper Cretaceous planation surface at the altitude of about 640 m. The two water courses were superimposed from the Upper Cretaceous sediments. They are trending towards S, even though the basement surface below the Cretaceous sediments is inclined to the N (toward the axis of the Bohemian Cretaceous Basin).

The exhumed crest of the Potštejn anticline W of Stašov at the altitude of 640-660 m, was described as Stašov ridge by Fajst (1969) and presents an almost perfect planation surface. Southwards, the surface ascends and it is dissected by deep valleys. In the surroundings of the village of Hlásnice, the surface is preserved only on some tops of high residual hills (e.g. Panský vrch 700 m). At the contact of the Bohemian Cretaceous Basin and the Českomoravská vrchovina (Highland) at Svojanov, the uncovered trace of the Semanín fault meets the northern closure of the Svratka Dome (this was the key area in the conception of Variscan nappe tectonics introduced at the beginning of this century). Practically at spike of the closure, the Semanín fault turns to the SE and stretches along the Křetínka R. for about 10 km as far as the Křetín Basin (Ivan, 1989). In contrast, the older and more important Svojanov mylonite zone continues to the S, maintaining its original direction.

Between the villages of Svojanov and Křetín the Upper Cretaceous sediments occur only on the downthrown block (Fig.7). The Semanín fault is also composed of two parallel branches here. However, only some their parts are used by the Křetínka valley. The southern branch is partly used by the Křetínka R. between the villages of Svojanov and Bohuňov, the northern one between Bohuňov and Křetín.

The southern branch of the Semanín fault is used by the Křetínka R. downstream of Svojanov in the reach about 2,5 km long. The floodplain in the valley of Křetínka R. is about 100 m wide and the narrow ledge of the exhumed pre-Upper Cretaceous planation surface is present on the left valley slope at Svojanov (at the altitude of 520 m, about 90 m above the floodplain). Displacement on the southern branch of the Semanín fault is about 100 m at Svojanov (Fig.7C).

At the village of Nová Lhota, the Křetínka R. departs from the fault trace, turning to the ESE. In the narrow saw-cut valley about 3 km long, the floodplain is only poorly developed and also rapids occur in the channel. On the other hand, the fault branch continues in its original SE direction and its elevation above the valley bottom progressively rises. In our opinion, the relation between the fracture and the valley suggests a thrust fault, although flexural bending is also possible. At the village of Bohuňov, the fault branch is located in the middle part of the right valley slope.

At Bohuňov, the more important northern fault branch crosses obliquely the Křetínka valley and turns to the SE. In the point of crossing the valley also assumes the SE direction. Downstream, the whole right valley slope of the Křetínka is developed on the upthrown block, built of different crystalline rocks. In our opinion, this right valley slope facing the Bohemian Cretaceous Basin is at the same time a southern marginal fault scarp (or a resequent fault-line scarp) of the basin. On the opposite downthrown block of the northern fault branch, the left valley slope is built by the Upper Cretaceous sediments (Fig.7B).

As a result, cross profile of the Křetínka valley downstream of Bohuňov is quite different. The valley becomes broad and open with a floodplain as wide as 200 m. The cross profile of the valley is assymetric, both height and inclination of valley slopes differ substantialy. The right valley slope (facing the NE) is stepped, only moderately inclined and up to 280 m high. The lower part of the slope consists of metabasites of the Letovice Unit, while the upper one of very variegated rocks of the Svratka Dome. Alike in the northern segment of the Blansko - Kunštát zone, the rocks of the Letovice Unit were thrusted over rocks of the Svratka Dome (Jenček, 1963). The parallelism of the narrow strips of rocks (gneisses, phyllites, quarzites and crystalline limestones) of the Svratka Dome and of the Semanín fault complicates the slope profile and this is also the reason, why influences of lithology and fault tectonics are hardly separable.

The opposite left valley slope, on the other hand, is only 130-160 m high, but relatively steep. The slope is composed only of the Upper Cretaceous deposits east of Bohuňov.The sediments crop out also at the base of slope and their presence below the floodplain of the Křetínka R. is not excluded. Downstream of the village of Horní Poříčí, the buried pre-Upper Cretaceous planation surface (angular unconformity) appears above the base of slope and rises (diverges) progressively downstream.

In the Křetín Basin the valley is narrow again, cut in metabasites. The floodplain is about 40-60 m below the exhumed planation surface on the basin bottom (Fig.7A).

It seems that the northern branch of the Semanín fault is followed by the Křetínka R. more strictly than the southern one. Downstream of Bohuňov, a distinct fault-line valley was created and original marginal character both of the Semanín fault and related tectonic scarp was obscured. The extensive erosion surface above the right valley slope at the altitude of 620-640 m is generally inclined to the S. The divide is just above the slope and this situation is similar to the west limb of the Potštejn anticline in the Bohemian Cretaceous Basin south of the town of Svitavy.

Above the lower left valley slope of the Křetínka R., the very flat surface truncates the Turonian sediments of the downthrown block of the northern branch of the Semanín fault at the altitude of 530 m. The base of slope is at the altitude 400 m at Bohuňov. As the exhumed pre-Upper Cretaceous planation surface above the

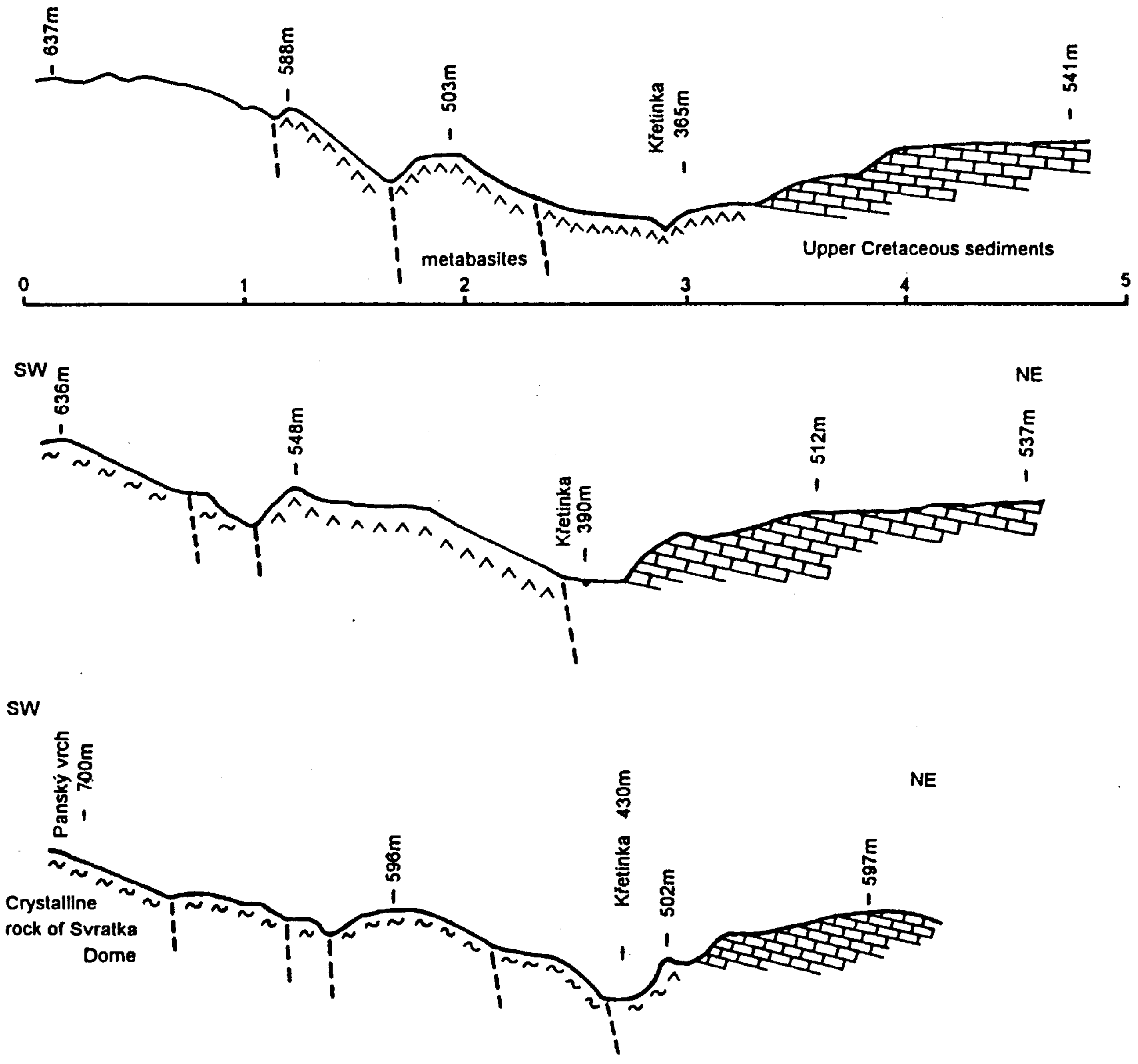


Fig.7. Profiles across the Křetínka valley.

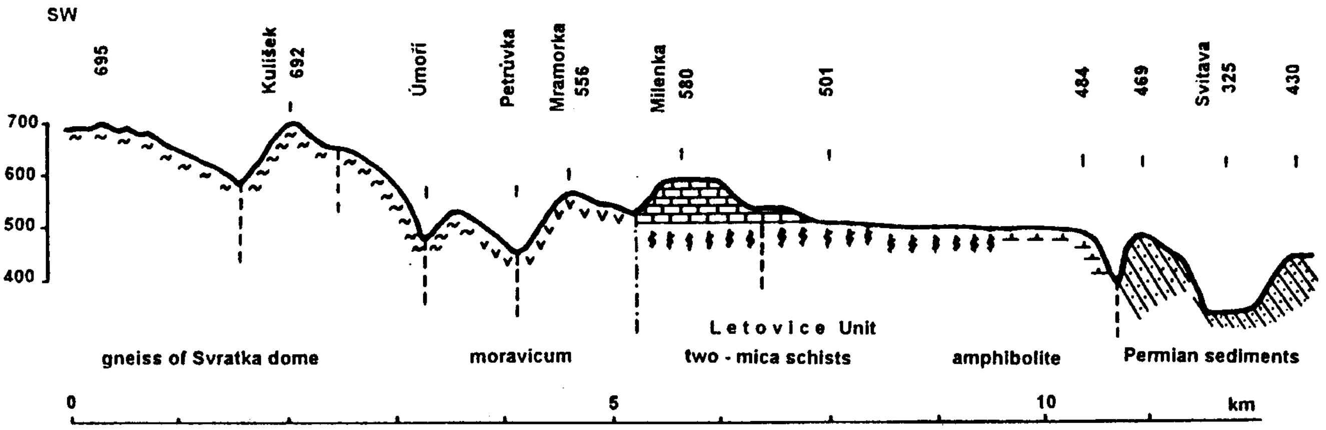


Fig.8. Profile across the northern part of the Blansko - Kunštát zone forming the threshold between the Blansko - Kunštát zone and Bohemian Cretaceous Basin.

higher right valley slope is in the altitude of 620-640 m, the total fault displacement on both branches combined with flexural deformation is at least 240 m. This corresponds well with data of Malkovský (1977) and Vachtl et al.(1968).

At Křetín, the Semanín fault turns again to the SSE and bounds the Blansko - Kunštát zone.

5.2 The Potštejn anticline and its southern continuation in the surroundings of Brno

The assymetric Potštejn anticline is a less distinct structure in the SE part of the Bohemian Cretaceous Basin. Because south of the town of Svitavy the Semanín fault is replaced by the Radiměř flexure, only a gentle slope developed instead of typical cuesta escarpment. The Kozlov Ridge associated with the anticline axis rises southwards culminating west of Stašov at the Baldeský vrch (hill) at the altitude of 693 m. The hill faces an exhumed pre-Cretaceous planation surface. The above mentioned flat Stašov ridge presents in fact an exhumed axial part of Potštejn anticline.

In the area of the exhumed pre-Upper Cretaceous topography between Stašov and Svojanov, the axis of the Potštejn anticline reaches the contact of the Letovice Unit and the Svratka dome. Here, in the drainage area of the Křetínka R., both the axis of the Potštejn anticline and the Semanín fault turn to the SE and run along the northeastern periphery of the Svratka Dome. The Křetínka R. also assumes this NW-SE direction.

The assymetric cross profile of the Potštejn anticline also persists in crystalline rocks. This is demonstrated both by the position of water divide direct above the right valley slope of the Křetínka R. and by longer tributaries of the Svratka R. directed to the S. In the surrroundings of Kunštát, the anticline axis turns to the SSE and crosses the eastern limb of the Svratka Dome.

The rocks of the eastern limb of the dome are predominately less resistant mica schists and at the village of Lysice also weak Lower Permian sediments are involved in the remobilized dome structure (see chap. 3.1). This is the reason why it is difficult to delineate the course of anticline axis here. The Svitava-Svratka water divide avoids these rocks, too. Generally, the divide runs in axial part of the Svratka Dome built of resistant Bíteš orthogneiss.

The Potštejn anticline crosses the Boskovice Furrow in the surroundings of the village of Černá Hora, but its

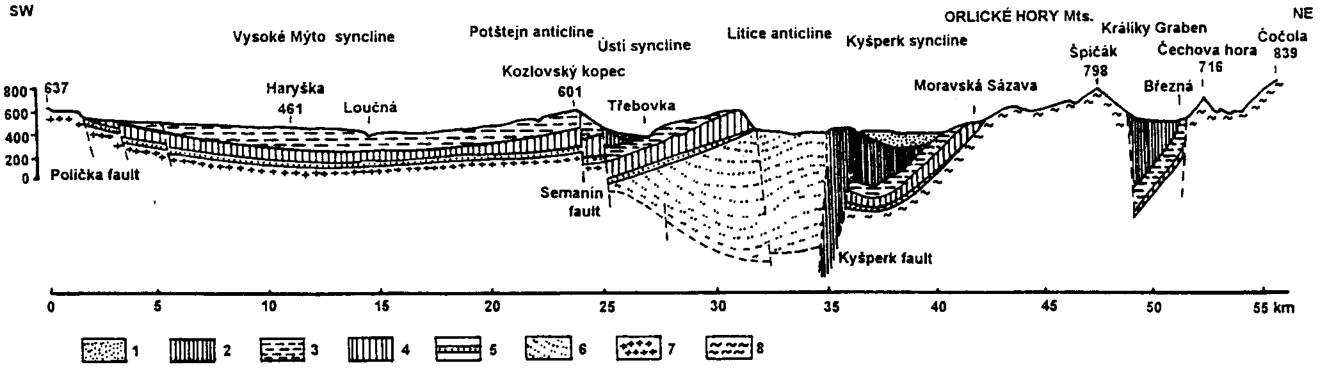


Fig.9. Cross profile of the Bohemian Cretaceous Basin, Orlické Hory (Mts.) and Králíky Graben (according to M.Malkovský,1977, modified)

course is not distinct morphologically. The presence of anticline is partly suggested only by the Žernovník Horst situated between the Lysice Depression and the northern part of the Brno Basin.

The Potštejn anticline affected significantly the course of the Svitava - Svratka water divide. Even though it runs generally southwards, south of Černá Hora it crosses the Žernovník Horst and the Závist Pass (415 m a.s.l.) in W-E direction. Then divide ascends to the top of the Hořice Horst (577 m) where it turns southwards again. In our opinion, the N-S ridge of the Hořice Horst coincides well with the axis of the Potštejn anticline. Moreover, south of the horst, the divide crosses perpendicularly the Svinošice Graben (of the W-E direction) and continues to the S along the axis of the Soběšice Dome as far as the north margin of Brno (Figs.10 and 12). The cross profile of the Hořice Horst is assymetric and as a result, the area west of the horst is drained towards the W into the Svratka R. This is true also for the part of the Svinošice Graben, from where the Kuřimka R. runs to the W through several gorges (Fig.10).

There were also changes in the river pattern owing to remobilization of the Svratka Dome. The upper courses of left tributaries of the Svratka, the rivers of Hodonínka and Lubě flowing towards E turn to the S suddenly west of the axis Potštejn anticline. We suppose, that they were tribututaries of the Svitava originally.

5.3 The Ústí syncline and its relation to the Blansko - Kunštát zone

The Ústí syncline is important mainly from the point of view of hydrogeology (Kříž 1975; Frejková 1960). In the surroundings of the town of Svitavy, the syncline is about 12 km wide. Thickness of the Upper Cretaceous sediments at the syncline axis is about 360 m. The Cenomanian and Turonian deposits prevail, however, younger Coniacian sediments are also preserved in the western part of the syncline. Control of the western margin of the Coniacian sediments by the Semanín fault, especially west of Svitavy seems to be probable. Lower Bądenian sediments are also present, mainly at the Main European Divide. Their occurences are in no relation to the fault tectonics.

Both the structure and topography of the Ústí syncline are assymetric in cross profile (Frejková, 1960; Kříž,1975, Fig.1). The axis of synline is situated in its western part, closer to the Semanín fault. The western limb of the syncline is shorter and steeper. It rises towards the crest of the Kozlov Ridge on the W and is affected by the Semanín fault. The planation surface on the bottom of syncline is at the altitude of 420 m near the village of Hradec n. Svitavou. On the contrary, the eastern limb of the syncline is wider and more gentle. Here, a very flat erosion surface almost paralell with bedding planes, rises towards the E up to 660 m and progressively truncates the older strata. The syncline axis ends in the Křetín Basin.

The main part of the Ústí syncline is drained by the Svitava R. towards the S. The river runs against the dip of syncline axis. At Svitavy, the channel is cut in the very flat syncline bottom and its gradient is extremely low (1 m per 1 km). Downstream, the river incises progressively into older formations, then into metabasites and in the town Letovice into the Lower Permian sediments. In more resistant rocks,the valley cross profile becomes V-shaped.Thus, the Svitava is an antidip stream.

The planation surface in the bottom of the Ústí syncline rises progressively not only to the E and W, but also from the N to the S. While south of the town of Svitavy the planation surface truncating the Coniacian sediments is at the altitude 420-450 m, downstream the surface rises up to 530 m (W of the town of Letovice), truncating the Middle Turonian Sandstone. This confirms the supposed antecedent origin of the Svitava valley (Neubauer, 1953) although its development was more complex.

In Letovice, the Svitava R. joins the Křetínka in a small depression of the Letovice Basin (Fig.12. Downstream of Letovice, the valley is narrower, cut in the Lower Permian conglomerates. They compose together with metabasites a threshold-like ridge trending WSW which separates the Ústí syncline and Letovice Basin from the Lysice Depression. On the ridge exhumed parts of the pre-Upper Cretaceous planation surface are preserved at the altitude of 520 m. The highest buttes of the northern segment of the Blansko - Kunštát zone are situated in WSW continuation of the threshold ridge (see chap. 3.1 and Fig.8).

5.4 Cuesta of the Hřebeč Ridge and the Litice anticline

As mentioned above, the eastern limb of the Ústí syncline is longer and gentler and towards the E it passes into the Litice anticline. The axial part of this structure was eroded (Fig.9) and a steep cuesta escarpment, named the Hřebeč Ridge, developed here. The cuesta is more than 50 km long and up to 150 m high, complicated by many embayments. The most complicating feature is a cross valley-like depression filled with the Miocene sediments at the village of Damníkov. The inconspicuous southern end of the escarpment NNE of the town of Letovice is connected with brachysynclinal closure of the Ústí syncline. While in the western limb of the syncline, the Upper Cretaceous sediments are preserved even in the brachysyclinal closure (west of Letovice), in the eastern limb of the closure, only small "islets" occur NNE of the Valchov Graben. In our opinion, denudation proceeded more rapidly where the Upper Cretaceous sediments are underlain with mostly the less resistant and unpermeable Lower Permian deposits. In comparison with crystalline rocks, no extensive rests of the pre-Upper Cretaceous planation surface are found on the Lower Permian sediments.

The cuesta escarpment faces a broad depression of the Moravská Třebová Basin originated owing to almost complete denudation of the Upper Cretaceous sediments in the core of the Litice anticline. The bottom of the basin composed of Lower Permian deposits at in the altitude of 350-450 m, however, the Badenian marine sediments are also widespread. Thus, the spectacular relief inversion in the core of anticline developed already before the Badenian. The Moravská Třebová Basin as a part of the Lanškroun-Černá Hora Depression is discussed shortly in chap. 3.2.

The eastern part of the Moravská Třebová Basin is complicated by the Kyšperk and Radkov faults and small Kyšperk syncline, all partly destroyed by the post-Cretaceous denudation. Especially the Kyšperk fault is a very ancient fracture along which Lower Permian sediments were downfaulted in the Uppermost Paleozoic. In the Uppermost Cretaceous or Tertiary, the Kyšperk fault was reactivated, but with opposite direction of the movements. The topographical effects of renewed faulting were also obliterated and tectonic inversion was accompanied by inversion of relief. Great thickness of the Miocene sediments in the axial part of the Kyšperk syncline suggests possible continuation of downwarping during deposition (Fig.9).

6. The Moravian Karst and its relation to the Blansko Graben

The Moravian Karst, "beautiful karst country of Moravia" (Ager, 1973, p.9), composed of folded and faulted Devonian limestones is situated between granodiorites in the W and the Culm graywacks, slates and sandstones ("Variscan flysch") in the E. From the geomorphological point of view, the Moravian Karst is situated close to the axial part of the dome-like structure of the Drahanská vrchovina (Highland). The N-S axis of this structure conforms well with general direction of limestones.

Variscan orogenesis was followed by long subaerial denudation and planation, completed probably in the Lower Mesozoic. Later, marine transgressions in the Jurassic and Cretaceous resulted in sedimentary covers. Thus, after renewed subaerial erosion, numerous relics of sediments, weathering crust as well as plenty of both surface and subsurface karst features, provide data for a reconstruction of landscape evolution. This fact was appreciated already at the beginning of this century.

The Moravian Karst is about 25 km long and 3 - 5 km wide. Its wider northern part is a shallow flat-bottomed depression at the altitude of 500 m. (Figs.5 and 11). Its bottom is in fact a planation surface truncating the folded Devonian strata. The surface is dotted by many deep karst depressions filled by Mesozoic unconsolidated sediments interpreted mostly as a reworked tropical weathering crust (named the Rudice Formation originated probably in the Lower Cretaceous). Some authors suppose the depressions beeing relics of a tropical karst of the cockit type (Panoš,1964a). The planation surface is about 100 m below adjacent flat surfaces on non-carbonate rocks and it is dissected by mostly dry widely spaced canyon-like valleys. According to Panoš (1964b), the canyons have a composite cross profile and were initiated already in the Paleogene.

As regards trends of the Moravian Karst (N-S) and the Blansko Graben (NNW-SSE), they converge toward the S at an acute angle. As the Blansko Graben dies out suddenly on the SSE in granodiorite of the Brno Massif, it does not cross the Devonian limestones. Thus the depressions do not intersect and the Blansko Graben and northern part of the Moravian Karst are different, but almost neighbouring landscape units separated only by a broad rounded ridge composed of granodiorite (Figs. 5 and 7). The planation surface of the Moravian Karst is about 200 m higher than the granodiorite bottom beneath the Upper Cretaceous sediments of the Blansko Graben.

While the pre-Upper Cretaceous planation surface of the eastern part of the the Blansko Graben was dome-like deformed, the karst planation surface (500 m) adjacent to the axial part of the dome-like deformation is almost horizontal. Therefore, there is a problem, if differences in the altitude and inclination between these planation surfaces are due to tectonic processes (updoming, faulting) or different processes of erosion.

There were many discussions about the origin and age of planation in this part of the Moravian Karst,but no univocal conclusion has been attained up to now. According to Musil et al. (1993a) the difference in elevation of planation surfaces truncating carbonate and silicate rocks existed in the Upper Jurassic already and then the Moravian Karst was probably covered by the Upper Cretaceous sediments in a thickness about of 50 m.

In our opinion, the unusual position of the planation surface in the N part of the Moravian Karst resulted probably from combined effects of young-Saxon tectonics (updoming of the Drahanská vrchovina Highland) and karst processes accompanied by climatic and paleogeographic changes. This is in accordance with the idea that karstification is one of etching processes.

The dome-like deformation of the Drahanská vrchovina (Highland) was probably an important factor in landscape evolution (Hrádek and Ivan, 1974; Hrádek,1983). Although the SE trending faults are numerous in the Moravian Karst (Dvořák et al.,1984), they were active mainly before the Upper Cretaceous, and in the present landscape are not so obvious. As mentioned above, in the closure of the Blansko Graben, the Semanín fault turns to the SE and crosses the Moravian Karst (probably as a branch of the Adamov fault zone) only with the fault-line effect (Demek,1960). Along the fault or series of paralel fractures remnants of the downfaulted Jurassic sediments are preserved at the village of Olomučany (Bosák, 1978).

In the central and southern parts of the Moravian Karst, movements along the SE trending faults led to a quite different relation between topographies underlain with carbonate and silicate rocks. Here, differences in elevation among landforms composed of rocks are negligible or even the surface truncating limestone is at higher altitude. At the village of Ochoz, a relief inversion developed in granodiorite at contact with the Devonian limestone (Dvořák and Pták, 1963; R.Musil et al.1993a). In our opinion, the limestone slope of the Babice Plateau, trending SE and facing the Kanice - Ochoz Graben is an obsequent fault-line scarp, associated with the southern branch of the Adamov fault. The southernmost part of the Moravian Karst takes part in the structure of the marginal slope of the Bohemian Massif facing the Carpathian Foredeep.

7. Problems of drainage pattern evolution of the SE part of the Bohemian Massif north of Brno

7.1 The complexity of the problem

The area under study is drained mainly by the rivers of Svitava and Svratka belonging to the Danube drainage basin. As regards their importance in evolution of the SE part of the Bohemian Massif, at least four points are worth to mention:

(1) Sources of both rivers are at the Main European Divide (Elbe - Danube) which crosses also the structural and topographic depression of the Bohemian Cretaceous Basin.

(2) Many authors believed that in the post-Cretaceous evolution, the Svitava R. was the most important watercourse in Moravia, which extended far to the N (for references see Balatka and Sládek, 1962).

(3) The SE part of the Bohemian Massif was mostly submersed also in the Lower Badenian. The sea flooded rather dissected landscape and many valleys or depressions were filled with the Badenian sediments (Czudek, 1984). North of the town Svitavy, the Badenian sediments are preserved even at the Main European Divide (at the altitude about 500 m). Thus, subaerial development of drainage pattern was not continuous owing to transgression. After the retreat of the sea, a new river pattern was established. However, not all buried valleys were exhumed. After sea regression, the rivers of Svitava and Svratka were emptied into the sea in the present Carpathian Foredeep near Brno. Folding and block-faulting in the Miocene or Pliocene was another cause of reshaping of the river pattern, whereas the role of climatic changes is not demonstrable.

(4) As mentioned above, the paleo-Svitava and paleo-Svratka were emptied into the Tethys or Paratethys during the Tertiary. Their mouths were located at the head of a huge fault embayment in the surroundings of Brno. This embayment functioning as an estuary (Stráník et al., 1992) was in fact the NW end of the Nesvačilka Graben (see Pícha, Hanzlíková and Cahelová, 1978). Thus, material washed from the Bohemian Massif including the Bohemian Cretaceous Basin, was transported through the graben into the flysch geosyncline. After regression of the Miocene sea and additional block faulting, the Brno Basin developed in place of the estuary.

It seems probable, that even before the marine transgression in the Upper Cretaceous, the drainage was directed towards the SE into the Tethys. The drainage was predisposed, at least partly, by fault tectonics. Vajdík and Vybíral (1973) supposed rivers guided by faults in the area of the present Blansko and Valchov Grabens and Vachtl et al. (1968) demonstrated that great thickness of the fresh-water deposits in the Blansko Graben was caused by downfaulting. According to Frejková (1975), the Cenomanian refractory clays in the Blansko - Kunštát zone are floodplain deposits.

The opinion prevails that the Upper Cretaceous sea retreated towards the NW. This is partly confirmed by the youngest Cretaceous sediments in the N parts of the Bohemian Cretaceous Basin. However, paleogeography was probably very complex. It seems possible that a connection between the Bohemian Cretaceous Basin and Tethys existed, at least during the maximum of the transgression. This is supported by presence of the Upper Cretaceous sediments in the flysch belt in the Western Carpathians (e.g. in the Pavlovské vrchy Hills in southern Moravia, see Stráník et al., 1995). Recent research has shown their preservation also in the Nesvačilka Graben (Hamršmíd, Krhovský and Švábenická, 1990).

The Bohemian Cretaceous Basin is separated from the Carpathian Foredeep by a belt of elevations trending NE or N (highlands of the Bobravská vrchovina in the surroundings of Brno, Drahanská vrchovina and Zábřežská vrchovina) at the altitude of 420 - 700 m. Thus, all important rivers of the Bohemian Massif flowing towards the foredeep cut long transversal gorges across the highlands. The highlands are in the fact, a forebulge, resulting from orogenic stresses in the Western Carpathians and subduction of the Bohemian Massif below the Carpathians.

7.2 The course of the Main European Divide and the drainage pattern in the eastern part of the Bohemian Cretaceous Basin.

Although the Bohemian Cretaceous Basin is an intracratonic basin surrounded by mountains, highlands and hilly lands, it is crossed by the Main European Divide (Elbe-Danube). In addition, some areas composed of the Upper Cretaceous sediments, at present separated from the major part of the Bohemian Cretaceous Basin, are drained by tributaries of the Oder (Odra) into the Baltic Sea. In result, the Elbe - Danube divide ramifies in northern Moravia into the Oder - Danube divide trending to the NE and the Oder - Elbe divide trending to the W.

In the Bohemian Cretaceous Basin, the Elbe - Danube Divide crosses important fold structures (Figs. 9 and 10). The divide course is irregular and the N-S and W-E trends alternate in connection with the crossing of structures. The lowest parts of divide are at syncline axes, the highest parts at anticline axes. The divide leaves the Bohemian Cretaceous Basin N of the town of Lanškroun.Here,the divide crosses the horst of the Orlické hory (Mts.) rising up to the altitude of 900 m. The eastern slope of the horst composed of resistant gneiss faces the Králíky Graben, presenting the southernmost part of the huge Klodzko Graben (in Poland) filled with the Upper Cretaceous sediments.

After crossing the Králíky Graben, the Elbe -Danube divide rises to the mount of Klepý (1143 m,called the Trojmorski Wierch in Poland), in the SW part of the Králický Sněžník (Mts.), where it ramifies into the forementioned two branches. The Elbe - Oder Divide runs towards the W (crossing the Králíky Graben once more) and the Danube - Oder Divide towards the E. The Mt. Klepý is the only point in the Bohemian Massif where divides of the three large European rivers (and three seas) meet. The Králíky Graben is interesting by great thickness of the Upper Cretaceous sediments, too (more than 730 m, mostly of the Coniacian age, Valečka, 1988).

Drainage of the Králíky Graben as well as of the Klodzko Graben is predominately longitudinal (N-S) but rather complicated (Fig.10). All major streams leave the grabens through gorges. In the S, the Králíky Graben is closed and separated from the Bohemian Cretaceous Basin by highland topography. In spite of some cross faults (NW-SE and NNW-SSE), main part of the Králíky Graben is drained to the S by the Březná R. (tributary of the Moravská Sázava R. coming from the Bohemian Cretaceous Basin). The other major rivers are Klodzka Nysa and Tichá Orlice. The Březná R. cuts the gorge about 15 km long. This feature is very similar to drainage of the Blansko Graben.

The drainage pattern of the eastern part of the Bohemian Cretaceous Basin north of Svitavy is in general radial. Water courses flowing to the W into the Elbe cross the N-S trending anticlines in water gaps cut mainly in the Upper Cretaceous sediments while the gorges of the rivers flowing to the E or S (the tributaries of the Morava R.) are cut in resistant basement rocks. It is also important, that the N-S axis of the Zábřežská vrchovina (Highland) (composed of crystalline rocks and folded Upper Paleozoic sediments) which separates the eastern part of the Bohemian Cretaceous Basin from the Hornomoravský úval (Graben, part of the Carpathian Foredeep) is parallel with fold structures in the adjacent part of the Bohemian Cretaceous Basin.

Some features of the drainage pattern of the eastern part of the Bohemian Cretaceous Basin are similar to the drainage pattern of the Klodzko and Králíky Grabens. As regards relation to geological structure, the main water courses are longitudinal and follow the axis of the Ústí syncline. The river of Třebovka (tributary of the river of Tichá Orlice and Elbe) flows towards the N and the Svitava towards the S. Only a small part of the Bohemian Cretaceous Basin is drained to the E by the rivers of Morávská Sázava and Třebůvka. Between headwaters of the Moravská Sázava and Třebovka, there is a short dry valley, forming the only break ("wind gap", Třebechovické sedlo Pass, 437 m a.s.l., Fig.10) in the cuesta of the Hřebeč Ridge.In it, the Badenian sediments rest on Lower Permian deposits. This is true also in the Lanškroun Depression, a northernmost part of the Lanškroun - Černá Hora Depression. In the gorge of the Moravská Sázava through the Zábřežská vrchovina (Highland) is a junction with the Březná R. coming from the Králíky Graben.

The Svitava probably used originally the Lanškroun - Černá Hora Depression. At present, however, northern and middle parts of the depression are drained by rivers of the Moravská Sázava and Třebůvka to the E (Fig.10). The Třebůvka flows to the N at first, but it turns to the E into a transversal gorge through the Zabřežská vrchovina (Highland).

Consequently, only a small southern part of the Lanškroun - Černá Hora Depression drained by the Semíč brook belongs to the Svitava drainage basin. It joins the Svitava R. in the northern part of the Lysice Depression.

The source of the Svitava is also in the eastern part of the Bohemian Cretaceous Basin. The Svitava (A - 1.146,9 km^2, L - 97,3 km) originates in a flat axial part of the Ústí syncline at the altitude of 465 m. It does not follow the syncline axis strictly and flows against dip of the floor of the basin. In this part of the drainage basin the tributaries are very short and restricted to the syncline only.

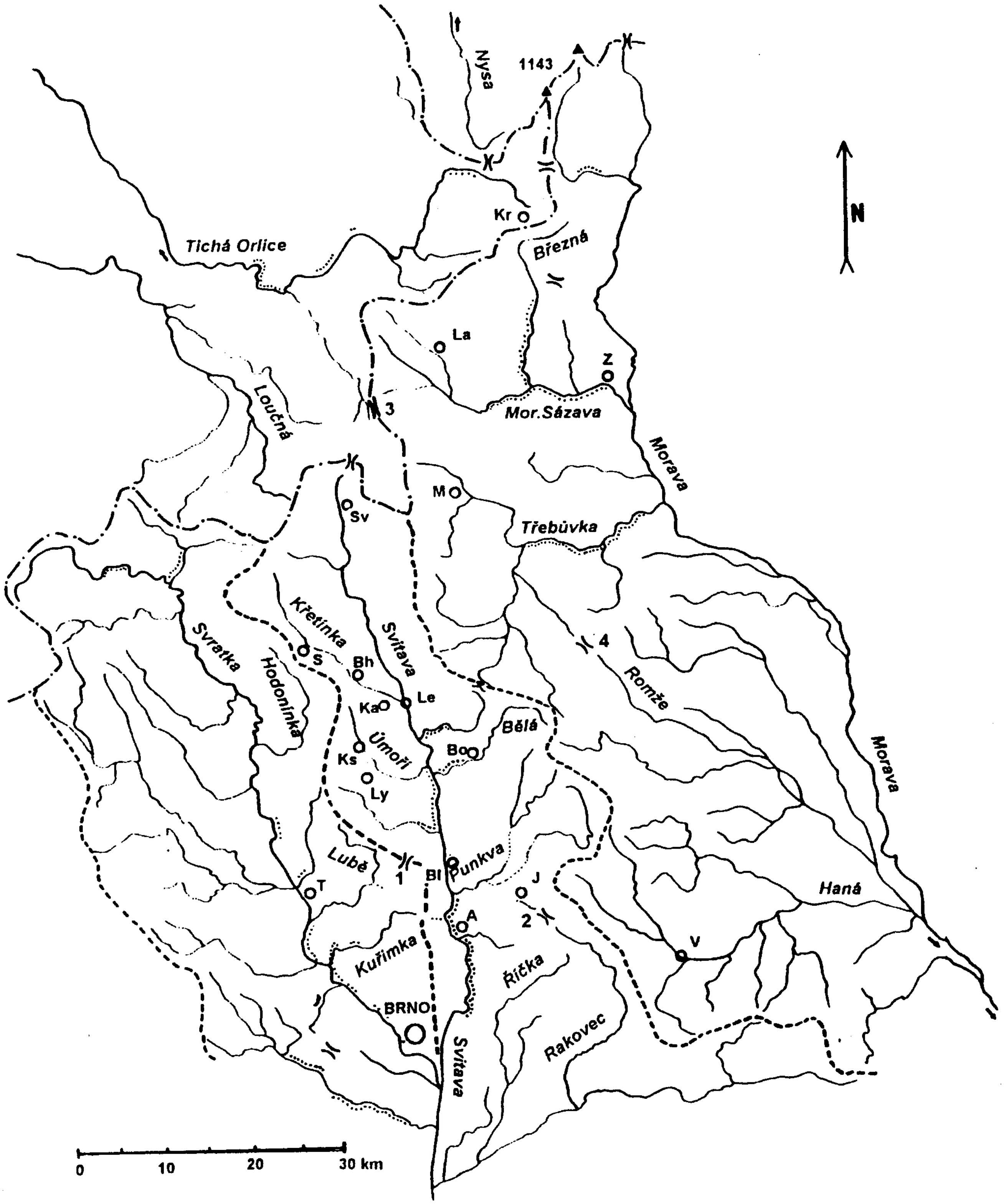


Fig.10. Drainage pattern of SW Moravia.

dot - and - dashed line - Main European Divide

dashed line - drainage basin of Svitava and part of Svratka,

A-Adamov, Bl-Blansko, Bh-Bohuňov, Bo-Boskovice, J-Jedovnice, Ka-Křetín, Ks-Kunštát, Kr-Králíky, La-Lanškroun, Ly-Lysice, M-Moravská Třebová, S-Svojanov, Sv-Svitavy, T-Tišnov, V-Vyškov.Passes and valley divides: 1 - Závist Pass, 2- valley divide in the Jedovnice-Račice Graben, 3- Třebechovice Pass, 4- divide between Romže R. and Třebůvka R. in the Drahanská vrchovina (Highland).

7.3 Svitava in the Lysice Depression and Blansko Graben, the problem of connection with the Carpathian Foredeep

Downstream of Letovice, the Svitava crosses the northern part of the Lysice Depression and continues towards the S into the Blansko Graben. The river makes use of neither tectonic directions of the Boskovice Furrow (NNE-SSW) nor of the Semanín fault (SSW-SSE), nor the major part of Lysice Depression. Instead of it, the Svitava breaks through resistant basement rocks along the contact of the Krhov Ridge with the Drahanská vrchovina (Highland) (see chap.3.2). In the gorge, the Svitava joins the Bělá R. (chap.4) and crosses obliquely the Boskovice-Diendorf fault. At the village of Rájec n. Svitavou the Svitava joins the right tributary of the Býkovka brook draining the southern part of the Lysice Depression.

The Lysice Depression was explained as a river valley (e.g. Jaroš, 1958b; Jurková, 1976). However, pedimentation by lateral planation of streams debouching from the adjoining highland, seems to be also possible. This is suggested by W-E cross profile of the depression. In it, an erosion surface truncating Lower Permian sediments below the Badenian deposits slopes down eastwards. The funnel-shaped mouths of some valleys coming from the Českomoravská vrchovina (Highland) (e.g. the Úmoří brook), and piracy described by Štelcl (1956) offer the support, too.

The Upper Cretaceous sediments were partly evacuated by the paleo-Svitava both from the Lysice Depression and the Blansko Graben before the Badenian (Figs. 4,5 and 11). The two depressions are connected by a wide valley of the Býkovka (brook). They are closed from the S by block-faulted elevations of the Žernovník and Hořice Horsts and by the Adamovská vrchovina (Highland).

The paleo-Svitava had four possibilities how to reach the Carpathian Foredeep, two from the Lysice Depression and two from the Blansko Graben. From the Lysice Depression, the Svitava could flow either through the Závist Pass in the Hořice Horst or across the Žernovník Horst. From the Blansko Graben, the river could continue either to the S through the granodiorite of the Adamovská vrchovina (Highland), similarly as the present Svitava, or turn to the SE across the Moravian Karst and the Drahanská vrchovina (Highland).

7.31 Possible drainage from the Lysice Depression

Numerous changes in the river pattern evolution of the Svitava R. during the Miocene and Quaternary between the Lysice Depression and the Brno Basin were supposed by Jaroš (1958b). He noted a tendency to an eastward migration of the Svitava R., from the crystalline basement of the Svratka dome to the Žernovník Horst in the Uppermost Miocene and than into the Závist Pass in the Lower Pleistocene. A critical point of the hypothesis is especially the age of sands and gravels at the village of Závist, interpreted either as the Miocene or Quaternary. According to Cicha and Dornič (1959), the sediments are marine by origin and were deposited in the Lower Badenian. Thus, the course of the Svitava R. through the Závist Pass in the Quaternary seems to be untenable. The difference in elevation of the Závist Pass and the present bottom of the Svitava R. in the Blansko Graben (about 150 m) argues against this course.

On the other hand, valleys filled with Badenian sediments exist in the southern continuation of the Závist Pass suggesting not only an integrated pre-Badenian river pattern, but also a possible fluvial function of the Závist Pass. The pass is probably guided by a fault. In our opinion, more detailed research is necessary.

7.32 Drainage from the Blansko Graben

The course of the Svitava R. from the Blansko Graben to the Carpathian Foredeep either southeastwards to the Vyškov Gate across the Moravian Karst or southwards to the Brno Basin has been discussed very much. The problem is more complex than the drainage from the Lysice Depression towards the Brno Basin.

7.321 Possible drainage across the Moravian Karst

In the southernmost part of the Blansko Graben, the Svitava R. joins the Punkva R. which drains partly (as an underground river) the northern part of the Moravian Karst. Its southwards course turns to the W where karst waters reappears at the surface. The lowermost course of the Punkva is a deep canyon cut in granodiorite. In the canyon, the Lower Badenian marine sediments were found below the present floodplain (Schütznerová-

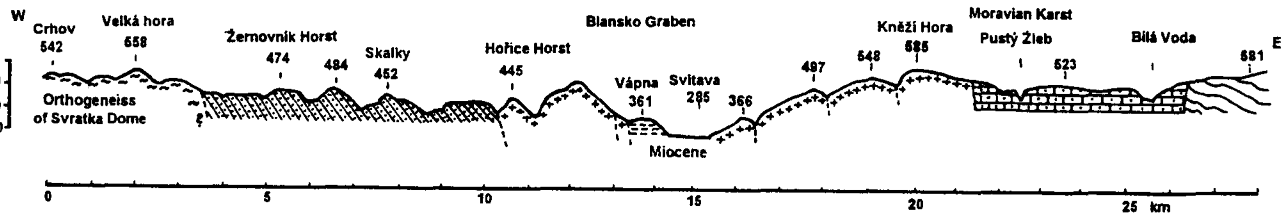


Fig.11. Profile across the Žernovník Horst,Hořice Horst,Blansko Graben and Moravian Karst.Note that in this part of the Blansko Graben, outcrops of the Upper Cretaceous sediments are absent.

Havelková, 1957,1958; Vilšer, 1962). The Badenian sediments occur also in the tributary valley of the Punkva at the village of Lažánky and beyond a local divide in the graben-like Jedovnice - Račice Depression, drained partly by the Jedovnický potok (brook), but mostly by the Rakovec (brook).

This led to a hypothesis that valleys of the lowermost Punkva and its tributary from Lažánky were used by the river connecting the Blansko Graben and the Vyškov Gate (Kettner, 1960). Two additional problems appeared, however. The first, importance of the underground of drainage of the Moravian Karst. The second, the problem of erosional or tectonic origin of the Jedovnice - Račice Depression (Dvořák,1995). A critical point of the hypothesis consits in the contact area of the Devonian limestones and Culm sediments on the E margin of the Moravian Karst near Jedovnice. The narrow Jedovnice - Račice Depression is drained to two opposite directions. The minor NW part is drained by the Jedovnický potok (brook) into the Svitava R. but not through the Punkva and its tributary valley at Lažánky. The Jedovnický potok (brook) is an allochtonous karst stream disappearing in the ponor at the Jedovnice. It continues as an underground stream towards the SW and reappears in the valley of the Křtinský potok (brook). It joins the Svitava in its gorge downstream of the Blansko Graben. Thus, an underground hydrography (ground-water capture?) of the Moravian Karst is involved in the problem of Svitava paleocourse, too (see R.Musil et al., 1993a).

The major part of the graben-like Jedovnice - Račice Depression is drained by Rakovec (brook) to the SE. The water divide between the Jedovnický potok and Rakovec brooks crosses the bottom of the depression E of Jedovnice at the altitude of 480 m. The Badenian sediments (more than 100 m thick) occur along the both streams.This SE part of the depression is about 20 km long and it ends suddenly in the S on the line of marginal slope of the Bohemian Massif (Fig.12). Here, the depression enters the Vyškov Gate which is a part of the Carpathian Foredeep. The drainage basin of the Rakovec (brook) is mostly only 4 km wide, without perennial tributaries. Slopes of this major part of the depression are composed of folded Culm sediments. They are very irregular in groundplan, partly zig-zag or rectangular, complicated by small embayment-like depressions.

The course of the depression is perpendicular to the marginal slope of the Bohemian Massif. Before crossing the margin, the depression ramifies into two branches, separated by a central isolated fault block with the top more than 150 m (437 m a.s.l.) above the bottom of depression. Hrádek (1980) described this configuration as a triple junction. The resemblance with the Y-type fault is also remarkable (see e.g.Brinkmann, 1972). It is worth to mention, that two branches of the depression belong to different drainage basins and the divide which crosses the central isolated block continues to the SE across the Carpathian Foredeep. This type of "bifurcation" occurs also in the Brno Basin (Ivan, 1992 and Fig.12).

As regards the relation of the graben to the basement structure, Dvořák (1993) noted a fault boundary in the Proterozoic basement along an axial depression between Jedovnice and Vyškov.

As to the origin of the Jedovnice - Račice Depression, opinions vary. According to some authors, the depression is of an erosion form, later filled with the Badenian sediments (Zeman, 1980; Dvořák, 1994, 1995). On the other hand, Krejčí (1967) pointed out some of its undisputable tectonic features. According to him, also the lowermost course of the Punkva cut in granodiorite is a tectonic valley, but this is less convincing. In our opinion, the Rakovec (brook) cut its valley in the bottom of the graben-like Jedovnice - Račice Depression, but time relations between vertical fluvial erosion, tectonics and Badenian marine transgression are too complex and not fully understood yet.

7.322 The Svitava gorge downstream of the Blansko Graben

At present, the Blansko Graben is drained towards the S. The gorge between the Blansko Graben and the Brno Basin is about 30 km long cut in granodiorite. But downstream of the town of Adamov, Devonian limestones crop out in the upper part of the left valley slope. Although the Svitava R. maintains generally the N-S direction, some NW and NNE sections alternate in its course. The cross profile of the gorge is also variable and several incised meanders occur, too. The most interesting features accompanying the Svitava gorge (but not discussed here in detail) are as follows:

(1) The short right tributary gorge of the brook of Šebrovka coming from the Svinošice Graben (Fig.12). The graben is filled with the Miocene sediments and the Upper Cretaceous sediments also occur.

(2) The canyon of the Křtinský potok (brook), the left tributary of the Svitava R. draining the middle part of the Moravian Karst (see chap. 8.321).

(3) The small basin at the town of Adamov developed along the branch of the Adamov fault (NW-SE) with a short tributary of barbed type.

(4) Downstream the village of Bílovice nad Svitavou the river is cut below the bottom of the Obřany Basin (Krejčí, 1964) in fact a "hanging" promontory of both the Nesvačilka Graben and the Brno Basin. Moreover, the promontory turns to the NE near Bílovice n. Svitavou and continues as the Řícmanice - Ochoz Graben (Demek et al., 1987) into the southern part of the Moravian Karst. The bottoms of both the Obřany Basin and Řícmanice-Ochoz Grabens are partly composed of Miocene (Ottnangian) sediments. The latter graben is believed to be a result of inversion of relief in the granodiorite (R. Musil et al., 1993a; Dvořák and Pták, 1963).

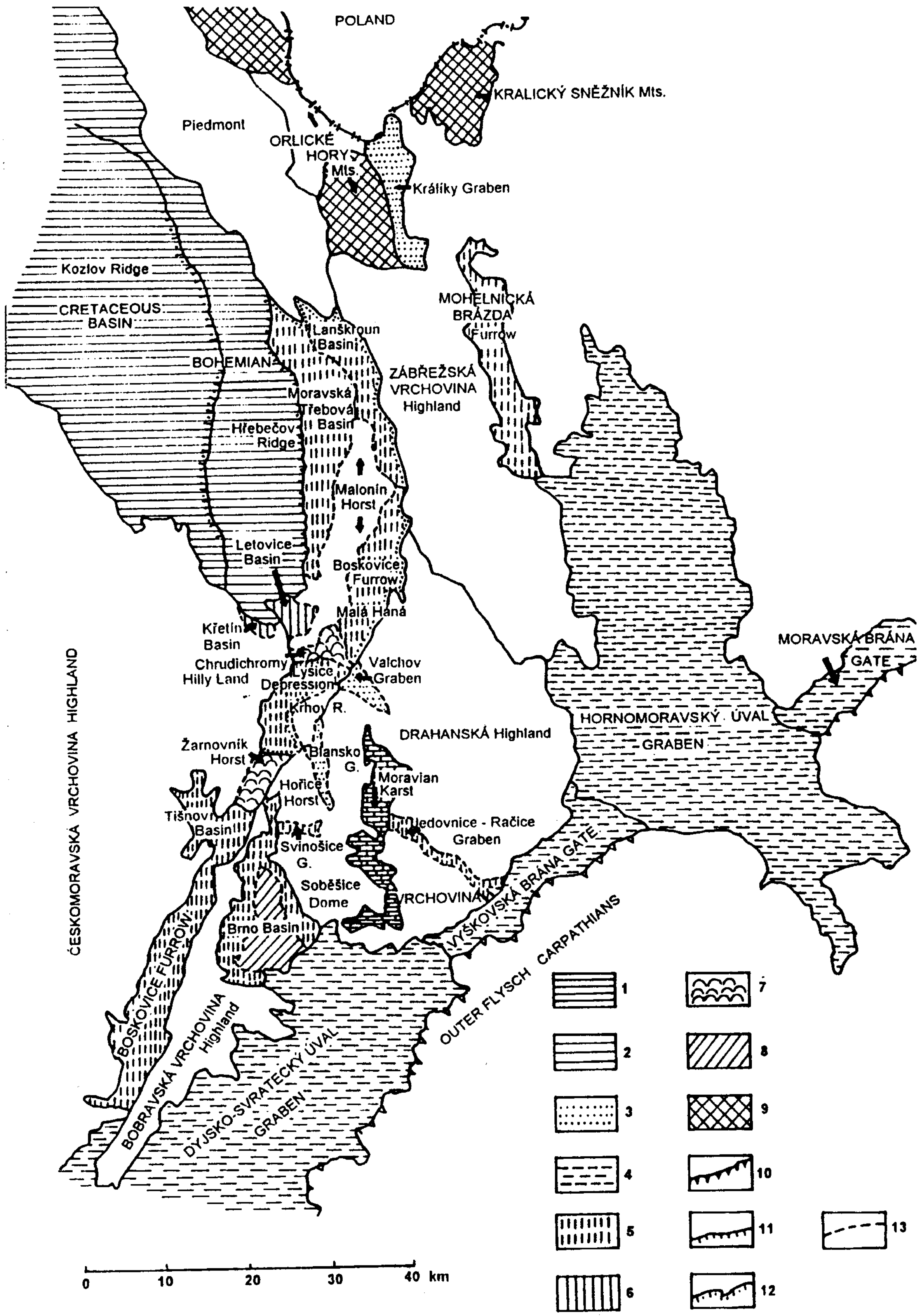


Fig.12.Some topographical features in the E part of the Bohemian Massif: 1- Devonian Limestones, 2- Upper Cretaceous sediments of the Bohemian Cretaceous Basin, 3- Upper Cretaceous sediments in the grabens, 4- Miocene sediments of the Carpathian Foredeep, 5- Miocene sediments in depressions in the Bohemian Massif, 6- depression without the Miocene sediments (Křetín and Letovice Basins), 7- thresholds in the Boskovice Furrow, 8- elevation in the Brno Basin, 9- mountains in the surroundings of the Králíky Graben, 10- Front of Carpathian nappes, 11- cuesta escarpment of the Hřebeč Ridge, 12- east slope of Kozlov Ridge, 13 a - boundary between Lanškroun and Moravská Třebová Basins, b - eastern boundary of the supposed Lanškroun - Černá Hora Depression.

The origin of the Svitava gorge downstream of the Blansko Graben was much discussed and both the antecedence and superposition were propounded. According to Demek, the gorge is antecedent (Demek et al., 1965) and Krejčí (1964) stated its guidance by a fault. In this connection, resemblance between the drainage of the Králíky and Blansko Grabens by southward trending gorges, diagonally to the NW - SE Variscan faults is spectacular. According to R.Musil et al. (1993b) the Svitava started to cut its gorge in the Paleogene already. The highest terrace of the Svitava (93 m) originated in the Pliocene. The prevailing part of its depth was cut in the Quaternary.

8. Problems of denudation chronology

The relics of kaolinic and lateritic weathering crusts, as well as the nature of buried topography demonstrate a very perfect planation before the Upper Cretaceous marine transgression. Thus, we classify this surface as a buried variety of the etchplain according to the scheme of Thomas (1989). The exhumed parts of the surface are preserved in many areas adjoining to the Bohemian Cretaceous Basin. The post-Cretaceous subaerial denudation in the Bohemian Massif resulted in a regional planation surface mostly referred to as Paleogene peneplain. This extensive planation surface truncates different rocks and structures, and also the Upper Cretaceous sediments. It is believed, that the planation surface had a low elevation above the general erosion base and this is the reason to consider it as a datum useful to estimate amplitudes of neotectonic movements (Kopecký, 1972). Relations between the post-Cretaceous movements and the Paleogene planation surface, however, are not well understood, especially in the Bohemian Cretaceous Basin and adjacent areas. The post-Cretaceous subaerial denudation was very long and no wonder that opinions about the more precise age of the Paleogene planation surface and mainly of block movements differ substantially. The main cause of difficulties is an absence of datable post-Cretaceous sediments, weathering crusts or duricrusts. The oldest post-Upper Cretaceous sediments in the E part of the Bohemian Cretaceous Basin, the Badenian basal clastics and marls, were deposited not only on the planation surface but also in depressions and valleys. Some authors suppose initiation of valley cutting already in the Paleogene (Panoš, 1964b; Dvořák, 1995).

In the area under study, the most extensive remnants of the Paleogene peneplain in the area of Upper Cretaceous sediments are supposed to be mainly in the Ústí syncline (Neubauer, 1953). Height differences among the remnants of the surface are explained by post-Paleogene tectonic deformations. The river pattern seems to be affected by the faults, too. The depression of Ústí syncline is tectonic, not erosional.

It is remarkable, that in the northern and central segments of the Blansko - Kunštát zone, surfaces on the mesas are underlain with the same formations (with an only exception of the buttte Chlum 512 m).This is true also in the Blansko Graben. However, it is possible, that the surfaces are at least partly structural.The surfaces in the surroundings of buttes are either exhumed pre-Upper Cretaceous surfaces (e.g. near Kunštát) or post-Paleogene but pre-Badenian in age. In the Krhov Ridge, the surface east of the butte of Malý Chlum truncates the post-Cretaceous and Lower Permian sediments.

The processes of exhumation of the pre-Upper Cretaceous planation surface took place from the time of sea regression and continue up to now. Therefore, from the paleoclimatic point of view, the buried surface was exhumed and reshaped by very different processes.

Depth of denudation of the exhumed pre-Upper Cretaceous planation surface composed of crystalline rocks is different, too. This is demonstrable especially in the Blansko - Kunštát zone. At Kunštát, at least 80 m schists corresponding to the present heigt of the Milenka mesa were denuded from the upthrown block of the Semanín fault after the exhumation. The original topographic effect of faulting was destroyed by differential erosion and relief inversion developed (Fig.13). The topographic position suggests that after denudation of the Upper Cretaceous sediments, deep chemical weathering continued. The most conspicuous relief inversion in the area under study, however, occurs where the Upper Cretaceous deposits are underlain with Lower Permian rocks.

The relief inversion is very common also in other parts of the Bohemian Massif composed of the Upper Cretaceous sediments. Large-scale inversion occured in northern parts of the massif (e.g. along Lusitanian fault, Louis 1961, Fig.42) and this feature of some Sudetes Mts. is mentioned also by Birot (1958). According to A.Jahn (1980, p.10) in the Polish part of the Sudetes:" The cause of the morphological inversion can be found in the peculiar character of the action of intertropical climate processes which react not to rock hardness, but to its hydrogeological properties such as porosity, permeability, chemical and mineral composition". In his interpretation, synclinal mountains evolved from parts of the North Sudetic and Intrasudetic throughs along the Main Sudetic Fault. An important factor in relief inversion evolution were differential tectonic movements, namely movements on the ancient Variscan faults. This is evident both in the Blansko - Kunštát zone and in the eastern part of the Bohemian Cretaceous Basin. In the northern segment of the Blansko - Kunštát zone, downfaulted Upper Cretaceous sediments were later uplifted and buttes originated on the local divide. On the other hand, in the Blansko Graben the sediments retained their original position and landforms presenting a relief inversion do not exist. An analogical contrast in the Polish part of the Sudetes present the Góry Stolowe (denuded anticline) and the Klodzko Graben.

In some depressions, the Badenian sediments buried a flat or gently inclined erosion surface truncating the pre-Mesozoic rocks, mostly moderately deformed Lower Permian sediments. The cuesta escarpment of the Hřebeč Ridge facing the large Lanškroun - Černá Hora Depression suggests possible pedimentation processes by retreat of the escarpment. In the Lysice Depression, the buried surface is sloping down from the foot of the Českomoravská vrchovina (Highland). The surface occurs also in embayments located where water courses leave the highland. Here, lateral planation by streams was a possible process. However, the period since formation of pediments to their burial by the Badenian sediments is unknown. Hassinger (1914) noted, that the pre-middle Miocene fault scarp (cuesta) in the surrounding of Lanškroun composed of the Upper Cretaceous sediments retreated 5-6 km after faulting. But since the Miocene, the retreat was only 1 km. More data are necessary, however, for both understaning and timing of the processes.

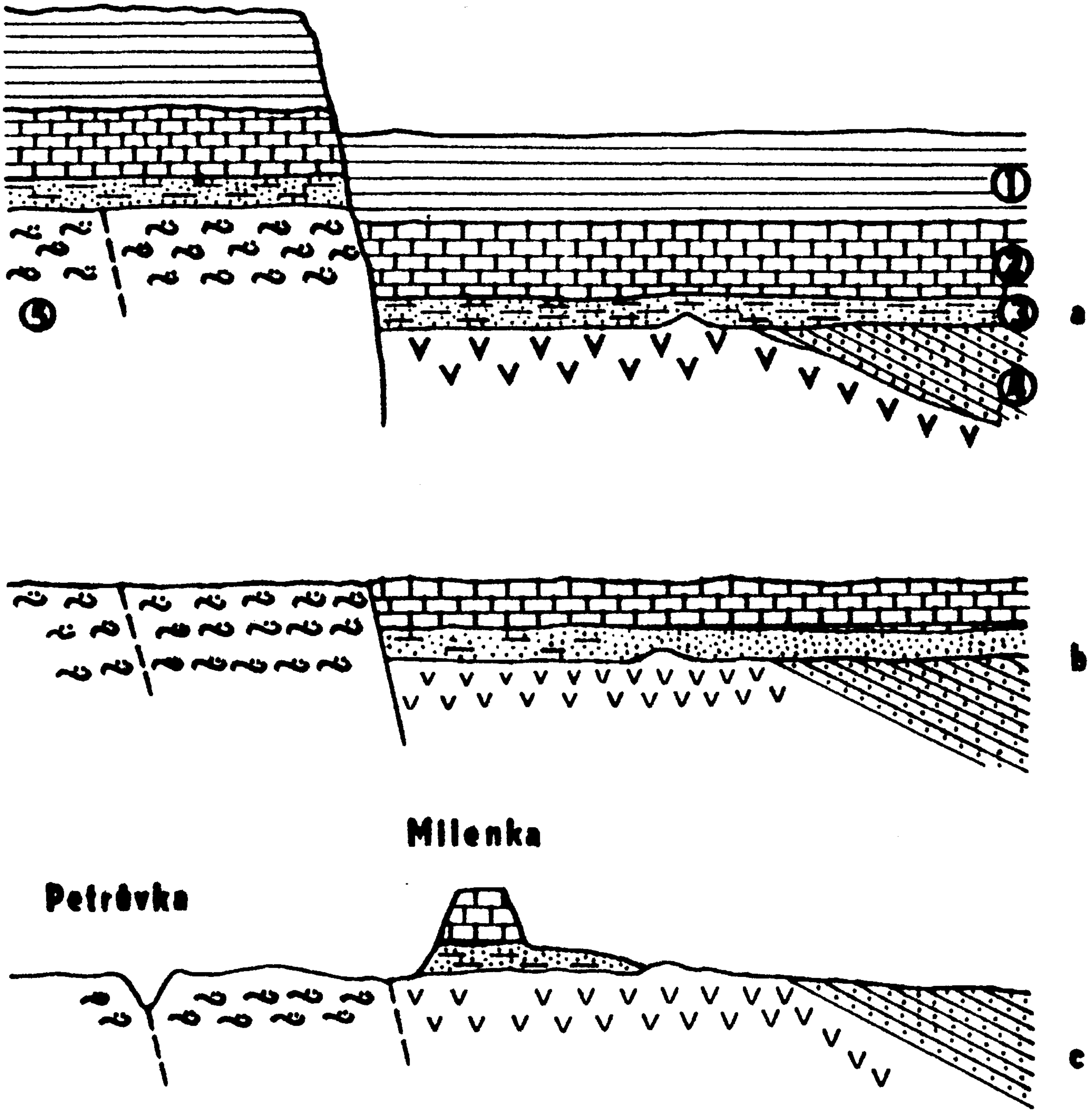


Fig.13. Inversion of relief along the Semanín fault in the northern part of the Blansko-Kunštát zone: 1- Upper and Middle Turonian sediments, 2- Lower Turonian sediments, 3- Cenomanian sediments, 4- Lower Permian sediments and metabasites of the Letovice Unit, 5- crystalline schists of the Svratka Dome.

Very different opinions were expressed also about the age of tectonic movements and deformations of the Upper Cretaceous sediments.

As mentioned above, some movements are evidenced already at the onset of Upper Cretaceous freshwater sedimentation (Vachtl et al., 1968). In the surroundings of Svojanov, Fajst (1969) demonstrated the existence of the Stašov ridge as a part of the Potštejn anticline at that time. In opinion of Malkovský (1977, 1979, 1980) the Ilsed phase in the Upper Cretaceous was perceptible. In the eastern part of the Bohemian Cretaceous Basin, synsedimentary movements were summarized by J. Soukup (in J.Svoboda et al., 1962). In the Klodzko Graben, strong synsedimentary movements took place especially during the Subhercynian phase (Jerzykiewicz, 1971). This was supposed also for eastern Bohemia (Vavřínová, 1946).

According to Kettner (1960), the age of the Blansko Graben is unclear, probably the Paleogene. In the scheme of tectonic movements of Malkovský, the major fold structures originated during the Savian phase in the Uppermost Oligocene - Lower Miocene. In contrast, Kopecký (1972) postulated the neotectonic age of all folds structures. According to him, the Potštejn anticline originated only in the Quaternary. This seems to be unrealistic.

In any case, it seems that the Young Saxon tectonic movements were long lasting or several phases occured at least. In the Miocene, the most intensive movements took place in the Blansko and Valchov Grabens affecting the very fractured rocks of the Brno Massif. This probably connects with proximity of the front of nappes in the West Carpathians located in the process of underthrusting of the Bohemian Massif below the Carpathians.

In fact, the nappe front of the Carpathian flysch thrusted over the Miocene (Karpathian) sediments resulted in a shift of the Carpathian Foredeep towards the NW and formation of the marginal slope of the Bohemian Massif. At present, the nappe front is only 20 km SE of Brno from the margin of the massif. In marginal parts of the Bohemian Massif, in the Drahanská vrchovina, Bobravská vrchovina and Zábřežská vrchovina (Highlands), a forebulge originated as a response to tectonic stresses in the Carpathians. It is possible that reactivation of some faults in the Boskovice Furow contributed to the formation of the forebulge. Importance of Variscan or older basement structure is supported by the fact, that dome-like deformations (the Svratka Dome, the Soběšice Dome) are present only in the Moravosilesicum and Brunovistulicum but not in the more consolidated Moldanubicum.

9. Discussion and conclusions

1. The Blansko-Kunštát zone and the Ústí syncline are similar tectonic structures. Their long axes, however, are inclined in opposite directions. In both structures, the Upper Cretaceous sediments are preserved mainly in western parts along the Semanín fault. The Blansko - Kunštát zone is narrower and more intensively faulted. The both structures are associated not only with the Semanín fault but also with the Potštejn anticline. The Semanín fault is composed of two step faults at least. The fault is most distinct in granitoids of the Brno Massif. In other parts, a process of bending into flexure was important, too. Some common features can be found also in the Blansko and Králíky Grabens. Thresholds between the Klodzko Graben and the Bohemian Cretaceous Basin, between the latter and the Blansko - Kunštát zone and between Blansko - Kunštát zone (Lysice Depression + Blansko Graben) and the Carpathian Foredeep (Brno Basin) have similar features. In the thresholds, drainage is directed southwards.
2. Young-Saxon tectonics north of Brno was differentiated in dependance on a very different basement structure of the Bohemian Massif and tectonic processes in adjacent parts of the Western Carpathians. The pattern of the major NW-SE faults was supplemented by faults of the NNW-SSE and N-S directions. The N-S trend was also important in the process of formation of forebulge in front of the Carpathians nappes in the Lower Miocene. The Blansko and Valchov Grabens are bounded on the E by slope of the domal uplift of the Drahanská vrchovina (Highland), complicated by N-S trending faults taking part in the dome-like deformation.
3. Some important S or SSE trending faults in the Bohemian Cretaceous Basin and in the half-grabens turn to the SE and some die out in western parts of the Drahanská vrchovina and Zábřežská vrchovina (Highlands). The Semanín fault turns to the SE in the closure of the Blansko Graben and crosses the Moravian Karst as a northern branch of the Adamov fault. Along the branch, several narrow blocks of the Jurassic limestone were downfaulted (P.Bosák, 1978). Similarly, the Kyšperk fault turns to the SE in the valley of the Nectava R., separating the Drahanská vrchovina from the Zábřežská vrchovina (Highlands). At the western foot of the Zábřežská vrchovina (Highland), small blocks of the Upper Cretaceous sediments are preserved on downthrown blocks. On the other hand, some faults suddenly end and the Upper Cretaceous sediments are found in a very exposed topographical situation. This is the case of the eastern fault of the Králíky Graben (the Upper Cretaceous sediments are preserved at Horní Studénky) and of the Radkov fault that dies out at Pěčíkov. Along the important Bušín fault (NW-SE) connecting the Králíky Graben and Mohelnická

brázda (Furrow) the northern promontory of the Hornomoravský úval (Graben), only an overfit fault-line valley developed. The Kyšperk fault is probably SE continuation of the Lusitanian fault.

4. The young-Saxon fault movements were at least partly inversional. Thus, the post-Cretaceous subaerial landscape evolution resulted in an inversion of the relief. The buttes of the Blansko - Kunštát zone are very instructive examples, but the tendency to relief inversion is apparent also in the Ústí syncline and in some marginal parts of the Bohemian Cretaceous Basin. In some cases, however, the relief inversion was probably inherited from the Lower Mesozoic (Babí lom Ridge, composed of the Lower Devonian conglomerates, Řícmanice - Ochoz Graben).
5. We believe that intensive denudation, including the formation of river valleys and depressions was important in the Lower and Middle Miocene (Karpatian and Badenian) in connection with thrusting of flysch nappes in the Carpathians (Czudek 1984, Dvořák 1995) and formation of the forebulge. In the Carpathian Foredeep situated between the forebulge and flysch nappes, rate of sedimentation was very high at these times (D.Vass and F.Čech, 1989).
6. Remnants of the Upper Cretaceous sediments at the western foot of the Zábřežská vrchovina (Highland) suggest that from morphostructural point of view, the western slope of the Zábřežská vrchovina (Highland) formed probably originally the eastern margin of the Bohemian Cretaceous Basin and western slope of the forebulge. This is true also for the western foot of the Drahanská vrchovina (Highland). Here, however, the location of this boundary was predisposed by the Boskovice - Diendorf fault.
7. The formation of the forebulge affected distinctly the evolution of drainage pattern in the eastern part of the Bohemian Massif. Although some water courses flowing from the Bohemian Cretaceous Basin to the E were guided by faults, they were blocked and beheaded (e.g. the river of Nectava). At present,only the rivers of Moravská Sázava and Třebůvka cross the Zábřežská vrchovina (Highland) in deep gorges and maintain their original courses initiated on the eastern limb of the Litice anticline. Between the depressions north of Brno (Blansko Graben and Lysice Depression) and the Carpathian Foredeep, development of drainage pattern was particularly complicated. Most complex was drainage evolution in the Moravian Karst. The deep valleys, especially transversal gorges, in the SE part of the Bohemian Massif as well as the valleys buried below the Miocene sediments of the Carpathian Foredeep and/or Flysch nappes present one of most difficult problem.

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Territorial Aspects of Changes in Biodiversity in Military Training Fields (A study made in the military training field Libavá with the use of satellite photography)

Jaromír KOLEJKA - Vítězslav NOVÁČEK - Jiří LAZEBNÍČEK

Abstract

Military training fields (MTF) are in the centre of attention during the last period. The study is the first approaching the more detailed analysis of the state of nature of the MTF Libavá on the basis of detailed knowledge of causes, ways and consequences of damage of the nature in the MTFs in the Czech Republic territory. The character of natural components of the environment in the MTFs is determined by the kind of a negative military activity, which is analysed with respect to environment devastation. Methods of the remote sensing have been utilised for detection of military changes of the nature. On the basis of false colour composites interpretation, an interpretation key was drafted and map data for MTF Libavá were plotted, recording the rate of military transformation of the environment and also the related phenomena of spontaneous regulation succession. The process of nature renewal is possible to be demonstrated on the MTF example after the removal of original forms of anthropogenic load, but also cases of enormous nature devastation. It is possible to observe vitality of natural forces and processes trying to restore the subtle balance in the landscape.

Shrnutí

Teritoriální aspekty změn biodiverzity ve vojenských výcvikových prostorech.

Vojenské výcvikové prostory (VVP) jsou středem pozornosti zejména v období několika posledních let. Předložený článek je pouze prvním přiblížením k mnohem podrobnější analýze stavu přírody ve VVP Libavá na základě podrobných znalostí procesů, způsobů a následků poškození přírody ve VVP na území České republiky. Charakter přírodních složek životního prostředí ve VVP je vymezen druhem negativního militárního působení, které je analyzováno se zřetelem na možnosti využití metod dálkového průzkumu Země pro detekci militárních změn v přírodě. Na základě interpretace nepravě barevné syntézy byl navržen interpetační klíč a byly vytvořeny kartografické podklady pro VVP Libavá s vyznačením stupně militární transformace životního prostředí s následným záznamem spontánní sukcese. Postupný průběh obnovy přírody můžeme pozorovat na příkladu VVP Libavá po skončení militárních forem antropogenního tlaku na přírodu, ale i v případech enormní devastace vojenského prostoru. Získané poznatky svědčí o značné vitalitě přírodních sil a naznačují možnosti uvedení přírody do původního stavu s cílem obnovení křehké rovnováhy v krajině.

Keywords : military activities, biodiversity changes, nature development

1. Introduction

Both the existing and former military training fields (MTF) attract attention of experts as well as that of non-technical public. Generally applied prohibition of entry for trespassers resulted in certain information chaos on one hand, and made impossible development of current social activities on the other, which often had an adverse effect on natural environment. It would not be possible to claim that from the naturalist point of view the areas were completely neglected. It is possible to say that, in principle, they were subjected to basic pedologic and forestry mapping, too. At the same time we can say that there was a whole range of other specialized research studies which were carried out in these spaces such as basic geological and geobotanical surveys and the like. However, there was not enough time for thorough covering research, nor possibilities, sometimes not even understanding, and the studies once made gradually grew obsolete. A considerable deficit of works and results is being felt from the viewpoint of environmentally oriented study events.

At the beginning of the 90's, there were altogether 7 major military training fields in the territory of the Czech Republic, which served local garrisons of former Czechoslovak and Soviet armies, and other 34 dislocated MTFs or their parts. Their distribution was rather uneven in spite of the fact that they were practically surrounding all important urban agglomerations with more than 100 000 inhabitants at a distance which was not too great (up to 50 km); see Figure 1.

As to covering variability of natural environment - natural landscape as that of a possible battle field, the MTFs are situated mainly in mountaneous terrain according to presumption of the then defense doctrine that military operations will happen in frontier mountains (Ivan at al., 1987). An important exception can be seen in MTF Mimoň, which is located in a moderate undulating terrain.

2. Nature of military injury to the biota within the MTF

Landscape sectors detached for training activities of armed forces in the past represent associations of landscape units differently sensitive to anthropogenic interference. Fundamental natural landscape elements are atmosphere, waters, lithosphere with land forms, soil and vegetation cover, possibly also radiation balance. Atmosphere (namely climatic conditions), lithosphere with land forms, and basic radiation balance are components which are more stable and more resistant to anthropogenic interference. Vegetation cover is particularly sensitive, waters and soils a bit less.

Losses on plant stands and relief, partially also on soils and exceptionally on waters (in the vicinity of the source) were identified visually within the terrain survey. Other physical and chemical injuries to soils and waters require auxiliary laboratory examination and instruments. Terrain transformations and related changes in soil and biota can be evidenced in the case that there are anthropogenic, mainly military relief formations (Zapletal, 1969).

Extent and forms of damage to the vegetation cover are of a very diverse character. The majority of them represent mechanical disturbance of both the integrity of forest stands and that of individual trees, their groups, shrub and herb vegetation by military transport vehicles. The losses are contributed to by training activities of armed forces themselves as well as by non-organized activities. Similar disorders arise in connection with troops camping in the forest, when trees are felled to complete erection of camps in spite of felling being prohibited, exceptionally also as fuel. The open stands then often gradually succumb to drought, frost, wind and insects. In principle, these types of losses are currently reported also elsewhere, outside the MTFs, but in consequence of different impulses.

A typical form of mechanical damage to the stand is shooting with live ammunition. Although the shooting takes place mainly in reserved firing ranges, in the case of field shooting, forest stands become unintentional targets, too. Afflicted are usually the areas meant for these purposes, repeatedly, to save other stands if

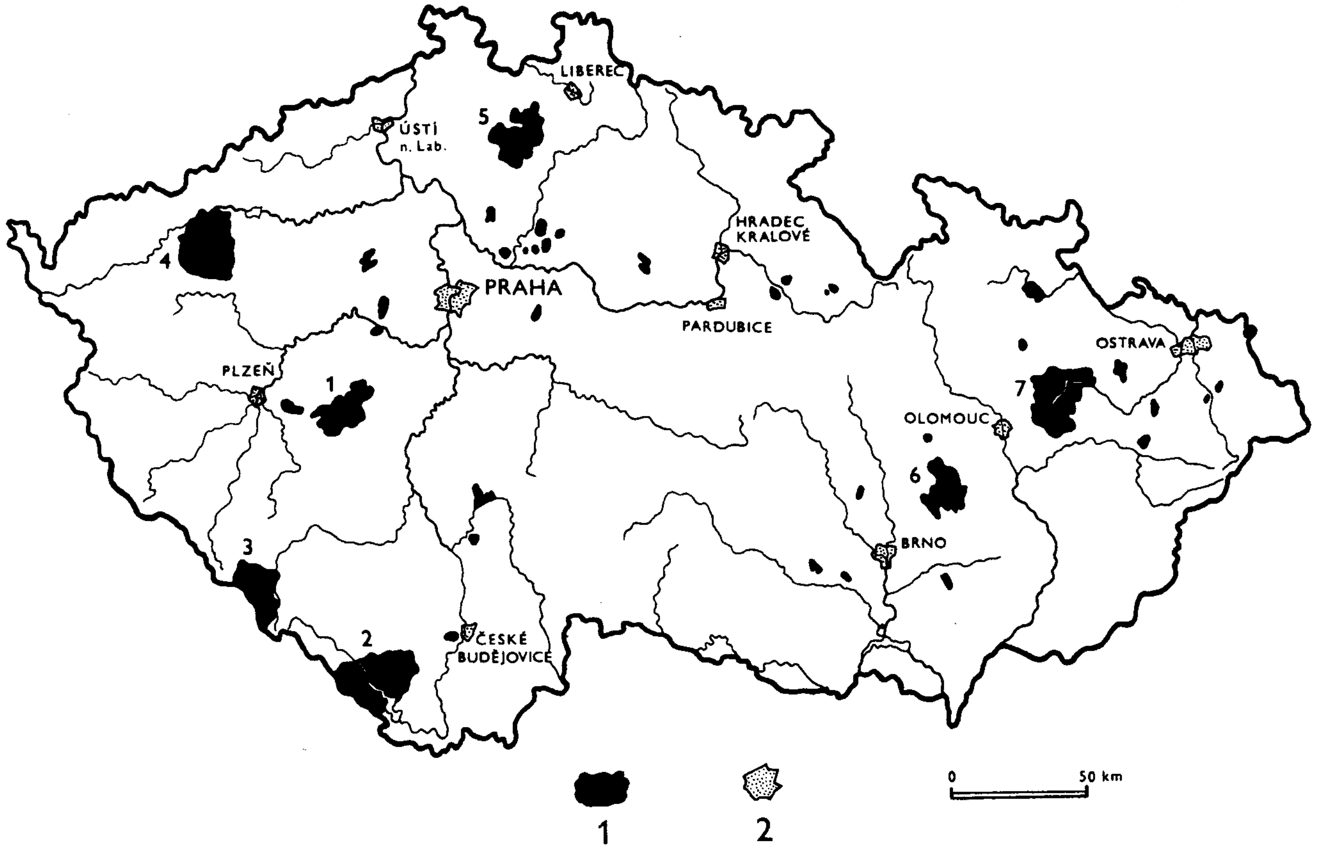

Fig. 1. The distribution military training fields in the territory of Czech Republic at the beginning of 90 s, which served local garrisons of the former Czechoslovak and Soviet armies. [1-military training fields, 2-urban agglomerations]

possible. Ammunition explosions result in various injuries to the trees and undergrowth. These activities of armed forces generally simulate extensive lightening effects. Further considerable economic (to lesser extent environmental) losses are caused by ammunition splinters. Metal fragments hit stems and tree crowns in the wide surroundings and these are practically excluded from normal commercial cutting since current machines and equipments cannot be used without the risk of their damage or injury to operator. Manual felling and processing of frequently very large volumes of timber are exceptional. Thus, the afflicted forest stands are left without any regeneration measures. In many respects they then represent an interesting object of natural historical science - often of considerable value - if they have been taken out from live shooting for longer period of time.

Driving and camping of troops as well as shooting with live ammunition have to do with fires. Inflammation often occurs at the contact of dry natural materials such as grass, moss, lichens, wood, etc. with parts of combustion engines, at burning slash or waste, fire setting, improper handling with flammables, ammunition explosions. Local importance have overgrown only the fires in MTF Ralsko which was originally utilized mainly by Soviet troops.

Intensive damage to the vegetation cover relates to concentration of driving tracks of both wheel and caterpillar military vehicles into relatively narrow corridors. This type of mechanical damage only exceptionally (MTFs Libavá and Mimoň) impacts extensive areas - as a rule only in localities of repeatedly held massive field trainings. These corridors of various sizes are practically without any vegetation cover. Soil cover here is practically non-functional due to extraordinarily compacted surface soil layers. Formation of impermeable crust at the very surface is often accompanied by formation of stone surface. Impermeability of the surface to water results in accumulated surface run-off. Severe linear erosion can be found at the places of repeated wheel run (so called "ruts") and disturbance by caterpillars (namely places where vehicles turn or change direction at moving on the slope).

Other mechanical damage to the vegetation cover is related to pioneer work of armed forces, which mostly consists in making trenches for vehicles, arms and corps, possibly firing ranges. Apart from some exceptions, these terrain formations are not removed properly after the drill ends and the relief is not put into its original condition again. Later, ever more new formations are being made, usually in intact areas. This is the way how biota, soil and relief are being changed in large areas.

Indirect anthropogenic damage to vegetation in the MTFs results from other disturbed natural elements of environment. Numerous are the cases of damage to soils and waters and consequent damage to biota by crude oil products, this being of mainly local character, though. Larger extent (not intensity) can be seen in losses caused by air pollution in MTFs Dobrá Voda and Libavá.

Training of armed forces connects with a relatively rare phenomenon in cultural landscape. Vast areas utilized for training of corps - in spite of being interlaid with rutty corridors and transformed by engineering corps objects - gradually become overgrown with pioneer plants (herbs, shrubs and trees). These open landscape areas were originally used for farming (arable soil, orchards, pastures), but the original forms of use were mostly abandoned after establishment of MTFs. Centres of military conditioned nature succession in the former intensively exploited areas become both original natural and man-made (military, urban, agrarian. ..) objects. Dominant role is apparently being played by remaining riparian stands along untreated water streams. Continuous strips of shrubs and trees gradually come into existence along water courses, which interconnect separated forest sites by so called biocorridors-much desirable both as to their form and quality. This is the case of the so called "linear succession". Starting points for "point succession" are a.o. remnants of abandoned settlements since liquidation concerned mainly buildings and not trees should the demolition be made intentionally, at random or partially by weathering. Ornamental and utility tree vegetation (village greens, around sacral buildings, in front of houses and on private plots) has become a starting point for further spread of the woody species. Another important centre for tree species succession can be seen in articulated military terrain forms, namely if they include steep slopes or their bottoms are permanently or seasonally water-logged. Regarding the fact that tiny and articulated military forms of the relief such as trenches are abundant and widely distributed in the terrain, all-area succession is a typical form of succession in these places.

Therefore it can be claimed that military activities have controversial impacts on nature. In relatively well preserved original complexes (forests, meadows, water areas) they are accompanied by locally increased anthropogenic pressure, usually in the form of fitful attacks, though with longer-lasting consequences which are considered to be damage to natural environment. Detached localities currently disturbed by corps exhibit improving biodiversity thanks to prohibition to entry for public. After the originally intensively used landscape has been taken over by the army, the all-area anthropogenic pressure usually drops in spite of the fact that destructive impacts onto water, soil and vegetation may locally be increased and in some rare cases afflict even larger areas. However, it is usually not of permanent character with the exception of traffic corridors, firing ranges, etc. This relatively short-term but deep reformation of some nature components (mainly soil and terrain) means their practical devaluation with the afflicted areas being left to their "natural" development for a certain period of time. They represent the area of practical experiment with spontaneous regeneration of the landscape, be it often with natural environment components otherwise intensively changed by man.

3. Methods of detection of biodiversity military changes in MTF Libavá by means of remote sensing

The MTF Libavá is situated westwards of the town Lipník nad Bečvou. It occupies frontier platforms of Oderské vrchy Mts., which are elevated 150-300 m above the neighbouring flat landscape of Hornomoravský úval (lowland) and Moravská brána (gate) into heights of over 600 m above sea level. They are built by layers of resistant Carbonic agglomerates and slates which bear only poor shallow cambiosol soils in the relatively cold and humid climate. The plateaux were deforested as early as in the Middle Ages and this should also be the date of origin to the typical elongated rural settlement in opened shallow upper sections of the valley. After 1937, when the military training field had been established here, population was gradually moved out and the villages turned to wilderness completely after the Second World War. The deforested plateaux were intensively used by drilled corps while the deep margin valleys mainly remained under forest cover. The MTF Libavá was directly used by the former Soviet Army for over twenty years.

Nature response to military activities can well be monitored by means of satellite and air photographs (Kuhn, Krull 1991; Marek, Furrer 1991). There are two satellite recordings that have been ensured for MTF Libavá, see false colour composites of the TM Landsat image of October 1988 [FCC : 2(B), 4(G) and 5(R) made at the scale of 1:500 000 on photographic paper] and original digital recording of August 1992. Starting point for comparison multitemporal study must be considered an available recording which can be provided with necessary supporting ground data at the least possible time delay, in the given case the image from 1992. According to the visualized image from 1992 there were altogether five main categories of damage/transformation to vegetation cover due to activities of armed forces defined for the purpose of mutual comparison in the given terrain, which are traceable in the both satellite photographs. They are as follows:

1. pronounced abiotic (bare) surfaces (rutted or compacted at the motion of military vehicles),
2. discontinuous herbaceous covers of damaged areas (disturbed by traffic and pioneer works),
3. herbaceous formations of mainly grasses, to lesser extent of ruderal vegetation species (in open terrains for infantry drills, training of tanks and artillery),
4. shrub stands (in areas with diverse engineering works in the terrain),
5. intravillan forests (in former settlements and their immediate surroundings).

Prior to processing, the image material was geometrically rectified into with the basic topographic map at the scale of 1:50 000. For this purpose it was necessary to carry out digitalization of false colour composite. With regard to completely different quality the images had to be evaluated by different procedures [1988 visual interpretation, 1992 normalised differentiated vegetationindex (NDVI) and maximum likelihood classification (MLC) calculations], taking into account the above mentioned classification of areas, though. Differentiated were also urban areas, water areas, coniferous forests, mixed and broad-leaved forests, farming arable land and meadows. Material prepared in this way was subject to multitemporal analysis.

Detailed ground survey was repeatedly made on three key sites : "Jestřábí" (15 km^2), "Nová Ves" (3,5 km^2), and "Milovany" (18 km^2) which were named by the formerly existing villages for convenience (Fig. 2). Interpretation of satellite data was made according to the ground data, results having been compared - at least partially - with the topographic map 1:50 000 of 1971. Any of the mentioned areas is representing possible type of landscape development in the course of intensive training of armed forces and after its end. Area development of the studied categories of military changes in vegetation was studied in each of the areas with a lot of statistic material available (Tab. 1).

4. Evaluating results of biodiversity dynamics according to changes of the vegetation cover

In the course of preparatory field research carried out in 1991-92 (Kolejka, Lazebníček, Nováček 1992) and during testing results of processed satellite photographs from 1993-94, numerous documents were accumulated which can to certain extent serve for deriving further developmental trends of landscape biodiversity in the studied MTF. It is necessary to point out in advance that to be able to define precise trends, we would have needed a much longer chronological sequence of information and similar material for comparison from many more tested sites than it was possible in our study. In spite of all this, the acquired data are relatively unique and allow to formulate certain general statements (Fig. 3 and 4).

A) The areas damaged by armed forces gradually regenerate in the following sequence: disconnected herbaceous covers - herb formations - shrubs - forest (of usually lower standard, originating from self-seeding forest tree species such as Salix caprea, Salix aurita, Betula pendula, Populus tremula). Site validation is

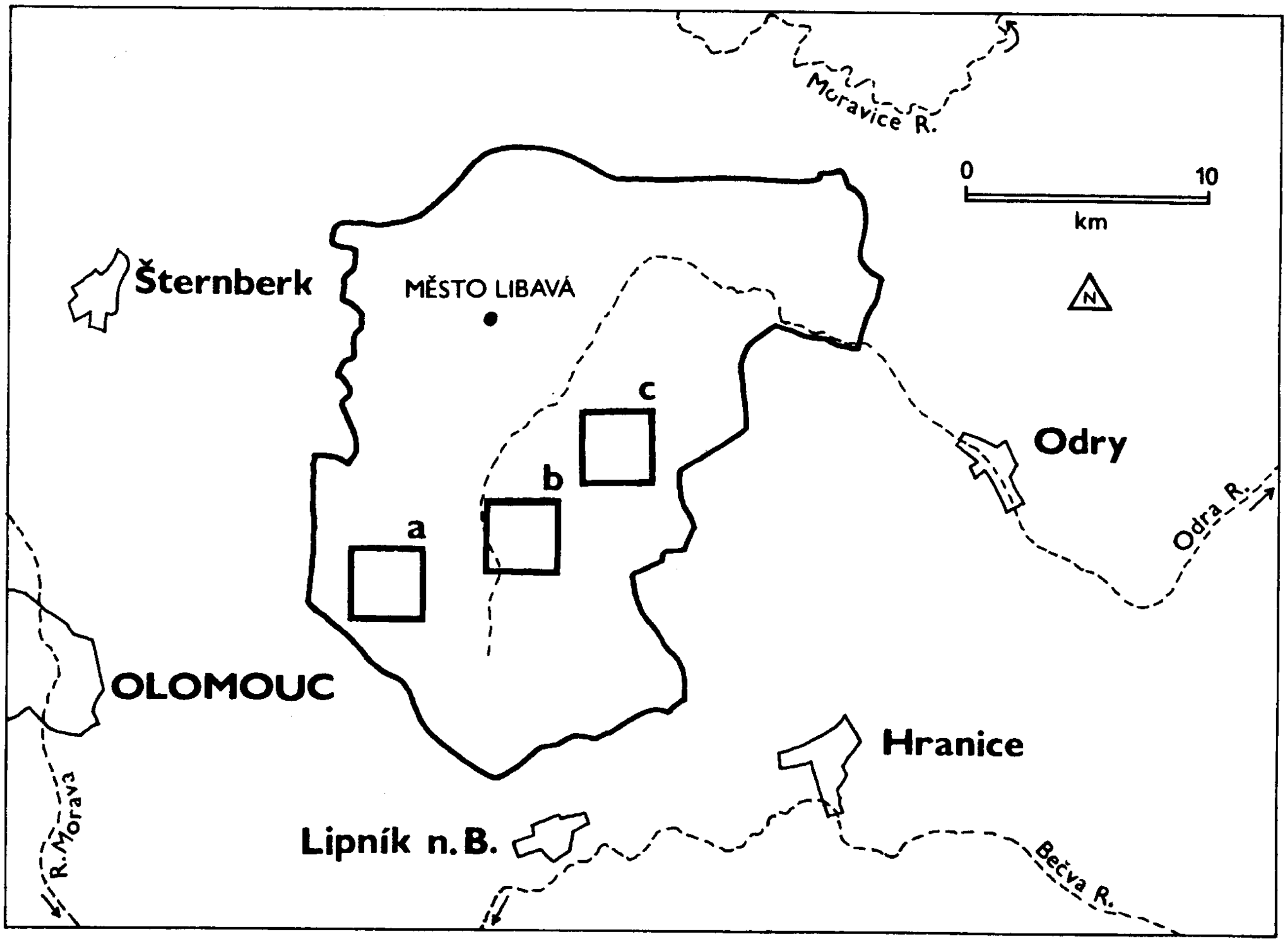

Fig. 2. The detailed ground survey in the MTF Libavá was repeatedly made on three key sites: a - "Jestřábí", b - "Milovany" and c - "Nová Ves" named after the formerly existing villages.

minimal in these cases since the plant cover hides artificial terrain roughness as well as injured or even water-logged soils. This process can be distinguished by rapid overgrowing with shrubs and bushes (short individuals of forest tree species) mainly to the detriment of herb formations. The overgrow usually comes out of humid localities (terrain depressions of all kinds and sizes) and is less applied in opened flat localities where grasses prevent growth of wood species (Fig. 5). The shrubs are a good indicator of anthropogenic relief transformation rate. According to experience gained through remote sensing interpretation, a period of five years should be sufficient to form a continuous shrub stand. For transition into the stage of "forest" we would probably need identical or a slightly longer period of time (older satellite photographs were not available for a site abandoned by corps).

B) Severely damaged sites (abiotic surface, compacted areas in traffic corridors) are incapable of spontaneous regeneration within realistic time and without man's support. Three years after the localities of this type were abandoned by Soviet troops, they have practically not changed at all. At lower damage (disconnected plant covers, partially also some ground objects), overgrowing with mainly ruderal flora species is more pronounced and occurs in the form of disintegration of originally integrated areas into smaller complexes in the most favourable localities (more broken surface, humidity). The time needed for spontaneous regeneration can be only guessed due to deficient suitable material. Up to now, the two years of monitoring have not provided these data in relevant form (Fig. 6).

C) Regeneration of localities with occurrence of rare flora species Menyanthes trifoliata, Iris sibirica, Gladiolus imbricatus, Orchis majalis, Scorzonera humulis, Lilium bulbiferum, etc.) is difficult due to intensive changes of original ecosystems and spontaneous rise of different new ecosystems (overgrowing of open and loose areas, alterations in moisture regime). The development leads to even sporadically preserved individuals losing their vitality. Artificial re-introduction is generally very involved and the choice of localities depend on assessment of the future fate of individual MTF sectors.

D) Corps activities are connected with intensive spread of invasion plant species such as Lupinus polyphyllus, Calamagrostis epigeios, Melilotus albus, Tanacetum vulgare, Chamaerion angustolium, Cirsium

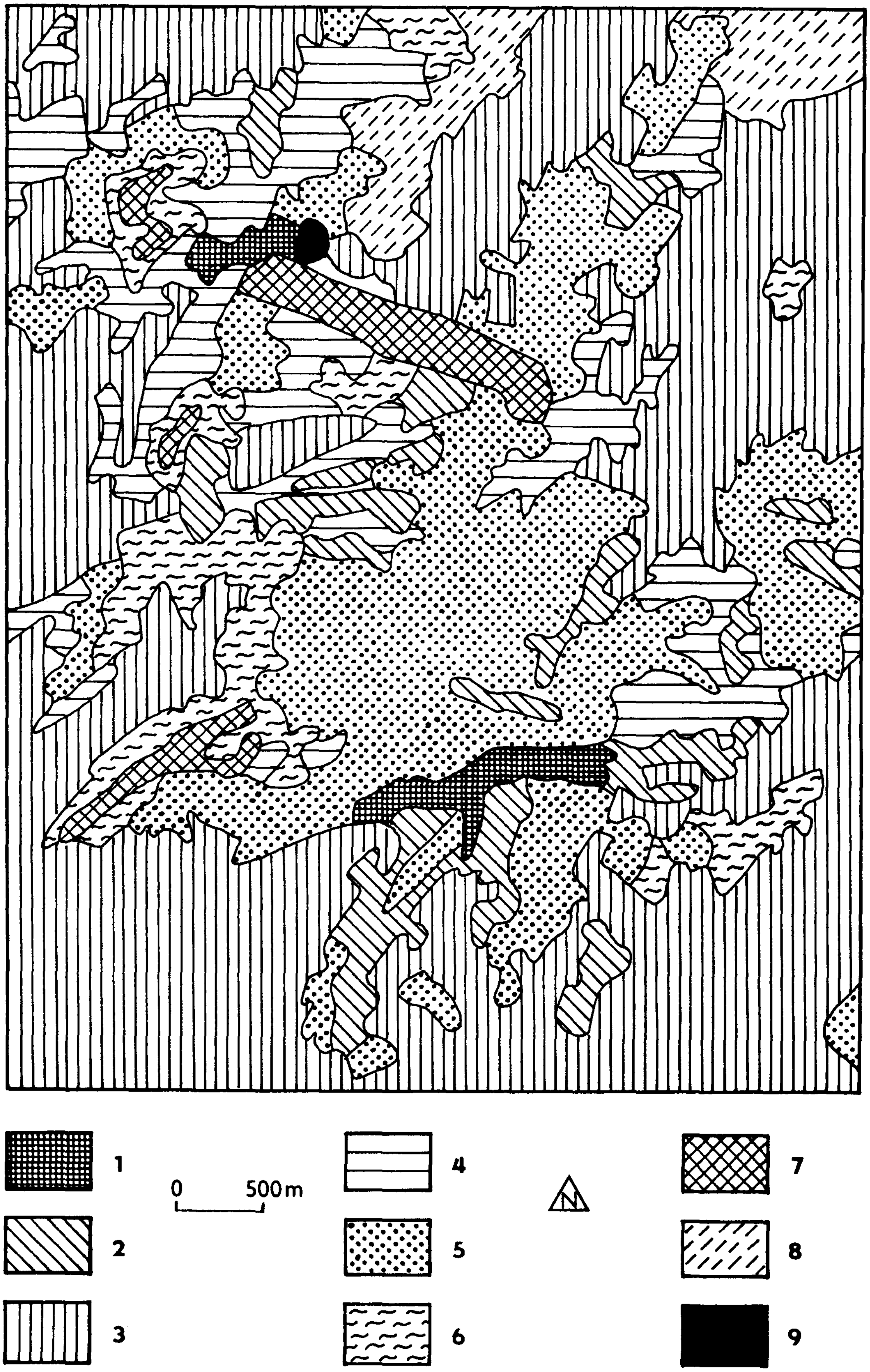

Fig. 3. Land cover of the military training field Libavá in 1988 (explanations see p. 39)

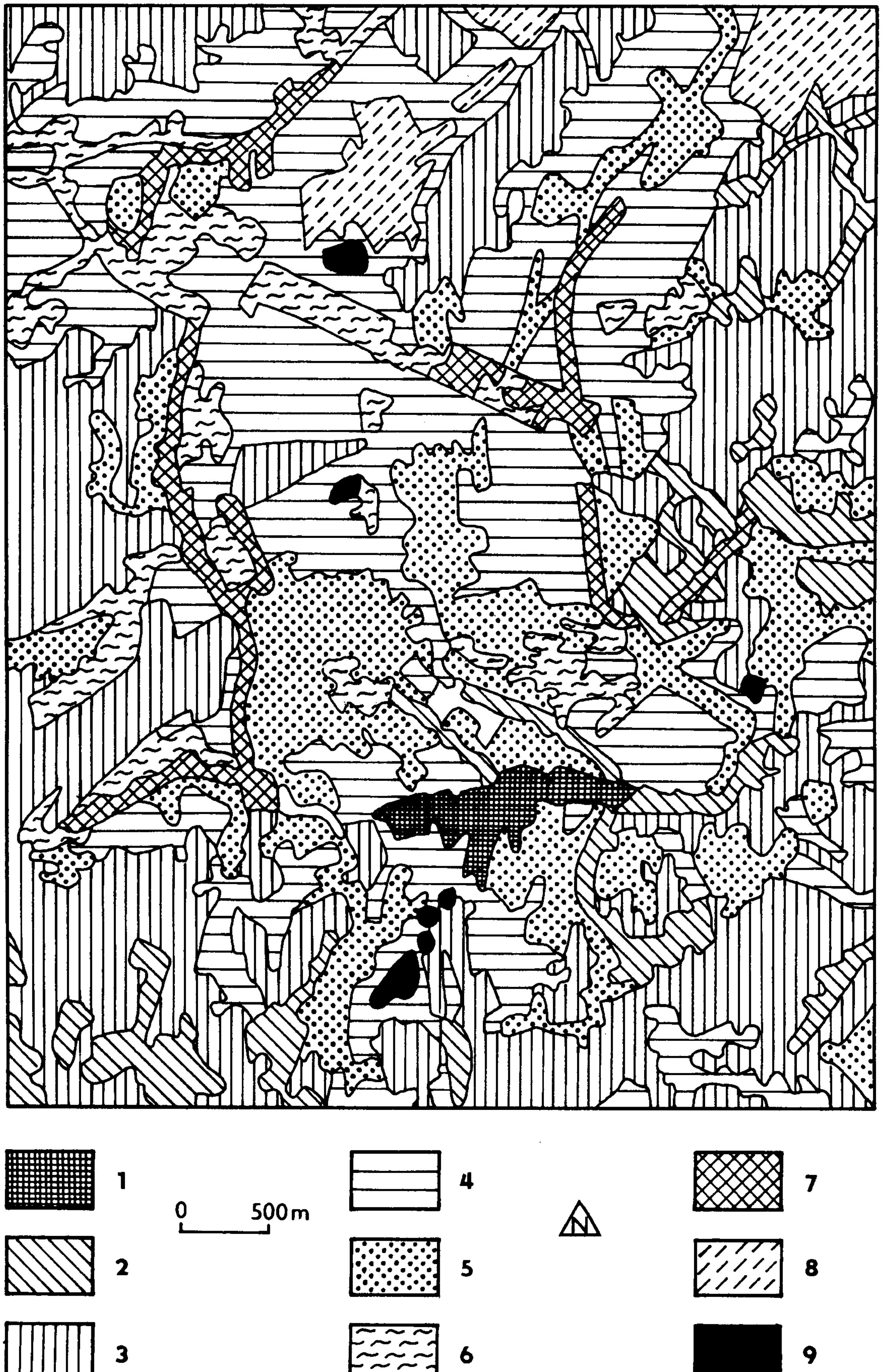

Fig. 4. Land cover of the military training field Libavá in 1992 (explanations see p. 39)

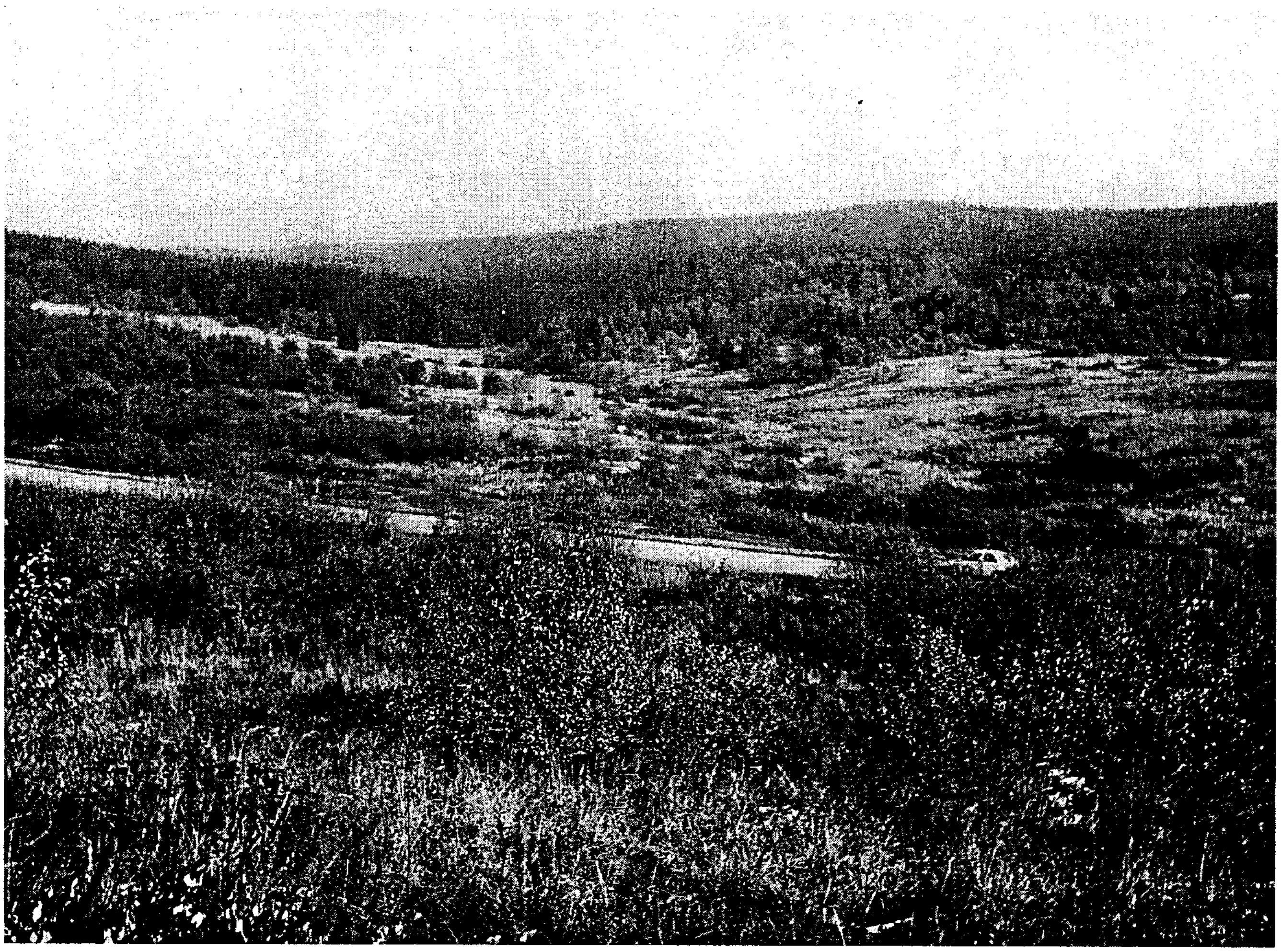

Fig. 5. Shrub stands in the open country cover artificial terrain roughness caused by pioneer work of armed forces, mean which the forest trees entered the originally grass areas.
Photo : J. Kolejka

arvense, Echium vulgare, Geranium pratense, Agrostis alba, Petasites officinalis, Phalaris arundinacea, Scirpus sylvaticus, Filipendula ulmaria, which force out, and at spontaneous development will be further driving out species of local flora. At weakened vitality of local species degradation of communities will most probably continue uncontrolled.

E) Land (terrain) shape development will be driven to gradual smoothening of military terrain roughness through the action of natural slope processes. This process will be contradicting to stabilization function of vegetation, and therefore the development will be growing weaker and longer proportionally to the biomass content per area unit of earth surface. Denuded land forms without any continuous vegetation cover are intensively decaying while the shrub stands conserve the formed terrain roughness to great extent, although they may be found in the stage of advanced destruction. Large ground objects such as tank and artillery firing ranges will most probably be preserved in the terrain. Complex development can be expected in compated surfaces. Firm crust of up to 1 metre in thickness prevents more intensive weathering on one hand, on the other hand it facilitates rapid run-off and water accumulation in active gullies. Crust weathering and overgrowing with vegetation will weaken intensity of erosion and gradual stabilization and overgrowing of gullies can be anticipated.

F) Major activity leading towards relatively fast recovery of the losses is agriculture. It participates to the decisive extent at recultivation of the most damaged areas. Water management (treatment of run-off) and forestry (plantation of cultural forest, unfortunately mostly the coniferous one, renovation of forest roads) will be applied to lesser extent. However, neither forestry nor agriculture contribute to improvement of biodiversity as they introduce only a narrow range of commercial species on large areas. Nevertheless, they increase economic value of the area.

G) To certain extent, the previous military activities led to increased retention capacity of the area as to amount of water retained in space not in reservoirs. On bare soils the run-off was locally accelerated. Differences in run-off among localities (areas of conversion military relief microforms and macroforms under shrub stands and in the forests except for bare soils) will

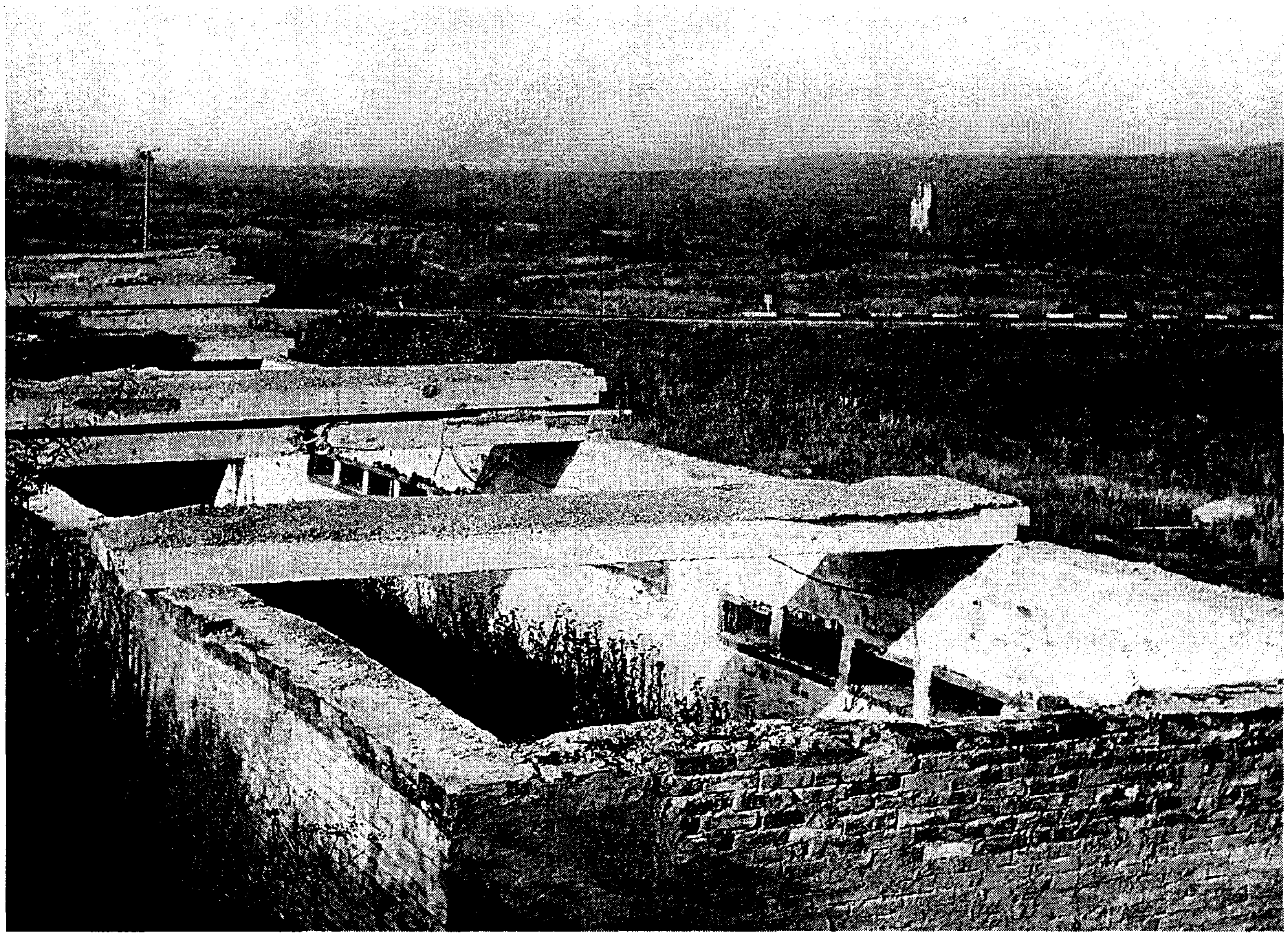

Fig. 6. Abandoned old settlement (former "Jestřábí" village church ruine in the background) and Soviet army buildings became cores of spontaneous reforestration.
Photo : J. Kolejka

gradually become less pronounced and it is to be expected that the resulting water capacity of the area will be higher than before opening the MTF in 1937. This development is connected with the increase in number of species and individuals of hydrophilous plant and animal species. Different is the situation in terms of water quality, particularly that of underground water which was not studied to greater details. At interpreting the satellite photographs, registrated active dumps were classified as abiotic surfaces whilst hurriedly covered and planted dumps before dislocation of the Soviet army remind forest steppe formations. The both types od dumps should be given special attention in the future (Fig. 7).

5. Conclusion

The former MTFs represent areas which became a scene of unintentional experiments with nature. In them it is possible to demonstrate both the process of biodiversity recovery after original forms of anthropogenic pressure have been relieved or removed, and cases of enormous devastation of nature. A special case should be seen in spreading belligerent kinds of biota to the detriment of autochthonous species and spread of introduced kinds of biota. In all these cases we can observe vitality of natural forces and processes attempting at a new equilibrium in the environment. Thanks to diversity of human impacts into nature as well as to their different age, natural components can be found in different stages of development or regeneration. It is not possible to say that the measure of vegetation cover transformation is a precise measure of conversion of the locality. In contrast, it often happens that the most afflicted localities become -after some time- oases of high biodiversity be it not only of natural species, and centres of nature development in environment affected by the man (in this sense there is a parallel of presently protected ancient castle hills - for protection of once treated areas).

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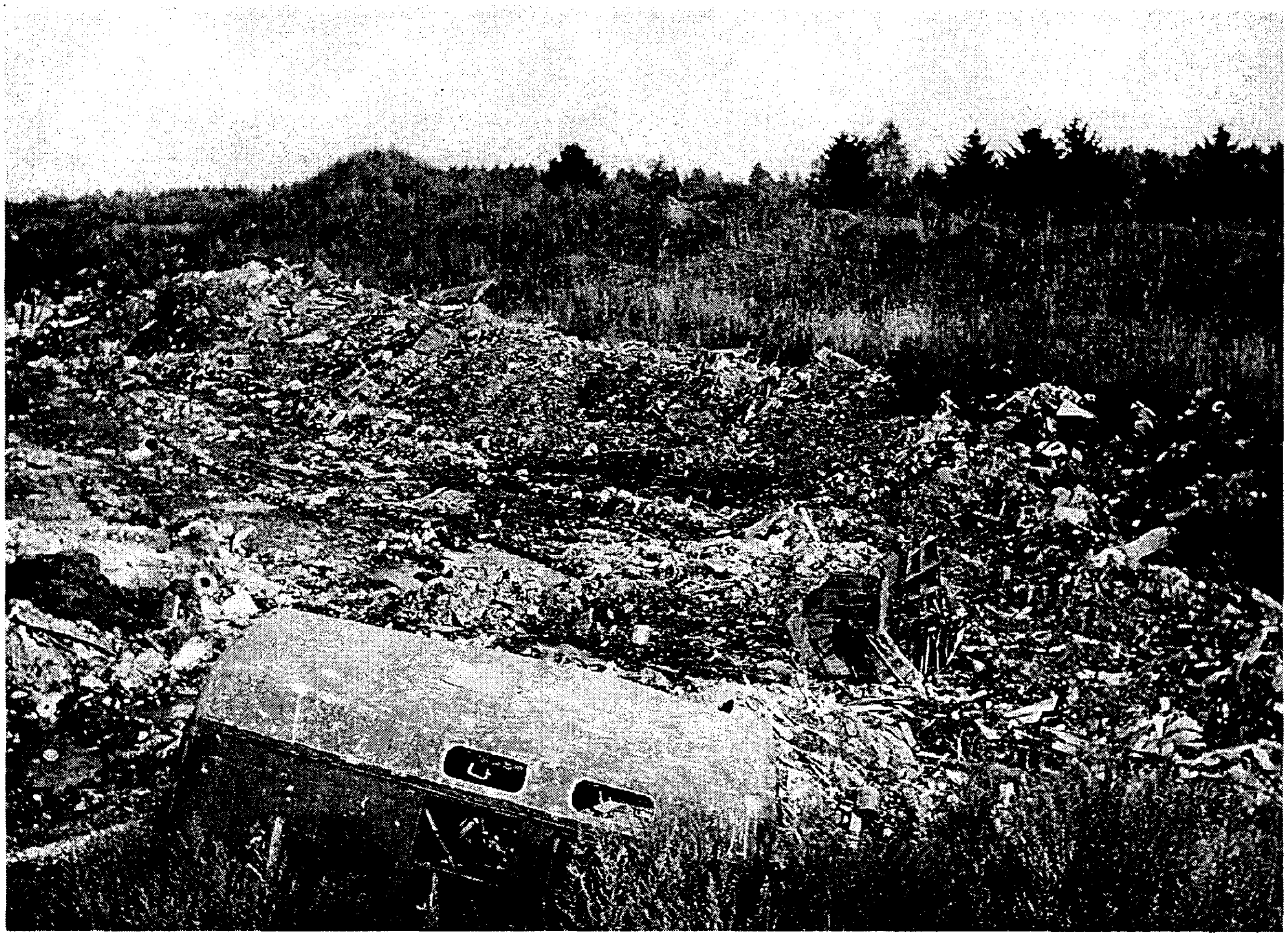

Fig. 7. Hidden parts of the Soviet army waste dumps with short conniferous stands and grass look naturally (in the background) and can be detected in the field only in the neighbourhoud of abandoned incovered dumps.
Photo : J. Kolejka

ences of the Czech Republic in České Budějovice, GIS Unit at the Department of Geography, University of Salford, United Kingdom and Canadian Centre of Remote Sensing at the Ministry of Natural Resources, Ottawa, Canada. Many enthusiastic workers of military forests and farms took part at collecting the supporting field data in all MTFs in the Czech Republic. Authors' recognition belongs to all of them.

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Table 1 : Territorial changes of the land use in the MTF Libavá between 1988 and 1992

cover type	percentage of the key site area					
	Nová Ves		Jestřábí		Milovany	
	1988	1992	1988	1992	1988	1992
intravillan forest	6.0	3.0	2.0	5.0	3.0	3.0
self-seeding forest	0.0	3.5	4.0	4.0	0.0	2.0
man-made forest	25.0	5.5	17.0	18.0	31.0	36.5
shrub stands	38.0	20.0	24.0	29.0	43.0	16.0
continuous herbaceous cover	17.5	35.0	17.0	11.0	9.0	30.0
discontinuous herbaceous cover	9.0	0.0	16.0	9.0	12.0	4.0
arable land	4.0	33.0	13.0	16.0	1.5	7.0
barren land	0.5	0.0	7.0	8.0	0.5	1.5

Explanations to the Fig. 3 and 4 :

A) FOREST STANDS
1 - intravillan forest
2 - self-seeding forest
3 - other forest
B) TRAINING FIELDS
4 - shrub stands
5 - continuous herbaceous cover
6 - discontinuous herbaceous cover
7 - barren land
C) AGRICULTURAL AREAS
8 - arable land
D) WATERS
9 - fish ponds

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A CONTRIBUTION TO THE RECONSTRUCTION OF WEATHER AND ENVIRONMENT IN CENTRAL EUROPE IN THE 16th CENTURY

Jan MUNZAR

Abstract

The first physico-geographical descriptions of larger towns include passages from Latin humanistic topographies from the mid-16th century. However, their praise to the location, healthy environment, climate, etc. for Olomouc, Louny or Prague is merely an irrealistic part of the standardized humanistic rhetorical model.

The hitherto oldest realistic course of weather in the territory of the Czech Republic for the concrete month or season originates from the SE Moravia for November 1533 and Autumn 1543 with the data being found for the period of 1533-1545. The course of weather and its socio-economic impacts apply for the year of 1555 and for the southern Bohemia. From 1588-1591 we then have a detailed weather characteristics of eleven months including its environmental impacts. Author of the characteristics was a Moravian noble man Karel of Žerotín. The work applies mainly to the district of Moravia (Náměšť nad Oslavou and surroundings) in July and August 1588, and/or in October and November 1591 (of Gregorian calendar) the data from Germany, where the author was trevelling.

Shrnutí

Příspěvek k rekonstrukci počasí a životního prostředí ve střední Evropě v 16. století.

K prvním fyzicko-geografickým popisům větších měst patří pasáže z latinských humanistických topografií od poloviny 16. století. Jejich chvála polohy, zdravého povětří, klimatu atd.pro Olomouc,Louny nebo Prahu je však pouze nerealistickou součástí standardizovaného humanistického retorického modelu.

Zatím nejstarší realistický popis průběhu počasí na území České republiky pro konkrétní měsíc nebo sezonu je z jihovýchodní Moravy pro listopad 1533 a podzim 1543, obsažený v záznamech z let 1533-1545. Průběh počasí celého roku a jeho socio-ekonomických impaktů je pro rok 1555 a jižní Čechy. Z let 1588-1591 se pak dochovala podrobná charakteristika počasí 11 vybraných měsíců a jejich dopadů na životní prostředí. Jejím autorem je moravský šlechtic Karel ze Žerotína. Týká se převážně Moravy (Náměšti nad Oslavou a okolí), v červenci a srpnu 1588, popřípadě v říjnu a listopadu 1591 však i Německa, kde pobýval na cestách.

Key words : historical weather, historical environment, 16th century, Central Europe

1. INTRODUCTION

The Committee for Historical Geography at the Historical Institute, Czech Academy of Sciences, Prague was re-established in 1991. One of its expert groups concentrated on historical ecology and historical development of environment (Boháč 1995, Semotanová 1995, Munzar 1995b).

Three years later, in August 1994, a meeting of the Committee on Historical Monitoring of Environmental Changes (Simmons and Mannion 1995) took place in the Czech Republic, linking up with the Regional Conference of International Geographical Union in Prague.

In March 1995, Prof. dr. J. Jacobeit and dr. R. Glaser organized a workshop on historical climatology at the Geographical Institute, University of Würzburg named Climatic Variations and Anomalies in Europe of the 16th Century, aimed at establishing closer cooperation among experts dealing with the issue as well as at coordination of both gradual compilation of data documenting climatic peculiarities of this period of time with relatively great climatic reversal changes in various parts of Europe, and the set-up of historical climatic maps and their synoptic interpretation in order to be able to look for similarities in the future development of weather and climate in Europe. This is a follow-up initiative to the long-term geographically motivated historical research of environment made by R. Glaser and his colleagues, which has up to now resulted in the first two volumes of meritorious and unique edition "Materials to the study of former environment". "The Home Chronicle of Hüsner Family of Wiesenbronn" was published as the first volume with records on economy, history, climate and geography of Mainfranken in the Main catchment area dating from 1750-1894 (Glaser-Schenk- Schröder 1991). The next volume was a monograph "Weather - Climate - Environment: Records and

Fig.1: Position of localities from the territory of Czech Republic in question.

Data from Franconia, Saxony, Saxony-Anhalt and Thuringia from 1500-1699" (Glaser-Militzer 1993).

To follow up with the above activities the paper aims at documenting the first more detailed information about weather and air in Central Europe of the 16th century as well as about their socio-economic impacts, and thus at contributing to the reconstruction of environment in this period.

2. COMMENDATION OF URBAN ENVIRONMENT IN HUMANIST DESCRIPTIONS

There is no doubt that one of the most detailed humanist descriptions of towns in the Czech Lands of the 16th century is a Latin poem "*Praise of Olomouc*" that was written by Simon Ennius Klatovsky and published in honour of the town council in 1550 (Bartocha 1946, Nešpor 1946). After describing location of this important Moravian town, the poem includes a passage about the cleanliness and usefulness of the River Morava which flows through the town and a separate section named "*Praise of the town for its mild climate*":

There is a particularly mild climate in our town, and the delicious air does good to all burghers, since the town has built all their abodes at a healthy place on the firm rock foundation. Winds soaked with poisonous vapours are forbidden here and the blow of plague will never be let in to enter. There has always been just a fine and healthy breeze and seldom any forbidding breath of infection..."

Other verses of the section speak of longevity of the local burghers, well-known doctors who can successfully cure town inhabitants in the case of harmful diseases, and famous drug-stores.

Another example of such a description is from the versed celebration of Louny, a town in Bohemia, "Descriptio urbis Lunae Boiemicae" originating from 1558 whose author is a humanist Martin Rakovsky from Rakov: ..."*There is probably no such a town in Bohemia with more pleasant and healthier climate. There are no harmful vapours here, neither moors, nor nasty smells. The soil is fertile, somewhat sandy, and always in the sun. The NW winds make the landscape very healthy.*" Similar praise can be heard about the towns of Prague from one of the first Czech botanists and a physician Adam Zálužanský from Zálužany in his calendar for 1596, who claims that "*they do good with their mildest and most excellent weather while being situated right in the middle of Bohemian Land near the Vltava River amidst vineyards and gardens*" (Hrudička 1930).

However, it is easy to assume that the commendations of towns as well as the praise of their climate, healthy air and other natural components of environment were usually not based on reality. They were simply a part of the model of poem or essay issued usually by local town council or at the expenses of local sponsors.

3. WEATHER IN MORAVIA (1533-1545)

The so far oldest systematic daily observations of weather in the territory of the Czech Republic date back to 1533-1545, and the experts succeeded in authorizitation of the records and their localizing in the southeastern Moravia, ie. in the present district of Uherské Hradiště (Munzar 1994, 1995a). The author -Jan of Kunovice (1482-1545) - was known to have made his observations regularly every day, but practically it was only in the period from the Autumn to Spring, data recorded in the warm half-a-year are usually missing. In spite of the fact that the weather character studies of longer periods counting several days are still rare, they can very well contribute to the reconstruction of climate in Central Europe in the 1st half of the 16th century (with the data of Julian calendar being respected):

November 1533_(southeastern Moravia)

The whole month was mild and moist up to the day 27. This was the date when a strong and very cold wind began to blow from the North.[original in Latin]

Autumn 1543 (southeastern Moravia)

There was no frost this year until the St. Wenceslas [28 October]. *After this date, there were some four harmless frosts and again a clean* [with no frost] *month till the St. Martin* [11 November]. *The severe winter began as late as on the Tuesday after the St. Martin* [13 November] *due to cold winds with rather big frosts. However, it did not last longer than till Saturday* [17 November], and there were again warm days with heavy and abundant rains and snow. There were also big and nasty waters [floods], and the heat lasts to this date, ie. 10 December, along with great and thick fogs [original in Czech].

4. WEATHER IN BOHEMIA (1555)

The first detailed description preserved for the course of the whole year is that of 1555 from southern Bohemia. Its author is a town scrivener in České Budějovice, Jan Petřík from Benešov, who lived in 1499-1559. With regard to his extraordinary character, we would like to cite him in full translation from the Czech original with explanatory notes in brackets:

"This year [1555] began - as it corresponds to its winter nature - with cold, frosts and big snows, as it was enough snow before the New Year as well. But then after Candlemas [2 February], the snow cover was off in such a way that it did not cause any floods.

The **Spring** began in the Lent [27 February - 13 April] very slowly, and people could easily sow the spring corn.

The **Summer** changed its character, and there were frequent rains and sudden rainstorms not being remembered. This is why unusual floods and losses were seen in many streams, which cannot be believed by everybody. Because in Benešov near Konopiště, there was such an unexpected big water that came in through the Pražská street above the hospital where there is no stream that the two loaded carriages of Rychnovsky carmen by the hospital were taken back and then tipped over so that three of their horses were drawned. The barrels and strong-boxes with glass were then found some near Bedrč - a quarter mile of Benešov, some in the village pond - both intact and broken. [Annalist J.F. Beckovský (1658-1725) mentioned the date of Ascension-Day, ie. 23 May]. Although the corn was of good growth in terms of straw, the grain was insufficient. Peas were growing up to beat any expectations, but little flies appeared on them when at bloom and did much harm. There was enough hay, although some was damaged by the floods, and enough second hay-crop, but much of it was damaged by frequent rains and was left on meadows.

The **Autumn** was very wet, it was impossible to either plough early nor sow because of the moisture, and that was why the sowing was made only around the St. Gallus [16 October] with both rye and wheat emerging and growing nicely though.

The **Winter** began in an unusual manner as it was always warm and wet and the people could not prepare wood for heating because of bad roads. There was no snow except the week before the St. Catherine [25 November] when a small snow fell but lasted not even four days. On Monday and Tuesday of Christmas Eve [23 and 24 December] and even several days before, the days were warm as if in the Autumn. In the night before the Christmas Day [24 / 25 December], the Moon was on long and the people going for the matutinal [Mass] could see it. But the sky was dull and there were no stars in sight. On Wednesday, the Christmas Day [25 December], the weather was clear, but dull as early as after the noon, and with such fogs arisen in the evening that you could hardly see the other side of the square. Weather was unstable the whole week and was changing every day: both clear and cloudy, snow, rain, hail stones, three times, four times a day and at night as well, as if it were the month of April. On Tuesday before the New Year,s Day [31 December], a wind and hails were on early in the morning, and snow and rain almost the whole day ..." [Köpl 1885].

The description by Petřík continued to 6 January 1556, and with regard to its details between 23 December 1555 and 6 January 1556 the observations are considered to be the oldest daily records preserved so

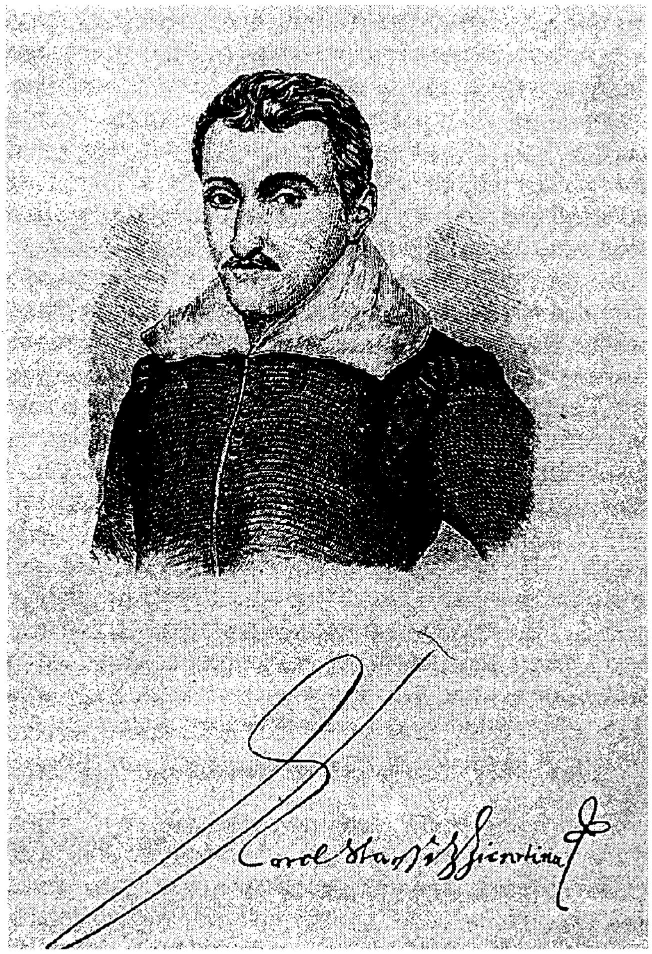

Fig.2: Karel of Žerotín (1564-1636) and his signature.

far in Bohemia (Brázdil-Kotyza 1995). The exceptional character of weather at the turn of 1555/1556 also at other places in Bohemia, Germany, Holland and Jutland call for further detailed regional analysis.

It is worth mentioning that a similar character of weather was confirmed in Germany, with a very warm period of several days around 2 February with following cold from 9 February that lasted 14 days (surroundings of Halle/S.). The unstable summer with rainstorms, floods and numerous damages is documented from the district of Eisenach. The warm, humid and unhealthy weather with occasional heavy fogs, winds and the ever clouded sky from the half of December 1555 was recorded in Saxony (Glaser-Militzer 1993).

5. WEATHER IN MORAVIA, BOHEMIA AND GERMANY (1588-1591)

The hitherto oldest weather records describing the weather situation in the territory of the Czech Republic in the course of the whole year by individual days were left by a Moravian nobleman Karel of Žerotín (1564-1636), one of the most educated representatives of his times. His entries are included in preserved diaries that were however of wider conception and included also social events and personal experience of the author. The observation in question took 524 days from 1 January 1588 to 15 April 1589 and from 14 April to 18 December 1591 of Gregorian Calendar (Zierotin 1590, 1887; Munzar 1984, 1992, 1996). As the author was travelling a lot, his data apply to many localities in South Moravia, Bohemia, Germany and Austria not to include episodical studies made in France from 11 to 29 September 1590.

Observations in 1588-1589 took a course of no less than 16 months and were practically uninterrupted because there are only data of two days missing in the whole lot. Meteorological records from 1591, however, do not apply to every day. In the first period of time, the majority of records was related to Žerotín,s residence at Náměšť nad Oslavou, then to Prague and to the German (88 days) and Austrian (10 days) territories. In the second period of the study, three quarters of the observations were focusing Bohemia and Moravia again with a centre of attention in Náměšť nad Oslavou. The rest was concentrated onto Germany in connection with Žerotín,s sailing along the Elbe towards the sea from where he was expected to continue to France. The records are in Latin (1588 and 1591) and in Czech (1589). Žerotín's comprehensive assessment of 11 months as a whole are very notable and important in order to learn the environment of those times :

January 1588 (Moravia: Náměšť nad Oslavou)

With an only exception of a few days, the whole month was very pleasant and bright as if it were Spring or Autumn. People say that such a weather and so mild has not been in this country many years. [Žerotín could not make a good judgement himself since he studied in foreign countries for nearly ten years.]

February 1588 (Moravia: Náměšť nad Oslavou)

This months was both colder and less pleasant than the previous one. More often we had snow, more often very severe winds were blowing, yet the frost was bearable, and rather milder than in other years. It surely did good not only to green corn that nearly died of drought due to the last month,s unusual warmth but also helped to clear the air [from plague infection].

March 1588 (Moravia: Náměšť nad Oslavou)

A colder beginning of this month brought harsh remainders of February and whole winter. Its kind end then seemed to smelling of Spring.

April 1588 (Moravia: Náměšť nad Oslavou)

What is expressed about the month of April in the proverb was evidenced again by changeability and diversity of this month. It was necessary to stand changing weather, there were rains after clear days and clear days after rains. It was particularly harmful with severe winds that were blowing almost continuously, partly from the North, partly from the South, and made the weather situation unstable and doubtful. The frequent rains and morning frosts did considerable harm to fruits and especially to wheat, namely at less fertile places which were made unfertile either by the nature or by negligence of farmers. [The assessment of April weather made more than 400 years ago is interesting both by having pointed out the meridional character of circulation and the fact that the April piece of weather-lore that Žerotín had in mind has not been preserved for us. It is perhaps wirth mentioning here an older entry about changeable April-like weather in December 1555 in the above description by Jan Petřík of Benešov from southern Bohemia].

July 1588 (Germany: Mansfeld-Magdeburg-Lüneburg-Lübeck-Hamburg)

This month, in other years very harmful by its oppressive heat, was of the least summer character this year. There was nearly no sultry weather at all, and only eight days were without rain with sun rays lightly dispersing finer clouds. Should this character of the month be ascribed to weather which was specific in this year, or to the location of these landscapes which are both swampy and maritime, I do not know. Nevertheless, I assume that earth moisture generates denser air which then gives rise to numerous clouds, and this could most probably be a cause to the changeability [of weather].

August 1588 (Germany: Bremen-Bamberg-Regensburg)

Also this month was very often a rainy one, no less than the preceding month. [Žerotín's data about July and August of 1588 in Germany or Austria favourably complement the German information of wet summer, low yields of grain and the consequential growth of prices in Hessen or Thuringia (Glaser-Militzer 1993).]

May 1591 (Moravia, partly Bohemia)

This month was very windy. It was not hot but bearable and mild. There was a big drought at the beginning and frequent and abundant rains at the end. Hoar frost did not harm the vineyards. Rains flooded the near meadows to make them unuseful this year. Corn appeared to be promising, with rich and well built ears but there is a fear that it might catch rot in the continual rains. There were [practically] no heats, and if so they were easily bearable.

June 1591 (Moravia: Náměšť nad Oslavou)

This month which is normally unpleasant because of excessive heat was almost chilly this year due to continuous rains and winds. At first, the weather was pleasant but did not last long. And although it was raining nearly without any stop, yet the soil suffered from such a strange drought that fields could be ploughed only with difficulties. It was most probably issuing of the fact that the heavy rains washed the earth surface without having got properly in, and if some water penetrated into the soil in some way supplying some moisture, the soil was immediately dried out by severe gusts of wind. All fruit crop was spoilt - either rotten due to the frequent and abundant rains or unripened due to cold. Vineyards suffered great losses as well, and although we do not fear that harvest will be insufficient, we think that there will not be enough sweetness and quality because the Sun does its duties only poorly this year. Among other, we have arrived at this conclusion because the grapes were in bloom late and therefore will certainly ripen late too. On the top of it, a certain kind of vine called Rivola in our language, of reddish colour, that gives splendid sweetness to wine has become entirely extinct. Grain was greatly abundant in the whole area with God,s help, and it could compensate for losses of the last year [1590]. The best harvest was in more cultivated and more fertile areas. God will endeavour that we use his gifts to his glory and do not misuse them. [A German source from the area North of Stuttgart confirms that it was raining steadily in the time of harvest, there was enough grain but it was soaked (Glaser-Militzer 1993).]

September 1591 (Moravia: Náměšť nad Oslavou)

The whole month was very pleasant and bright. Except for a couple of days when the weather was colder, the weather was remarkably mild which would have compensated for the unstable weather of preceding months if only the frosts would not have damaged the vineyards in this month thus taking from us all hopes for abundant crop and its high-grade and quality.

October 1591 (Moravia and Bohemia, Germany from 12 October: a trip on the Elbe River)

In its greater part this month was characterized by bright and pleasant days so that it really could be claimed that the Autumn has compensated for bad weather in the Summer with its kindness. However, it is uncertain whether it could have also compensated for losses caused by this summer weather namely in winegrowing districts, since we dwell in the North now where no wine is grown. [As to Žerotín's entries about the crop and quality of wine in Moravia or in winegrowing districts of Central Europe in general, records from the greater part of Germany confirm the year of 1591 not to be favourable for vintners. In spite of the fact that the yields were average or even sufficient, wine was acid due to the lack of warmth (Glaser-Militzer 1993).]

November 1591 (Germany: Hamburg and surroundings)

With great dislike I spent the whole month idling in Stade where I could not do anything else but carefully watch changes of winds as well as growing and shrinking of the Moon. [Žerotín and his companion had to wait for favourable wind to sail on the sea.]... And the entire delay would have been even more hateful should the whole month not have relieved my moodiness to some extent by its bright and dry weather. When I made myself tired by reading or writing in the house, I could refresh myself nearly every day by a walk, horse ride, carriage trip or similar entertainments thanks to favourable weather. [Žerotín's records about unfavourable wind for sailing to Normandy in order to lend a hand to the troops of French King Henry IV at besieging Rouen are scattered in both non-systematically arranged daily entries and his preserved letters from Stade that he wrote to his friends in many places in Europe in Latin, Italian and Czech (Rejchrtová 1982).]

6. CONCLUSION

The weather records from 1555 and 1588-1591 link up with the hitherto oldest preserved observations of Jan of Kunovice from the southeastern Moravia originating from 1533-1545, and extend out so far knowledge of weather, climate and environment in Central Europe in the 16th century to a considerable extent. They complement for the given years the so far most extensive reconstruction of historical weather for the northwestern Bohemia that was published by K. Pejml (1966) thirty years ago. The mentioned study includes only an entry on rainy and bad weather at the harvest time that lasted for many weeks in the summer of 1591, which has now been confirmed not only for the territory of Moravia but also for Germany (Glaser-Militzer 1993). It is worth mentioning the mild January of 1588 since some authors assess the 2nd half of the 16th century as a beginning of the Little Ice Age in Europe. It seems, however, that according to the so far knowledge, it is impossible to speak of any cooling trend in this period of time but rather of sudden weather reversals in the main seasons of the year.

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SOME REMARKS ON DIGITAL MAP PREPARATION

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1. Introduction

At the Institute of Information Processing of the Austrian Academy of Sciences, Department of Spatial Information Processing (former Institute of Cartography) the attempt was made to prepare digital information from Geographical Information Systems for printing with offset lithography. One of the main obstacles within the used low cost computing environment were severe differences in colors seen on a monitor and on color-proofs or prints. This problem concerns especially the reproduction of satellite image maps where the combination of three spectral bands displayed in 256 intensity levels of red, green, and blue produces theoretically 16.7 mill. different colors. In the past, these kind of images have been exposed to color positive film and then prepared like any other photograph for printing (BUCHROITHNER, 1987). The first aim was therefore the production of process color separation halftone screens from the digital GIS data within a PC environment using more or less standard software packages (BEISSMANN, 1994). This project was funded by the municipal authorities of Vienna.

Two examples from our very beginning of digital map preparation are enclosed to this article. We named the resulting products GISMAP because the printed maps are also available in digital form within a Geographical Information System. From this starting point up to now some new ideas had to be realized to meet the needs of some other projects, e.g.:

- the combination of raster and vector graphics, images, and manual fair drafts;
- the placement of names and symbols;
- the organization in layers - that means all themes are treated like hierarchical transparencies in a certain order of succession which determines the visibility or non-visibility of their graphical representation;
- the use of a color calibration tool for the "high fidelity" simulation of the printed colors on a monitor.

Now a GISMAP typically consists of one or more raster images combined with linear features and text in vector format and can therefore be called an "image-line map".

2. Description of enclosed GISMAP Examples

The **Multisensor Image Map of Vienna** (Appendix No.1) using Landsat-TM and SPOT-HRV data was the first attempt to solve the color problem. The data sources were bands 1, 2, and 3 of the Landsat/Thematic Mapper image from 2nd June 1984 with a ground resolution of 30 x 30 m and the SPOT/HRV image from 20th April 1988 with a ground resolution of 10 x 10 m. Both images had been rectified and resampled to a uniform ground resolution of 10 x 10 m which corresponds to a resolution of 0,1 mm in the map scale of 1:100.000. The digitally enhanced color composite from the 3 TM bands (band 3 in red, band 2 in green, and band 1 in blue - RGB color model) was transformed into the IHS (intensity-hue-saturation) color model. The intensity information was replaced with the slightly modified panchromatic band from SPOT and then transformed back into the RGB model. Frame, grid, legend, and text annotations have been added with commercial standard software (Corel Draw). At that time it was necessary for the typesetting process to rasterize all these elements for the a priori selected map resolution of 0,1 mm. This resulted in a rather poor quality of the printed text and was changed in the next GISMAP versions.

For the production of the **Map of Surface-Temperatures of Vienna**, (Appendix No.2) which belongs also to the first GISMAP-generation, the data source was band 6 (Thermal Infrared) of the Landsat/Thematic Mapper image from 2nd June 1984. The radiometric measurements of temperature recorded by the satellite depend on the heat radiation and emission capacity of a surface as well as the absorption and emission capacities of solid, fluid, and gaseous particles in the air between the surface and the measuring devices of the satellite. This leads to variations in the measured values; there is until now no fully satisfactory method for correcting these variations. It should also be noted that surface temperatures have to differ substantially from the ambient air temperature (as measured in a standardized cabin at 2 m above ground). The recording of surface temperatures of large areas by satellite permits the formulation of new research questions.

For the correction of Vienna's surface temperatures the calibration method of R.G. LATHROP and T.M. LILLESAND, 1987 was used. This method is particularly useful when the focus of interest is not the precise surface temperatures of an object but rather the relative differences of their spatial distribution. The temperatures computed in degrees Celsius were filtered digitally according to their spatial frequencies (which produces a smoothing effect), then pseudo-color, frame, grid, legend and text were added.

Of the manifold possibilities of interpretation we would like to mention only the influence of different land uses on the local climate on a typical day at the height of summer. Twelve different classes of land use have been derived by classification of the Thematic Mapper image, interpretation of airborne imagery and field mapping. Some classes are relatively homogeneous and easily discernible, while others are rather inhomogenous and strongly interrelated (i.e. a loosely built-up area intermixed with parks). Thus the new housing areas on Vienna's periphery were classified as "loosely built-up" because their relatively high population density is offset by the intermixing of parks and garden areas. The surface temperatures indicate that these green areas have indeed an adequate beneficial effect on the local climate. Densely built-up areas, large objects such as industrial plants or roads and squares, as well as construction sites can be localized as hot spots. Harvested agricultural areas are characterized by a negative thermal effect; beneficial thermal effects are provided by areas covered with vegetation, forests, and bodies of water.

The thermal image permits even the evaluation of the effect on the local climate of inner-city parks. Their size and make-up has a significant impact on the difference of temperature in comparison to the surrounding built-up areas. Differences of 5° C and more cause the development of a local wind system which results in the local exchange of warm and dry with cool and humid air; thus the higher humidity of the park is carried into surrounding built-up area.

3. Preparation for color printing

The next step within the preparation process for printing for both maps was the conversion from the digital working environment of map preparation - including the visualization on a computer monitor with the underlying additive RGB color model - into the working environment of offset lithography using the subtractive color model. Some more details are given in this paragraph.

The visible spectrum contains about 10 mill. discernible colors. Only about 1.2 mill. colors are surface colors; 48 % of these can be printed using 4 process colors. If 7 process colors are allowed the quota rises to 57 % (SCHLÄPFER, 1993). Every device for producing a color illustration reproduces a different range of color which is called the "gamut" of the device. It should be noted that it is impossible to get the same colors in print exactly as seen on the monitor. When "true" color prints of an image are required it is necessary to consider a lot of influences and to perform extensive calibrations so that acceptable fidelity is obtained. In 1931, an effort was made by the Commission Internationale de l'Eclairage (CIE) to build a model defining the range of visible colors. The so-called chromaticity diagram is a two-dimensional plot with a third axis, the luminance, which corresponds to the panchromatic brightness. The other two primaries, called x and y, are always positive and combine to define any color - omitting individual and subjective variations - a so-called standard observer can see. One of the drawbacks of the CIE diagram is that it does not indicate the variation in color that can be discerned by the eye. Sometimes this is shown by plotting a series of ellipses (instead of circles) on the diagram.

The original model and the underlying colorimetric relationships expressed in mathematical terms have been modified several times. In 1967 the CIE L*a*b model was developed which serves as an internationally used device independent reference model. "L" describes a luminance or brightness component whereas "a" (reaching from green to red) and "b" (reaching from blue to yellow) describe chromatic components. The conversion between different color spaces usually is done by means of lookup tables which are also provided in several commercial software packages such as Adobe Photoshop.

Video technology uses three color phosphors (RGB) to generate a very large fraction of the total range of colors that the human eye can see. The colors are simulated by the combination of varying intensities of the three wavelengths. The "missing colors" that cannot be generated using these particular phosphors include the most saturated colors, also pure cyan or yellow cannot be displayed correctly on a monitor. Variations between devices may be caused by influences of mask or phosphors; thus, even within one individual device, color representation can vary. The natural aging process of the phosphor coating of the monitor and external factors, such as changes in temperature, affects the colors displayed on the screen over time.

As the CIE standard allows reference to the wavelength of colors, a spectrophotometric calibration of computer displays is possible. A calibration tool allows color-calibrating the graphics system by means of an electronic sensor which is attached with a suction cup to the monitor screen. The calibration software evaluates the data measured by the sensor and accordingly calibrates the hardware (color temperature, system gamma, ambient lighting conditions). Considering a lot of some other parameters like type of inks used for printing, paper quality and finish, half tone dot gain of the used printing press and many more, it is possible to simulate the printed colors on the monitor.

Printing uses the subtractive color mixture by deposing several color inks on paper. These inks absorb and reflect light - we perceive the reflected light as different colors. To guarantee the printing of a considerable high amount of colors with a tolerable amount of economic expense, usually three or four standardized printing inks (cyan - C, magenta - M, yellow - Y, black - K) are used and called process-colors. Except for dye-sublimation technology continuous-tone images have to be broken up (separated) for printing into varying sized dots for each process color and any spot color ink. The pattern of dots is called a halftone screen; by printing overlapping dots the possible range of colors is simulated. In terms of the subtractive color space the blank paper starts off as non-ideal white and the addition of inks removes the complementary colors from the reflected light. To create blue for example, cyan (which absorbs red and reflects blue and green) and magenta (which absorbs green and reflects blue and red) dots are combined. The human eye merges the dots to perceive the color blue, which has very little in common with the blue displayed on a monitor. Using standardized cyan, magenta and yellow ink a large portion of the color space is omitted, causing a small gamut of mostly rather unsaturated colors. Especially blue and purple hues are represented rather unsatisfactorily. In fact, this is one of the major problems with color printing, which has difficulty producing strong, vibrant colors. Non-printable colors have to be transformed (usually by reduction of saturation) for printing.

In addition, the colors depend critically on a lot of parameters:

- *Viewing conditions*: Changing the room light will slightly alter the visual appearance of colors on a RGB monitor, but because the monitor is generating its own illumination this is a secondary effect. Since a print is viewed by reflected light only, changing the amount or color temperature of room light can completely alter the appearance of the image. The color temperatures of incandescent bulbs, fluorescent bulbs, direct sunlight, or open sky are all quite different. It is necessary to select for the display on monitor the color temperature and the brightness of the light source which normally illuminates the printout.

- *Black generation:* The mixture of all three colors (CMY) cannot produce a very good black, but instead gives a muddy grayish brown. The most common solution is to add a separate, black ink (K) to the printing process. This reduces the need for large amounts of colored inks, the thickness of ink buildup on the page and it allows dark colors to be printed without appearing muddy. Rules to calculate how much black to put into various color representations depend mainly on visual response to colors, the kind of paper to be printed, the illumination the print will be viewed with, and even the contents of the image. Algorithms for converting from CMY to CMYK specify levels of undercolor removal (UCR) and gray component replacement (GCR) which are essentially arbitrary, little documented and vary considerably from one software program to another. The general approach is to use the darkest value of the three components to determine the amount of black to be added. It is difficult to design algorithms for these substitutions that do not cause color shifts. Also, the substitutions do not work equally well for printing with different combinations of ink, paper finish, etc.
- *Total ink limit:* The addition of black ink to CMY may cause the problem that there can be too much ink on the page. Depending on the paper quality, the printing press, and many other influencing factors, the recommendations for the maximum ink coverage differ between 180 % to 320 % so that the paper does not become oversaturated and stretch or tear. Otherwise multicolor jobs tend to print out of register. This would cause three problems: slight gaps between overlapping colors, moiré patterns and color shifts. To minimize the effects of misregistration adjacent colors are slightly overprinted (trapping).
- *Halftone dot gain:* The overall quality of the print is also influenced by the halftone dot gain. One problem could be a miscalibrated image setter, but many other processes affect the size of printed halftone dots. Typically, dots increase in size during printing. If to much dot gain occurs, images plug up and colors print darker than specified. As the dot gain differs between the process colors gray balance can be lost. It is important to know the behavior of paper and printing press to correct this effect within the digital data in advance.

It is not only color which needs to be considered as a challenge within the production process of a GISMAP. In fact, one has to consider some more influencing factors:

- *Screen ruling:* The decision for a certain screen ruling (also called halftone or screen frequency, halftone cell) defines the size of the halftone cells that make up the printed image. Screen ruling is measured in lines per inch or the number of halftone dots in a row one inch long. A high screen ruling prints the dots close together creating sharp distinct colors and images. A low screen ruling prints the dots farther apart, creating a coarser effect. Because different types of paper absorb ink differently, the characteristics of paper and printing press determine the screen ruling to be used; for the GISMAP example it was 60 lines per cm (152 lpi).
- *Screen angle:* The halftone screen for each process color ink is printed at a specific angle so that the ink dots do not print on top of each other. They form a symmetrical pattern, called a rosette pattern, which the human eye merges into smooth color gradations. If the rosette pattern is not printed correctly, a so-called moiré pattern appears which disrupts the perception of smooth color gradations. But even ideal screen angles cause some of the dots to be superimposed on each other. Since some inks are partially transparent, this can produce various color biases depending on the order of printing. Several screening technology solutions address this problem. New developments in this area, especially the frequency-modulated screening solutions, promise better results.
- *Resolution of image setter:* The resolution of the image setter is the number of tiny black dots that can be deposited on film to form halftone dots, characters and lines. Within this halftone cell, some or all of the dots may actually be printed. Where no dot is printed, the paper shows through. If the cell is reasonably small, the observer will

not see the individual dots but will instead visually average the amount of dark ink and light paper to form a grayscale or process color. To print a visually convincing halftone image it is necessary to print more than 140 shades of gray (color) so that the halftone cell is composed by an array of 12 x 12 image setter dots in the minimum. Generally, the rule for the maximum number of grayscales available is (printer resolution/screen ruling)2 + 1. The resolution of a professional image setter is required to be 2540 dpi or more. This resolution causes a screen ruling of only 158 dpi when halftone dots with 256 gradations (16 x 16 array) are exposed.

- *Scan resolution:* The last factor mentioned here influencing the preparation for printing is the required resolution for scanning the image to be printed. The rule for the desired scanning resolution is screen ruling x 2 to 2.5 if the image will not be resized. As mentioned above, the resolution of the GISMAPs is 100 dots per cm. Following the rule it should have been 120 to 150 dots per cm to receive the best possible quality.

4. Concluding remarks

As described, the enclosed GISMAPs of the first generation have been our starting point of digital map preparation, which is not a kind of desktop mapping system but suitable for the preparation of image-line maps. Many of the mentioned problems have been solved in expensive commercial systems some time ago. The low cost computing environment we used was occasionally a limiting factor because it was often necessary to find a compromise between available disk space, memory and achieved quality in printing. At present, most of the necessary software tools are offered by commercial packages. The described way of map production should be applicable for anyone who is interested in; nevertheless, we think that satisfactory results cannot be achieved without a certain level of personal experience.

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Spatial aspects of the 1994 elections for the National Council of the Slovak Republic

Peter Mariot

1. Introduction

Irregular elections to the National Council of the Slovak Republic (SR) held in Sept. 30 - Oct. 10, 1994 provided the specialists of various sciences dealing with the results of political preferences of constituency with another and very valuable set of exact data. Contrary to the first elections to the Slovak National Council realized in the socio-economic conditions at the beginning of 1990, the 1994 elections occurred in a completely new interial political situation.

The overall enthusiasm of the first elections in summer of 1990 manifested in pleasant sensations of the majority of the population of Slovakia evoked by the hope that a more democratic, economically better ruled or more human system than the one that was so ostentatiously abandoned by the then common decisive forces of the Czech and Slovak political scene would be established. In the autumn of 1994, the population of Slovakia was divided under several political signs adopting often antagonistic attitudes.

A relatively large part of the population responded to this fact politic apathy. In comparison to the elections of 1990, in the autumn of 1994 the largest number of voters were registered but participation at the elections was lowest (Table 1.) was thus confirmed. The decreasing interest of the population to participate at the elections with a stable spatial macrostructure. The lowest interest in the elections was in all three cases found in Bratislava, where negative divergences from the national average grew from the initial 1.78 (1990) to 7.25 (1992) and/or to 9.93 % (1994). However, differences between the participation of population in extra-Bratislavian electoral districts are growing as well (0.15, 2.11 % and/or 3.44 %).

Table 1 Comparison of the participation in elections in 1990, 1992, 1994

Year	Total voters (registered)	Participation for the SR	Regions			
			Bratislava	West	Centre	East
		(%)	(%)	(%)	(%)	(%)
1990	3 622 650	93.25	91.47	93.48	93.39	93.33
1992	3 770 073	81.76	74.51	82.81	83.31	81.20
1994	3 876 555	75.65	65.72	76.49	78.41	74.97

Out of 17 parties, movements, and coalitions participating in the 1994 elections, the following seven subjects made their way to the Parliament, passing over the limit of 5 %.

- coalition Movement for Democratic Slovakia (HZDS) and the Agrarian Party of Slovakia (RSS) - leader Vladimír Mečiar,
- coalition Common Choice (SV) formed by the Left Democratic Party (SDĽ), Social Democratic Party of Slovakia (SDSS) Party of the Greens in Slovakia (SZS), Movement of farmers of the Slovak Republic (HP SR) - leader Peter Weiss,

- Hungarian Coalition (MK) consisting of the movement Coexistence (ESWS), Hungarian Christian Democratic Movement (MKDH), Hungarian Civic Party (MOS) - leader Béla Bugár, Miklós Duray,
- Christian Democratic Movement (KDH) - leader Ján Čarnogurský,
- Democratic Union of Slovakia (DÚ) - leader Jozef Moravčík,
- Association of the Workers of Slovakia (ZRS) - leader Ján Ľupták,
- Slovak National Party - leader Ján Slota.

Note: After the elections, a coalition of HZDS, ZRS and SNS was created.

Complete results of the elections are presented in Table 2.

Table 2 Results of the elections to the National Council of the SR realized on Sept. 30 and Oct. 10 of 1994

	No.	Obtained absolute	votes %
Movement for the prospering Czecho-Slovakia (HZPČS)	1	30 292	1.05
Social Democracy (SD)	2	7 121	0.24
Association of the Workers of Slovakia (ZRS)	3	211 321	7.34
Hungarian Coalition (MK) MKDH, ESWS, MOS	4	292 936	10.18
Coalition Common Choice (SV) SDĽ, SDSS, SZS, HP, SR	5	299 496	10.41
Democratic Union of Slovakia (DÚ)	6	246 444	8.57
Party against Corruption (SPK)	7	37 929	1.31
Association for the Republic - Republicans (ZPR-REP)	8	1 410	0.04
Democratic Party (DS)	9	98 555	3.42
New Slovakia (NS)	11	38 369	1.33
Communist Party of Slovakia (KSS)	12	78 419	2.72
Romany Civic Iniciative in the SR (OISR)	13	19 542	0.77
Slovak National Party (SNS)	14	155 359	5.40
Christian Democratic Movement (KDH)	15	289 987	10.08
Coalition Movement for Democratic Slovakia (HZDS) and the Agrarian Party of Slovakia (RSS)	16	1 005 488	34.96
Christian Social Union of Slovakia (KSÚ)	17	59 217	2.05
Real Socio-Democratic Party of the Slovaks (RSDSS)	18	3 573	0.13
Total		2 875 458	100.00

The elections to the National Council of the SR in the autumn 1994 confirmed that the results of the parliamentary elections realized in Slovakia in the years 1990, 1992 and 1994 can be expressed by a relatively simple model of the system of electoral preference of political subjects. From system contains this view the point of stability, two fixed elements (a triumphant political subject + political subject representing the interests of the Hungarian minority) and 3-4 unstable elements (political subjects lacking the preference of the triumphant subject but capable of obtaining more than 5 % of total votes). We suppose that this relatively simple scheme of the model of political preferences subjects at the parliamentary elections in Slovakia is more interesting for the politologists. Geographical research concentrated upon its territorial aspects.

2. A Model of electoral preferences

In our contribution we realized the analyses on the level of districts of the Slovak Republic. For each of the three studies elections to the Slovak Parliament we considered the political subjects that obtained the number of votes sufficient to pass the limit of 5 % valid votes.

The position of a victorious political subject was occupied by the Public Against Violence in 1990 (VPN - 29.3 % valid votes). Another stable element of the model of the electoral preference in Slovakia was the coalition of Coexistence (ESWS - 8.6 %). The group of unstable elements was represented by the Christian Democratic Movement (KDH - 19.2 %), the Slovak National Party (SNS - 13.9 %) and the Communist Party of Slovakia (KSS - 13.3 %). The remaining subjects left outside the Parliament obtained a total of 15.7 % votes. Regarding a relatively low profit of the victorious party, VPN had to share its majority with other political subjects in all districts of the SR. It was mostly KDH that obtained a relative majority in three districts of the SR (Dolný Kubín, Stará Ľubovňa, and Humenné). The same success was achieved by SNS in the districts of Považská Bystrica, Žilina and Žiar nad Hronom. However, the absolute majority was obtained only by ESWS in the districts of Dunajská Streda and Komárno.

In spite of the comparably high share votes obtained in the 1990 elections by KDH, the next elections held in two years, time showed that it lacked a firm basis. On the other side, the two stable elements of our model confirmed their special position. Position of the leading political subjects passed to the Movement for Democratic Slovakia (37.3 %) choosing the voters a partner for it that ensured an absolute majority in the Party of the Democratic Left (14.7 %), and a secondary partner in the Christian Democratic Movement (8.9 %). While the Slovak National Party (7.9 %) has almost disappeared from the political scene, the Hungarian coalition (7.4 %) confirmed the stability of the regional picture of its preferences in the southern boundary part of the SR. An increased dispersion of the constituency documents the fact that a total of 23. 8 % of votes was consumed by the parties that did not pass the limit of 5 % of votes.

Acceptability of the model of the electoral preferences of the population of the SR is confirmed also by the results of the elections to the National Council of the SR, realized in autumn 1994. The function of stable elements of the model was preserved by the same political subject as in 1992. HZDS has unequivocally proved its position of a leading political force (34.9 votes) capable of obtaining an absolute majority in some regions of the SR (except the two districts ruled by the MK) and participating at the formation of relative majority in whole Slovakia. The partners of HZDS from among the unstable elements of the model were replaced and their number has been increased by new subjects (Democratic Union, Association of the workers of Slovakia).

3. Territorial aspects of the results of the 1994 elections

A spatial picture of the HZDS preference (Fig. 1) is characterized by a relatively strong representation of voters from this Movement over the whole territory of Slovakia. The core of its support is in the western part of Central Slovakia (districts of Čadca, Žilina, Považská Bystrica, Prievidza, Topoľčany and Žiar nad Hronom), where the Movement won an absolute majority of votes in the both parliamentary elections. Also in the districts surrounding this core area, there is a relatively strong interest in HZDS contributing to the expansion of the area of the main supporting region. In the elections 1994 another core of preference of HZDS originated in the northeastern tip of the SR (districts of Svidník, Vranov nad Topľou, Michalovce, Humenné). It was here where the HZDS obtained the votes of voters who preferred SDĽ or KDH in the previous elections.

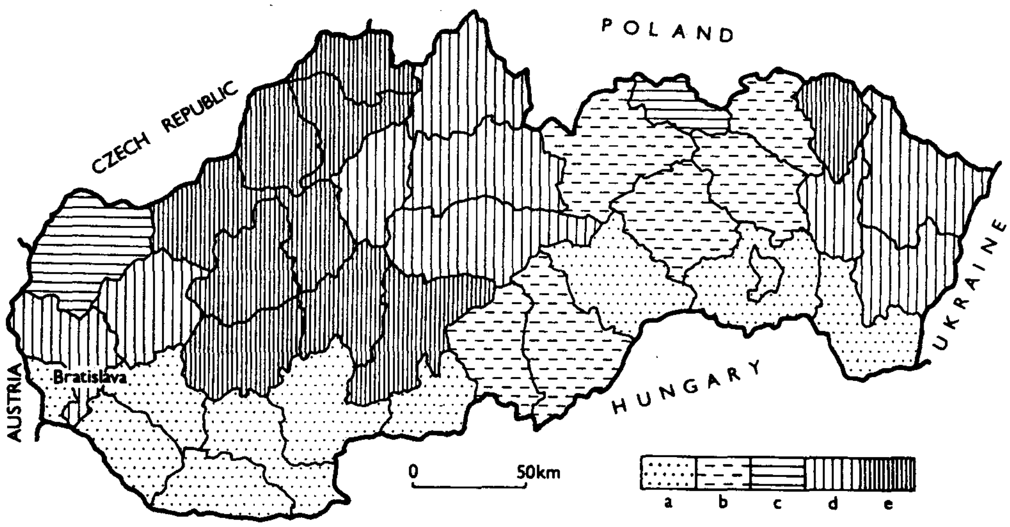

Fig. 1 Preference given to the Movement for Democratic Slovakia (HZDS) of national average of 34.96 % votes, the Movement for Democratic Slovakia achieved following percentages of votes in individual districts of Slovak Republic: a - up to 74.9 %, b - 75.0 to 94.9 %, c - 95.0 to 104.9 %, d - 105.0 to 124.9 %, e - 125% and more.

Also for the coalition Common Choice the main source of votes was one party - SDĽ. But the 1994 elections were a minor success for this subject, as in comparison to 1992, it lost 4 % of the voters. The most important reason of this loss is a substantial drop of the support of SDĽ at the districts of the Eastern Slovakian electoral area (from 21.45 % to 12.62 %). This drop was represented for instance in the district of Svidník by 19 % and by 15.5 % and 11.7 % in Humenné and Michalovce districts respectively. However, not even this fact has changed the principal features of the spatial picture of the preference of SDĽ in Slovakia.

The core region of this support (Fig. 2) remains the Eastern Slovakian constituency though differences in the intensity of equalled this support equalled the remaining territory of Slovakia. The most stable part of this region appears to be the district of Rožňava (its northern part) where SDĽ regularly obtains the position of the strongest party. New feature of the spatial picture of preference of SDĽ in Slovakia after 1994 is an increase in relative significance of the westernmost districts (Larger Bratislava, Senica, Trnava, Trenčín) and the largest cities of the SR (Bratislava, Košice) in formation of new areas of relative preference of SDĽ. Meanwhile, the district of Senica is the only district of Slovakia where SDĽ experienced in 1992-1994 an increase of votes (by 0.7 %).

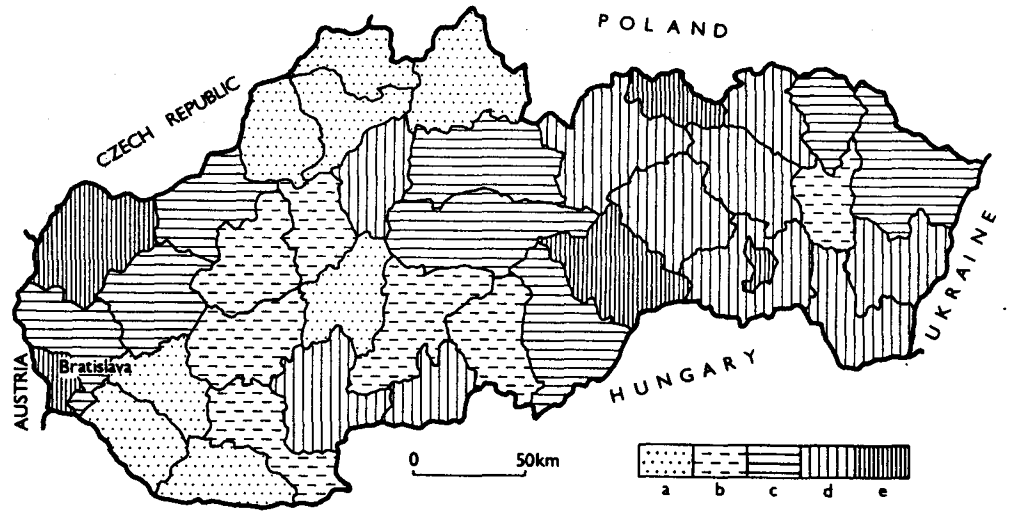

Fig. 2 Preference given to the coalition Common Choice (SV). Of the total Slovak average (10.41 %) the SV obtained following shares in individual districts of the SR: a - up to 74.9 %, b - 75.0 to 94.9 %, c - 95.0 to 104.9 %, d - 105.0 to 124.9 %, e - 125 % and more.

The Hungarian coalition (MK) proved again in the 1994 elections that it can unity all inhabitants of Hungarian nationality with the right to vote regardless of their social rank, education, age, size of the commune the voter lives in, etc. It is confirmed also by the comparison of the data on percentage of the inhabitants of Hungarian nationality (including the ones not entitled to vote) in southern districts of the SR - Table 3.

Table 3 Comparison of the share of MK votes and the share of the inhabitants of Hungarian nationality in southern districts of the SR

District	Share of the votes given to MK in 1994	Share of the inhabitants of Hungarian nationality (1991)
Bratislava-Province	6.29	7.24
Dunajská Streda	83.20	87.16
Galanta	42.09	42.80
Nitra	6.08	6.76
Komárno	71.05	72.16
Nové Zámky	39.89	41.53
Levice	29.59	31.62
Veľký Krtíš	28.97	60.64
Lučenec	18.96	23.77
Rimavská Sobota	40.97	46.08
Rožňava	23.04	23.04
Košice-Province	16.83	16.83
Trebišov	34.41	34.41

Thanks to high electoral discipline of the voters of Hungarian nationality, MK obtained the best result in the 1994 election (10.18 % of votes). Although only 2.76 % more voters voted MK than in 1992 (and 1.52 % more than in 1990), nevertheless at the regional core of the preference of this coalition (Fig. 3) the share of MK votes in 1992-1994 grew more

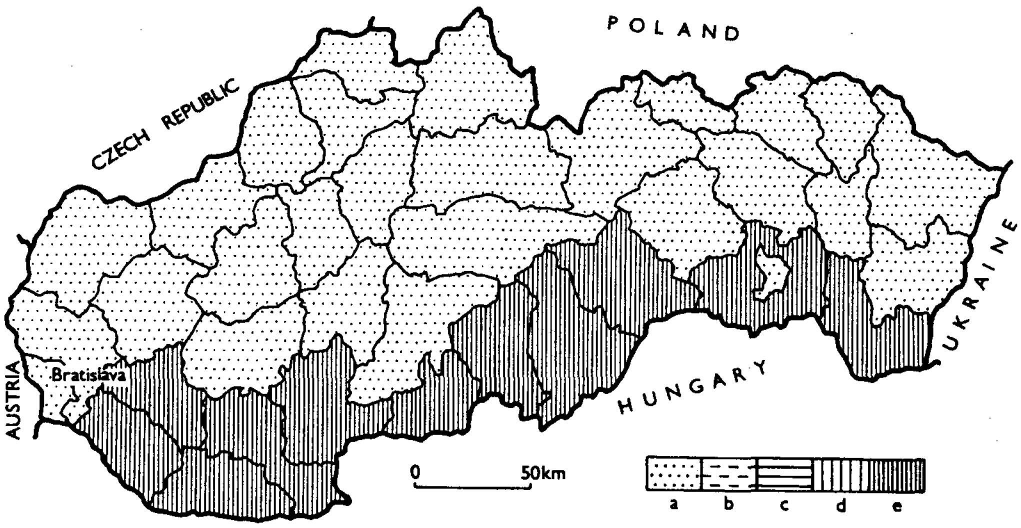

Fig. 3 Preference given to the Hungarian Coalition (MK). Of the total Slovak average (10.18 %) the MK obtained following shares in individual districts of the SR: a - up to 74.9 %, b - 75.0 to 94.9 %, c - 95.0 to 104.9%, d - 105.0 to 124.9 %, e - 125 % and more.

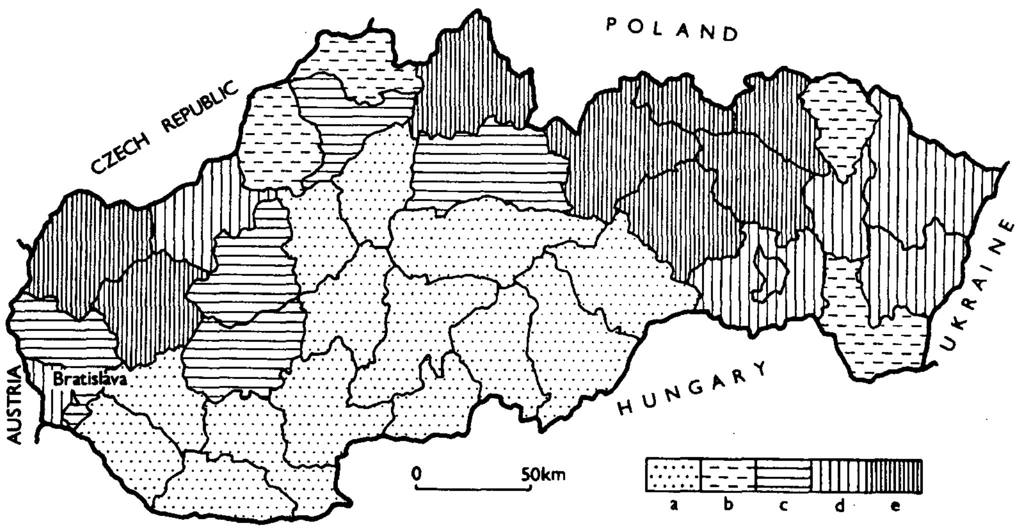

Fig. 4 Preference given to the Christian Democratic Movement (KDH). Of the total Slovak average (10.08 %) the KDH obtained following shares in individual districts of the SR: a - up to 74.9 %, b - 75.0 to 94.9 %, c - 95.0 to 104.9 %, d - 105.0 to 124.9 %, e - 125 % and more.

significantly (in the districts of Dunajská Streda by 25.4 %, Komárno by 16.8 %, Galanta by 12.0 %).

In 1994 the Christian-Democratic Movement (KDH) joined political subjects that obtained higher share of votes (by 1.2 %) compared to 1992. Meanwhile, the core areas of this support were gaining their definite from and it stabilized in three regions (Fig. 4). An area with the most intensive support is the district of Dolný Kubín, that -- as the only one of the districts belonging to substantially broader area in the northwestern Slovakia --- preserved the priority preferences of KDH in all three ballots. However, the intensity of the support in 1994 reached only 50 % of votes given to this Movement in 1990.

Although the Democratic Union (DU) - another political subject that entered the National Council of the SR in 1994 -- originated only in the course of the 1994, after 8 deputies left the political club of HZDS, in the course of their relations with HZDS degenerated to such degree electoral campaign that the DU became the most distinct adversary of the HZDS. The same process took place also among the sympathizing votes on both sides and consequently the preference regions of DU are almost identical with

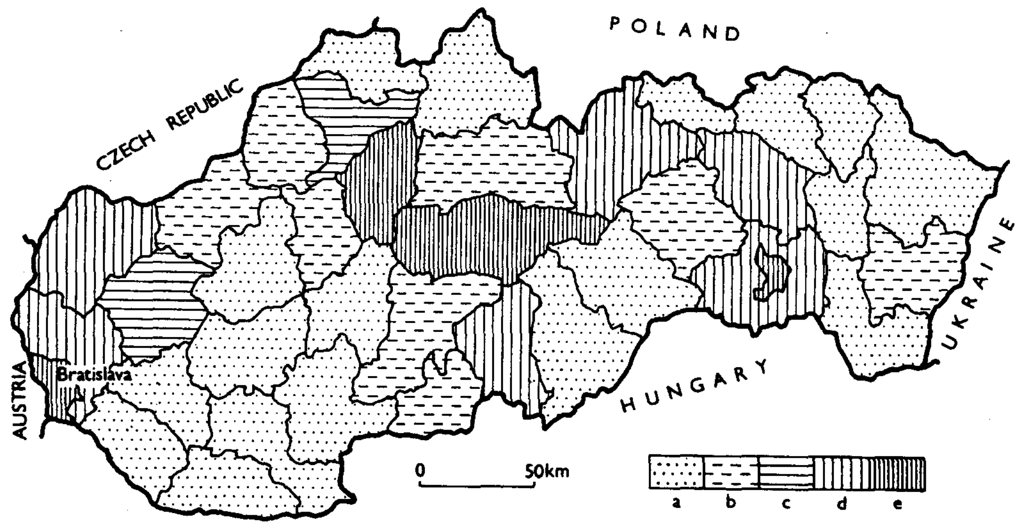

Fig. 5 Preference given to the Democratic Union of Slovakia (DU). Of the total Slovak average (8.57 %) the DU obtained following shares in individual districts of the SR: a - up to 74.9 %, b - 75.0 to 94.9 %, c - 95.0 to 104.9 %, d - 105.0 to 124.9 %, e - 125 % and more.

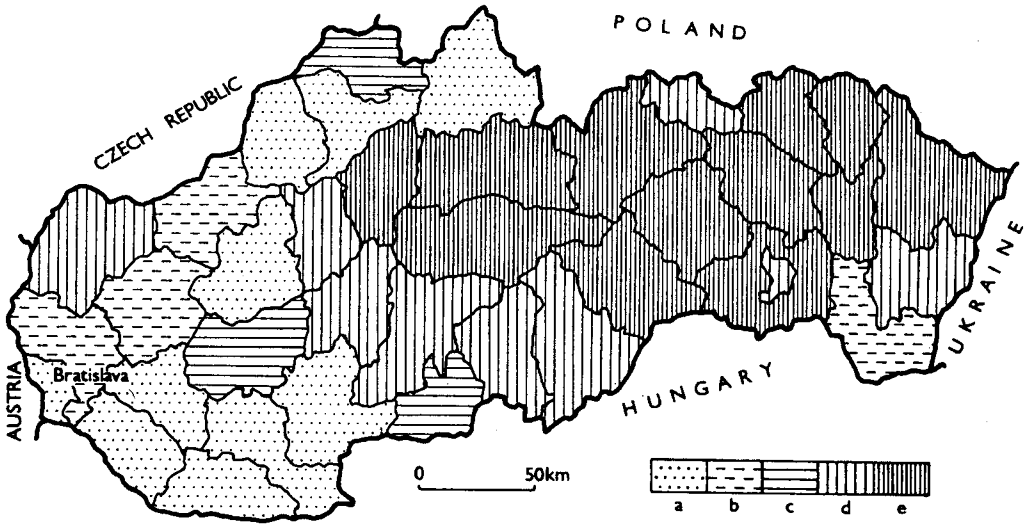

Fig. 6 Preference given to the Association of the workers of Slovakia (ZRS). Of the total Slovak average (7.34%) the ZRS obtained the following shares in individual districts of the SR: a - up to 74.9 %, b - 75.0 to 94.9 %, c - 95.0 to 104.9 %, d - 105.0 to 124.9 %, e - 125 % and more.

the regions of the lowest support to HZDS and vice versa. This is also confirmed by comparing Figs. 2 and 5.

Similary to the DU, also the Association of the Workers of Slovakia (ZRS) was constituted only before the 1994 elections and represented an alternative to the older SDĽ. Their first appearance on the Slovak political scene revealed that they are a party building on support of the voters of the eastern part of the SR (Fig. 6). In this region it played almost the same role as the SDĽ,,or in some district it even won over its leftest rival (Spišská Nová ves, Svidník, Vranov n. T., Humenné). The ZRS reached success in the traditional centers of support to SDĽ, and was considerably less successful in the western Slovakia. The great majority of its votes were given to it, naturally, by workers and vocationally trained individuals.

If we denote the ZRS a party finding support in the eastern part of the SR, then the Slovak National Party (SNS) can be, using the same criterion, characterized as the one supported by the voters in the western part of Slovakia (Fig. 7). It surpassed the limit necessary for the entry to the National Council of the SR only by 11 586 votes, especially because of an increased support given to it by inhabitants of Bratislava (13.7 % of the

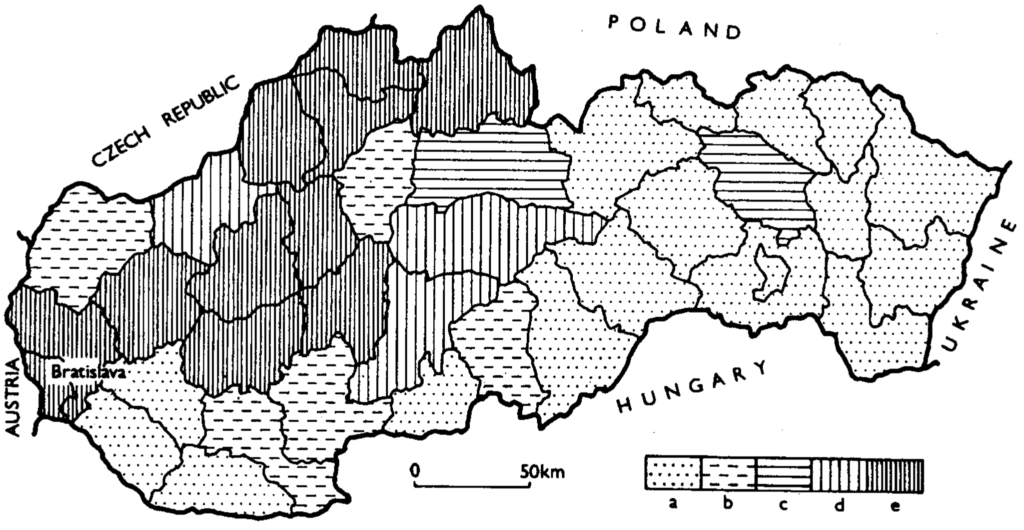

Fig. 7 Preference given to the Slovak National Party (SNS). Of the total Slovak average (5.40 %) the SNS obtained following shares in individual districts of the SR: a - up to 74.9 %, b - 75.0 to 94.9 %, c - 95.0 to 104.9 %, d - 105.0 to 124.9 %, e - 125 % and more.

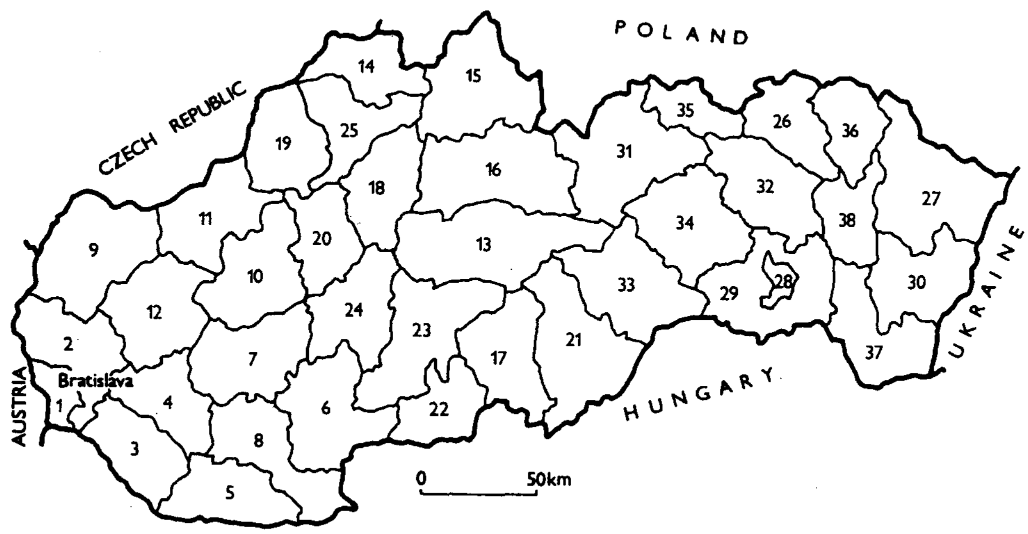

Fig. 8 Districts of the Slovak Republic in 1994. 1 - Bratislava, 2 - Bratislava Province, 3 - Dunajská Streda, 4 - Galanta, 5 - Komárno, 6 - Levice, 7 - Nitra, 8 - Nové Zámky, 9 - Senica, 10 - Topoľčany, 11 - Trenčín, 12 - Trnava, 13 - Banská Bystrica, 14 - Čadca, 15 - Dolný Kubín, 16 - Liptovský Mikuláš, 17 - Lučenec, 18 - Martin, 19 - Považská Bystrica, 20 - Prievidza, 21 - Rimavská Sobota, 22 - Veľký Krtíš, 23 - Zvolen, 24 - Žiar nad Hronom, 25 - Žilina, 26 - Bardejov, 27 - Humenné, 28 - Košice Town, 29 - Košice Province, 30 - Michalovce, 31 - Poprad, 32 - Prešov, 33 - Rožňava, 34 - Spišská Nová Ves, 35 - Stará Ľubovňa, 36 - Svidník, 37 - Trebišov, 38 - Vranov nad Topľou.

total number of votes) -- within which the SNS occupied the best position in the 5th Bratislava district (10 %) and the votes in the districts of central part of the Váh Basin and Nitra region. On the other side, the SNS did not penetrate to the eastern Slovakia where it obtained only 1.5 - 1.7 % votes in some districts.

Conclusion

The analysis confirmed that the regional features of preference of individual politic subjects -- candidates to the National Council of the Slovak Republic are determined by various factors. They include particulary the nationality structure of the populations (votes of MK), its social composition (voters of SV and ZRS) and religiousness (votes of KDH), political orientation represented by the grade of trust in the leaders of individual parties (voters of HZDS, DÚ). Effects of these factors on the individual political subjects are variable and their stability in time is also varying. The criterion of nationality may be considered as most stable here and a less stable criterion is the one of political orientation that can change within several days and offers itself to manipulation.

Further geographical research of electoral behaviour of Slovak population may reveal other features of the regional picture of the preference of political subjects standing for to enter the National Council of the SR. It is for instance the question of stability of electoral preference in various regions, the question of similarity of electoral preference, etc. We started to process the mentioned problems using the 1990, 1992 and 1994 electoral resulta and they will be the subject of one of the coming papers.

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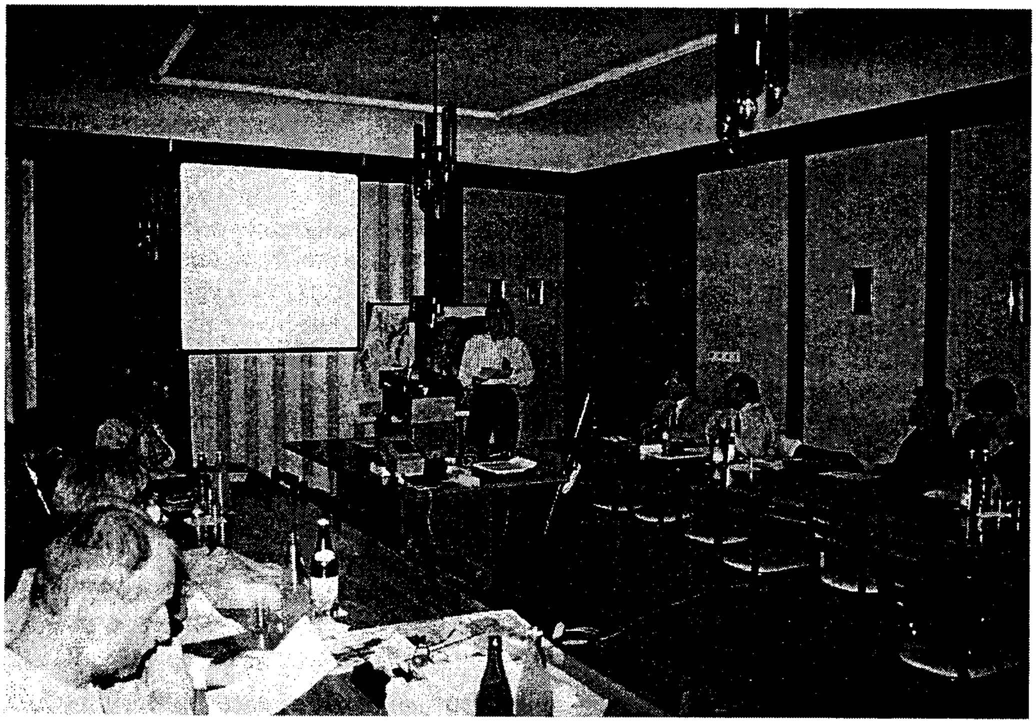
THE FIRST MORAVIAN GEOGRAPHICAL CONFERENCE CONGEO 95 GEOGRAPHY AND URBAN ENVIRONMENT held in Brno, 4-8 September 1995

Vítězslav NOVÁČEK, Antonín VAISHAR

The 1st Moravian Geographical Conference CONGEO 95 was held in the south-Moravian metropolis of Brno at the beginning of September 1995, whose main organizer was the Brno Branch Office of Institute of Geonics, CR Academy of Sciences and co-organizers were departments of geography from the Masaryk University in Brno and University of Ostrava. Scope of the Conference was expressed in the name "GEOGRAPHY and URBAN ENVIRONMENT" and the following groups of problems were put in the center of attention:

- natural environment in urban agglomerations,
- social environment and dwelling environment,
- basic conditions and consequences of economic transformation,
- cartography, GIS and remote sensing for urbanized environment, etc.

By organizing the Conference, the Brno Branch Office of Institute of Geonics, CR Academy of Sciences formed a good basis for organization of regular international CONGEO conferences in two years intervals. Each conference will have a technical topic defined in advance that will be sufficiently wide to make it possible to present contributions



Academy of Sciences and the Department of Applied Geography, Geographical Institute, K. FRANZENS University in Graz, Austria at a joint project concerning dumps in towns. There is nothing more left except for a wish that the Conference of CONGEO 97 which will be focused on the changed environment of rural landscape is at least as successful as the previous one.

The Conference Proceedings of CONGEO 95 "GEOGRAPHY AND URBAN ENVIRONMENT" (ISBN 80-901844-0-5) are available at the editorial office of this periodical for 295.00 CZK.

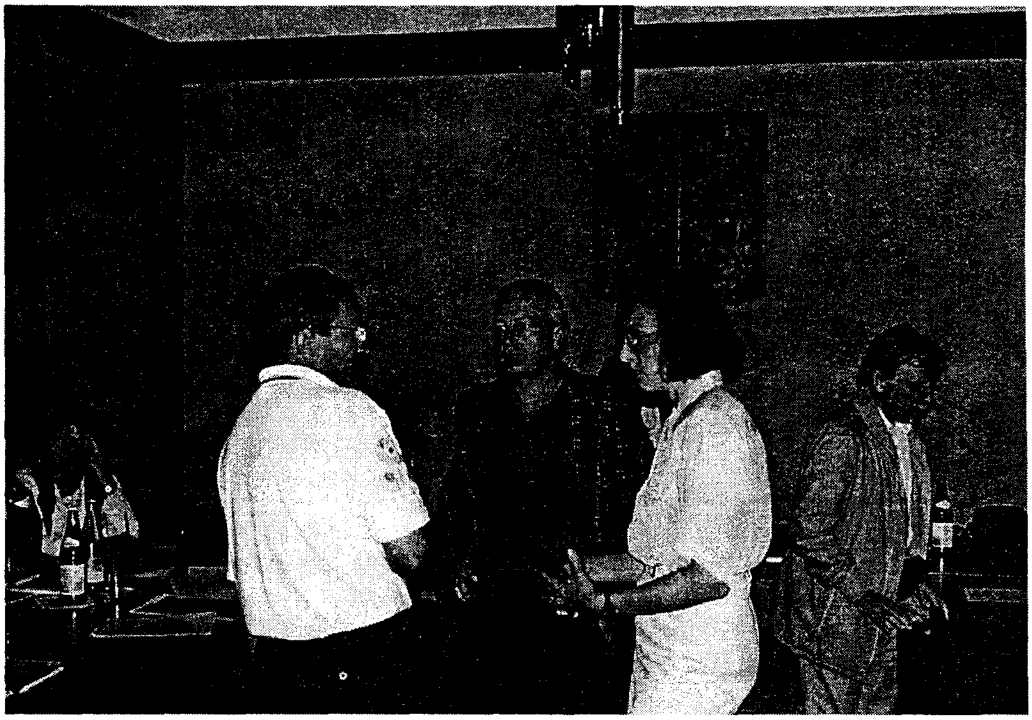
from as many geographical disciplines as possible. The conferences are meant for geographers from the Czech Republic, from the countries of Central Europe and also from other regions. Starting with CONGEO 97, they will provide contacts between geographers and experts in other scientific disciplines.

Technical discussions at CONGEO 95 lasted two days and took place at the chancellor's of Masaryk University in Brno, Žerotínovo náměstí (Square). They were attended by a total number of 18 geographers from the Czech Republic and 14 representatives of geographical institutions from abroad (two participants were from Austria: W. ZSILINCZAR, W. FISCHER, three from Slovenia, Ljubljana: D. PLUT, M. RAVBAR, M. ŠPES, two from Slovakia, Bratislava: J. OŤAHEL, M. LEHOTSKÝ, two from Croatia, Zagreb: K. BAŠIĆ, M. ILIĆ, two from Poland, Warsaw: B. KRAWCZYK, Katowice - W. OLES, and Hungary, France and the most distant country - India were represented by one respective expert each: Pécs - Z. WILHELM, Paris - G. ZRINSCAK, Varánásí - V.K. KUMRA.)

Working character of the Conference was obvious from informal and active approach of all participants, which was further supported by appropriate arrangement of individual thematic groups. The contribution is not meant to enumerate and evaluate the individual papers that were published in the conference proceedings but rather to acknowledge efforts of all participants who contributed to good technical standard of discussed issues on urban environment from their own angle of view and pointed out some serious problems that are in the center of attention in some urban regions.

The problems discussed were then confronted with reality at excursions. At the first of them the participants were informed of actual problems in the Brno agglomeration and were shown some examples of both favourable and adverse effects of economic activities on environment. The second excursion that was organized by the University of Ostrava was planned for a whole day and tackled the issue of Ostrava agglomeration where sub-surface black coal mining was recently stopped and production of heavy metallurgy considerably limited. Nevertheless, problems of waste dumps, undermined areas and negative factors from steel production are still highly topical, among other also in connection with necessary restructuring of industries in the town of Ostrava.

It is possible to say that the Conference met the expectations of organizers and provided a space for establishing new contacts among specialists from countries with diverse geographical conditions. The latest results of the meeting is establishment of a very close cooperation between the Brno Branch Office of Institute of Geonics, CR



URBAN AND RURAL GEOGRAPHY IN PARIS

Antonín VAISHAR, Jana ZAPLETALOVÁ

In Paris, urban and rural geography is developed mostly in workplaces of the National Center for Scientific Research[1], University of Paris (Pantheon - Sorbonne) and École Normale Supérieure in Fonteney - Saint Cloud. Although the research is being run at various institutions, it is considerably integrated in terms of personal collaboration.

In the CNRS, a P.A.R.I.S.[2] team of scientists works on four scientific programmes of which the first one is called Urban Systems. Subject of research are demographic and socio-economic changes in French towns as well as the development of living conditions of their inhabitants. The research team disposes of a data base for 400 French towns with the population over 10 000. It is also engaged in a study of European urban systems. ("Europe" in this study, however, is meant as countries of European Union without post-socialist countries and often also without Scandinavia and Switzerland). One of the objectives is to generate a comparable data base for all European agglomerations with more than 100 thousand inhabitants. The team is connected with the international scientific programme within NUREC[3], where its eminent lady workers Denise PUMAIN and Thérese SAINT-JULIEN hold leading functions.

One of important outputs of the programme is an edition series VILLES subedited by D.PUIMAIN. Individual monographs of the series are of both theretical and empirical character. Of them, the System of European Towns[4] can be recommended for incorporation of the issue of Czech towns into whole-European context and for regional knowledge of West Europe.

There is another research programme of P.A.R.I.S. team that is interesting for Czech geography, viz. Territorial systems in political contexts. This programme includes among other also the Czech Republic (Ex-Czechoslovakia) and its transformation processes.

Within the CNRS there is another scientific team - STRATES[5]. Especially interesting are the first two of its scientific programmes: Collective agents and individual strategies of housing localiza-

Fig. 1. A house in Rue du Four 4 is among other also a seat of the P.A.R.I.S. team

1 Centre National de la Recherche Scientifique
2 Pour l,Avancement des Recherches sur l,Interaction Spatiale
3 Network on Urban Research in the European Union (firmer European Community)
4 CATTAN,N.-PUMAIN,D.-ROZENBLAT,C.-SAINT-JULIEN,T.: Le Systeme des villes européennes. Editions Economica Paris 1994. 208 p.
5 STRAtégies Territoriales et dynamiques des ESpaces

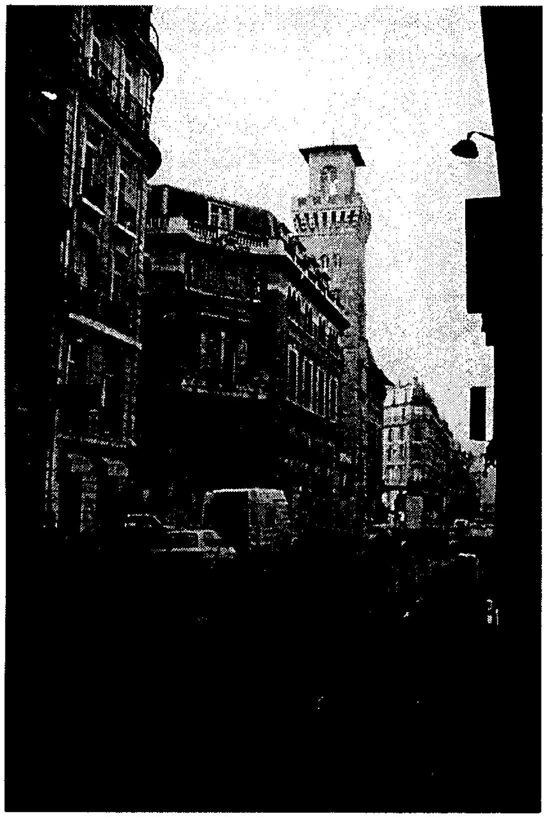


Fig. 2. The building of Geographical Institute in Rue St. Jacques 191 that belongs to the University of Paris is among other also a seat of the STRATES team

tion in Paris area, and The systems of power and dynamics of rural spaces. The first of them, represented for instance by Ms. Martine BERGER, could become an inspiration and guidance at the future research into problems of suburbanization that is certainly to be expected also by Czech geographers in the future.

The second programme opens an issue of rural geography in France. Differences between the metropolitan region of Paris and marginal countryside areas are considerably greater than those between the towns and countryside in the Czech Republic. Processes that are subject to warning in our country such as depopulation of whole rural areas and the high percentage of derelict land are a hard reality in some French districts. This is why the issue is very topical in France. Jean-Pierre FRUIT from the GEOPHILE team assumes that a solution consists in diversification of rural activities whose necessary pre-requisite is countryside identity.

The GEOPHILE scientific team (Center of Rural Geography) operates at the prestigeous École Normale Supérieure in Fontenay-aux-Roses. It is led by the popular geographer Violette REY. The principle piece of work is a theoretical study by doyen of the group Jacqueline BONNAMOUR:

Fig. 3. The building of École Normale Supérieure in one of Paris satellites in Fontenay-aux-Roses is among other a seat of the GEOPHILE team.

Géographie rurale[6]. Also this team pays a considerable attention to the problems of Central and East Europe in general, and of the Czech Republic in particular within the scope of one of its research projects devoted to South-North and East-West relations. The research works have been focused on the issue of consequences following out of decollectivization of agriculture.[7]

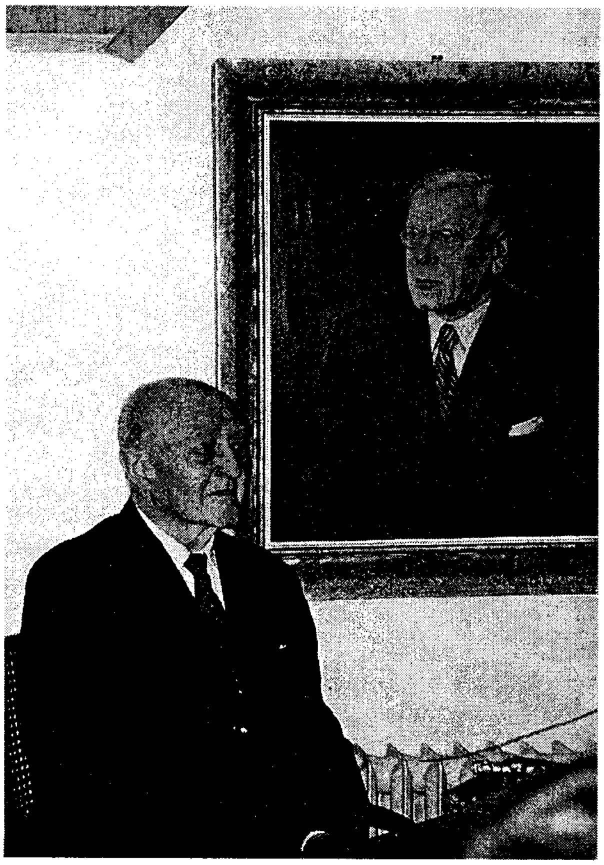
The French geography offers a whole series of inspirations to Czech geographers, which not only concern technical problems but also organization of scientific work. The environment of ideas is a characteristic and original identity, supported by language barrier, which makes the French school different from other west-European geographies. Even this is the reason for drawing from the original ideas and no less original works. It is also worth mentioning that the social prestige of French geography is much higher than in our country. There is no doubt that this is contributed to by a considerable number of thematic atlases issued by French geographical institutions among which one of the most important roles is that of Maison de la géographie in Montpellier. Surprising is also the number of studies dealing with the eastern Europe where France can probably sense good markets.

6 Masson, Paris, Milano, Barcelona, Bonn 1993. 134 p.

7 e.g. the research work by REY,V.(ed.): Nouvelles campagnes d,Europe centrale et Balkanique

The 90th Birthday Anniversary of dr. Jaroslav LINHART

Mojmír HRÁDEK



Dr. Jaroslav LINHART at the meeting organized by the Branch Office of Institute of Geonics, CR Academy of Sciences. In the background, a picture of his teacher and later on also liberator from totalitarian work engagement - Prof. František VITÁSEK.

Emeritus scientific worker of the former Geographical Institute, CR Academy of Sciences, Brno - dr. J. LINHART celebrated his 90th birthday anniversary in full freshness of spirit on 4 March 1996.

An informal meeting with dr. LINHART on the occasion of this wonderful life anniversary was organized by the Brno Branch Office of Institute of Geonics Ostrava, CR Academy of Sciences jointly with the Brno group of Czech Geomorphological Committee. Younger colleagues could learn many interesting things about initial stages of systematic geomorphological research in Moravia.

In the course of the 50's, dr. LINHART and his family were politically persecuted by the Communist regime. Dr. LINHART mentioned that he is much obliged to Professor František VITÁSEK for his own come back to scientific work at the Academy of Sciences, who asked for dr. LINHART's assistance when being forced to manual work. Unusual scientific recognition was extended to dr. LINHART for his research of bank abrasion of dams. In 1964 he was invited by organizers to the XXth international congress IGU in London in order to present a paper about regularities of abrasion development of dam banks. The then Czechoslovak political and geographical authorities would have never given him the chance.

The meeting with the doyen of Czech geomorphologists was a rare experience for all participants who highly appreciated the results of scientific work, absorbing narration and personal charms of this modest research scientist.

Outcrops of calcareous sandstones and marlestones of Lower Turonian (Upper Cretaceous) on the front of cuesta of the Hřebečovský hřbet (Ridge) in south part of Svitavská pahorkatina (Hilly land) near Chlum village, 40 km northly from Brno. (Illustration for the paper of A.Ivan)

Photo: Mojmír Hrádek

GISMAP* WIEN

Multisensorbildkarte

Landsat-TM / SPOT-HRV

- Dicht verbaut
- Locker verbaut
- Landwirtschaftliche Nutzfläche
- Wiese
- Wald
- Gewässer

* GISMAP ist das kartographische Endprodukt von verschiedenen am Institut für Kartographie der Österreichischen Akademie der Wissenschaften eingesetzten Methoden zur Verwaltung, Auswertung und Darstellung digitaler, raumbezogener Informationen. Die als GISMAP in analoger Form gedruckten Kartenthemen sind auch in digitaler Form als geographisches Informationssystem verfügbar.

Herstellung am Institut für Kartographie der Österreichischen Akademie der Wissenschaften von H. Beissmann (digitale Bildverarbeitung und Reproduktionstechnik), R. Hengsberger (digitale Bearbeitung) und Ch. Hsu (kartographische Bearbeitung).

Maßstab 1:100 000

0 1 2 3 4 5 km

Wien, 1993

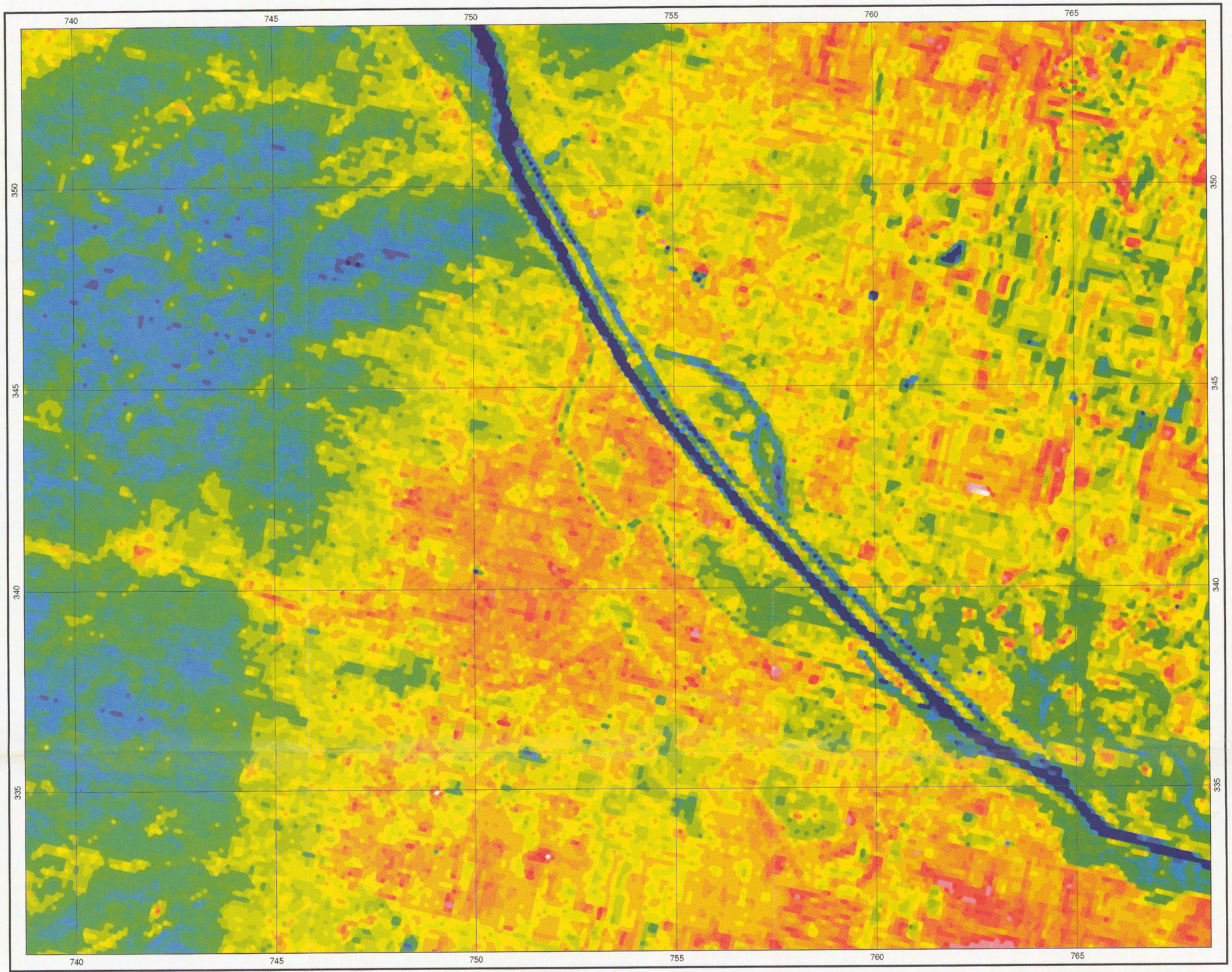
Herstellung der Multisensorbildkarte Wien:
Als Datenquellen dienten digitale Satellitenbilder von Landsat/Thematic Mapper (Spektralkanäle: 1 in Blau, 2 in Grün und 3 in Rot dargestellt, Grundauflösung 30 x 30 m, Aufnahmedatum 2. 6. 1984) und von SPOT/HRV (panchromatischer Spektralkanal, Grundauflösung 10 x 10 m, Aufnahmedatum 20. 4. 1988).
Die Farbinformation der 3 Spektralkanäle von Thematic Mapper wurde lasierend über den panchromatischen Kanal von SPOT gelegt, um die Vorteile der Farbinformation mit denen der höheren Grundauflösung zu kombinieren. Dazu erfolgte während der geometrischen Rektifikation auf das Gauß-Krüger-Netz eine Angleichung auf die einheitliche Grundauflösung von 10 x 10 m.
Danach wurden die 3 Spektralkanäle von Thematic Mapper von der Darstellung im Rot-Grün-Blau (RGB)-Farbsystem in das Intensity-Hue-Saturation (IHS)-Farbsystem transformiert. In diesem System wird jede Farbe durch ihre Helligkeit (Intensity), ihren Farbton (Hue) und ihre Sättigung (Saturation) festgelegt. Nach dem Ersetzen oder der Modifikation der Intensität durch den panchromatischen Kanal von SPOT erfolgte die Rücktransformation in das RGB-Farbsystem.

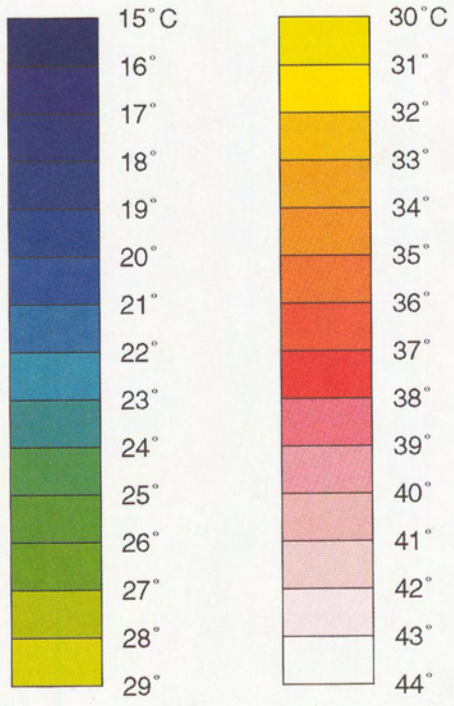
Diese so entstandene Multisensorbildkarte wurde mit Methoden der digitalen Bildverarbeitung optimiert und digital mit Rahmen, Gitternetz, Legende und Beschriftung versehen.

Die zur Visualisierung auf einem Farbbildschirm abgestimmte Bildkarte wurde mit Methoden der digitalen Reproduktionstechnik für die Farbseparation und den anschließenden Offsetdruck mit Normdruckfarben aufbereitet. Dabei muß besonders beachtet werden, daß nur ein Teil der am Farbbildschirm darstellbaren Farben druckbar ist, da die Druckfarben mangelnde Hauptabsorption und relativ hohe Nebenabsorptionen aufweisen.
Zur Lösung dieser Probleme wurde die Farbinformation der Bildkarte in das CIE-Farbsystem (Commission Internationale de l'Eclairage) transformiert und auf den Bereich der druckbaren Farben eingeschränkt. So war es möglich, die Druckfarben am Farbbildschirm zu simulieren und zu modifizieren.

GISMAP* WIEN

Karte der Oberflächen-temperaturen





* GISMAP ist das kartographische Endprodukt von verschiedenen am Institut für Kartographie der Österreichischen Akademie der Wissenschaften eingesetzten Methoden zur Verwaltung, Auswertung und Darstellung digitaler, raumbezogener Informationen. Die als GISMAP in analoger Form gedruckten Kartenthemen sind auch in digitaler Form als geographisches Informationssystem verfügbar.

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Maßstab 1:100 000

0 1 2 3 4 5 km

Wien, 1993

Herstellung der Oberflächentemperaturenkarte von Wien:
Als Datenquelle diente der Kanal 6 (thermisches Infrarot) des digitalen Satellitenbildes von Landsat/Thematic Mapper (Grundauflösung 120 x 120 m, Aufnahmedatum 2. 6. 1984). Die am Satelliten aufgezeichneten radiometrischen Temperaturmeßwerte hängen von der Wärmestrahlung und dem Emissionsvermögen einer Oberfläche, aber unter anderem auch vom Absorptions- und Emissionsvermögen von festen, flüssigen und gasförmigen Teilchen der Luftschicht zwischen der zu messenden Oberfläche und der Meßvorrichtung am Satelliten ab. Diese Effekte bedingen Meßwertverschiebungen, deren Korrektur bis jetzt erst teilweise gelungen ist. Es ist noch darauf hinzuweisen, daß die Temperaturen von Oberflächen erheblich von der Lufttemperatur (gemessen in 2 m Höhe in einer Wetterhütte) abweichen müssen. Die flächenhafte Erfassung von Oberflächentemperaturen durch den Satelliten ermöglicht die Bearbeitung neuer Fragestellungen.
Für die Korrektur der Oberflächentemperaturen von Wien wurde die Kalibrierungsmethode von R.G. Lathrop und T. M. Lillesand (In: Remote Sensing of Environment 22, 1987. S. 297-305) angewendet. Diese ist vor allem dann zweckdienlich, wenn nicht die genauen Oberflächentemperaturen eines Objektes, sondern die relativen Unterschiede in ihrer räumlichen Verteilung von Interesse sind. Die in Grad Celsius berechneten Temperaturen wurden digital hinsichtlich ihrer Ortsfrequenz gefiltert (dies entspricht einem Weichzeicheneffekt), gefärbt, mit Rahmen, Gitternetz, Legende und Beschriftung versehen, und schließlich mit Methoden der digitalen Reproduktionstechnik für den Offsetdruck mit Normdruckfarben aufbereitet.
Von den vielfältigen Interpretationsmöglichkeiten soll hier nur die Untersuchung lokalklimatischer Wirkungen der verschiedenen Klassen der Landnutzung erwähnt werden. So verbessert z.B. eine Grünfläche erst dann auch das Lokalklima ihrer verbauten Umgebung, wenn durch eine genügend hohe Temperaturdifferenz zwischen diesen Gebieten ein lokaler Austausch von warmer/trockener und kühler/feuchter Luft verursacht wird.