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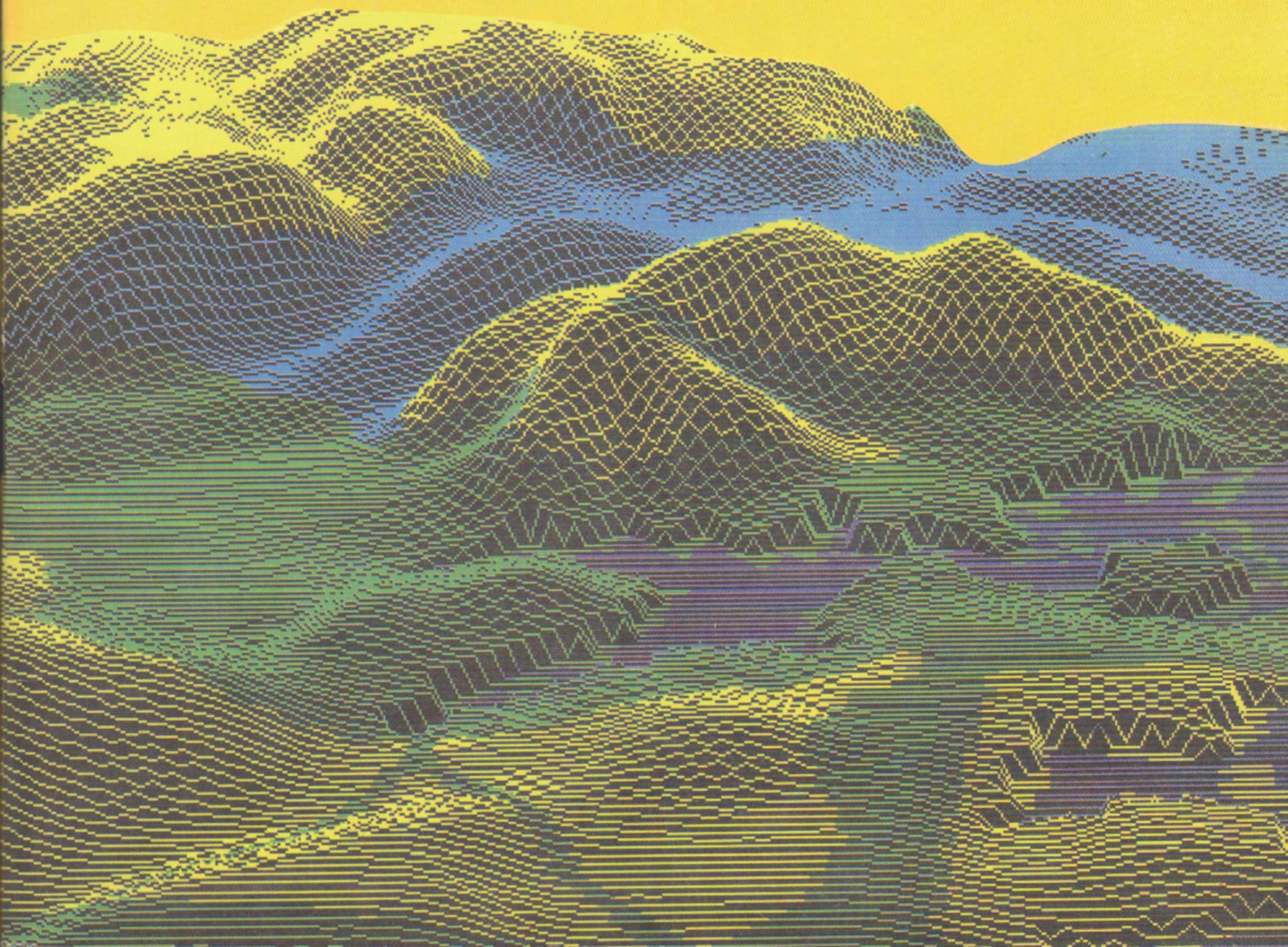

Křivé jezero Lake is one of the common river arm lakes in the extended alluvial plains of the Lower Moravian Lowland (Basin of Vienna). Highly productive inundated riverine meadows and forests with typical willow stands are subjects of the nature protection in the proposed Danube-Morava-Dyje National Park.

Photo: J. Kolejka

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GEOMORPHOLOGY OF THE PODYJÍ NATIONAL PARK IN THE SOUTHEASTERN PART OF THE BOHEMIAN MASSIF (South Moravia)

Antonín IVAN - Karel KIRCHNER

Abstract

The canyon of the Dyje river on the frontier between Moravia and Austria is a main landscape feature in the Podyjí National Park declared in 1991. The canyon is deep to 250 m and incised in various crystalline rocks, dissecting extensive planation surface with many rests of kaoline weathering crust. The canyon originated by surimposition from cover of Miocene sediments is also a unique landscape feature in the Bohemian Massif with many incised meanders, fissure ice caves, gravitational forms, block fields, tors, pseudolapiés and interesting anthropogenic forms.

Shrnutí

Kaňonovité údolí Dyje mezi Znojmem a Vranovem nad Dyjí na hranici s Rakouskem je základem Národního parku Podyjí vyhlášeného r. 1991. Kaňon v krystalických horninách je zahlouben pod regionální zarovnaný povrch se zbytky kaolinické zvětrávací kůry. V kaňonu až 250 m hlubokém jsou četné zakleslé meandry, ledové sluje, gravitační tvary, kamenná moře, tvary zvětrávání žuly a také neobvyklé tvary antropogenní.

Key words: Podyjí National Park, Geomorphology, South Moravia, Dyje canyon

1. Introduction

Political changes in Europe in the autumn 1989 have brought a possibility to investigate the formerly forbidden territories, in particular those adjacent to the "iron curtain". One of the most valuable territories includes part of the Dyje river valley situated on the Czech-Austrian border. The most exciting reach of the valley between the towns of Vranov nad Dyjí and Znojmo, in fact a canyon, has been declared the Podyjí National Park (NP) in 1991. Since 1978, however, it was a part of the Podyjí Protected Landscape Area even though in different acreage. In Austria, on the opposite side of the Dyje river the declaration of national park, the "Thayatal Nationalpark", is being prepared, too.

In addition to the romantic and rugged landscape, the Podyjí National Park surroundings is supplemented by attractive towns, viz Znojmo and Vranov nad Dyjí in Moravia and Hardegg in Austria, with interesting architectures and histories. On the other hand, with regard to intensive tourism and recreation in the area (particularly around the Vranov Dam, west of the Podyjí NP and upstream of the Dyje river), observation of protection rules in the park must be well secured.

Although, ironically, the area was forty years under barbed wire and many traces of former military activities there still exist , the environment is less damaged here than in the inner country. The last important and undesirable anthropogenic disturbance in the area of Podyjí NP was erection of the Znojmo Dam in 1966.

At the same time , it is not surprising, that both the landcape and the relief of the Podyjí NP are little understood and even the most remarkable feature, unique fissure ice caves near the town of Vranov nad Dyjí, which were discovered more than a hundred years ago, is studied in detail only now. In spite of a relatively early discovering of the fissure ice caves, main problem was believed to be presence of the perennial underground ice that was the matter of dispute only from the climatic and meteorological point of view (K. JARZ 1882). Later, some attention was devoted to relief forms in short papers of F. KOLÁČEK (1922) and V. ŠPALEK (1935a,b), too. Short descriptions can be found also in papers of J. SKUTIL (1950), J. VÍTEK (1979, 1982, 1992) and T. ANDREJKOVIČ (1993). Results of recent research have been published by J. ZVELEBIL - B. KOŠŤÁK - J. NOVOTNÝ - P. ZIKA (1993) and in report by V. CÍLEK (1993). In the wider areal context the papers of H.NOWAK (1969) and J. KARÁSEK (1985) are inspiring.

The authors have studied the Podyjí National Park relief by the method of detailed geomorphological mapping at the scale of 1 : 25 000. The relief is very dissected, not providing an easy survey and thus

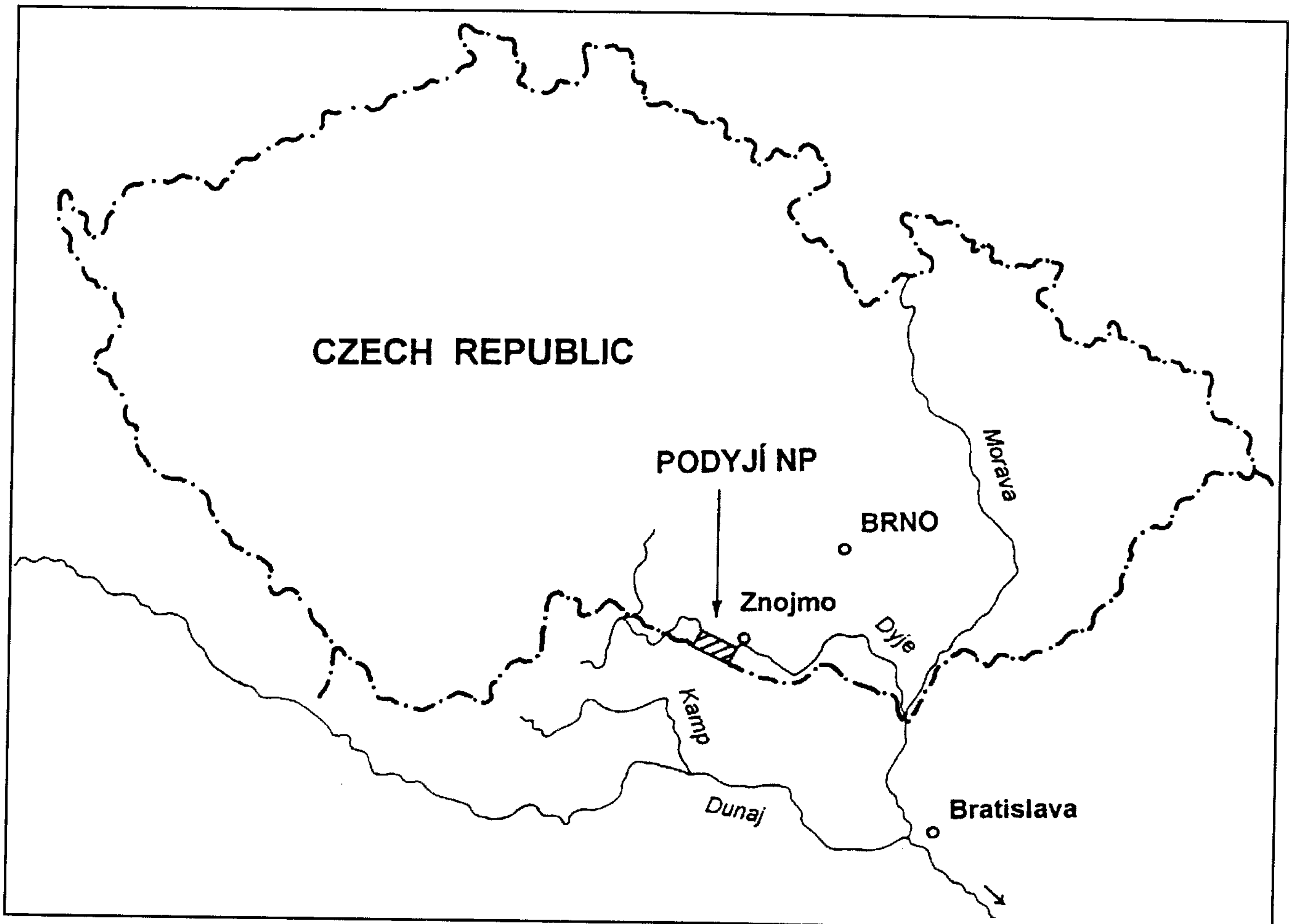


Fig. 1 Position of Podyjí National Park in south Moravia

time-consuming. On the other hand, numberless microforms, such as tors, low exfoliation domes, honeycombs, block fields, debris accumulations, cutoff meanders and interesting anthropogenic phenomena provide a good opportunity to resolve very complicated problems. We are pleased to express our thanks to people, who helped to make this research possible. We are indebted to Administration of the Podyjí NP in the town of Znojmo, particulary to its director ing. T.ROTRÖCKL, to the head of the branch of natural sciences, ing. ŠKORPÍK and to geologist, RNDr. T. ANDREJKOVIČ. The research was supported by internal grant of Czech Academy of Sciences No. 31 459 and grant of the Ministry of the Environment of the Czech Republic (No. 774/93). We also thank Doc. Dr. J KARÁSEK, Masaryk University Brno for constructive criticism of the manuscript.

2. Regional setting

With its area of about 63 km^2, the Podyjí NP is rather small, surrounded both in Moravia and Austria by relatively densely populated and high productive agricultural landscape. In this marginal area, the river of Dyje has been fixed as historical frontier between the two countries for almost a thousand years.

From the point of view of physical geography, geology and biogeography, the Podyjí NP is situated in the SE marginal part of the Bohemian Massif, close to the contact with the West Carpathians. This contiguity of two major landcape systems of Middle Europe is difficult to overestimate. At the same time, however, the Podyjí NP is not an obvious natural unit. Thus it is reasonable to study most of its problems in the larger area context.

From geomorphological point of view, the Podyjí NP is situated in the geomorphological subsystem of the Českomoravská vrchovina (Highland) in the unit, delineated as Jevišovická pahorkatina (Hilly land). The flat or rolling topography in altitude of 300-600 m, gradually rising westwards is a very characteristic feature of the area. On the other hand, this rather monotonous relief with some undinstinct hills contrasts strikingly with very deep valleys, too narrow for both settlements and roads.

In the Podyjí NP the only more important road that crosses the 40 km long reach of the Dyje canyon is between the small town of Hardegg in Austria and the village of Čížov in Moravia. Valley slopes of Dyje as well as those of low sections of its tributaries are continuously covered with deciduous and coniferous woods with distinct differences as related to aspect.

As to geomorphological units in the Podyjí NP neighbourhood and in drainage area of the Dyje river, in particular upstream, west of the Jevišovická pahorkatina (Hilly land), there is the Křižanovská vrchovina (Highland) in approximately the same altitude, with more dissected relief and small river in basins trending predominately to N or NE. The Javořická vrchovina (Highland), west of the Křižanovská vrchovina (Highland), is the highest unit of the Českomoravská vrchovina (Highland) and is dominated in its southern part by a rather monotonous, wooded topography of low rounded ridges and isolated hills underlain by granites. In crest parts, in the altitude of 600 - 700m (V.J. Novák 1935), the main European divide runs, coming from Austria and trending NNE. Here, the major rivers draining the southeastern part of the Bohemian Massif originate.

East margins of the Jevišovická pahorkatina (Hilly land) and Podyjí NP, are bounded by a distinct landscape feature, the eastern marginal slope of the Bohemian Massif. The slope faces depression of the Dyjsko-svratecký úval (Graben), which is one of the Outer Carpathians Depressions, situated between the Bohemian Massif and low flysch mountains of the West Carpathians. From geological viewpoint the depression is Carpathian Foredeep composed of unconsolidated Miocene and Quaternary deposits. The Dyjsko-svratecký úval (Graben) is noted for its very flat or gently rolling topography, with prevailing arable land many vineyards and orchards, but little woods.

The Dyje river leaves both the Bohemian Massif and Podyjí NP in the town of Znojmo. Its course is transversal both to the geological structure and relief. The Dyje crosses successively the intermontane depression of the Dyjsko-svratecký úval (Graben), Outer Flysch Carpathians (Pavlovské vrchy Hills and Ždánický les Highland) and Dolnomoravský úval (Graben), where it joins the river of Morava, left tributary of the Danube. From geomorphological and environmental point of view the Pavlovské vrchy (Hills) are both the Biosphere reserve (UNESCO) and the Protected Landscape Area named Pálava. In the confluence area of the Dyje and Morava rivers, a tripartite national park in the floodplain forest is being proposed. In the Austrian part of the Bohemian Massif, the Westliches Waldviertel corresponds to the Českomoravská vrchovina (Highland). In contiguous area of the West Carpathians and Alps, the Wiener Becken (Vienna Basin) and its portion the Westliches Weinviertel are counterparts of the Carpathian Foredeep and Dyjsko-svratecký úval (Graben) of Moravia.

3. Geological structure

3.1 Complexity of basement structure of the SE part of the Bohemian Massif

Crystalline rocks, both igneous and metamorphic, distinctly dominate in the deeply eroded SE part of the Bohemian Massif. Structure of the crystalline basement is very complex and controversial.The territory is believed to be classic area of Hercynian nappe tectonics. From the beginning of this century, the most exciting

1. Canyon of the Dyje river in the western part of the Podyjí National Park, in the foreground incised meander with rock ridge. On the northwest facing slope of this ridge, the locality of the Ledové sluje (ice caves) is situated. Photo: K. Kirchner

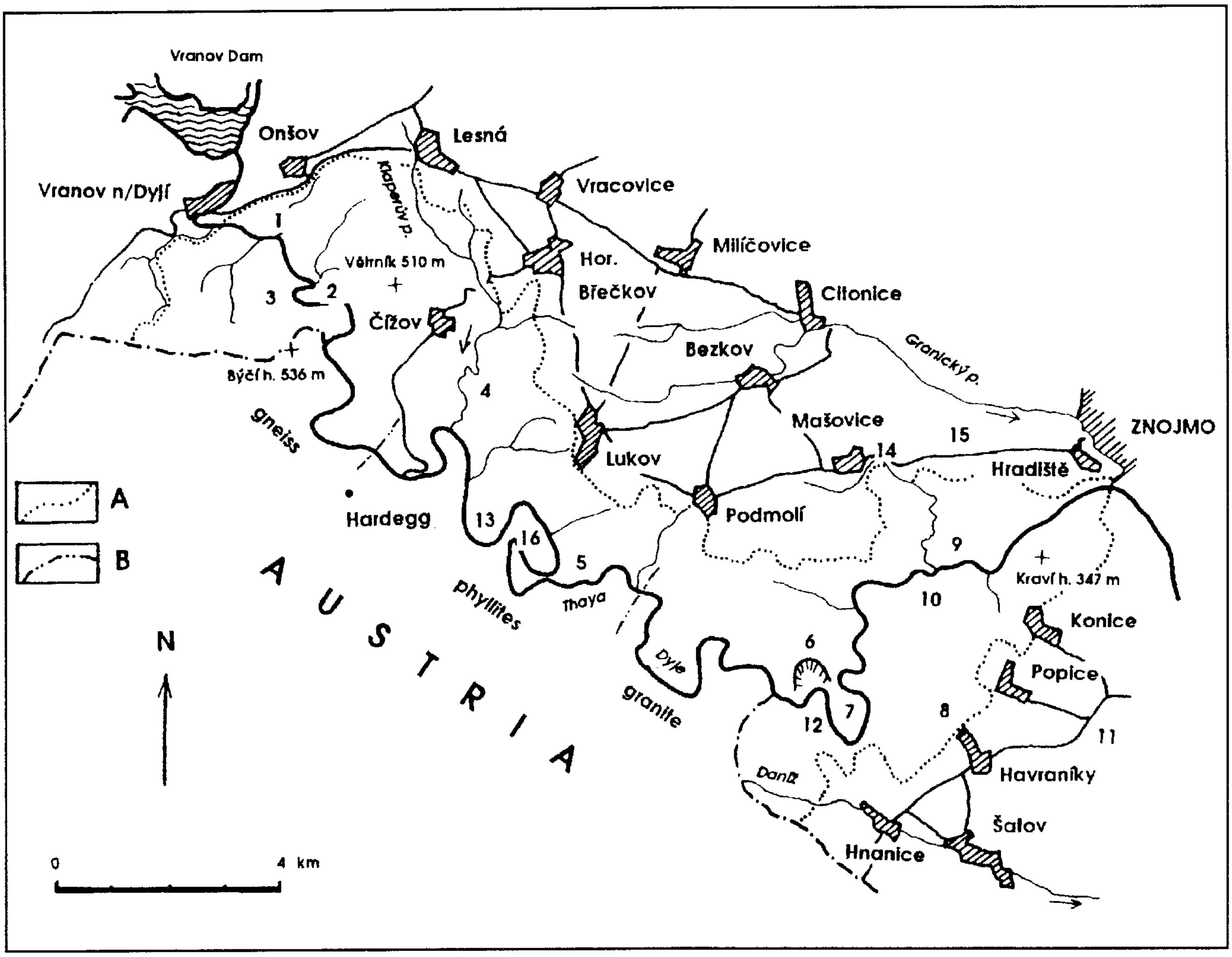


Fig. 2 Important geological and geomorphological localities in Podyjí NP

A - boundary of Podyjí NP
B - lithologic boundaries in Dyje canyon

1 - Vranov - ptygmatic folds
2 - Vranov - fissure ice caves
3 - Býčí hora - gravitational phenomena
4 - Klaperův potok (brook) - incised meander, cryogenic and karst forms
5 - Nový Hrádek (castle) sand pit in Lower Miocene deposits
6 - Devět Mlýnů (Nine Mills) abandoned incised meander
7 - Šobes active incised meander
8 - Havraníky - forms of granite weathering
9 - Králův stolec (King's table) weathering forms, cultivation terraces
10 - Sealsfieldův kámen (Sealsfield stone) - weathering forms
11 - Pustý kopec (Deserted hill) exhumed granite inselberg
12 - part of Dyje valley with distinct low right slope
13 - Gališ (hill) - Vraní skála (Crow's rock) - low river terrace, bluff
14 - Maršovice - kaolinized biotite granite
15 - Hradiště - deposit of kaoline (not exploated yet)
16 - Umlaufberg (core of incised meander)

discussions tackled existence of the Moldanubian nappe, thrusted eastwards over Moravicum and later uncovered by erosion in tectonic windows. At present, after many discussions and modifications, the nappe tectonics is generally accepted, even though different opinions still exist (for references see M. SUK et al. 1984, G. FUCHS 1990). In the course of last decades, the complicated tectonic, petrographic and chronological problems of the area were discussed mainly by P. BATÍK (1984), T. HÁJEK (1985,1990), V. JENČEK - A. DUDEK (1971), M. KRATOCHVÍL - K. SCHULMANN (1984), S. SCHARBERT - P. BATÍK (1980) and G. FUCHS (1990). The nappe structure was most convincingly demonstrated by J. JAROŠ (1992) in the Svratka dome west of Brno.

In present division, three high-order geological units participate in the structure of the Podyjí NP and its surroundings. They are, from the east to the west the Brunovistulicum, the Moravicum (or newly Moravosilesicum) and the Moldanubicum.

The Brunovistulicum (after A. DUDEK 1980), in the eastern part of the Podyjí NP, presents in the structure of the Bohemian Massif a relatively alien element, and is originally thought to be a part of the Fenno-Sarmatian platform (M. SUK et al. 1984). In the west, the Brunovistulicum is separated from the Moravicum by the newly defined Moravian thrust, characterized as terrane boundary by Z. MÍSAŘ - A. DUDEK (1993).

The Brunovistulicum is composed of intrusive rocks of the Dyje Massif (Cadomian. S. SCHARBERT - P. BATÍK 1980) believed to be, together with the Moravicum, a complicated structure of the Dyje Dome. The Dyje Massif is its core. However, the whole of east half of the dome was denuded.

Petrographically, the Dyje Massif is rather homogenous in the area of Podyjí NP. The prevailing biotite granite, called also the Dyje granite, is close to contacts with the Moravicum schistosed and mylonitized. The Dyje Massif was probably deeply eroded already before the Devonian.

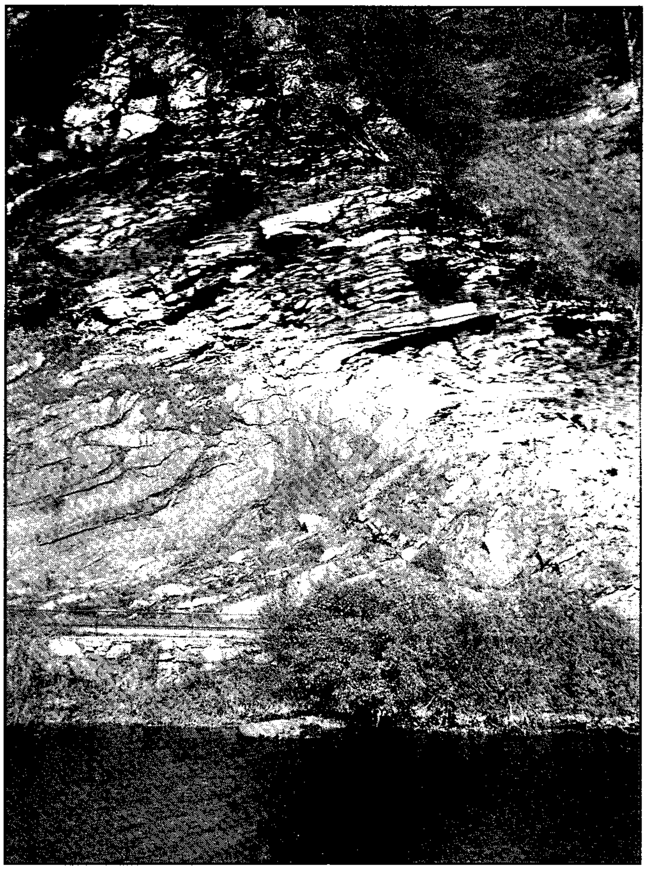
The Moravicum, is an extraordinary complex by its structure, composed mainly of metasediments and gneiss. It consists of three units, all present in the Podyjí NP (see e.g. geological map of the Podyjí NP, 1 : 25 000 in P. BATÍK, 1992).

In the west, there is an east marginal part of the Vranov unit (the Outer Phyllites in the original conception of the Moravicum and the Dyje Dome) built of paragneiss with intercalations of amphibolites and crystalline limestones. Under these rocks, the Bíteš unit composed of two-mica orthogneiss (Bíteš augen gneiss), occupies a zone wide about 6 km. The Bíteš orthogneiss is metagranitoid rock probably of Cadomian or older origin (see M. SUK et al. 1984). The lowest, Lukov unit (the Inner Phyllites) on the east, is composed of two parts. The upper part consists of garnet-staurolit mica schists with crystalline limestones and erlans, the lower part of two-mica schist with quarzites.

Although the crystalline rocks of the Moldanubicum are not present in the Podyjí NP, they form the majority of the drainage area of the Dyje river and crop out relatively close both to the west and north boundaries of the Podyjí NP. Here, important tectonic contacts form the Moldanubian thrust (even though its exact position is controversial) and Kravsko fault (Z. MÍSAŘ - A. DUDEK 1993, K. SCHULMANN - O. MATĚJOVSKÁ - R. MELKA 1992).

West and north of the Podyjí NP, the prevailing Moldanubian rocks are different types of paragneiss and orthogneiss, trending generally to NNE. The Javořická vrchovina (Highland), further to the west, is composed mainly of different types of post-orogenic Hercynian granites of the Central Moldanubian Pluton. The various two-mica granites (the Eisgarn granite) prevail with typical granite relief forms. It is remarkable, that in this so called Bohemian-Moravian part of the Central Moldanubian Plutone, the axis of intrusive structure conforms roughly with the course of main European divide.

The nappe structure in the eastern part of the Bohemian Massif was demonstrated most convincingly in the Svratka Dome west of the town of Brno (J. JAROŠ - Z. MÍSAŘ 1974, J. JAROŠ 1992). There, two nappes in



2. Rock wall of the Bíteš gneiss near town of the Vranov nad Dyjí with ptygmatic folds. Photo: K. Kirchner

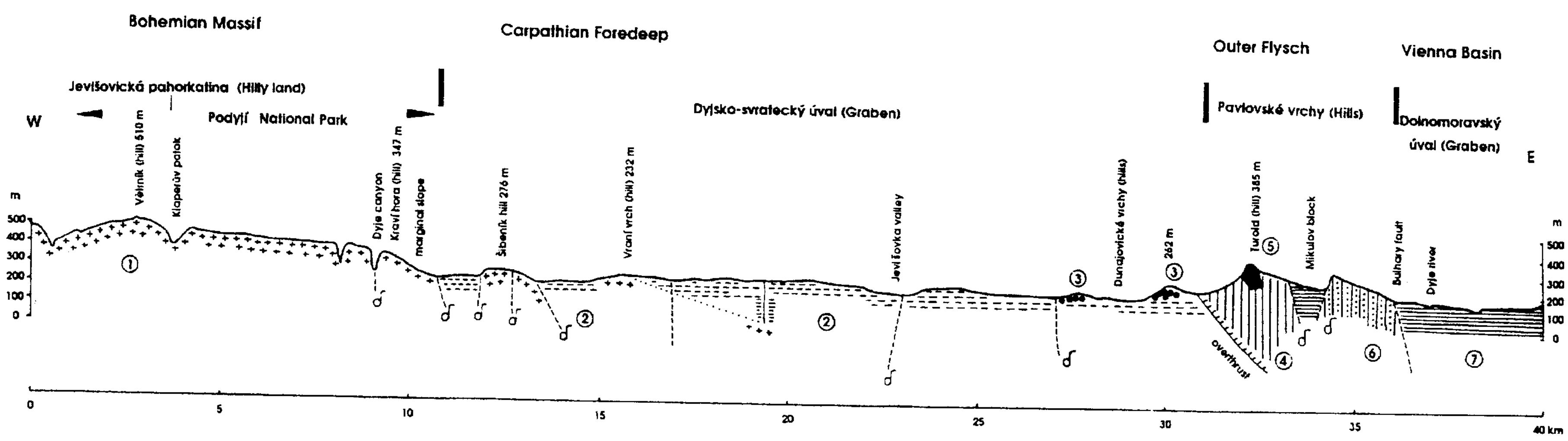


Fig. 3 Profile across southern part of Bohemian Massif and adjacent part of West Carpathians

1 - biotite granite
2 - Miocene sediments in Carpathian Foredeep
3 - Miocene basal conglomerates (Lower Badenian)
4 - Cretaceus - Lower Paleogene flysch
5 - Jurassic limestone (klippes)
6 - Upper Paleogene flysch
7 - Miocene sediments in Vienna Basin

superposition, composed of different metamorphic rocks have been distinguished. Both the nappes, the higher Moldanubian and the lower Moravian, were thrusted eastwards over the Brunovistulicum, consisted of granitoid rocks. After long denudation, metamorphic rocks of the Moravian nappe as same as the Brunovistulian granites have been uncovered in the tectonic windows and half-windows.

The structure of the Dyje Dome is rather similar. Both in the Svratka and Dyje domes the autochtone (the Brno and Dyje granite) and parautochtone (Bíteš orthogneiss, two-mica schists and phyllites) are strongly influenced by dynamometamorphosis. This fact is of primary geomorphological importance.

The differences in resistance of crystalline rocks of the Podyjí NP are well visible in the 40 km long canyon of the Dyje river. But even minor differences led to diversity of slope profiles, microforms assemblages and intensity of weathering. Nevertheless, the structural control is a significant but only secondary factor in the present topography. The most resistant rock is the Bíteš orthogneiss, forming the highest points in the area of national park (Býčí hora - hill 535.9 m, on the right side of the Dyje canyon and Větrník 510 m, on the left side), close of the western boundary of the park. The strip of this orthogneiss, sandwiched into metasediments, forms a flat convex elevation, with the west boundary more distinct than the east one. High resistance is partly obscured by moderate general dip of the area towards the east. The granites of the Dyje Massif, although schistosed,are resistant, too. Less resistant are phyllites and mica schists in the middle part of the Podyjí NP, but not only owing to petrographic composition, but also to tectonic shattering and presence of many faults and fissures.

3.2 Geomorphological aspects of platform tectonic regime in the SE part of the Bohemian Massif

The Hercynian orogenesis was followed by a period of transition to stabile platform regime lasting about 70 million years (J. VACHTL 1974) accompanied by intensive subaerial denudation. In the SE part of the Bohemian Massif, depth of denudation was enormous owing to general dip of the area to the north. In the south of Moravia, this inclination is apparent from 1) the more deep erosion of the Dyje Dome in comparison with the Svratka Dome, 2) the absence of Upper Carboniferous and Lower Permian continental deposits along the Boskovice-Diedendorf fault in the surroundings of Znojmo, and 3) the fact, that in half- graben structure of the Boskovice Furrow the conglomerates are more abundant in its southern part than in the northern part. The steepening of the more gentle west limb of the Boskovice Furrow (to 30-50° and in some places even to 80°, J. JAROŠ in J. KALÁŠEK et al. 1963) resulted probably from uplift of the Svratka Dome at that time.

As to the role of post-Hercynian platform tectonic regime in relief evolution of SE part of the Bohemian Massif, two aspects were important. First, the ancient block structure of the massif was accentuated and the NW-SE trending faults became most important. Second, formation of the Tethys took place and its margin in South Moravia was determined by faults of SW-NE direction. In opinion of Z. ROTH (1978, p.350), this margin of the Bohemian Massif "had experienced since the Late Cretaceous more conspicuous and more differentiated vertical displacements than other parts of the platform". The SE part of the Bohemian Massif influenced by tectonic processes in the Tethys was defined as a block of the Moravian foredeeps by Z. ROTH (1980). The area under study belonged to the South - Moravian block. A. DUDEK and V. ŠPIČKA (1975) named this block as Waschberg-South Moravian, and three subblocks, Nikolčice, Pavlov and Waschberg, distinguished. In this detailed division the surroundings of Znojmo belongs to the Waschberg block.In structure of this block take part faults of direction SSW-NNE (Boskovice-Diedendorf fault) and N-S (Miroslav fault and part of Velké Pavlovice fault north of the town of Mikulov).

The South-Moravian block was in a very low position and in connection with several marine transgressions it was submersed in the Late Jurassic and Cretaceous periods. In the epicontinental sea platform carbonates were deposited on the sub-Hercynian planation surface in Jurassic (M. ELIÁŠ 1981, 1992, M. ELIÁŠ-G. WESELY 1990). The present west limits of these autochtone Jurassic limestones, now buried under Miocene deposits of the Carpathian Foredeep, are about 15 km east of the topographic margin of the Bohemian Massif in surroundings of Znojmo. The limit of limestones is erosional and some authors (J. OPPENHEIMER 1932, K. JÜTTNER 1940) suggested that Jurassic sediments were extended originally far much westwards.

In the Tertiary the topographical margin of the Bohemian Massif has been brought near both to the Eastern Alps and the Carpathians as a result of subduction in the Tethys. Fronts of nappes were shifted towards the north in the Alps and towards west in West Carpathians and margins of the Bohemian Massif subsided. Between the Bohemian Massif and Carpathian nappes, foredeeps originated in which molasse sediments were deposited. Orogenetic phases in Alps and Carpathians have been evidenced (R. TRÜMPY 1973) and migration of orogenic phases, both in the radial and longitudinal directions (R. JIŘÍČEK 1979) influenced relief in a part adjacent to the platform. In the SE part of the Bohemian Massif these effects were stressed by wandering of orogenetic phases and their action from the south at first and later from the west.

Both the sedimentation and tectonic processes in the adjoining mobile areas together with tendency to quasi-permanent uplift in the Bohemian Massif have resulted in deformation of marginal parts of the massif into a large monocline complicated by longitudinal and cross faults. The present marginal slope of the massif which is only the uppermost part of this monocline originated in the south Moravia in Mesozoic and Tertiary. However, like in Jurassic and Cretaceous, the Miocene transgressions have spread extensively and rests of marine sediments occur far inside of the massif, at present. During formation of monocline the ancient basement faults were reactivated.

The eastern limit of the South-Moravian block coincides with Peripienine lineament that contacts the Bohemian Massif with Western Carpathians.The lineament is hidden under flysch and Neogene sediments. This deep contact with the West Carpathians system was much discussed from the point of view of geotectonics and geophysics (M. DLABAČ - E. MENČÍK 1964, Z. ROTH 1980). On the other hand, the western or inner limit of the South Moravian block is rather arbitrary and would be connected with the foot of the marginal slope related to fault (see the tectonic map in M. MAHEL - O. KODYM - M. MALKOVSKÝ 1984). The Outer Carpathians Depressions (Carpathian Foredeep) in front of the slope are composed of unconsolidated Miocene sediments. The profile of the slope is very variable. In the South-Moravian block this slope is distinct in granites. In the area between the towns of Brno and Moravský Krumlov the slope is built of granite of the Brno Massif and in the surroundings of Znojmo of the Dyje granite. On the other hand, in metamorphic rocks this slope is very undistinct or absent.

The low position of South-Moravian block and probably also the fact, that its regional dip was not only toward E, to the Carpathian Foredeep, but also towards S to the Alpine Foredeep, caused that the sea transgressed in the SE part of the western part of Bohemian Massif and South Moravian block already in the Paleogene and the Lowest Miocene. The Lower Miocene sediments (Eggenburgian) are more preserved than in other parts of the Bohemian Massif (P. ČTYROKÝ 1991). In contradistinction to the Middle- and North-Moravian blocks, in the South-Moravian block it is not possible to differ distinctly the Carpathian and Badenian foredeeps. This can also help to explain the very flat planated relief of the Jevišovická pahorkatina (Hilly land) that is, in fact a western continuation of the South-Moravian block.

In the Moravian part of the Carpathian foredeep adjacent to the Jevišovická pahorkatina (Hilly land) the Egerian, Eggenburgian, Ottnangian Carpathian and Badenian predominantly marine sediments occur (R. JIŘÍČEK - P.H. SEIFERT 1990). The sediments of the younger stages, the Sarmatian and Pannonian, are present only in the Austrian part of the foredeep. In the Austrian territory, close to Moravian borders and only about 15 km from the margin of Bohemian Massif the hill Buchberg (416 m), with the top composed of the Lower Badenian Lithothamnion limestone, is the highest point in this part of the foredeep and whole of the Dyjsko-svratecký úval (Graben).

In the Jevišovická pahorkatina (Hilly land) the many remnants of Miocene sediments of different age and in different altitude are preserved (M. DLABAČ 1976). They rest on bare or weathered crystalline rocks. This suggests only feeble effects of marine abrasion processes. Some authors believed that the whole of the Českomoravská vrchovina (Higland) was covered with Miocene deposits. No detailed research of the Miocene sediments in the national park itself was made.The polymict gravels and sands are supposed to be Ottnangian by P. BATÍK (geological map, 1992). West of the Podyjí NP, in surroundings of the villages Šafov and Langau (the latter in Austria), also the rests of downfaulted Lower Miocene (Eggenburgian) coal-bearing sediments in thickness of up to 50 m occur (A. DUDEK et al. 1962, V. JENČEK et al. 1984).

4. Relief of the Podyjí National Park

4.1 Regional planation surface

4.1.1 The problem

The flat or moderate rolling surfaces in interfluvial areas are rests of originally extensive regional planation surface and present the most distinct topographic feature of the SE part of the Bohemian Massif. Owing to absence of pre-Miocene deposits in the whole of SE part of the Bohemian Massif, the problem of origin and age of this surface, referred previously to as Paleogene peneplain, is very difficult and impossible to resolve in the small area of the national park.

The platform limestones of Jurassic age as well as the Cretaceous sediments buried under Tertiary sediments in the Carpathian Foredeep on the South-Moravian block (partly incorporated in flysch nappes) indicate a very planated relief in the adjacent land at that time. Also the Upper Cretaceous sediments in the present South Bohemian Basins were deposited on weathered surface of low relief. Thus, it is very probable that the whole of southeast part of the Bohemian Massif was covered by Mesozoic sediments. After regresssion, the planation processes have continued without any perceptible intervention of tectonism in progressive downwearing of subdued relief up to Upper Paleogene (the acyclic development after C. KLEIN 1974). With regard to the fact,that in platform stage the Moldanubicum was the most stabile part of the Bohemian Massif, we agree to designate the planation surface as Mesozoic-Paleogene (M. SUK et al. 1984).

In the W-E cross profile from the main continental divide on the Bohemian- Moravian border to the eastern margin of the Bohemian Massif, the planation surface truncates different rocks and dips unperceptibly eastwards, down to the upper edge of the marginal slope near of Znojmo. The planation surface is continuous and smooth. An undistinct break is only at the contact of the Javořická vrchovina (Highland) with the Křižanovská vrchovina (Highland), corresponding probably to contact of the Central Moldanubian Pluton granites with the Moldanubian paragneiss or with the zone of the Přibyslav deep fault trending to SSW. In the Central Moldanubain Pluton typical granite relief evolved with inselbergs, tors, corestones and different microforms. Therefore we believe that rests of only one, originally widespread planation surface are preserved in the SE part of the Bohemian Massif. The present diferences in extent and altitude of surface resulted from the Late Paleogene or post- Paleogene moderate differential tectonic movements and lithologic control of denudation.

In the area of Moldanubian paragneiss, the planation surfaces are more dissected owing to their lesser resistance. The resistant quarzite and orthogneiss form only narrow strips. On the other hand, in Moravicum, the resistant Bíteš orthogneiss and Dyje granite prevail and the area of relatively weak mica-schists is small.

4.1.2 Planation surfaces in the Podyjí National Park

4.1.2.1 Regional planation surface

Although in the surroundings of the Podyjí NP the planation surface truncates both the granites and steeply dipping crystalline schists, some parts of planation surface are almost perfectly flat and we found no strict structural control. But lithologic contacts are perceptible in the relief and also weathering products of rocks are different. Generally, two types of weathering mantle occur. The first are rests of fossile deep chemical weathering, the second consists of products of physical weathering of firm rocks. Here, the weathering mantle is mostly thin, composed predominately of loamy and sandy debris. Some parts, especially in low altitudes, are covered with loess which smoothed down the small superficial irregularities. Whereas in inner parts of the Českomoravská vrchovina (Highland) the second type is dominating, in the eastern marginal part numerous denudation relics of fossile kaolinic weathering crust are very important and some of them are mined (see M. KUŽVART 1965, M. KUŽVART et al. 1983).

The rests of planation surface, underlain by various types of crystalline rocks, sound or weathered, but also by unconsolidated Miocene and Quaternary sediments, are in the Podyjí NP, in our opinion, the polygenetic forms. The surface is somewhat monotonous, some parts are rather very moderate slopes. Forms as tors, boulder accumulation or corestones are exceptional on the surface.

In the west part of the national park, the rests of planation surface are in altitude 450-535 m, in the east, above the marginal slope of the Bohemian Massif only in 300 m. In generalized NW-SE profile, the surface is smooth and dips eastwards with inclination of 0.2-0.3^{o} only. The lithologic and structural control of topography is apparent partly also in the adjacent part of Austria (profile in H. NOWAK, 1969). The altitude of planation above the high eastern marginal slope south of the town Retz is 460-480 m. Thus, difference in altitude of planation surface in surroundings of the PNP is surprisingly almost 200 m.

4.1.2.2 Importance of deep chemical weathering

The many remnants of deep weathering crust in the SE part of the Bohemian Massif, their distribution and contrast with the crusts in higher altitudes attracted attention of geologists and geomorphologists already long ago. They were discussed in detail especially by L. SÝKORA (1949). Recent inquiry of J. KARÁSEK (1985) into problems of areal distribution of weathering products, their genesis and relations to the Miocene sediments and planation surface aids substantially in understanding of relief evolution.

There are many localities of remnants of fossile weathering crust also in the surroundings of the Podyjí NP. Detailed research of kaoline deposits in last decades has confirmed both climatic and areal (non-linear) character of kaolization. In opinion of M. KUŽVART (1965, for references see also J. VACHTL ed., 1969 and M. KUŽVART et al. 1983), the Moravian kaolines in eastern part of the Bohemian Massif originated in warm humid climate, and are pre-Upper Miocene, probably of Oligocene age. In handbook by J. KONTA (1982), the South Moravian kaolines are mentioned to be originated mainly in Cretaceous, partly in Paleogene. Their origin was probably connected with brown coal or lignite seams, existing at that time in their neighbourhood.

However, how M. KUŽVART and other authors have stressed, in some places the kaolization was preceded and facilitated by dynamometamorphism or cataclasis and the problem of origin is not quite unambiguous. In this connection it is very interesting, that the South Moravian kaolines occur predominantly in the Moravicum, both in the Svratka and Dyje Domes, characterized by Variscan nappe tectonics. In the last modification of structure of the Svratka Dome (J. JAROŠ 1992), in which the important kaoline deposit of Lažánky occurs, even two nappes are in superposition. Both nappes, the lower Moravian and the upper Moldanubian, were thrusted over Brunovistulicum. The largest known deposit in the centre of the Svratka Dome originated by kaolization of cataclased granite of the Brunovistulian autochtone, which was uncovered by denudation in a tectonic window. Less important occurences of kaoline are present also in the Moravicum (Bíteš orthogneiss and phyllites), which is a tectonic half-window originated by denudation of the Moldanubian nappe. The depth of kaolization in the Lažánky deposit is about 110 m (M. KUŽVART, 1965).

Kaolinization in the area of the Dyje Dome was prepared, too. However, tectonic development was different here (e.g. absence of eastern half of the dome could indicate the deeper denudation). Main kaoline deposits are again on granite (Dyje granite) in the centre of dome. In the deposit Únanov the depth of kaolinization is more than 80 m (M. KUŽVART 1965). According to L. KRYSTKOVÁ (1971) thickness of kaolines at the deposit of Plenkovice (about 6 km north of Dyje NP) attains 81 m. Here, the kaolines originated on the Bíteš orthogneiss and importance of tectonics is also emphasized.

In the past, the processes like diapthoresis of phyllites (retrograde metamorphism) were connected (but later refused) with overthrusting in the both domes. However, it is more probable, that it was dynamometamorphism, which prepared very different rocks for kaolization.It it also possible, that unusual great depth of chemical weathering also connects with this process.

The largest kaoline deposits in the surroundings of Znojmo, Únanov and Plenkovice, are close to the margin of the Bohemian Massif, in the altitude of about 300-350 m, only. Here, in short segment of margin, instead of distinct marginal slope, only an undefinable, very long and gentle slope passes the Carpathian Foredeep. The absence of slope connects probably with the cross fault trending to SE (A. DUDEK-V. ŠPIČKA 1975). Here the kaolines probably were thicker and their denudation was delayed owing to the low altitude.

The well-known deposit Únanov in the altitude of 300 m is in a very shallow depression trending to NE in the head of the first-order valley. The potential deposit Hradiště, 2 km west of the town of Znojmo at the boundary of the Podyjí NP, is in the altitude of about 350 m. It is situated on an almost ideal flat surface underlain with Miocene sediments and Quaternary loams.

The Austrian deposits in surroundings of the Thaytal National Park are in the altitudes of above 400m. Niederfladnitz (5 km NW of the town Retz) originated on the Dyje granite, the Mallersbach (4 km WSW of the town Hardegg) on the Bíteš orthogneiss (H.F. HOLZER - P. WIEDEN 1969).

The kaolines were found and studied also in the area of the Podyjí NP, especially near the villages of Hradiště and Mašovice - Podmolí (J. NEUŽIL - M. KUŽVART, 1972, J. PAVLÍK 1987), or in their immediate vicinity. Results of the recent research were published also by L. KRYSTKOVÁ (1971) and P. BATÍK - M. GABRIEL - P. ŠEBA - O. LUBINA (1979).

In the paper about kaolines of the discovered deposits in the surroundings of Znojmo, J. NEUŽIL - M. KUŽVART - P. ŠEBA (1980) found, that biotite of the Dyje granite is primary chloritized by dynamometamorphosis and its fine scales parallel with dynamometamorphic foliation facilitate deep weathering at many places. Another interesting aspect is that alternation of potash feldspars started after complete weathering of plagioclas.

As to comparison with granite weathering products in Hercynian Europe (J.P. BAKKER - Th.W.M. LEVELT 1964, J.P. BAKKER 1960), the detailed analyses of kaolines from the localities of Hradiště and Mašovice-Podmolí, in the immediate vicinity of the Podyjí NP, published by J. NEUŽIL, M. KUŽVART and P. ŠEBA (1980) have shown different proportions of clay, silt and sand fractions, with 2.4-17.4 % of clay particles, predominately kaolinite, 10-15 % of illite and a few percent of montmorillonite. J. PAVLÍK (1987) has found in the Mašovice-Hradiště deposit of 87 % kaolinite in primary kaoline and 86 % kaolinite and 9 % montmorillonite in redeposited kaoline. As concerns weathering of two-mica schist or phyllites in the Dyje Dome, M. KUŽVART (1965) has only mentioned decay of phyllites into black plastic clay at the deposit from Únanov.

There are great differences in thickness of kaolines and the basal surface of weathering is not well defined in most of the cases. Without a doubt, the existing rests of kaoline weathering crust are only the deepest roots of an originally thick, probably almost continuous mantle. Absence of corestones near kaoline deposits is significant, too. Regardless of these facts, the deep chemical weathering and stripping (etchplanation) was very probably the major planation process in Mesozoic and Paleogene.

In the opinion of authors, the prevailing portion of kaoline weathering crust was denuded in the southeastern part of the Bohemian Massif already before Lower Miocene marine transgression. The products of deep chemical weathering were washed out into shallow erosion or tectonic depressions. Gravels and boulders in the Lower Miocene sediments suggest that also bare rocks of adjacent elevation such as inselberg (Schildinselbergs of J. BÜDEL 1978) were strongly attacked. Thus the sea trangressed over topography which was a low hilly landscape rather than a perfect flat plain. The landscape consisted of weathered and bare rock surfaces with forms such as inselbergs (e.g. Býčí hora, 536 m). In the conception of F.E. THOMAS (1974) it could be a partially or dominantly stripped etchplain. The local height differences could attain more than 100m and clearly, the relief evolution was controlled by resistance of rocks and climatic changes. As A.VELDKAMP and A.P.OOSTEROM (1994) point out, "etching and stripping processes tend to increase relief instead of reducing it". But the relief evolution since the marine trangression in Lower Miocene was too complex, to consider present relief to be an etchplain, although processes of etchplanation were cooperating in certainty in morphogenesis (T. CZUDEK - J. DEMEK 1970).

In discussing geodynamic evolution of the central Paratethys and its climatic implications, I. CICHA and M. KOVÁČ (1990, p.72) refer, that "within Ottnangian humidity gradually decreased and climate became drier with continental features". In connection with application of plate tectonics in the West Carpathians region, the paleogeographic changes are thought to be very important for changes of climate. The content of montmorillonite in several profiles would indicate a possibility of some drier climate, too. Further, global climatic changes in Late Tertiary and Quaternary have influenced relief evolution and we must pressupose also other types of weathering of granite and crystalline rocks.

4.1.2.3 Position and importance of Lower Miocene deposits

In the middle part of the Podyjí NP, 2.5 km south of the village Lukov and at the road to the castle Nový Hrádek, the planation surface forms a flat topped ridge in the altitude of 390-400 m, about 130 m above floodplain of the Dyje. The flat surface is composed of polymict gravels and sands, about 3 m thick, with distinct dominance of quartz. The sediments are occasionally mined in the shallow pit. The deposits contain predominantly well-rounded pebbles and also badly rounded or angular fragments of different rocks. The sediment is not sorted,some rounded boulders are more than 50 cm in diameter, requiring long transport and rapid rash accumulation. The gravel and sand have character of basal clastics and rest uncorfomably on sligtly weathered chloritized mica schist of the Lukov unit. According to the geological map of P. BATÍK, the sediments are of Ottnangian age (Lower Miocene). In opinion of V. ŠPALEK (1935a) the gravel is of Pleistocene age.

The palynological analysis of sands and clays (up to 25 m thick) of near-by deposit Únanov has shown the Eggenburgian - Ottnangian age (P. BATÍK - M. GABRIEL - P. ŠEBA - O. LUBINA 1979), too. However, the last mentioned authors have noted in the locality Únanov also quarzite (Oligocene ?) in one of the drills.

A less instructive locality, also underlain by two mica schists, is about 1.5 km west of the Lukov village on the flat-topped ridge in the altitude of 400 m. Here, the residual quartz pebbles, very well rounded, mixed with resedimented kaoline clay are present.

It seems, that the Miocene sediments occur prevalently in the area of some lower altitude underlain with less resistant micaschist. Towards the NE they extend up to the local drainage divide north of the Lukov. The sands and gravels fill a shallow depression between the flat ridge composed of the Bíteš gneiss on the NW and the less distinct elevation with flat rock-bare surface built of the granite of Dyje massif on the SE. It is interesting in this context, in spite of intensive research, among a lot kaoline occurences, the only mention of deep weathering crust on the less resistant phyllites is in the paper of (M. KUŽVART 1965 and J. KARÁSEK 1985). No relation both of the depression and Miocene sediments to the present drainage lines is apparent.

In Austria, in the SW extension of the zone of micaschists, the depression is also visible.Owing to the greater altitude of granite relief east of micaschist, the depression is more distinct there (see also the profile in H. NOWAK 1969). Lower Miocene sediments are also occuring in the depression.

Very interesting is also the position of Lower Miocene sediments on the bottom of a structural and topographic depression in the surroundings of villages Šafov and Langau west of the Podyjí NP. In the flat depression trending to SW the Lower Miocene sediments were downfaulted in a zone of non-resistant two-mica schists. (The geological map of CSSR 1 : 200 000, sheet Jindřichův Hradec, A. DUDEK a kol. 1962). The bottom of depression in the altitude of 430-450 m corresponds well with sediments near Nový Hradek. The height difference between the bottom of depression and planation surface in adjacent part of the Podyjí NP truncating the resistant Bíteš gneiss is about 100 m.

Different, but a very instructive locality of Miocene sediments is on the east margin of the Podyjí NP above the marginal slope of the Bohemian Massif. Here, at the village of Konice and at the elevation point of Kraví hora (347 m), the pavement of perfectly rounded quartz pebbles originated on the flat granite surface in the altitude of 335 m. Northeast of the Kraví hora, in the lower altitude of some 310 m, rests of gravel of the same type are preserved on the rather irregular surface of sandy weathered granite. The sediment is thought to be of Eggenburgian - Ottnangian age (geological map 1 : 25 000, sheet Znojmo, 1983). Similar sediments crop out also on the marginal slope of the Bohemian Massif.

4.1.3 Buried planation surfaces in the adjacent part of the Carpathian Foredeep

In addition to analysis of planation surface in the Bohemian Massif itself, additional but important information is also provided by the buried relief in the Carpathian Foredeep. In front of the marginal slope of the Bohemian Massif, the planation surface truncating various crystalline rocks and Upper Paleozoic sediments continues under Miocene sediments of the foredeep eastwards. Here, however, the surface is more affected by young tectonics. The planation surface is block-faulted (J. KARÁSEK 1985), but in generalized profile almost horizontal in forefield of the marginal slope. However, some protrusions of basement occur here. The thickness of Miocene sediments does not usually surpass 200 m. The basement surface dips to the east at the rate of 9-25 m per km and in depth about 400-500 m and 20-25 km from the marginal slope passes over on Jurassic limestone. Thus, eastwards of the village of Jaroslavice there are under Miocene sediments two buried planation surfaces. The younger one, truncates in the same level both the crystalline rocks and gently inclined Jurassic limestone. With its moderate basinward dip, the carbonate structure is potential for formation of cuesta, but details of buried topography are not known.

The latter planation surface, buried under Jurassic sediments and underlain with crystalline rocks, dips eastwards gently at first but approaching to the front of Carpathian flysch nappe, its basinward dip is steeper (some 200 m per km) and is both downwarped and faulted. In our opinion, this planation surface on crystalline rocks is very probably of post-Hercynian age. Further eastward, under flysch nappes, the Jurassic sediments are thicker and together with basinal facies of Upper Cretaceous sediments are present. The projection of the sub-Hercynian planation surface towards the west anticipates a relatively great height difference (and also intensive post-Jurassic denudation), compared to altitude of the present planation surface in surroundings of the town of Znojmo.

4.2 Marginal slope of the Bohemian Massif and relief in its eastern forefield

4.2.1 The marginal slope

The SE marginal slope of the Bohemian Massif faces the Dyjsko-svratecký úval (Graben), which originated after regression of Miocene sea coming to the SW part of the Carpathian Foredeep. As stated above, the SE marginal slope of the Bohemian Massif between Brno and the Moravian-Austrian border is distinct in granites of the Brno and Dyje Massif, while in metamorphites (between towns of Miroslav and Znojmo) transition to the Dyjsko-svratecký úval (Graben) is very gradual and in some places the slope is practically absent. There, the margin is also masked with thick cover of loess, deposited on the leeward.

Eastern limit of the Podyjí NP is situated in the upper part of the marginal slope of the Bohemian Massif between the towns of Znojmo on the N and the state boundary on the S. Morphology of the slope, its height, profile, structure as well as of its piedmont are very variable. The marginal slope is about 8 km long and 1-1.5 km wide in this section. Its upper edge is not quite distinct everywhere and this applies also to the foot.

In the short section immediately south of Znojmo, the slope is 40-100 m high, composed mostly of Eggenburgian-Ottnangian sediments. As mentioned above, near the village of Konice, remnants of quartz gravel rest on granite. The gravel can be seen also in old inactive gravel-pit in the uppermost part of the marginal slope. At foot of the slope, however, granite protrudes above surrounded fine grained sand with silt. In the middle section of the slope also fluvial sediments called "younger gravel cover" assigned to Lower Pleistocene (Günz)

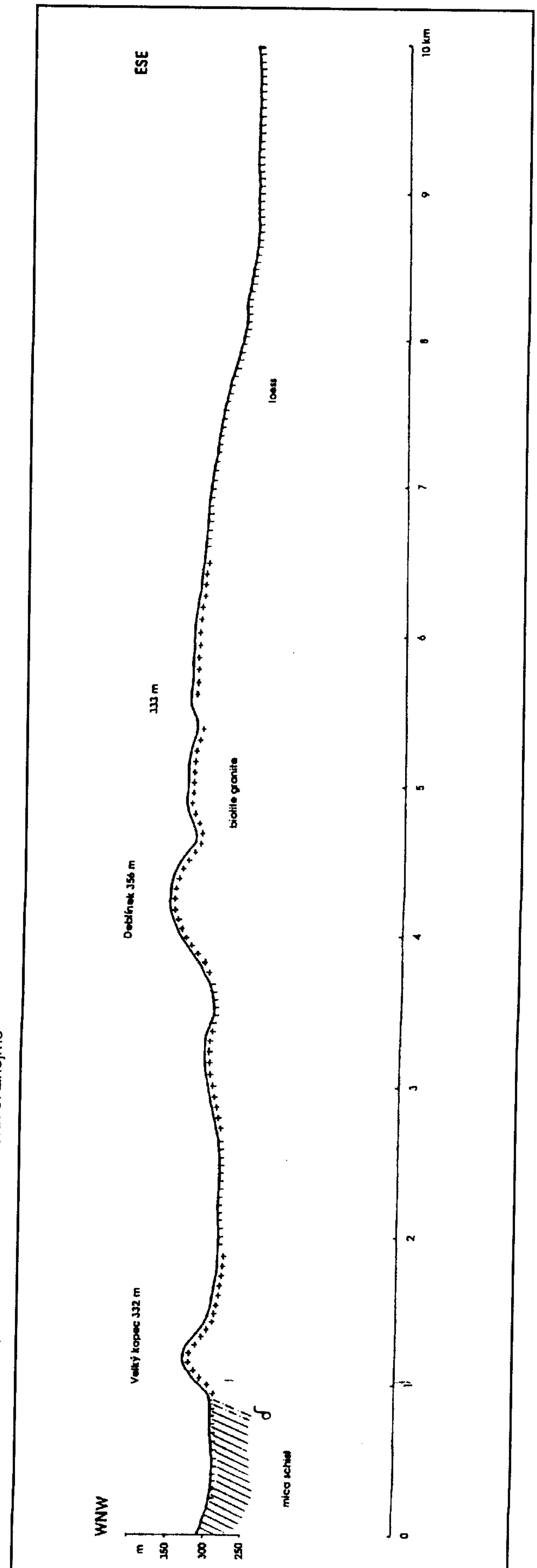


Fig. 4 Profile of marginal slope of Bohemian Massif north of Znojmo

are mapped, too. The slope dips only 4-9^{o}, the foot being in the altitude of 230-270 m.

Between the villages of Konice and Hnanice morphology of marginal slope is even more complex . In the uppermost part of the slope, in the altitude of 300-330 m, some tors and boulders protrude from sandy weathered biotite granite, some of them in the protected heather. The marginal slope is more gentle, rarely more than 5^{o} inclined. On the slope, the low rocky ridges, tors and boulders occur, too. Whereas general direction of the slope is NE, the rocky ridges and other forms prefer the N or NNW direction, related to schistosity of granite. The foot of slope in the altitude of 270-290 m is rather arbitrary. At the foot of slope, about 15 m high granite inselberg (Pustý kopec - Deserted hill, 263,7 m) projecting from the very flat bottom of shallow first-order valley is a very striking form.

Most distinct is the marginal slope in Austria. Towards SW from the village of Hnanice to the rivulet of the Pulkau (in Austria), the marginal slope is higher (up to 200 m, see profile of H.NOWAK 1969). Foot of the marginal slope is in the altitude of 270-370 m, planation surface above the slope in 370-480 m. In front of the slope many granite elevations are present, some of them of inselberg type.

Origin of the marginal slope and its evolution are difficult problems. Austrian authors support the idea, that the marginal slope was created by tectonic movements in the Oligocene or Lower Miocene. Then, following subaerial erosion the sea transgressed over the very dissected shore with many embayments (one of the largest is the Eggenburg Bucht-embayment) in Eggenburgian time. During the repeated transgressions , the thick sediments were accumulated and have buried dissected erosion relief under Egenburgian-Ottnangian, Carpathian and Lower Badenian sediments, in opinion of Austrian geologist up to the altitude of 420 m. After sea regression, the relief on crystalline rocks was ressurected step by step. The denudation levels in the forefield of Bohemian Massif as well as on its marginal slope are explained by this mechanism. H. NOWAK (1969) recognized 8 post-Badenian denudation levels in NW part of Weinviertel and marginal part of the Bohemian Massif. Thus, in concept of Austrian geologists and geomorphologists, the marginal slope is Late Oligocene or Early Miocene form, partly denuded, then buried and exhumed. R. GRILL (1958) recognized a less important tectonic phase in Lower Miocene (Helvetian and Lower Tortonian) yet. Some authors have admitted queer elevation in the SE-NW direction.

In the Czech literature, there is no mentioning of how the marginal slope originated. Only J. KARÁSEK (1985) in general review of relief evolution of the surroundings of Znojmo stressed the importance of post-Badenian faulting, especially with graben-like structure of this part of Carpathian Foredeep.

In our opinion, the evolution was rather complex and the differences in structure basement were significant.

In Austria a very important tectonic disturbance in the structure of SE part of the Bohemian Massif is the zone of Mailberg fault trending to NE. This fault with the amplitude of 3000 m separates the subsided Hollabrunn-Laa Depression(or block) with very thick Jurassic and Cretaceous sediments from the uplifted Sitzendorf block, where only 360 m thick Tertiary sediments rest on the basement rocks. The Mailberg fault was most active in Jurassic. On the uplifted block the marginal slope originated, too, but now is about 15 - 20 km from the buried fault-line.

As to geomorphological importance, the Mailberg fault rises two questions. The first is a problem of renewed fault movement of Mailberg fault zone in Miocene and its amplitude. The second problem, the large, some 15 - 20 km, parallel retreat of marginal slope from the fault-line.

The basement structure of South Moravian block, in front of marginal slope of the Bohemian Massif is even more complex. The Velké Pavlovice fault system (V. ŠPIČKA 1976) very probably corresponds with Mailberg fault zone. Addition to parallell to this fault system, the Ždánice flexure is suggested under marginal part flysch nappes. The Mailberg fault zone branches out in the surroundings town of Mailberg. The main fracture named the Velké Pavlovice fault system, has a complicated course and runs under Carpathians nappes, some 40 km from the margin of the Bohemian Massif (Z. STRÁNÍK - J. ADÁMEK - V. CIPRYS 1979). The others are subsidiary branches, the East Dyje and West Dyje faults dislocating the Lower Miocene, Carpathian and Lower Badenian sediments Carpathian Foredeep (M. DLABAČ - M. MOŘKOVSKÝ 1963). Thus, the marginal slope of the Bohemian Massif is on no account connected with Velké Pavlovice fault system.

More acceptable explanation is presence of a parallel fault situated close to the foot of marginal slope, as suggests the Tectonic map of CSSR (M. MAHEL - O. KODYM - M. MALKOVSKÝ, 1984). In the surroundings of Znojmo this marginal fault crossed with the Boskovice -Diedendorf fault. In our opinion, the main fault movements along these disturbances occured in Oligocene or Lower Miocene with some repetition after Lower Badenian. The crossing of the marginal fault with the Boskovice-Diedendorf fault resulted in a block-faulted relief (J. KARÁSEK 1985), in front of the marginal slope of the Bohemian Massif. The differences in height of marginal slope areas have been caused probably by undulations along quer axes. Thus, absence of marginal slope of the Bohemian Massif north of Znojmo connects with fault trending to SE, which separates the partial Pavlov and Waschberg blocks inside of South Moravian block (A. DUDEK - V. ŠPIČKA 1975).

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Between the villages of Konice and Hnanice morphology of marginal slope is even more complex. In the uppermost part of the slope, in the altitude of 300-330 m, some tors and boulders protrude from sandy weathered biotite granite, some of them in the protected heather. The marginal slope is more gentle, rarely more than 5° inclined. On the slope, the low rocky ridges, tors and boulders occur, too. Whereas general direction of the slope is NE, the rocky ridges and other forms prefer the N or NNW direction, related to schistosity of granite. The foot of slope in the altitude of 270-290 m is rather arbitrary. At the foot of slope, about 15 m high granite inselberg (Pustý kopec - Deserted hill, 263,7 m) projecting from the very flat bottom of shallow first-order valley is a very striking form.

Most distinct is the marginal slope in Austria. Towards SW from the village of Hnanice to the rivulet of the Pulkau (in Austria), the marginal slope is higher (up to 200 m, see profile of H.NOWAK 1969). Foot of the marginal slope is in the altitude of 270-370 m, planation surface above the slope in 370-480 m. In front of the slope many granite elevations are present, some of them of inselberg type.

Origin of the marginal slope and its evolution are difficult problems. Austrian authors support the idea, that the marginal slope was created by tectonic movements in the Oligocene or Lower Miocene. Then, following subaerial erosion the sea transgressed over the very dissected shore with many embayments (one of the largest is the Eggenburg Bucht-embayment) in Eggenburgian time. During the repeated transgressions , the thick sediments were accumulated and have buried dissected erosion relief under Egenburgian-Ottnangian, Carpathian and Lower Badenian sediments, in opinion of Austrian geologist up to the altitude of 420 m. After sea regression, the relief on crystalline rocks was ressurected step by step. The denudation levels in the forefield of Bohemian Massif as well as on its marginal slope are explained by this mechanism. H. NOWAK (1969) recognized 8 post-Badenian denudation levels in NW part of Weinviertel and marginal part of the Bohemian Massif. Thus, in concept of Austrian geologists and geomorphologists, the marginal slope is Late Oligocene or Early Miocene form, partly denuded, then buried and exhumed. R. GRILL (1958) recognized a less important tectonic phase in Lower Miocene (Helvetian and Lower Tortonian) yet. Some authors have admitted queer elevation in the SE-NW direction.

In the Czech literature, there is no mentioning of how the marginal slope originated. Only J. KARÁSEK (1985) in general review of relief evolution of the surroundings of Znojmo stressed the importance of post-Badenian faulting, especially with graben-like structure of this part of Carpathian Foredeep.

In our opinion, the evolution was rather complex and the differences in structure basement were significant.

In Austria a very important tectonic disturbance in the structure of SE part of the Bohemian Massif is the zone of Mailberg fault trending to NE. This fault with the amplitude of 3000 m separates the subsided Hollabrunn-Laa Depression(or block) with very thick Jurassic and Cretaceous sediments from the uplifted Sitzendorf block, where only 360 m thick Tertiary sediments rest on the basement rocks. The Mailberg fault was most active in Jurassic. On the uplifted block the marginal slope originated, too, but now is about 15 - 20 km from the buried fault-line.

As to geomorphological importance, the Mailberg fault rises two questions. The first is a problem of renewed fault movement of Mailberg fault zone in Miocene and its amplitude. The second problem, the large, some 15 - 20 km, parallel retreat of marginal slope from the fault-line.

The basement structure of South Moravian block, in front of marginal slope of the Bohemian Massif is even more complex. The Velké Pavlovice fault system (V. ŠPIČKA 1976) very probably corresponds with Mailberg fault zone. Addition to parallell to this fault system, the Ždánice flexure is suggested under marginal part flysch nappes. The Mailberg fault zone branches out in the surroundings town of Mailberg. The main fracture named the Velké Pavlovice fault system, has a complicated course and runs under Carpathians nappes, some 40 km from the margin of the Bohemian Massif (Z. STRÁNÍK - J. ADÁMEK - V. CIPRYS 1979). The others are subsidiary branches, the East Dyje and West Dyje faults dislocating the Lower Miocene, Carpathian and Lower Badenian sediments Carpathian Foredeep (M. DLABAČ - M. MOŘKOVSKÝ 1963). Thus, the marginal slope of the Bohemian Massif is on no account connected with Velké Pavlovice fault system.

More acceptable explanation is presence of a parallel fault situated close to the foot of marginal slope, as suggests the Tectonic map of CSSR (M. MAHEL - O. KODYM - M. MALKOVSKÝ, 1984). In the surroundings of Znojmo this marginal fault crossed with the Boskovice -Diedendorf fault. In our opinion, the main fault movements along these disturbances occured in Oligocene or Lower Miocene with some repetition after Lower Badenian. The crossing of the marginal fault with the Boskovice-Diedendorf fault resulted in a block-faulted relief (J. KARÁSEK 1985), in front of the marginal slope of the Bohemian Massif. The differences in the height of marginal slope areas have been caused probably by undulations along quer axes. Thus, absence of marginal slope of the Bohemian Massif north of Znojmo connects with fault trending to SE, which separates the partial Pavlov and Waschberg blocks inside of South Moravian block (A. DUDEK - V. ŠPIČKA 1975).

4.2.2 Crystalline elevations in forefield of the marginal slope

In front of the marginal slope of the Bohemian Massif, solated elevations, some of them rather larger, composed of predominately crystalline rocks protrude from the weak Miocene sediments. Some small hills, situated at the foot or close to the marginal slope and composed of the same rocks are certainly inselbergs. However, large rectangular elevations in some cases composed of very different rocks are supposed to be fault blocks.

The largest block, the Krhovice horst, about 3x5 km in size, lacks distinct margins and in NW it is attached in little depth with the basement rocks of the Bohemian Massif. Only in the W it is separated by a 2 km wide depression, trending and dipping to the N, from the marginal slope of the Bohemian Massif. In the depression the S trending fault is supposed. The flat bottom of the depression is in the altitude of 205-250 m. The depression is crossed by the Dyje river. In two boreholes on the bottom of the depression, the Dyje granite was found in the depth of 118 m and 147 m respectively (approximately 100m above sea level) under Lower Miocene sediments.

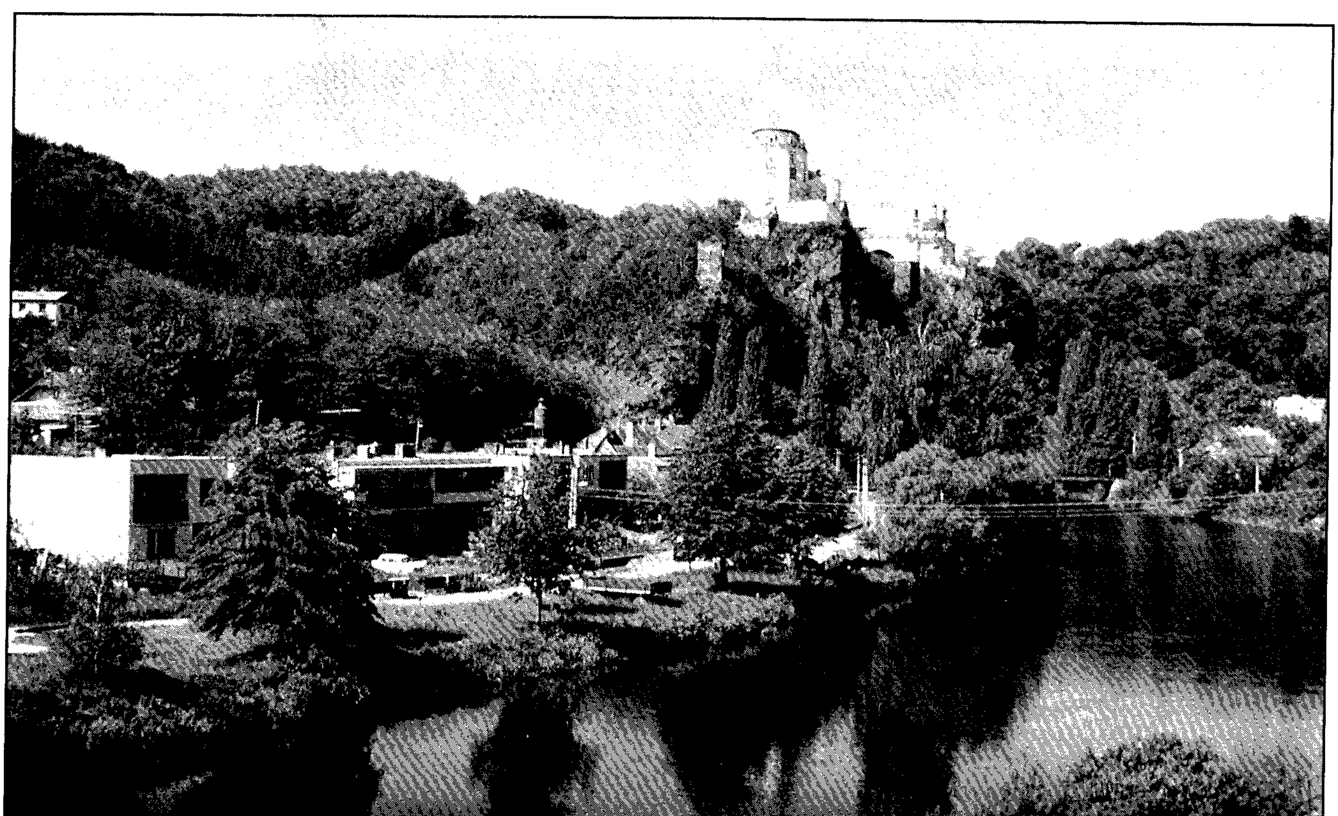
The intrusive rocks, the Dyje biotite granite and quarz diorite form the western part of the horst. They are separated by downfaulted block of Lower Devonian conglomerates from metamorphites, which were enigmatic for geologists for long time. The different gneiss and mica-schist and phyllite are believed to be a volcanic-sedimentary unit belonging to Moravicum (P. BATÍK in J. DORNIČ and al. 1984).

The Krhovice horst dips gently to the east, conformably with the marginal part of the Bohemian Massif. Thus, the highest point of the horst, the Načeratický kopec (hill), attains 290 m above sea level and is situated in the flat granite terrain in the western part. The rests of fluvial gravels in the altitude of about 230 m are thougt to be younger gravel cover of Lower Pleistocene age (Günz). The most interesting form of the horst is the gorge of Dyje, 5 km long and about 50 m deep, incised into crystalline rocks, at present intensively mined.

4.3 The Dyje canyon and valley pattern of the Podyjí NP

4.3.1 Position of the Podyjí NP in the drainage area of the Dyje river

The Dyje river (Thaya in Austria, L-305, 6 km, A-13.418 km^2) is a major water course in the SW Moravia and the largest tributory of the Morava river. Generally, the Dyje river flows towards ESE,down the regional slope. From its unregular, zig-zag or meandering course follows the anomalously high sinuousity connected possibly - at least partly - with prevailing dips of metamorphic rocks to the W or NW.



3. Valle of the Dyje river in town of the Vranov nad Dyjí, the Vranovský zámek (Vranov chateau) is slanding on the rock ridge.
Photo: Mojmír Hrádek

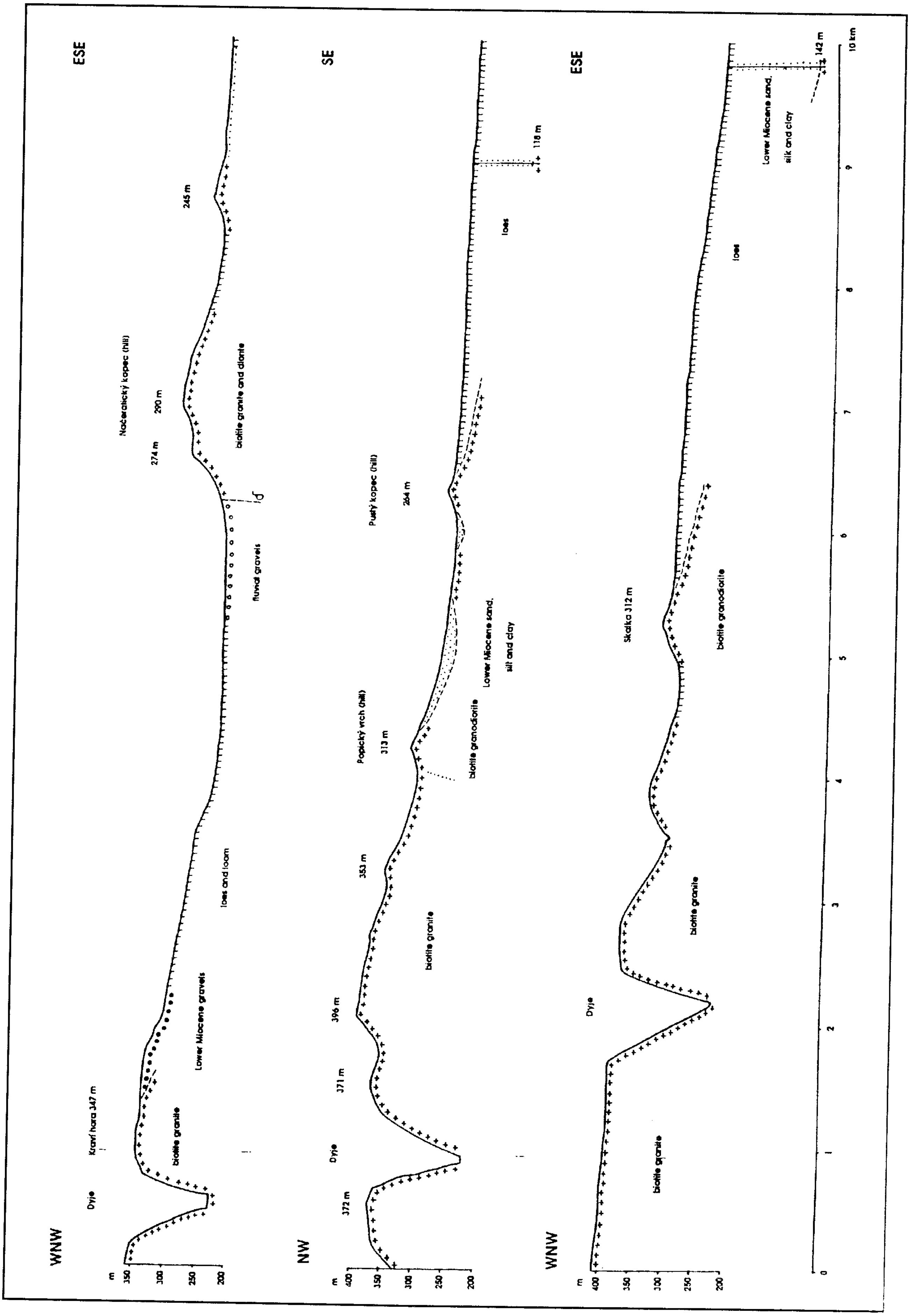


Fig. 5 Profiles of east marginal slope of Bohemian Massif south of Znojmo

Sources of the Dyje river are the Moravská Dyje in Moravia and the Deutsche Thaya in Austria, the first trending to the South, the latter to the North. Both sources join together in the Dyje river near the town of Raabs an der Thaya in Austria. The Dyje river is followed in several sections by the Czech-Austrian border and joins the river of Morava in the Dolnomoravský úval (Graben, geologically in the Vienna Basin) at the contact of Austria, Slovakia and Czech Republic.

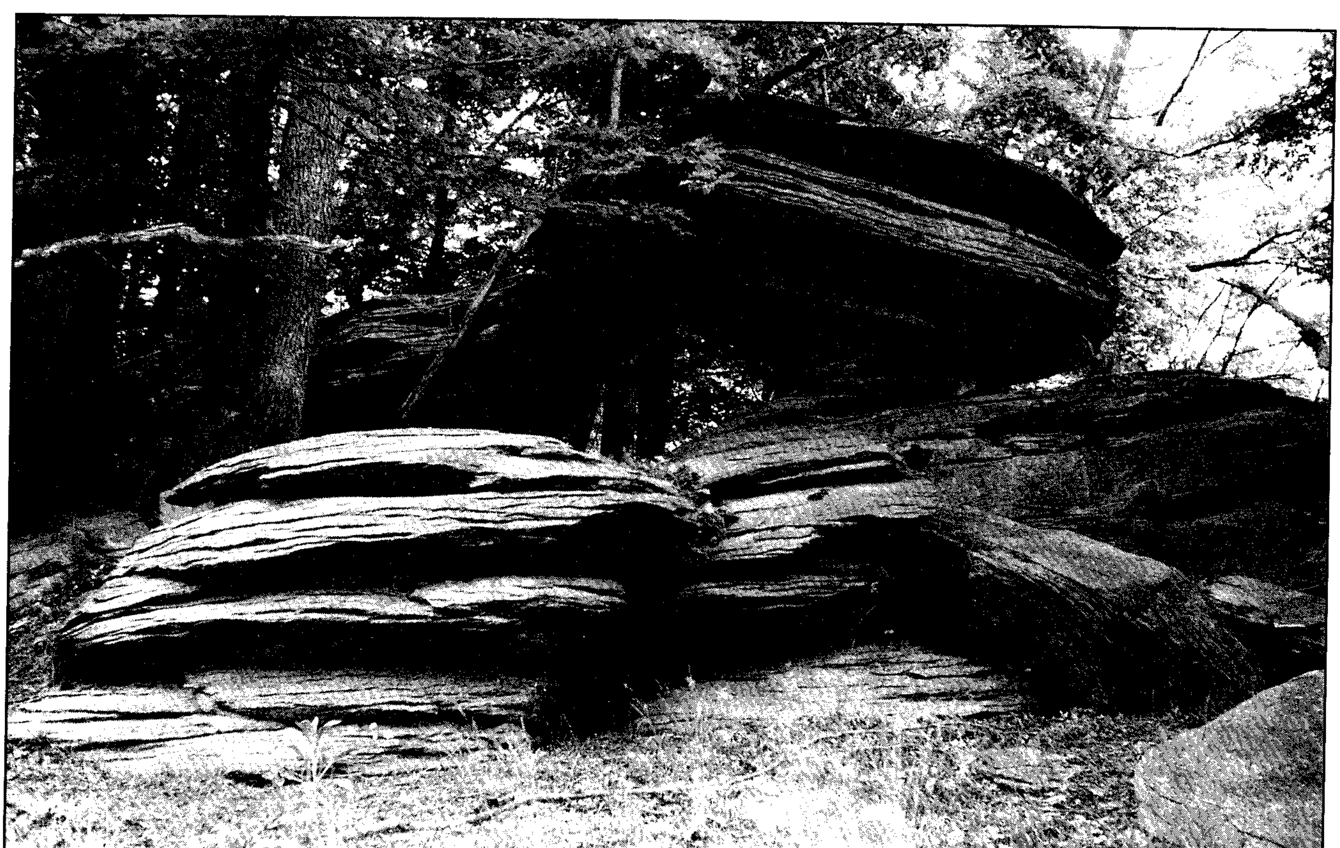
Complicated course of the Dyje river is characterized by four large bends each being some tens of kilometers long. These bends are not regular in form, but broken and composed of reaches of SW-NE and NW-SE direction. The Podyjí NP is situated in the lower part of the second bend and in the uppermost part of the third bend. In these bends, the Dyje river has created many meanders, incised in the bedrock (in the Bohemian Massif, in the upper and middle course) or free alluvial meanders (in the Carpathians, in the lower course). Although the river course is generally independent of structure and lithology, their influences are apparent in detailed morphology of canyon as well as the pattern of low-order tributaries.

4.3.2 The Dyje canyon

The complicated and predominantly meandering canyon of the Dyje river, between the towns of Vranov nad Dyjí and Znojmo is the main and unique landscape feature of the national park. Whereas, the air distance between the river channel at the beginning of the Podyjí NP and its end in Znojmo is only 17 km, actual length of the Dyje river is 41.6 km. The anomalously high sinuosity ratio (2.4) resulted partly from sharp change direction about 9 km upstream of Znojmo, too.

The Dyje river enters the Podyjí NP at Vranov nad Dyjí about 2 km downstream of the Vranov Dam in the altitude of 305 m. The downstream end is at the Znojmo Dam at 215 m. From the vertical difference of 90 m follows an average slope of 2.16 m per km. The cross profile of the canyon, its depth, width and form of slopes, are rather variable, being controlled by gelogical structure. Thus, in harmony with the main geologic units, we distinguish in the Dyje canyon three sections with different morphology.

1) The western section in Bíteš orthogneiss,between the towns of Vranov nad Dyjí and Hardegg. In the surroundings of Vranov nad Dyjí, before entering the Podyjí NP, the Dyje river is incised in lesser resistant paragneiss to the depth of 130 - 150 m. Here, small riverine basin is filled with the Vranov Dam. Downstream of Vranov the Dyje river enters the deepest section composed of Bíteš orthogneiss. On the right side, below the highest point of the Podyjí NP, the Býčí hora (hill) 535.9 m, the depth of valley is almost 250 m. Slopes of the valley are very steep up to vertical at some places. Many tower-shaped tors up to 20-30 m high are accompanied by ledges, steps, boulders and in lower parts of the slope by



4. Tors of the Bíteš gneiss modelled by selective weathering (locality of the Býčí hora, hill - eastern slope). Photo: K. Kirchner

talus and boulders accumulations. The slopes are densely forested and partly inaccessible. Whereas the tors or tor-like forms crop out in several levels, the rock walls rise from the bottom of the valley only in very rare cases.

In this valley section two remarkable geologic and geomorphologic features occur, namely ptygmatic folds in bluff near the entrance to the Podyjí NP and fissure ice caves about 1 km downstream.

The strip of resistant Bíteš orthogneiss between the town of Vranov and Hardegg is 6 km wide, but owing to crookedness, the length of the river is 9.3 km in this rock. Due to high resistance the river bends are rectangular rather than bow-shaped. The meanders are principally symmetrical in cross profile (entrenched type). The sinuosity of 3 successive bends is 1.9. As to relation to bedrock structure the Dyje is up-dip stream. The Bíteš orthogneiss trends NE and dips 20-40^{o} NW. Form of the bends seems to be depending on resistance rather than on structure of the rock.

2) In the middle second section only the left valley side is on the Czech territory. The Dyje is incised in less resistant two-mica schists of the Lukov unit (with the important intercalations of cristalline limestone). The strip of mica-schists is about 5 km wide, however length of the valley (talweg) is 12.9 km (sinuosity in the whole reach being 2.3). The river maintains general canyon-shaped forms, but some valley features are rather different here.

   Large untypical meanders elongated in groundplan in NW-SE direction with very long and narrow necks are the most remarkable forms of the section. The sinuosity of meandering part of the section is very high (2.9). In the cross profile meanders are assymetric and thus belong to ingrown type. Smooth meander curves suggest lesser importance of bedrock structure than in Bíteš orthogneiss. Narrow meander necks, one in Moravia with the castle Nový Hrádek, the other "Umlaufberg" in Austria, demonstrate initial cutting off. The Dyje is predominantely up-dip stream here. As to trend difference between bedrock dip and flow direction (D.R. HARDEN, 1990), anti-dip relation trend difference of 180^{o} prevails, however in short sections in meanders also difference of 90^{o} occur.

   The canyon in the mica-schists is mostly of about 120 - 150 m deep. Very steep rock slopes or bluffs which rise above the river bank are present only at undercut of meander slopes. Distinct rock-walls and bluffs, some tens of meters high, are present particularly upstream of junction of the Dyje river and Klaperův potok (brook), at the locality of Vraní skála (Crow's rock) and between the castle of Nový Hrádek and the mouth of Žlebský potok (brook). At the opposite valley side of the section, in Austria, the canyon of Fugnitz, is the most interesting form of the longest tributary of the Dyje river in the Podyjí NP.

3) The third, eastern section of the Dyje canyon, incised in the biotite Dyje granite is almost 20 km (18.35 km sinusoity 2.1) long. Depth of the canyon does not surpass 160 m, however the canyon-like features are in all respects unique also here. Steep slopes with many tors and exfoliation phenomena especially in the upper parts are accompanied by surprisingly large blockfields and screes. In the lowest part of the section the Dyje river is impounded for 5.5 km behind the Znojmo Dam.

   The Dyje granite is schistosed or cataclased, mainly close to contacts with Moravicum. The schistosity planes trending to NE dip about 70^{o} NW. There is a tendency of the granite to disintegrate into large blocks or boulders.

   Wealth of granite forms in the Podyjí NP is surprisingly large particularly in comparison with Brno granite. There, in deep valleys of Svitava and Svratka rivers, in surroundings of the town of Brno, the weathering granite forms are rather exceptional, as same as the traces of deep chemical weathering. In our opinion explanation of this difference consists in more intensive tectonic shattering rather than cataclasis in the Brno Massif, where depth of denudation is also lesser.

   Course of the Dyje river in the section is very complicated, different from upstream sections. Downstream of the junction of the Dyje river and Žlebský potok (brook), the river flows for about 9 km down the regional slope in tortuous course with some undeveloped incised meanders (sinuosity 1.9). At apex of the last of them, termed Šobes, which is of entrenched type, the Dyje turns at first to the N for 3 km and then to the NE up to the eastern margin both of the Podyjí NP and Bohemian Massif. In this slightly winding course trending to NE the Dyje river is impounded. Thus, in spite of the regional slope the Dyje river flows from the Šobes meander approximately in parallel with marginal slope of the Bohemian Massif.

The floodplain of the Dyje river in the Podyjí NP is well developed mainly in the section of two-mica schists and in meanders.

Quaternary fluvial terraces are very rare in the Dyje canyon. Hopeful places as slip-off slopes, e.g. the Šobes meander, are transformed in agricultural terraces cultivated for centuries. At the Gališ meander,in the middle section of canyon composed of mica-schist, we found the rest of fluvial accumulation, destroyed by slope processes.

The most hopeful profile has been found,for the time being, in lower part of the left valley slope below Králův stolec. In the altitude of 256 m, about 30 m above the floodplain we found fluvial, mostly coarse-grained gra-

…es with slightly rounded pebbles of quartz and orthogneiss. Sediments of loess type occur in the gravel intercalations. Known thickness of the sediments in the profile is 2.45 m. According to its elevation and relation to the Dyje river terraces in adjacent part of the Dyjsko-svratecký úval (Graben), gravel is probably analogous to the young gravel cover of Early Pleistocene age (A. ZEMAN 1974).

4.3.3 Pattern of tributary valleys

Tributaries of the Dyje river in the Podyjí NP are mostly low-order streams. The Granický potok (brook) as the longest left tributary of 13.3 km in length is the stream of the 3rd order. The Klaperův potok (brook) is only 8.6 km and Mašovický potok (brook) 5.6 km long. Other streams are no more than 2-4 km long. Some short watercourses are episodic and disappear in the bottom or in slope sediments.

On the right side, no tributary is longer than 3 km in the Moravian part of the Podyjí NP. In Austria, on the other hand, the Fugnitz is 21 km long and flows in deep canyon incised in mica-schist of the Lukov unit. The abandoned incised meander is another interesting form of its course.

Headwaters of the longer tributaries are trending to SE, suggesting the direction of original drainage straight to the Dyjsko-svratecký úval (Graben). The Granický potok (brook), as the best example flows towards SE for the most part of its course and only some last hundred metres turn suddenly to the SW.

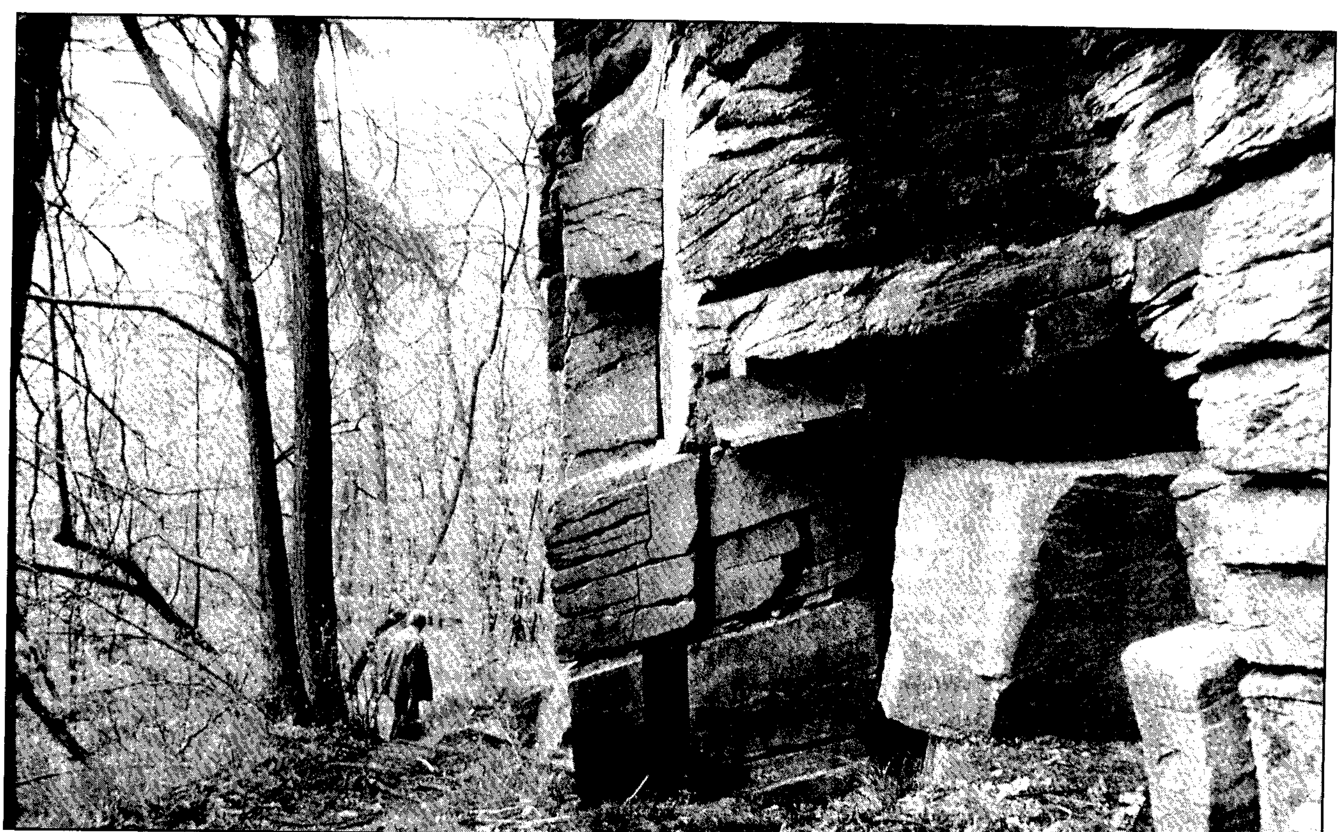
In the source areas valleys are both open and very shallow, channels being straightened up artificially in the mostly agricultural landscape. In the middle and lower courses both the slopes and gradients are steeper. Nickpoints are mainly in granite. Alluvial fans are mostly neglectable.

5. Some interesting geomorphological localities

In the Podyjí NP many interesting relief forms occur. Here only a very short information is given about forms developed predominately by processes of erosion and denudation.

1. Vranov - fissure ice caves and gravitational phenomena

The fissure ice caves are situated on the narrow rock ridge in core of a deep incised meander of entrenched type. The ridge composed of Bíteš orthogneiss is almost 1 km long, 130 m high and it narrows towards SW to the tip of spur. The ridge is trending to ENE, the rock dips 15 - 30° NW. Thus NW facing the concave undercut slope of meander is well predisposed to gravitational loosening, cambering and desintegration. Thin intercalations of biotite schists were important for realizing of movements, too



5. Rock walls of the Bíteš gneiss afected by gravitational processes (failure) on the locality of the Ledové sluje (ice caves).
Photo: Mojmír Hrádek

(V. ŠPALEK 1935b). As a result, the whole slope from the top to the foot has been affected. The rock walls, pillars, deep opened fissures, huge angular blocks and coarse debris are very main features of the slope. In the rock and block accumulation tens of meters deep and some hundred meters long fissures occur, known by year - long preservation of ice.

At present, dynamics of block movements is monitored (J. ZVELEBIL - B. KOŠŤÁK - J. NOVOTNÝ - P. ZIKA, 1993).

The form has been classified mostly as rock slide (J. KOUTEK, 1934, V. ŠPALEK, 1935b), however some features resemble rock glacier (cf. H.E. MARTIN - W.B. WHALLEY 1987). Age of slide movements is obscured.

In front of the slide slope and the block accumulation the valley of Dyje (river) is somewhat wider, also owing to erosional activity of two short left tributaries. On the flat valley bottom an unusual isolated rock protrudes. The rock is about 75 m long, 30 m wide and flat-topped, composed of bare rock. The top is 12 m above the floodplain surface. The rock was interpreted as cutoff meander core or severed spur by V. ŠPALEK (1935a). In his opinion, the cuttingoff took place when 9 m terrace of the river Dyje was formed. However, the terrace gravel mentioned in the ŠPALEK's paper is in fact a sediment of alluvial cone of two left tributaries.

However, another explanation of the isolated rock is also possible, connected with loosening of the slope. In our opinion, the isolated rock was separated from the opposite meander spur not by lateral erosion from opposite sides, but more probably by breaking or overspilling of the spur due to updamming of a part of the valley bottom by catastrophic slope failure.

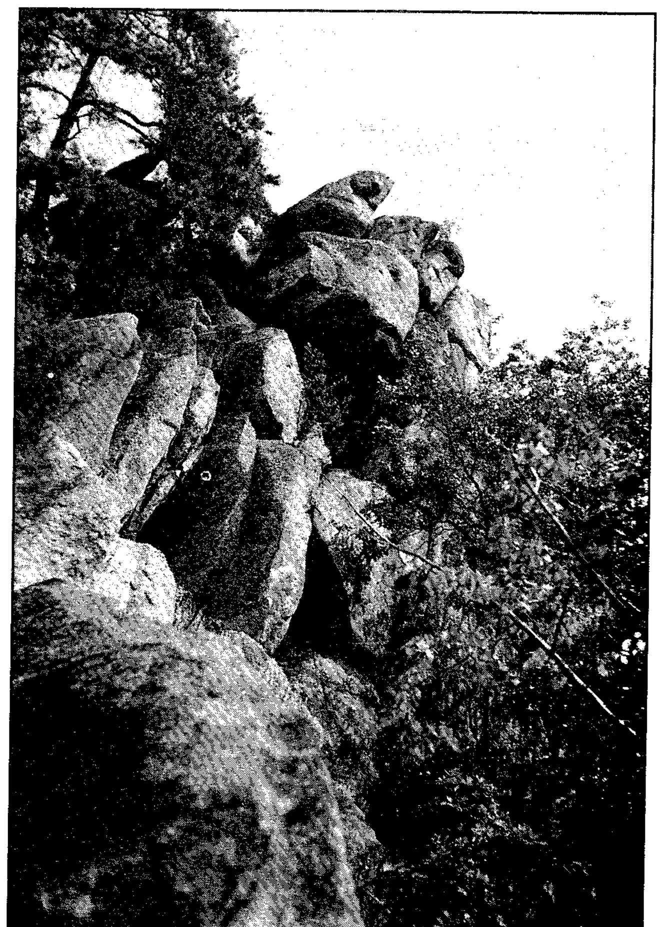
The features indicating the slope loosening have been found also on the right valley slope, about 250 m high,especially near its upper rim. This slope is remarkable by many tower-shaped tors and scree accumulations.

2. Valley of Klaperův potok (brook). In its upper course the brook is incised in Bíteš orthogneiss. Here, incised meanders and many cryogenic forms on valley slopes occur. In the middle and lower course the valley is incised in mica schists with intercalations of crystalline limestone. This is important for studying Upper Pleistocene and Holocene landscape evolution. Cave entrances, corrosion microforms and loess with two interglacial soils are regarded by V. CÍLEK (1993). The Klaperův potok (brook) is the only left tributary with the continuous floodplain and steps indicating several episodes of erosion and accumulation. In the lowermost course direction changes occurred probably.

3. Šobes. The local name includes vineyards on a slip-off slope of the (ingrown) meander of the Dyje river incised in biotite granite. Several very interesting forms are in its surroundings. In neighbourhood of the Šobes, some hundred meters upstream, an incised cut-off meander with amphitheatre facing southeast is very remarkable. Bend of the abandoned meander is about 600 m wide. Walls of the amphitheatre are up to 100 m high. The neck is 400 m long and forms a sharp-topped ridge (291 m) with tors and boulders. The floodplain surface is in the altitude of 250 m, the saddle between the neck and amphitheatre wall in 280 m. The neck separates the former valley bottom into two parts. The planation surface above abandoned meander as well as on opposite valley side is in the altitude of 400 m.

The Šobes meander is rather rectangular, elongated in the direction of NNW-SSE. The narrow neck, more than 800 m long, connects with mutual position the Šobes meander with the above mentioned abandoned meander. Undercut slopes are very steep with tors and screes. The floodplain of Dyje river around the slip off slope of meander is wider and ruins of several mills are preserved (this locality is termed the Nine Mills).

At the apex of the Šobes meander an important direction change of the Dyje river course takes place. Here the Dyje river flowing towards SE turns suddenly to the north. It is interesting, that the change was



6. Weathering forms of granite on the southern slope of the Krá[illegible] stolec (King's table) Photo: K. Kirch[illegible]

made possible owing to lesser height of the undercut concave slope of meander. Although both the right and the left valley slopes are mostly up to 150 m high, height is only 50 - 60 m in the short reach of the undercut concave slope (about 450 m long). The reach is delimited by two short right tributary valleys trending to SE. This direction suggests that the former course of Dyje continued from Šobes to the SE, probably in position, used by Daníž brook at present. The shallow heads of both tributary valleys pass upstream into undistinct cols in the altitude of 295 - 300 m, only 50 m above the river. These cols are practically in hanging position above marginal slope of the Bohemian Massif.

Šobes is the last incised meander in the Dyje canyon. Downstream of the meander the valley is extremely rocky with rudimentary floodplain only, many tors, blockfields and exfoliation forms. Above the right valley slope we found the fissure paralell with the river. The fissure is some hundred meters long suggesting potential gravitational loosening.

4. Havraníky. The village of Havraníky is situated in the upper part of marginal slope of the Bohemian Massif. In the uppermost part of the slope several groups of granite tors composed of subangular boulders with microform such as weather pits occur.

5. Králův stolec (King's table, 339 m) is a viewpoint at the rim of Dyje canyon with many sub-skyline granite tors, ledges, ribs, exfoliation slabs, weathering pits, pseudolapiés and perched boulders. On the opposite slope similar forms occur near Sealsfieldův kámen (Sealsfield's stone, 373.6 m).

   In the surroundings of Králův stolec many cultivation terraces on the south facing slope occur, mostly abandoned at present. In the small steep rocky valley or ravine we found up to 12 artificial steps and terraced fields, every few m^2 only (K. KIRCHNER - A. IVAN 1994). These petty fields with very favourable microclimate were probably used for vineyards.

6. *Drainage and relief evolution*

As a result of long denudation an extensive post-Hercynian planation surface has become a basic topographic feature in the whole SE part of the Bohemian Massif in Lower Mesozoic. Probably no substantial change due to differential tectonic movements took place in its position. Thus this area belongs to the most stabile part in the Bohemian Massif. Its geotectonic evolution from light block of sialic type into heavy and more persistent simatic block (after J. ZEMAN's classification 1978, see IVAN, 1990) also corresponds, at least partly, to cratogenic regime with its implications for relief evolution (R.W. FAIRBRIDGE, Ch.W. FINKL, jr. 1980).

Information about longterm deep post-Hercynian denudation is scarce. Rests of kaolinic weathering crust, Miocene sediments as well as bare-rock surfaces, loess and periglacial covers suggest polygenetic origin of the regional Meso-Ceinozoic planation surface. Pre-Miocene evolution was characterized by deep chemical weathering in warm climates. However, most of the kaoline weathering crust was denuded before Lower Miocene transgression.

The Dyje river flows down regional slope to the E and SE only with little regard for lithology or structure, nevertheless in a rather zig-zag course. The southeast trend was predestinated probably in Paleogene already and was only slightly modified by orogenic events in adjacent parts of the Carpathians and Alps. The effects of Alpine orogenic movements north of the Danube are apparent in drainage changes of some rivers. In Austria, the Kamp river flowed originally eastwards, up to the Horn or Eggenburg Basin, where it joined the Dyje and Pulkau rivers (F. MACHATSCHEK 1958). Later, perhaps owing to tectonic activity in the Eastern Alps, the Kamp turned southwards to the Danube in the south surroundings of the town of Horn.

Although the main drainage direction was down regional slope to the E or SE, lithologic control of tributaries (SSW-NNE and S-N directions) was important. This is evidenced by the rivers of Moravská Dyje, Deutsche Thaya, Želetavka and Vápovka. The NNE-SSE direction is characteristic for tributaries of the Dyje river in the Podyjí NP, too.

We agree with P. BATÍK (1992) and V. ŠPALEK (1935a), that the Dyje river was superimposed from a sediment cover of unknown thickness. In opinion of V. ŠPALEK vertical erosion and canyon development started in Pleistocene. However timing of this incision is unclear. The incised meanders are thought to have developed from free meanders. However, it is difficult to explain the incised meanders of short tributaries such as Klaperův potok or Fugnitz. The thickness of Miocene sediments must attained at least 130-150 m to process of superposition could start.

ŠPALEK's view of the direction changes is partly in consistence with Machatschek's view. The redirection of the Dyje river could have been caused by uplift movements on quer axis of SE-NW or E-W direction or by repeated movements along the marginal fault. This suggests higher altitude of the marginal slope between the town of Retz and Pulkau river, too.

Distribution of Miocene sediments in the Podyjí NP, mainly in the area of two mica schists also suggests southtrending depressions and possible local and temporary drainage directions in the past. Weak post-Lower Miocene (?) fault tectonics, recognized at kaoline deposit Únanov (P. BATÍK - M. GABRIEL - P. ŠEBA - O. LUBINA 1979) was a possible contributing factor, too. Approximately same direction is characteristic for subsided Lower Miocene sediments between Šafov and Langau.

The Eggenburg Basin situated at the margin of the Bohemian Massif and connected broadly with the Carpathian Foredeep (Outer Vienna Basin) is in a similar position as the Brno Basin and Bránice-Ivančice Basins in Moravia. These basins, related both to the graben structures in the Carpathian Foredeep and to present or ancient rivers, are partly filled with Miocene sediments. East of Eggenburg Basin, there is the Zaya Graben trending to east and filled with sediments of Ur-Donau (Paleo-Danube) of Middle Badenian to Pannonian age (R. JIŘÍČEK - H. SEIFERT 1990). It is supposed, that the river Zaya had an important role in pre-Quaternary evolution of drainage of the SE part of the Bohemian Massif and speculation includes also middle course of the Dyje river and its tributaries (K. JÜTTNER 1940, B. BALATKA - J. SLÁDEK 1962). It is also a question, if the Zaya graben is not analogous to Nesvačilka and Vranovice grabens in Moravia to a certain extent.

Appendix

The regional chronostratigraphic stages of Central Paratethys and their approximate equivalents in Mediterranean region (in parantheses). Compiled from M. SUK et al. (1984) and D. VASS - K. BALOGH (1989)

	Quaternary	
1.8 m.y.		
	Romanian	
3.7 ± 0.1		(Tabian, Plainsancian, Astian)
	Dacian	
5.6 ± 0.2		
	Pontian	(upper Tortonian - Messinian)
7.0 ± 0.2		
	Pannonian	(upper Tortonian)
11.0 ± 0.5		
	Sarmatian	(upper Serravallian-lower Tortonian)
13.6 ± 0.2		
	Badenian	(Langhian-lower Serravallian)
16.6 ± 0.5		
	Karpatian	(upper Burdigalian)
17.5 ± 0.5		
	Ottnangian	(middle Burdigalian)
19.0		
	Eggenburgian	(upper Aquitanian-lower Burdigalian)
22.0 ?		
	Egerian	(Chattian-lower Aquitanian)
25		

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MAPS OF NATURAL LANDSCAPE TYPES AND LAND USE IN THE CZECH REPUBLIC

(at the scale of 1 : 1 500 000)

as a basic countribution to functional maps of Landscape Use in Central Europe

Jaromír KOLEJKA - Vítězslav NOVÁČEK

Abstract

Natural landscape types were formed exclusively by the action of natural forces and at the same time they presented natural material base for the formation of territorial structures of the environment. Properties of any natural territorial unit influence both the choice of anthropogenic actvities in the landscape and their distribution in the area. On the basis of natural landscape and through the influence of human activities territorial units of the present landscape with its characteristic structure are formed. Land use is an essential physiognomic element of the contemporary landscape and data on land use inform us about basic functional differentiation of the territory in the Czech Republic.

Shrnutí

Základní členění krajinné sféry na území České republiky odpovídá rozložení megaforem reliéfu Země, tj. nížin a vysočin. Nížiny se vyznačují převážně plochým nebo zvlněným akumulačním nebo erozně-akumulačním reliéfem, který vzniká v důsledku dynamických procesů na sedimentech různého stáří a téměř homogenním klimatem. Vysočiny, které jsou tvořeny pohořími a vnitrohorskými sníženinami, jsou charakteristické značnou vertikální i horizontální členitostí erozně-denudačního reliéfu. Zvláštní postavení mezi nimi zaujímají kotliny a pánve. Geneticky jsou vázány na vysočiny, neboť vznikají společně s nimi a to jako lokální sníženiny v důsledku působení endogenních nebo exogenních činitelů.

Krajiny nížin, pánví, kotlin a pohoří můžeme členit podle typu podnebí a jeho účinků na půdní kryt a biotu. Na pozadí určitého mezoklimatu se jako nižší diferenciační činitel uplatňují v nížinách, pánvích a kotlinách charakteristické dominantní tvary reliéfu se specifickou geologickou stavbou a oběhem podzemních vod. V krajinách pohoří tuto roli zaujímají morfometrické parametry reliéfu, které popisují výškovou a horizontální členitost terénu ve spojení s geologickou strukturou.

Přírodní krajinné typy vznikly výhradním působením přírodních sil a zároveň tvoří přirozený materiální rámec pro formování teritoriálních struktur životního prostředí. Vlastnosti každého přírodního územního celku ovlivňují výběr antropogenních aktivit, které působí v krajině a jejich rozmístění v území. Na základě přírodní krajiny se vlivem lidské činnosti utvářejí územní jednotky současné krajiny s charakteristickou strukturou. Využití ploch je tedy projevem hospodářského, ale i mimoekonomického působení na přírodní prostředí a to v závislosti na přirozených vlastnostech daného území, výrobních a intelektuálních schopnostech a možnostech obyvatelstva, historickém, politickém a sociálním vývoji aj. V průběhu historického vývoje se na území dnešní České republiky vytvořili čtyři základní funkční typy současné krajiny, které jsou definovány prostorovou strukturou využití ploch. Využití ploch je hlavním fyziognomickým prvkem současné krajiny (společně s přírodním-fyzickogeografickým pozadím), které nám dokumentuje prostorovou strukturu krajiny z environmentálního hlediska. Existující teritoriální struktura využití ploch s přírodním pozadím charakterizuje ráz současné krajiny a definuje její územní jednotky.

Key words : natural landscape type, territorial structure, land use, physiognomic element, territorial unit, Czech Republic

1.Introduction

The requirement for the creation of a special map of functional aspects of the landscape is known from the middle 1980's. Different detailed projects evaluating functions of the landscape made by man or serving him were made even much earlier, but no international cooperation occurred until present. International importance of this kind of map is based on the opportunity to compare the landscape use in individual countries and evaluate present state of the environment in European countries in particular. The idea of compilation of the map of landscape use for Central European countries was presented by professor A. RICHLING (University of Warsaw, Poland) and under the technical, organizational and material support of the Austrian Institute of East and South-East European Studies (Vienna, Austria): the map was finished in 1994. A large amount of data were collected in every participating country which made a good material for understanding the integrated map. Separated data on the natural background - landscapes and present state - land use describe different development in regions of the Czech Republic.

2. *Map of Natural Landscape Types*

2.1 General land overview

The territory of the Czech Republic - the inland country in the Central Europe - is extended in the west-east direction with its length exceeding 400 km. Width of the territory in the north-south direction is in average over 200 km. The aggregate area of the Czech Republic is 78 862 sq km. A decisive factor for territorial differentiation of the landscape sphere in the territory of Czech Republic is configuration of the relief and particularly its altitudinal variability. Mezoclimatic stratification is then depending on this factor. Elevation climatic changes usually call for adaption of vertical arrangement of zones with the characteristic soil cover, biota and in a certain way modified hydric regime in dependence on conditions of the terrain as well as on the geological structure.

2.2 Mapping

Any landscape can be described in two fundamental ways : by emphasizing specific features of the individual components of the landscape unit and relationships between them, by which the area differs from other regions - this is typical for the characterization of the individual landscape, non-repeatable in space and time; and by searching more general features of the components, relationships or the complex, which would distinguish the given area from its surroundings but with similar localities occuring repeatedly in space and time on an individual basis - this applies to typological landscapes. Between the landscapes of both conceptions, there are relationships of superiority and subordination, i.e. hierarchical relationships which are defined by the measure of similarity of definition between the feature values. External manifestation and results of the process of classification of territorial units is typization and regionalization. By this way, we can demarcate in the process of mapping the natural landscape, the landscape types of the precisely defined hierarchical rank, definition set of properties and the measure of internal homogeneity. This fact transferred into the map means identification and localization of these territorial units within an interest region with the identical hierarchical arrangement. The hierarchy of differentiation factors applied in the process of typization and regionalization of the natural landscape in the Czech Republic resulted in a system of types of choric units which repeat across the country and which are illustrated in the scale of 1 : 1 500 000 (see Appendix No.1).

2.3 Natural landscape types of the Czech Republic

Three historical Czech lands developed here in the past thousand years: Bohemia in the west, Moravia in the east and Silesia in the north-east. The origin of these historical lands is narrowly related to the natural environment.

Bohemia, the most western one of the Czech lands, posseses a circle-like form of polygonal countours created by medium high border mountains surrounding the so called Bohemian Basin with some central elevations to the south from the Prague metropolitan area. Starting from the southern corner of the country contours to the west are as follows: Šumava Mts. (Bohemian Forest), Český les Mts. (Oberpfalzer Wald Mts.), Smrčiny Mts. (Spruce Mts.), Krušné hory Mts. (Ore Mts.), Labské pískovcové pohoří Mts. (Elbe Sandstone Mts.), Lužické hory Mts., Jizerské hory Mts., Krkonoše Mts. (Giant Mts.), Orlické hory Mts. (Eagle Mts.), Českomoravská vrchovina Highland, Novohradské hory Mts. The drainage network in Bohemia is typical radial concentric with one output only - River Labe (Elbe R.).

Moravia in the east is an exemplary transit country consisting of two crosspassing terrain depression systems. The main transit gate system is a chain of the Outer Carpathian Depressions on the contact of the Meso-European Bohemian Highland in the west with the Neo-European Carpathian folded mountain zone in the east. This chain goes from south-west to north-east counting the Svratka-Dyje Lowland, the Gate of Vyškov, Upper Moravian Lowland, Moravian Gate (main European watershed across) and the Basin of Ostrava. The transit corridor of secondary importance goes from the Danube in the Basin of Vienna in south-east to north-west into the Basin of Klodzko following the Morava river valley upstream, later crossing the main European watershed.

Silesia (both Polish and Czech parts) is located on the steep northern slopes of the Sudeten Mts. (Bohemian Highland) and the Beskydy Mts. (Carpathians) and in their northern foothills. Facing north Silesian mountains and foothills are drained by mostly parallel tributaries of the Odra river leaving the Czech territory not far from the foot of the mountain ranges.

This main general features of the natural background influenced not only functions of the teritorry (land use), but to certain stage human behavior and feeling.

Without respect to regional view, landscapes of lowlands, basins and mountains were distinguished in the territory of the Czech Republic. The natural landscapes of external (north) and internal (south) lowlands are represented by flood plains following the main rivers of Dyje, Morava and Odra as broad belts (MAZÚR et al., 1985, KOLEJKA 1992a, KOLEJKA 1992b). Most of them are accompanied with higher terrain of fluvial terraces and accumulation-erosional hilly lands with sandy arenosols, chernozems or vertisols, originally covered with ancient xerophilous oak forest in the south in the Basin of Vienna. Typical accumulation-erosional hilly lands, morainic hills and polygenetic foothills with luvisols and pseudogleys and oak-hornbeam forests were common in the margins of the Silesian lowland in the north. A similar situation occurs in Moravian mountain foreland landscapes, both in open and enclosed ones, where according to climatic changes from south to north the southern chernozems and phaeozems are being gradually substituted with pseudogleys in the north.

The Western Carpathian landscapes, e.g. wide intermountain valleys and erosionally dissected medium high mountains with brownearths or podzolic soils were in the past covered with the xerophilous oak, oak-hornbeam and beech-coniferous forest depending on the sea elevation, occupy only a part of Central Moravia and border zone to Slovakia. Hight of these flysh rock mountains with some isolated limestone cliffs ranges from about 300 m high hilly lands in Central Moravian Carpathians up to 1300 m high and steep sandstone of the Beskydy Mts.

The ring of the Bohemian border mountains consists mostly of faulted mountain ranges built of old crystalline rocks covered with poor podsolic soils and beech-coniferous forests. Most of these mountains reach over the height of 1000 m above the sea level. The highest point of the Bohemian Highland is Mt.Sněžka (1602 m) in the Giant Mts. There are some extended flat mounts of subalpine character, dissected with Pleistocene glacial land forms.

Inland slopes do not go continously down into the Bohemian Basin. A chain of basins divides the border mountains from central mountains in the south-west and in the north-west. Many of them are of the Tertiary/Quaternary volcanic origin in North-western Bohemia (e.g. Bohemian Middle Mts., Doupovské hory Mts.). About southern two thirds of the Bohemian Basin are composed of variable medium high mountains, predominately hillylands, small basins and relatively deep and narrow river valleys. Geology of this area is very complex consisting of non-metamorphic Lower Paleozoic sedimentary rocks of Barrandien, partially limestones, Upper Paleozoic agglomerates, old volcanic bodies and metamorphic and magmatic Proterozoic/Paleozoic rocks covered mostly with poor oligotrophic brownearths and pseudogleysols, stony rankers and rendzinas originally covered with dominating oak-beech and oak-pine forests in the Central Bohemian Hilly land. Only exeptionally reach some ranges mountainous forms, e.g. Brdy Mts. to the south of Prague, with the highest point of Mt.Praha (862 m).

The northern third of the Bohemian Basin is filled with Mesozoic, Tertiary and Quaternary deposits of the Bohemian Cretaceous Tableland. Although the central flat and hilly part of this large depression is covered with loess and alluvial deposits with fertile soils along the River Elbe and its tributaries, many rock outcrops occur on the margins of the tableland, forming typical cuesta a table mountain terrain.

Eastern extension of the Bohemian border mountains is interrupted by the Boskovická brázda Furrow and Podorlická brázda Furrow, a chain of long and narrow tectonic and erosional depressions with a flat bottom and a relatively rich soil cover.

A complex system of the mountain landscapes goes from the Brno area in the south to the Polish boundary in the north, based on folded metamorphic and sedimentary rocks of the Varisian age, mostly covered with poor cambisols. Many medium and small karst areas follow from the City of Brno to the nothern limit of the Jeseníky Mts. and Rychlebské hory Mts. They are located in Devonian limestones and in older crystalline marbles. The massif of the Králický Sněžník Mts. (1424 m) is drained into three sea basins : Baltic Sea in the North, Black Sea in the South-East and North Sea in the West. The highest mountains in this region - the Jeseníky Mts. with Mt. Praděd (1492 m) posses a typical vertical consequence of landscapes starting from oak-beech forest on the foot up to the alpine meadows on the flat tops of main ridge and some isolated domes.

2.4 Dual character of Czech landscapes

Despite its small extent and spread on the Earth surface, the territory of the Czech Republic is very diversified, especiallly due to the relief variability. Some differences are obvious at the first sight between the western Hercynian part and the eastern Carpathian part. Territories of the Bohemian Highlands are characterized by lesser variability of mountain ranges and relatively greater variability of lowlands and basins. The Carpathian area exhibits dominat great natural variability of mountains and lower variability of depressions. The Bohemian Highland is characterized by extensive flat and dissected hilly lands on acid rocks and by shallow flat basins. In the Carpathians there are systems of pronounced basins mutually separated by high dissected mountain ranges, often on the flysch or limestone rocks with high energy of the relief.

3. Land Use Map

3.1 Land use and land cover development in the Czech Republic

The Czech republic is a country where exact land registration has been conducted for 170 years. The investigations carried out from 1824-1843, enabled cadastral maps to be drawn up at the scale of 1 : 2 880. Every plot (the "parcel") was registered according to its use and property. These records were regularly revised and completed both in the textual and cartographic parts.

The small scale land use maps were made in former Czechoslovakia (for example : Atlas of the Czechoslovak Socialist Republic /1966/, at the scale of 1 : 1 000 000; Atlas of the Environment and Health of the Population of the Czech and Slovak Federal Republic /1992/, at the scale of 1 : 1 000 000). The land use map at the scale of 1 : 500 000 of the Czech Republic was compiled by authors J. KOLEJKA and V. NOVÁČEK in the year 1992 to cover requirements of a government commission. In the Institute of Geography CSAS in Brno were constructed the maps of land use at large scales, which were component of the regional geographical research. All of them contain three basic categories : technogenous land use forms, agricultural land use forms and forestry land use forms.

Land use is accordingly a manifestation of economic but even extra-economic human effects on the natural environment in defence respecting natural qualities of the given territory, economic and intellectual abilities and possibilities of the population, historical-political and social development and even aesthetic attitude of people to neighbouring environment.

Since the beginning of the Neolithic, i.e. on the territory of present-day Czech Republic since the 5 000 years B.C. a conscious selective transformation of the landscape took place. Very sensitive landscape components and elements, such as flora, fauna and water regime were the first subjects to the transformation , particularly due to expansion of agricultural areas. Later, mainly in connection with developing extraction of mineral raw materials and origin of extensive urbanized regions, remodelling of relief, changes of the river pattern and expansion of cultivated land occurred. Since supreme Middle Ages, in the course of colonization campaigns of miners, herds and timber men almost the entire territory of our country has been affected by anthropogenic influence. With respect to the fact that the anthropogenic pressure on nature took place in waves, often with subsequent weakening of the influence, utilization of the areas has always been locally selective. Areas most suitable for the given purpose were utilized first in the natural environment i.e. those occuring nearest the place of permanent settlements. After the considerably extensive deforestation in the Middle Ages when share of the forest compared to the original state decreased to approximately 10 %, restoration of forests above all on poor lands, steep slopes, in less populated regions, frontier regions but even in some cases on the areas of emptied medieval ponds was carried out. At the beginning of the 19th century, the distribution of woodland and other areas stabilized in substance. The later partial corrections in the distribution are connected mainly with the development of intensity of economic effects on natural environment and with the development of continuing urbanization and industrialization of the territory.

Result of the historical development of four basic functional types of present landscape defined by spatial pattern of the land use can be differentiated as follows: man-made and urbanized landscape, agricultural landscape, agricultural-forest landscape, forest and grass landscape (see Appendix No.2).

3.2 Applied land use mapping

The proper content of the land use map is the result of integrating data of different character. The map displays the structure of physiognomic elements of landcape utilization in the Czech Republic and was compiled using various thematic maps, satellite and aerial data and - last but not least - information collected during the field research and mapping. In establishing some of the given kind use categories shown in the map, needed to accept even few compromising solutions (be it for technical or time reasons). For example, the category of settlements and urban areas consisting only of the settlements and their surroundings with population number of 50 000 and more, was drawn according to the present state recorded in the satellite photographs of high resolution.

3.3 Regional land use types in the Czech Republic

The types of man-made and urbanized landscape are formed by urban and rural built-up areas in the intravillans of settlements, built-up production areas, recreational weekend-house colonies, roads and motorways, energetic and irrigation canals, artificial water bodies, mining and abandoned areas. The types of agricultural landscape involve landscapes with a distinct prevaleance of arable land, landscape with a distinct prevaleance of grassland, landscape with substantial share of orchards and plantations of fruits and vegetables, including hop-field areas. The agricultural-forest areas and forest-grassland areas shape transition group. Forest and meadows consist of areas of coniferous, mixed and deciduous forests and Alpine meadows.

The land use map reading allows to distinguish that the types of the present-day landscape of the Česká vysočina (Bohemian Highland) possesses much more often mixed polyfunctional character than a monofunctional one. Basically, the favourable terrain and other natural conditions lead to the development of a relatively complex pattern of small and medium-size functional areas, accompanied in some selected regions even by the network of fishponds (typical of Southern Bohemia). The monofunctional blocks of predominately coniferous forest cover extensive areas and are common for the boundary mountain ranges. Large arable field landscapes are typical of the Labe (Elbe river) and Ohře river basins as well as of Moravian margins of the Česká vysočina (Bohemian Highland). Mixed functional types of the present-day landscape occur in some parts of Eastern Moravia, where the pattern of forests, meadows and pastures is representative. The present landscape of the Southern Moravia is a typical agricultural area with the substantial share of orchards and vineyards. The agricultural areas with arable land and distinct share of hop-gardens are typical of the lower Ohře river basins and surroundings of the town Rakovník in the Central Bohemia.

3.4. Understanding the land use map

The physiognomic elements of the landscape utilization delimited in this way, content of the land use map, help to imagine the spatial structure of the landscape from the environmental point of view. The information presented by this suitable manner became a valuable starting point for solution of problems connected with spatial organization of the cultural landscape.

The present land use pattern is heavilly affected by some damaging man activities, for example air pollution, building operations, agricultural and recreational activities. The coniferous forests cover in the northern mountains needs a basic reconstruction due to the large portion of dead canopies caused by polluted air. Some constraints of interests in this area (forestry, recreation, ecological function, watersupply, etc.) make the future unclear. Large ecological stabilizing measures connected with land use structure should be realized both in steep slope mountain and river valley areas and in extended agricultural lowlands of Central Bohemia, Central and Southern Moravia simultaneously with the programme for land privatization.

4. Conclusion

The map natural landscape types and the map land use were utilized as foundation material for compilation of the map Landscape Use in Central Europe at the scale of 1 : 1 500 000. Coordinator of this international project is prof. Andrzej RICHLING from the University of Warsaw, Poland. The map landscape Use in Central Europe (incl.accompanying text in English and German) will be published at the beginning of 1995, its edition being guaranteed by the Austrian Institute of East and South-East European Studies in Vienna.

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Explanations to the map - Appendix No. 1

(the numbers correspond to numbers in the legend of enclosed map)

1 Flood plains with alluvial soils and riparian forests, local reeds and halophilous vegetation

2 Higher plains of accumulation, often terraced with chernozems and arenosols and xerophilous oak forest

3 Higher plains of accumulation, often terraced with luvisols, arenosols and oak-hornbeam forest, local oligotrophic oak-pine forest

4 Accumulational-erosional plain and gentle undulated regions with chernozems and xerophilous oak forests
5 Accumulational-erosional hilly regions with chernozems, luvisols, pseudogleys and oak-hornbeam forests
6 Erosional denudational hilly regions with luvisols, grey forest soils and oak-hornbeam forests
7 Erosional hilly regions with luvisols and grey soils and xerophilous pubescent oak forest
8 Erosional hilly regions with luvisols and grey soils and oak hornbeam forests
9 Erosional hilly regions with arenic and podzolic soils and oligotrophic oak-pine forests
10 Undulating loess landscape with degraded chernozems phaeozems, local vertisols and xerophilous oak forests
11 Hilly glacial and glacio-fluvial surfaces with grey forest soils, cambisols, local pseudogleys and oligotrophic red pine forests and local oak-hornbeam forests
12 Dissected pediment surfaces of varied origin with chernozems, phaeozems, vertisols, local cambisols and xerophilous oak forest and local oak-hornbeam forests
13 Dissected pediment surfaces of varied origin with luvisols, pseudogleys and oak-hornbeam forest
14 Limestone hilly region of denuded tectonic relief with rendzinas and xerophilous oak forests with sprinklings of sub-Mediterranean types
15 Basins and wide intramontane valleys without typological differentiation with phaeozems, local pararendzinas and xerophilous oak forests
16 Basins and wide intramontane valleys without typological differentiation with phaeozems and luvisols and oak-hornbeam forests and local beech forests
17 Basins and wide intramontane valleys without typological differentiation with pseudogleys, cambisols and oligotrophic oak and oak-pine forests
18 Basins and wide intramontane valleys without typological differentiation with cambisols, podzolic soils and beech forests
19 Deep erosional valley systems with rankers, cambisols and slope aspect related very variable vegetation cover
20 Surfaces of truncation in old massifs with cambisols and oak forests
21 Surface of truncation in old massifs with cambisols, podzolic soils, local pseudogleys with oligotrophic oak and oak-pine forests
22 Surfaces of truncation in old massifs with cambisols, rankers, local luvisols and oak-hornbeam forests
23 Surfaces of truncation in old massifs with cambisols, podzolic soils, luvisols and pseudogleys with beech-coniferous mixed forests
24 Flat upland areas of cuesta landscape with pararendzinas, cambisols and beech-coniferous mixed forests
25 Highlands landscape, mainly shaped by erosion with grey-brown podzolic soils, brownearths and oak-hornbeam forests
26 Highlands landscape, mainly shaped by erosion with brownearths, local podzolised and oligotrophic oak-pine forests
27 Highlands landscape, mainly shaped by erosion with brownearths, podzolic soils, rankers and beech or beech-coniferous mixed forest
28 Mountain landscape of subalpine character with podzolic soils, rankers and subalpine scrubs and grassland
29 Karst landscape with cambisols and oak-coniferous forest
30 Karst landscape with luvisols and cambisols and beech-coniferous mixed forest

Explanation to the map - Appendix No. 2

(the numbers correspond to numbers in the legend of enclosed map)

Man-made and urbanized landscape

1 - residential and productional built-up areas
2 - mining and devastated areas
3 - surface waters including bigger artificial lakes

Agricultural landscape

4 - with distinct prevaleance of arable land
5 - with arable land and distinct share of fish-ponds
6 - with arable land and with share of grass growths
7 - with prevaleance of grass growths
8 - arable land with distinct share of orchards
9 - arable land with distinct share of vineyards
10 - arable land with distinct share of hop-fields

Agricultural-forest landscape

11 - agricultural-forest areas with mosaic type of use, mostly agricultural with substantial share of dispersed forest areas covering less then 50 % of the area
12 - agricultural-forest areas with predominance of arable lands, forest surface together makes less than 30 % of the area
13 - forest-grassland areas, dispersed forest areas and permanent grassland (meadows and pastures)

Forest and meadows landscape

14 - deciduous forests

15 - coniferous forests

16 - mixed forests

17 - alpine meadows

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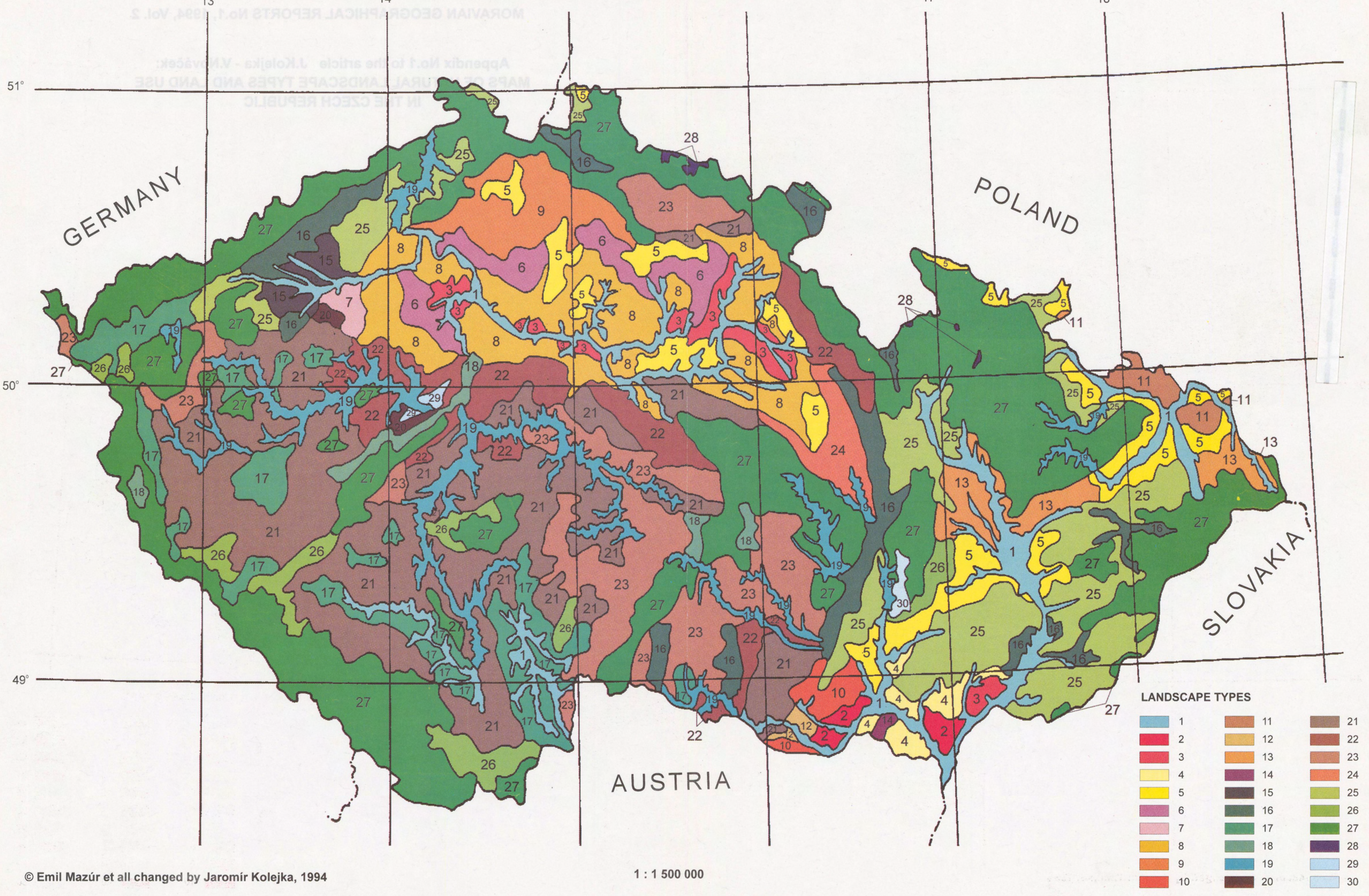
Reviewer

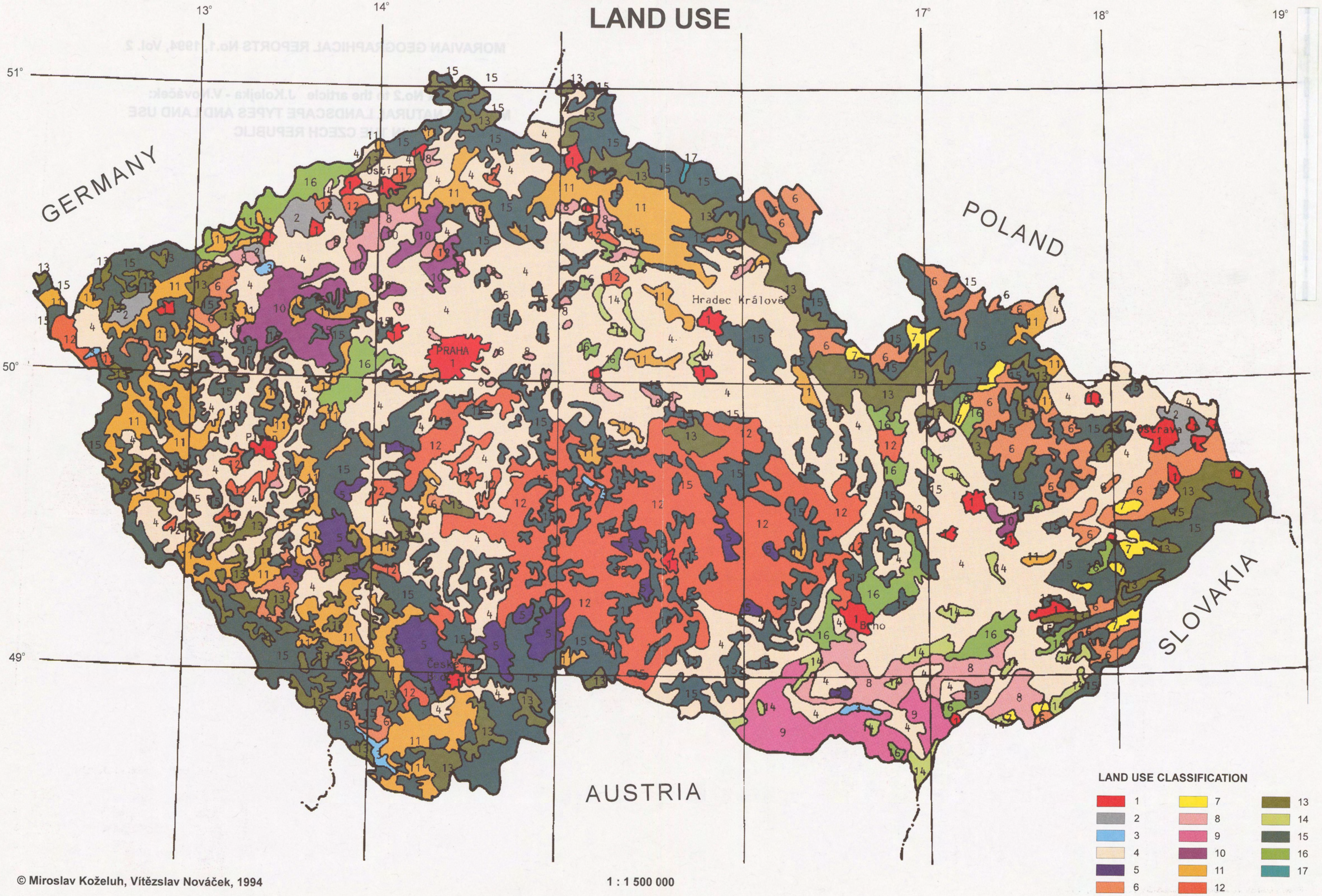
Doc. RNDr. Milan KONEČNÝ, CSc.

CZECH REPUBLIC
NATURAL LANDSCAPE TYPES



1 : 1 500 000

CZECH REPUBLIC
LAND USE



1 : 1 500 000

IN MEMORIAM Dr. VLADIMÍR VLČEK (28 October, 1938 - 25 June, 1994)

Jan LACINA

Towards the end of this April, we were wandering with Vladimír VLČEK across the Dyje floodplain at the far end of Břeclav. Spring was culminating in the floodplain landscape. Wings of storks and buzzards were casting their passing shadows into the wide of meadows. Mud of peat bogs was blooming with snowflakes and bog milkweeds. Young leaves of ramson in the floodplain forest undergrowth suddenly yielded their dazing scent under our steps. We lied in young and fresh grasses right on the line of Pohansko - site of a fortified settlement of the former Great Moravian Empire- sucking in strength of Mother Earth at full draughts. We were delighted that we again succeeded in escaping the merciless and hurried time of the town. We knew that this was again one of those exceptional days thanks to which it was possible for us to still survive within the city walls.

Those twenty years of our joint studies and investigations in the nature could see many of these wonderful days spent in Moravian, Bohemian and even German landscapes. Nevertheless, it was the floodplain landscape of South Moravia, which was closest to Vladimír's heart. It had attracted him since his childhood when he visited these places to fish many times with his father and brothers. It was not only his sizeable grey beard which commanded natural respect, but above all his deep knowledge of riverine landscape dynamics to which he devoted a considerable part of his scientific work that will always rank Vladimír VLČEK side by side with the greatest personalities in the gallery of SouthMoravian heroes. He belonged to those scientists and artists who not only loved the viniferous South Moravia, but also attempted at resolving some problems of the region, often notwithstanding official opinions and requirements. He would not have been able to act in another way. This was his landscape in which he launched his studies as a member of the creative group of Jan ŠMARDA, botanist and landscape biologist - irreconcilable adversary to technocratic water management measures.

It is a matter of course that this memorable April day did not only mean carefree walks in the spring nature. Vladimir had been appointed to become one of major people responsible for the programme of revitalization of the Dyje River below the hydroengineering work Nové Mlýny. From the straightened river stream we hurried to cut-off meanders with kingfishers. With Vladimír, it was quite easy to perceive both natural and aesthetic values of the landscape at the same time. With his engagement, inquiring mind and exceptional capacity of understanding the landscape in all its complex relationships, Vladimír was a geographer in the genuine sense of the word. Incindentally, he also belonged to senior experts of geographical workplaces at the Academy of Sciences - without interruption from the beginning of the sixties. Even in Mid-June, only a couple of days before he died, he was eager to develop his revitalization ideas being down on the hospital bed.

He died, and there is a pervading emptiness after him. Because Doctor of natural sciences Vladimír VLČEK, local patriot of his native Brno neighbourhood Královo Pole, was not only a prominent Moravian expert at hydrology of surface and karst waters, caring husband, father and grandfather, in his young days also a successful sportsman and the first league coach. First of all, he was a great friend. He was an individual with whom it was relieving to be in harmony. He was water with which it was a pleasure to flow along and wildly ignore stream banks from time to time.

I have not met a man in my life who would have been more sensitive, in order to help others, he had no time for his own problems. We used to say that he was given a special gift of saying a couple of wise words at the right place and at the right time. It was a matter of course for him to communicate in similar way with anybody of good moral standard-be it an intellectual, artist, bricklayer or tramp. What he really could not stand were people with crooked characters.

He loved music and was an excellent singer, too. His heroic voice used to be heard in many a pub and wine cellar. He was very good at joining sad individuals into one joyfully sounding community.

My friend Vladimír, thank you for having been able to share your life with us in that very special way. We shall never forget.

Photo: Jindřich Grepl

Za RNDr. Vladimírem Vlčkem (28.10.1938-25.6.1994)

Jan LACINA

Koncem dubna letošního roku jsme se s Vladimírem Vlčkem toulali údolní nivou Dyje pod Břeclaví. Jaro v nivní krajině vrcholilo. Perutě čápů a luňáků vrhaly prchavé stíny do šířavy luk. Bahno mokřadů rozkvétalo bledulemi a bahenními pryšci. Mladé listí česneku medvědího v podrostu lužního lesa se pod našimi kroky prudce rozvonělo. Leželi jsme v mladých a svěžích travách na valu velkomoravského hradiště Pohansko a plnými doušky sáli sílu matky Země. Libovali jsme si, že se nám zase jednou podařilo uniknout před nemilosrdně uspěchaným městským časem. Věděli jsme, že se nám po dlouhém čase podařil jeden z těch výjimečných dnů, díky kterým se pak dá ve městských zdech žít.

Za těch dvacet let, kdy jsme spolu v přírodě bádali, byly takových nádherných dnů v moravských, českých ba i německých krajinách desítky. Ale právě nivní krajina jižní Moravy byla Vladimírovy nejbližší. Přitahovala ho od dětských let, kdy sem jezdíval s otcem lékařem a s bratry rybařit. Nejen pro svůj mohutný šedivý vous, vzbuzující přirozenou autoritu, ale především pro své hluboké znalosti dynamiky říční krajiny, které zasvětil podstatnou část své vědecké práce, patří Vladimírov Vlček do galerie jihomoravských bohatýrů. Zařadil se mezi ty vědce a umělce, kteří vinorodou jižní Moravu nejen milovali, ale i řešili její problémy, často navzdory oficiálním názorům a požadavkům. Nemohl jinak. Vždyť zde před léty začínal zkoumat v tvůrčí partě botanika a krajinného biologa docenta Jana Šmardy, nesmiřitelného odpůrce technokratických vodohospodářských úprav.

Ani v ten dubnový den samozřejmě nešlo jen o bezstarostné toulky jarní přírodou. Bylo právě na Vladimírovi, aby se stal jedním z hlavních řešitelů programu revitalizace řeky Dyje pod vodním dílem Nové Mlýny. Od napřímené řeky jsme utíkali k odříznutým meandrům s ledňáčky. S Vladimírem se daly vždycky souběžně vnímat přírodovědné i estetické hodnoty krajiny. Šířkou záběru, zvídavostí a výjimečnou schopností chápat krajinu v jejích složitých vztazích byl Vladimír geografem v pravém slova smyslu. Patřil ostatně k služebně nejstarším, kmenovým pracovníkům geografických pracovišť akademie věd - nepřetržitě od začátku šedesátých let. Ještě v polovině června, pár dní před smrtí, dokázal na nemocničním lůžku rozvíjet své revitalizační nápady.

Zemřel a zůstalo po něm pronikavé prázdno. Neboť doktor přírodních věd Vladimír Vlček, lokální patriot své rodné brněnské čtvrti Královo Pole, byl nejen předním moravským odborníkem na hydrologii povrchových a krasových vod, starostlivým manželem, otcem a dědečkem, v mládí i úspěšným sportovcem a prvoligovým trenérem. Byl především velikým kamarádem. Byl živlem, s kterým bylo úlevné souznít. Byl vodou, se kterou bylo radost plynout a občas divoce vybřežit.

Nepoznal jsem člověka vstřícnějšího - pro problémy druhých nemyslel na ty své. Měl výjimečnou schopnost - jak jsme trochu s úsměvem říkávali - pronést pár moudrých vět v pravý čas a na pravém místě. Bylo pro něj samozřejmostí komunikovat na stejné úrovni s každým morálním člověkem, ať to byl intelektuál, umělec, zedník či tulák. Bytostně ovšem nesnášel lidi charakterově křivé.

Miloval hudbu a byl výborným zpěvákem. Jeho bohatýrský hlas dokázal rozezvučet mnohé hospůdky a vinné sklípky. Uměl spojovat smutné jedince v radostně zvučící společenství.

Příteli Vladimíre, děkujeme Ti za to, že ses dokázal o svůj život tak nezištně dělit. Nelze na Tebe zapomenout.

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A MEETING OF IGU COMMISSION ON "HEALTH, ENVIRONMENT AND DEVELOPMENT"

Antonín VAISHAR

A post-conference session of the commission for health, environment and development was organized by the Brno Branch of the Institute of Geonics, Czech Academy of Sciences jointly with the Medical Faculty, Masaryk University Brno. The meeting was attended by fifteen speakers from twelve countries of four continents.

The session of nearly chamber character took place on the premises of the Institute of Preventative Medical Care, Masaryk University Brno. Themes of the ten presented papers were rather differentiated not only in terms of their scope but also as to methodological approach and angle of view to the issue. Several contributions presented by authors arriving from exotic countries tackled partial problems such as AGGARWAL and DAVGUN, SINGHANETRA - RENARD, ABU. Other papers attempted at general evaluation of certain regions (MOON), mathematic and statistic methods to study the population health status (DARÓCZI) as well as at their critics (MUNZAR and VAISHAR). Some contributions concerned problems indirectly related to the population health status (BLAŻEJCZYK on temperature balance, ŠEBENIK on deposition of solid wastes). A. AASE informed of cartographical illustration of population health status in the Norwegian National Atlas.

Low number of participants facilitated discussion and exchange of opinions immediately after presentation of the papers. Each of the papers was discussed, the greatest and most controversial discussion having been evoked by contribution of G. SALEM who had opened an issue of definition of medical geography as such. A question was presented of relationship between medical geography and comparison epidemiology. Unfortunately, it was exactly this paper that was presented "ad hoc" with no written documentation and has therefore not been included in the Proceedings.

Eight contributions were published in the Proceedings which had been issued before the meeting, which enabled the speakers to concentrate on the problems rather than on presenting fundamental factography. The Proceedings include also a non-presented paper by L. NESVADBOVÁ, which was a study into the health status of our compatriots who settled in the Czech Republic after breakdown at Chernobyl. The Proceedings can also be obtained from editorials of MORAVIAN GEOGRAPHICAL REPORTS.

Meeting of the commission, which was held to discuss programmes for both near and farther future, was presided by its Secretary, Prof. Y. VERHASSELT.

There were several excursions made during the session. A walk through the City of Brno could introduce only a part of the centre of the Moravian largest town. A quite interesting comparison of two towns was offered to those foreign participants who arrived to Brno via Prague. One-day excursion was organized to the Moravian Karst where the participants were shown a speleotherapeutical medical centre for children in the Sloup-Šošůvky complex of caves and visited all tourist attractions of the area. The excursion ended with inspection of the Cloister at Staré Brno-former working place of the founder to modern genetics, J.G. MENDEL.

EUROPE IN MOTION in the context of geographical information systems. Conference held in Brno, 28 - 31 August 1994

Milan KONEČNÝ

In the end of August, the Moravian metropolis witnessed another of traditional conferences so very much typical of Brno, which was devoted to geographical information systems (GIS). Compared with previously organized conferences Euro Carto VI and Brno-GIS-1991 the last one (under the work name of Brno-GIS-1994) was a confirmation to the ever growing interest in GIS both at home and in abroad. The event in Brno was held as a part of festivals commemorating the 75th anniversary of Masaryk University and was one of the greatest international events organized during the celebrations. From the international point of view, it linked up with the Regional Geographical Conference IGU held in Prague.

Conference activities consisted of the scientific conference itself, technical exhibition, workshops and a novelty - the so called technical workshops. Ceremonial and scientifically valuably fulfilled opening took place on 28 August under the auspices and in the presence of prof.dr. Eduard SCHMIDT, President of the University, Ing. Stanislav ŽALUD-Deputy to the Minister of Economy, and prof.Ing. Emanuel ONDRÁČEK-Deputy to the Minister of Education, Ing. Jiří HORÁK-Mayor of Brno, Ing. Jiří ŠÍMA-Chairman of ČÚ-ZAK, and other prominent guests. Key speeches at this ceremonial opening were presented by Ing. ŽALUD, Ing. ŠÍMA, prof. Sachio KUBO-Chairman of GIS IGU Committee, and Ian MASSER-Co-Chairman and Manager of GISDATA ESF Programme. Other key presentations were made by dr. Joel MORRISON-former president of Int. Cartographic Association /ICA/ from the U.S.A., prof. Francois BOUILLÉ from Paris, and prof. Henk SCHOLTEN from the Netherlands in the course of next days of the event. All the mentioned contributions were of high scientific standard. They focused results achieved so far as well as pre-requisites for forther development of GIS in the Czech Republic within international organizations and at the world-wide scale, namely as related to programmes similar to NorthAmerican 'information superhighway'. Other papers of which there were over eighty informed the participants of present development and latest scientific knowledge in the area of GIS and digital cartography, GIS business applications, activities of private, national and cooperative organizations, about GIS applications in areas where they have not yet been used too much such as transportation and medical care, educational issues, and finally also about problems relating to GIS integration and remote sensing of Earth.

The conference programme included three workshops as follows: Meta-data: Basics and quality of information systems (H. KREMERS, Germany), Object orientation and GIS (W. KUHN, Austria), and Introduction into Automated Geographical Analysis (K. MARTIN, USA), and firm workshops of four companies: FORESTA a.s., Intergraph ČR, Arcdata Prague, and Help Service Group Prague.

Thanks to sponsors Foresbank a.s. Zlín, Česká pojišťovna a.s. Brno, Intergraph ČR Prague, ŽS Brno a.s., Foresta a.s. Velké Karlovice, and Brewery Černá Hora, the organizers could apply an extensive grant programme namely for participants from countries of the former Soviet Union, Yugoslavia and developing countries.

Significant and attractive part of the Conference was a technical exhibition which was attended by some 30 exhibitors both from home and from foreign countries. The participating Bohemian and Moravian companies represented all that can be considered important in our country in the field of GIS systems at present. The majority of our companies are representatives of renowned foreign firms.

Both the Conference and the exhibition were widely publicized in mass media, which significantly contributed not only to popularization of the present GIS possibilities but also to that of scientific branches of geography and cartography to the public.

The Conference was attended by altogether 329 participants from 25 countries, a.o. Albany, Austria, Belorussia, Canada, Egypt, Japan, Hong Kong, India, Lithunia, Norway, Poland, Russia, South Africa, The Netherlands, Great Britain, etc.

Abstracts of the presented papers and Conference Proceedings 1 and 2 have been published in English and can be obtained at the price of 300.00 CZK from the Department of Geography, Faculty of Natural Sciences, Masaryk University Brno, Kotlářská 2, 611 37 BRNO. The next GIS conference will be held in Brno end April 1996.

40 years of the Institute of Geography and Spatial Organization, Polish Academy of Sciences

Antonín VAISHAR

A scientific session was arranged by the Institute of Geography and Spatial Organization, Polish Academy of Sciences in Warsaw in April 1994, its main idea being based on the 40th anniversary of the above Institute. The session was presided by Managing Director of the Institute - Prof.Dr.hab. Piotr KORCELLI who delivered a short evaluation of Institute's history. His performance was followed by congratulations presented by foreign guests to the session from the Institute of Geonics, Czech Academy of Sciences, Brno and from the Institute for Regional Geography in Leipzig, Germany.

The first paper was presented by Prof.Dr.hab. Roman SZCZESNY, its theme being "Topical Problems of Polish Agriculture-Myths and Reality". The paper reflected the situation in Polish agriculture in the period of economic and social transition. The second paper was performed by Assoc.Prof.Dr.hab. Wojciech FROEHLICH: "Monitoring of Hydrogeomorphological Processes in the System of Mountain River Basin". The paper referred to possible application of radiological methods at investigating processes of erosion and deposition of materials.

An exhibition of results published within the last period of time was a part of the session. It documented high activity of the Institute as well as of its scientists. In 1993, the scientists of the Institute published 293 scientific papers, 25 documentary articles and 33 popular papers in 8 series issued by the Institute and/or in other ways. The most interesting publication which was distributed to the guests was an "Atlas of Polish Geographical Environment".

The Institute consists of 12 scientific departments: Department of Biogeography (localized in Milanówek), Department of Geomorphology and Hydrology of Mountains and Uplands (localized in Kraków), Department of Geomorphology and Hydrology of Lowlands (localized in Toruń), Department of Economic Geography, Department of Urban and Population Studies, Department of Agriculture and Rural Areas, Department of Geography of Global Problems of Development, Department of Climatology, Department of Spatial Organization, Department of Ecological Fundations of Space Economy, Department of Ecological Management, Laboratory of Cartography.

History and present of the Institute are connected with names of many famous Polish geographers. Let us mention professors LECZCZYCKI, DZIEWONSKI, J. KOSTROWICKI, A. KOSTROWICKI, PASZYNSKI, WRÓBEL, ROSCISZEWSKI, KOZLOWSKA-SZCZESNA, STARKEL, BREYMAYER, MATUSZKIEWICZ, SZUPRYCZYNSKI, KORCELLI, STASIAK and many others.

The Institute of Geography and Spatial Organization, Polish Academy of Sciences in Warsaw is the first foreign partner to the Brno Branch of the Institute of Geonics. Agreement on bilateral collaboration was signed in 1993. The mentioned collaboration includes three official topics as follows: climatology, hydrogeography and settlement. However, traditional contacts exist also in other fields of interest, namely in ecogeography, geomorphology, etc. The Institute also participates at multilateral collaboration "Regional Fundaments of Eco-Development", coordinated by the Institute of Geonics, Brno.

Policy and Practice of Environment

Antonín VAISHAR
Oldřich MIKULÍK

An international conference "Environmental Policy and Practice: Perspectives from East and West Europe" was organized in Pécs, Hungary by Transdanubian Research Institute, Hungarian Academy of Sciences in the days from 29 May to 1 June, 1994. The Conference was held jointly with a Working Group from Association of British Geographers and was financially supported by British Council, which was reflected in the structure of participants. There were 45 papers presented at the Conference, speakers being from Hungary (20), United Kingdom (22), Czech Republic (2), The Netherlands (1), Croatia (1), Austria (1), and U.S.A. (1).

As indicated by name of the Conference, and as it is usual on similar occasions, the scope of papers was considerably wide with the exception of the first plenary meeting which endeavoured for presenting a comprehensive survey on environment in Hungary. Despite traditional rural character, the situation of this Central European country is far from being favourable. Heavy industrialization and chemization of agricultural production during the years of socialism did what they did. The capital of Budapest ranks with the most environmentally afflicted cities in Europe and Hungarian population lives to be of the lowest age among all European nations.

From our point of view, interesting seems to be also the international aspect of environment in Hungary. The problem in question indicates that Hungarian environment is-to considerable extent-impaired by far reaching transport of pollutants, a.o. even from our country. This applies mainly to water because practically all important Hungarian water streams flow in from abroad. It is namely the water streams from Slovakia that cannot be distinguished by their cleanliness, and if we add the issue of Gabčíkovo-Nagymaros hydroengineering structure, which has become more-less a political issue at present, there is simply just one more reason to call the today's Hungarian-Slovakian relationships delicate.

The majority of other papers tackled general knowledge and generalized experience from management of environment. Only a few papers were focused on concrete regional problems, these including the contribution of O. MIKULÍK and A. VAISHAR "Economic Revitalization in Protected Landscape Areas", which utilized experience from a study made in Horňácko. Proceedings from the Conference will be published shortly.

The Conference was of high social standard and it was accompanied by several excursions and social programme. From this point of view, the only shortcoming appeared to be the fact that experts from Russia, Ukraine and Bulgaria, who had already been registered for the Conference, cancelled their attendance at the last moment.

Organizer of the Conference - Transdanubian Research Institute, Centre for Regional Studies, Hungarian Academy of Sciences, Pécs is a very successful and efficient workplace. Professional contacts between its experts and Department of Environment from the former Institute of Geography, Czech Academy of Sciences have been lasting for more than fifteen years now. The workplace in Pécs has 18 scientific workers, which precisely corresponds to the capacity of the Brno Branch of the Institute of Geonics, Czech Academy of Sciences. Of those only 5 are geographers, however. Only 30% of research costs are being covered from budget of the Hungarian Academy of Sciences. Other receipts must be earned on the market by all branch offices.

Of institutional scientific programmes which are of any geographical importance we can mention the following ones:

- Regional development strategies and models in the Alps-Adria region
- The relationship of sub-national administration and regional development policy

- Regional problems of cross-border economic development
- Development of regional integration in Central Europe
- The effects of new information and communication technologies on regional and settlement development
- The geography of administration in Hungary
- Environmental impacts of economic restructuring of depressed areas
- The prospective role of rural tourism at socio-economic innovation of the country-side
- New factors of regional development.

A preliminary agreement on bilateral collaboration was only one of the results achieved by participants from the Brno Branch Office of the Institute of Geonics, Czech Academy of Sciences.

Pécz Photo: O. Mikulík

ORBIS GEOGRAPHICUS BOHEMO-MORAVICUS 1994

Antonín VAISHAR

There were many personal changes in Bohemian and Moravian geography within the last five years. It is therefore a bit more complicated namely for foreign partners to see their way in these changes. This fact led to publication of the list of addresses of the Bohemian and Moravian geographers, one version of such a list having been issued in SBORNÍK ČESKÉ GEOGRAFICKÉ SPOLEČNOSTI (Proceedings of the Czech Geographical Society) on the occasion of IGU Regional Conference held in Prague. Due to the lacking space, however, only a list of the most significant geographical workplaces could be published, possibly also workplaces at which geographers' activities become more visible. Similar situation can be seen in Slovakia where a list of the most important geographical workplaces has been issued by the Department of Geography, Paedagogical University, Nitra (V. DRGOŇA ed.: Slovak Academic Geographical Institutions).

Our list presents Czech and Moravian geographers in alphabetical order, including those who individually often work at non-geographical workplaces as well as those who have already retired but still are active in geography. It will thus facilitate good orientation in present working places of individual colleagues. It is quite natural that not all of the contacts have been maintained. Some of the geographers do not even wish to be included in the list, which they have expressed by not having answered our polite request for topical data.

The list is based on geographers working at geographical institutions of universities in the Czech Republic and in the Institute of Geonics, Czech Academy of Sciences. This fundamental list can be considered complete and institutionally authorized. Contacted were also some non-academic workplaces which employ geographers. Individual institutions were given a chance of notifying ORBIS authors of experts who had left and to indicate their new workplaces. Another source of information was ORBIS GEOGRAPHICUS BOHEMOSLOVACUS, which was published in the journal ZPRÁVY GEOGRAFICKÉHO ÚSTAVU (News from Geographical Institute), Czechoslovak Academy of Sciences, No. 2/1991. All geographers mentioned there were contacted so that we could verify their present workplaces. The rest of information has been completed on the basis of personal contacts of MGR editorial staff and some other geographers. Here we feel obliged to express our gratitude to our prominent historical geographer, Dr. TRÁVNÍČEK.

ORBIS GEOGRAPHICUS BOHEMO-MORAVICUS includes geographers working at universities, at scientific research run by Academy of Sciences, and those working in other national and private institutes and companies as well as in central institutions and their affiliations, exceptionally also private natural persons. The list does not include secondary school teachers who amount to several hundreds in the Czech Republic, neither does it include structure of the Czech Geographical Society, which was presented in its Proceedings mentioned above. The material is equipped with addresses and contact data for geographical workplaces at universities and in the Czech Academy of Sciences.

Structure of the entry is as follows:

Name and surname inclusive all academic and scientific titles and ranks in original Czech form which is recommended for correspondence. However, the names are being listed according to English alphabet. Surnames are presented in capital letters, female ones usually ending with -ová or -á.

Institution and workplace address: Name of the workplace is in English so that it can be identified by overseas readers (official translation is not available for all institutions, however), address is presented in Czech official form in the order: zip code, town, street, number. Home addresses are presented for retired geographers (if available).

Line of specialization is coded according to the list of specializations enclosed.

Date of birth - day-month-year-place (in the case that the data are available).

University and the date of graduation if known.

Academic and scientific titles and ranks, year of their acquirement (see explanatory notes).

It was originally planned to also include functions in national and international geographical organizations and editorial boards. However, as the data available were of non-uniform character, it has been decided not to include them.

LIST OF TOPICAL SPECIALISATONS

10 Physical Geography, Landscape
11 Geomorphology
12 Soils Geography
13 Climatology, Climageography
14 Hydrology, Hydrogeography
15 Biogeography
16 Karst Geography
17 Geology
20 Human Geography
21 Population Geography, Geodemography
22 Geography of Settlements and Dwelling
23 Agricultural Geography
24 Manufacturing Geography
25 Transportation Geography
26 Recreational Geography
27 Marketing and Services Geography
30 Cartography
35 Mathematical Methods, Statistics
36 Remote Sensing
37 Geographic Information Systems
40 Regional Geography
41 Regional Geography of the Czech Republic
42 Regional Geography of Foreign Countries
43 Regional Economy
45 Regional and Urban Planning
50 Environmental Geography, Geoecology
60 Theoretical Geography
65 Historical Geography, History of Geography
66 Political Geography
67 Medical Geography
70 Teaching Techniques in Geography

Structure of the isue on an individual is as follows:

- first name and surname including titles[1],
- address of the workplace,
- specialisation code (see list of topical specialisations),
- date and place of birth,
- completed university[2], acquired scientific and pedagogic ranks, year and place of their acquirement,
- position at work.

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2 in the period 1960 - 1990, the Masaryk University in Brno was named University of Jan Evangelista Purkyně

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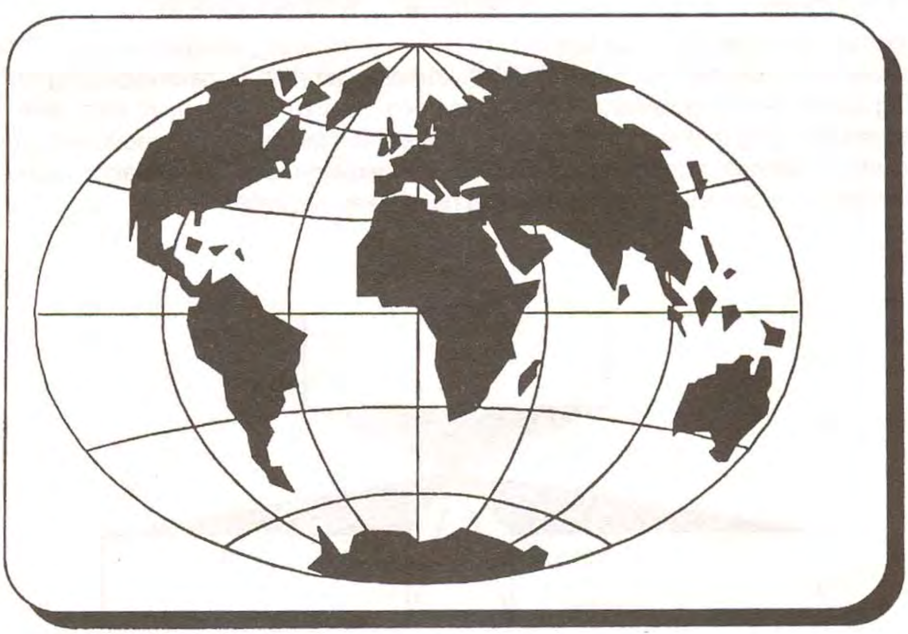
A. RICHLING: KOMPLEKSOWA GEOGRAFIA FIZYCZNA. PWN, Warsaw, 1992, 375 pp., ISBN 83-01-10186-5

Tadeáš CZUDEK

This very interesting book by A. RICHLING will certainly fascinate any physical geographer namely with its methodological approach to the given issue. Unlike the majority of similar publications dealing in fact with only individual physico-geographical disciplines, the author went for a new and untraditional procedure. Introduction of the book tackles the subject and development of complex physical geography. Following are the chapters on general laws of epigeosphere, its evolution, on geocomplexes, spatial physico-geographical units, functioning of geosystems and their mapping. Chapter 8 includes definition of typological areas, chapter 9 speaks about methods of physico-geographical regionalization. Further two chapters are devoted to the use of mathematic methods and modelling of physico-geographical phenomena.

All physical geographers will surely be captured also by the last two chapters of which one discusses relationship of the man to natural environment (mutual relations between human activities and natural environment, classification of anthropogenic changes of natural environment, modelling of interactions between man and environment, anthropogenic landscapes and natural-technical complexes and issues of the so called construction geography). The last chapter (13) is named 'Using physico-geographical research for practical purposes' (p.273-354). Here the author describes a.o. methods of valorization of natural conditions, potential of geocomplexes, evaluation of natural conditions for civil engineering, agriculture, recreation, classification of aesthetic values of the landscape, fundamentals for management in the natural environment, and in the end, he deals with prognosing alterations of the natural environment.

The book which is considered to be a comprehensive text book for general physical geography with accent on its practical use is closed with a long list of references and subject register. The book is very well illustrated with numerous maps, diagrammes and tables. Its approach is original and it can be cordially recommended for study.



Rudolf MUSIL (ed.): Moravský kras - labyrinty poznání. GEO program, Jaromír BLIŽŇÁK, 336 pp., Adamov 1993.

Antonín IVAN

The Moravian Karst is a small area of 85 sq. km north of the town of Brno, composed of Devonian limestone. Numerous attractive surface and sub-surface forms and phenomena are very important for understanding landscape evolution of the whole eastern part of the Bohemian Massif. This also corresponds with a very long tradition of karst research, extensive literature and efforts to preserve this unique landscape. At present, the Moravian Karst is a Landscape Protected Area which is - however - overloaded with intensive tourism.

Exhaustive description of all karst explorations before the 2nd World War was given by famous investigator of the area, prof. Karel ABSOLON (1877-1960) in his posthumously published book 'Moravský kras' (The Moravian Karst) which was published in two volumes in 1970.

The book of prof. Rudolf MUSIL and his collaborators summarizes results of karst studies made mainly over the last twenty years which were characteristic of very successful discoveries (not without losses of human lives) of cave systems (mainly the Amateur Cave which is more than 10 km long), which substantially contributed to knowledge of the very complicated sub-surface hydrography. In addition to recent investigations, chapters about geological structure, topography, climate, hydrology, biogeography, mining, settlements, landscape protection and environmental issues are included, too. At the same time, many problems remain to be resolved yet.

In comparison with the book of prof. ABSOLON probably main progress concerns geological structure of the area. There are also some new ideas postulated such as Pliocene pediments in the northern part of the Moravian Karst or already Paleogene initiation of deep river valleys (both in limestone and crystalline rocks). However, the most difficult problem - depressional character of the northern part of the Moravian Karst with regard to non-carbonate rocks in its surroundings - remains unresolved.

A certain shortcoming of the book is low quality of print of geological and karsological maps. We also assume that instead of the karsological map, a geomorphological map pointing out all karst phenomena would have been more useful. Also, an extensive list of references showing that results of research have been published in specialized journals in English or German, summaries of the texts and explanations to the maps, figures and photographs in these two languages would have been desirable.

Selective landscape use on the territory of Southern Moravian Carpathians. Prevailing rich chernozems carry an intensive agriculture even on terraced slopes. Southern dry steep slopes are covered with shallow calcarous pararendzina soils and nature near xerothermic steppe or forest-steppe vegetation islands. Oak forests and rocky grassland is typical for the limestone steep slopes of the Pavlovské vrchy Hills (in background). Photo: J. Kolejka