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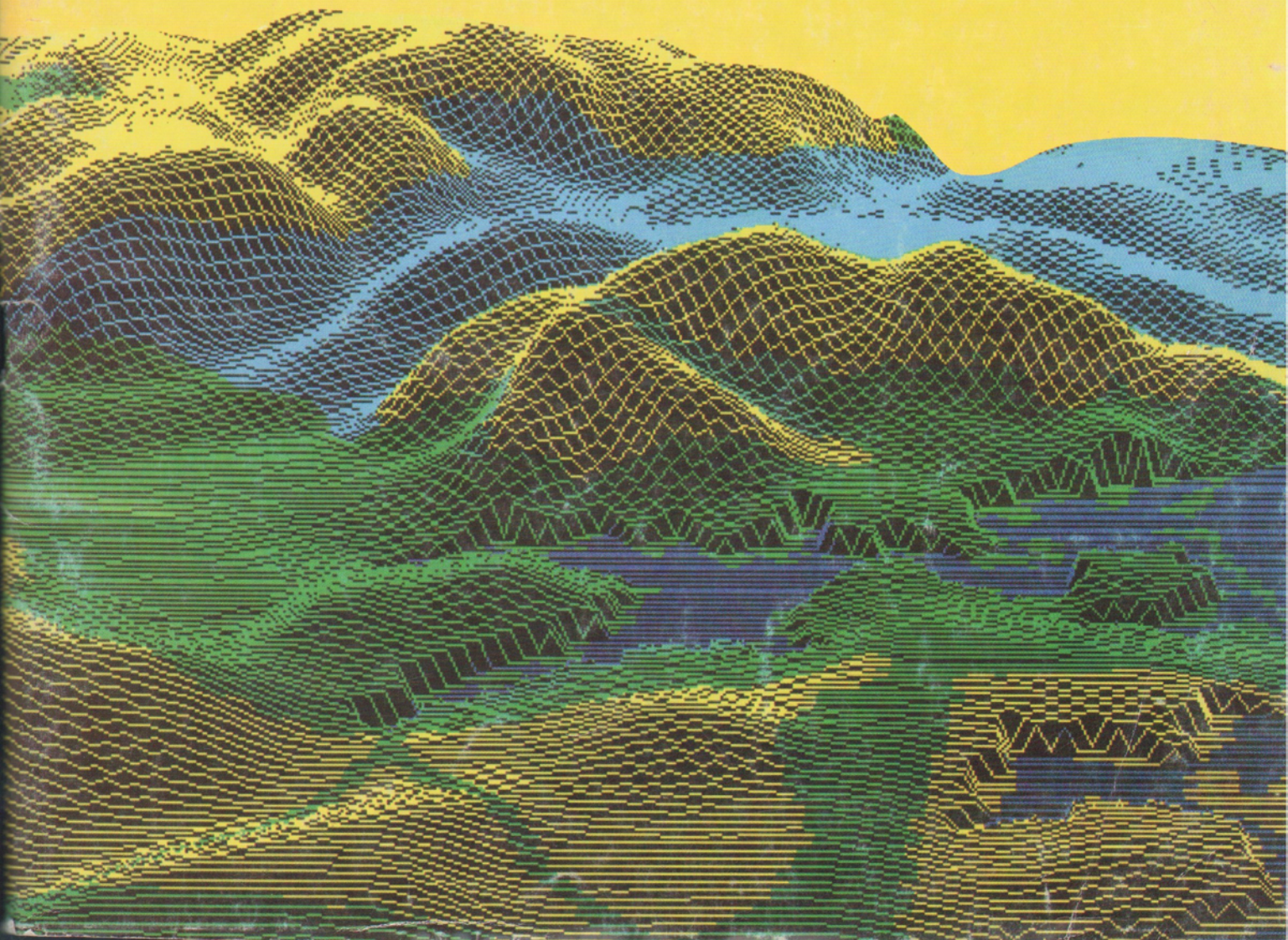

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Contents

THE GEOMORPHOLOGICAL MAP OF BRNO SURROUNDINGS

Antonín Ivan – Mojmír Hrádek

Abstract

Positive development in geomorphology in the course of the last tens of years has been related to increased interest in studying formations and processes induced by man at economic exploitation of the landscape. Attention is being paid to some types of anthropogenic transformations of relief-both direct and indirect. The trend has also been reflected in geomorphological mapping, and authors of the map attempted at application of the principle in the surroundings of Brno. Decisive importance for relief formation in this area is being assigned to previous tectonic development on the margin of Hercynian platform with incorporated older units (Brunovistulicum), varied lithological rock composition and neo-tectonic movements related to collision of the platform edge with Carpathian-Pannonian blocks and rise of marginal flexure of the Bohemian Massif. The above events and features led to a mosaic of formations and relief types of which many have a unique character. Basic characteristic is presented of the relief types along with more detailed classification of their shapes including anthropogenic ones that are related to development of the town.

Shrnutí

Typy reiéfu a vybrané tvary

Pozitivní vývoj v geomorfologii posledních desetiletí je spojován se zvýšeným zájmem o výzkum tvarů a procesů vyvolaných člověkem při ekonomickém využívání krajiny. Upozorňuje se na některé typy antropogenních transformací reliéfu, přímé i nepřímé. Tato tendence nalezla odraz i v geomorfologickém mapování a bylo snahou autorů mapy uplatnit tento princip i v okolí Brna. Určující význam pro utváření reliéfu této oblasti měl předchozí tektonický vývoj na okraji hercynské platformy, do níž byly inkorporovány i jednotky starší (Brunovistulicum), pestré litologické složení hornin a neotektonické pohyby, mající souvislost s kolizí okraje platformy s karpatsko-panonskými bloky a vznikem okrajové flexury Českého masívu. Zmíněné vlastnosti a události vedly ke vzniku mozaiky tvarů a typů reliéfu, které mají řadu jedinečných rysů. Je podána základní charakteristika typů reliéfu a detailnější klasifikace jejich tvarů, včetně antropogenních, majících vztah k rozvoji města.

Key words: marginal flexure of the Bohemian Massif, Carpathian depression, West Carpathians, relief of Hercynian platform, neo-tectonic movements, basins and furrows, anthropogenic transformation of relief

1. Introduction

Progress in geomorphology in the last decades is characterized among others also by intensive study of man-made landforms, changes of intensity in geomorphological processes caused by man, and expansion of methods of geomorphological mapping. At present, geomorphologists participate ever more in solution of practical environmental problems and many of them are directly or indirectly related to disastrous exploitation of renewable and non-renewable natural resources. The surface of Earth as planetary source (D.R. COATES, 1981, p. 20) is damaged by activity of man very severely and it has even been proposed term of "relief pollution".

Classification of relief as a planetary resource is to a certain extent controversial. In strictly geometrical meaning the relief is thought to be a two dimensional surface on the contact between the litosphere and atmosphere (subaerial) or hydrosphere (subaquatic), and is materialized by rocks and soils. In actual cases, the existence of surface relief and relief forms is understandable only in the contex of landscape. We can visualize a landscape without atmosphere, hydrosphere and biosphere but not without the solid rock (or soil) surface and landforms.

Although practical importance of land surface and its changes due to intervention of man is quite evident, it is not yet sufficiently appreciated. Only in the last decades, anthropogenic geomorphology attempts at overcoming the existing gap in research and even some new text-

books have been published. The geomorphological terms used for subaerial surface of lithosphere are relief, georelief or terrain, the last two beeing less common. In general, the relief of earth surface is–as a rule–thought to be land (as opposite to sea), or an area which is suitable for different types of human activities, rather than concrete relief forms in strictly geomorphological sense. Geomorphologists also classify the relief as mostly not renewable or non-renewable resource, but by other criteria such as morphometry, morphography, genesis and age of landforms. In practice, it is important to evaluate the relief just from the point of view of its availability for different social and economic activities, (e.g. agriculture, traffic, military purposes).

At present, man with his technology is a very important geological and in some places even dominant geomorphological agent which has assumed arrogantly rights of unlimited usage of all natural resources. Through his activities he permanently and inventively transforms the earth surface, often in opposite sense than would natural forces and processes do. No wonder that the man very often disturbs natural equilibrium and as a result he must attempt to bring more and more geological and geomorphological processes under his own control, not only exogenous but now also endogenous. To geomorphologists the present participation in solution of important environmental problems provides better professional satisfaction, but it is truth that problems of this type are not always sufficiently attractive for them. At the same time, anthropogenic changes of relief and landscape are seemingly the less urgent problems than air and water pollution and destruction of forests. On the other hand, environmental impacts of human interference into the relief are more visible and of longer duration in the landscape.

Types of human interference into the natural relief are very different and we have proposed the general term anthropogenic relief transformations (ART) for them (A. IVAN – K. KIRCHNER 1988). Two different categories of ART are distinguished. The direct ART consist in true man-made forms which originated by intentional transfer mainly of earth materials by man (quarries, open-mines, dumps, dikes, dams, canals etc.) On the other hand, the indirect ART are represented by secondary, unintentional and mostly negative effects of different human activities, which either modify intesity of existing geomorphological processes (e.g. accelerated soil erosion, landsliding after deforestation) or induce new relief forms such as subsidence depressions due to underground mining, landslides in quarries or abrasion cliffs in man-made lakes (dams).

Substantial progress in geomorphology in the last three or four decades has brought in the geomorphological mapping. Geomorphological maps can provide most exhaustive information about all aspects of relief including anthropogenic relief transformations and changes of landscape. Thus, geomorphological mapping is helping to better understanding of landscape relief, gathering more complete data bases and minimizing fashionable themes in geomorphology.

At the beginning, the geomorphological maps were compiled according to much different principles and different legends. Many national schools existed and great effort was devoted to international cooperation and unification of geomorphological map legends. This effort has been succesful mainly in cooperation concerning small-scale geomorphological maps (The International geomorphological map of Europe 1:2,5 mil.). As to large-scale geomorphological mapping, the situation is less satisfactory. The present detailed geomorphological maps are rather different and unification of their legends is more difficult. Apparently, the cooperation in construction of small-scale maps that emphasize mainly relief types or macroforms is easier. But up to now, great differences have been existing in use of this method in different countries (e.g between continental Europe and English-speaking countries).

The general and applied geomorphological maps are two basic types of these thematic maps. Both types have been constructed and prepared for scientific and practical purposes (mineral prospecting, regional planning, study of present-day geomorphological processes including natural and induced catastrophes). Discussions about different types of geomorphological maps and their importance for practice were very characteristic, especially at the initial phase of the mapping (J.P. BAKKER 1963, D.A. ST-ONGE in R.W. FAIRBRIDGE ed. 1968, J. DEMEK ed.1972). In Czech geomorphology both types of maps have been constructed, too (J. DEMEK 1969, A. IVAN 1971, M. HRÁDEK 1988). In fact, some applied geomorphological maps are very specialized (e.g. morphostructural).

2. *Geomorphology of surroundings of Brno city*

2.1 Geological and geomorphological position of the area

Brno area is situated at the contact of two very contrasting geological and geomorphological sys-

tems of the Czech Republic, namely that of ancient structure of the Bohemian Massif consolidated definitively during Hercynian orogeny with a much younger alpine-type structure of West Carpathians. It is the region " where the more or less subparalell Variscan and Alpine orogens with opposite vergencies are overlapping" (Z. STRÁNÍK et al. 1993).

Although the outermost part of the West Carpathians originated as a depression of Carpathian Foredeep built of weak Tertiary and Quaternary sediments, topographic contrast between the two systems is not very distinct in surroundings of Brno. The line of contact is very irregular on the map. Many promontories or even islands of basement rocks of the Bohemian Massif rise above Tertiary deposits which, on the other hand, protrude into the massif like embayment-shaped depressions. There is no doubt that Brno is situated in the area of the Bohemian Massif, but its considerable part is to be found in a depression widely opened to the Carpathian Foredeep. Foothills of the West Carpathians elevation structure built by Paleogene flysch are only 20 km to SE of Brno.

The Bohemian Massif with very heterogeneous and complex block structure is a part of the West European platform.The most eastern marginal part of massif designated as Brunovistulicum differs from other parts by its geological structure and relief evolution. Together with pre-Hercynian granitoid rocks the Paleozoic sediments (Devonian, Carboniferous and Permian) are very characteristic and take part in complicated structure of the basement. Opinions about geotectonic position of this marginal block of the Bohemian Massif have been changing substantially in the last two or three decades, partly in connection with new ideas, e.g.tectonic terranes (A. DUDEK 1980, M. SUK et al. 1984, Z. MÍSAŘ – A. DUDEK 1993). Now it is believed to be originally a part of the Fennosarmatian platform incorporated later as a strange geotectonic element into morphostructure of the Bohemian Massif.

In the post-Hercynian period, eastern part of the Bohemian Massif has become a passive margin of a platform which was gradually underthrust below the Carpathian-Pannonian plate (Z. STRÁNÍK et al. 1993). From the morphostructural point of view, the margin of Bohemian Massif is the uppermost part of a great flexure complicated by longitudinal and cross faults that descends to the Southeast and is buried by sediments of the Carpathian Foredeep and flysch nappes.

In the system of geomorphological division of Bohemian Massif its eastern marginal part in surroundings of Brno (corresponding to Brunovistulicum) belongs to the Brněnská vrchovina (Highland). This area is presented in eastern and middle part of geomorphological map. In contrast, western part of the map sheet belongs to the Českomoravská vrchovina (Highland), a huge unit built predominately by metamorphic rocks with different tectonic structure (Moravosilesicum) and relief.

2.2 Brněnská vrchovina (Highland)

Importance of tectonics and lithology is a deciding factor of division into low-order geomorphological units (morphostructures) in present relief of the Brněnská vrchovina (Highland). Both influences of late-Hercynian tectonic movements and post-Hercynian germanotype tectonics in relief of this very exposed marginal block of Bohemian Massif are perceptible. Reccurent marine transgressions accompanied with fossilizations and exhumations of planation surfaces in Mesozoic and Tertiary were another complicating factor in evolution of the relief.

The Brněnská vrchovina (Highland) consists of three geomorphological units: Boskovická brázda (Furrow), Bobravská vrchovina (Highland) and Drahanská vrchovina (Highland).

a) The Boskovická brázda (Furrow) is a narrow tectonic depression wide only 5 – 7 km which coincides with a very old deep Boskovice - Diedendorf fault near the contact of Brunovistulicum with Moravosilesicum (Z. MÍSAŘ – A. DUDEK, 1993). The depression originated as a late-Hercynian halfgraben of NNE-SSW direction which was filled with Upper Carboniferous and Lower Permian continental deposits, in some places with coal seams.

Present topography of the furrow characterized by small basins (with rests of Miocene marine sediments) separated by low hilly thresholds has resulted from differential erosion and tectonic remobilization in Tertiary. Due to this fact, the topographic depression in not so wide as the original graben structure. Another interesting phenomenon is drainage across the depression.

The largest partial basin in surroundigs of the town of Tišnov is situated at the crossing of Boskovická brázda (Furrow) and Železnohorský zlom (Fault) from NW-SE. In this basin isolated

subsided blocks of Devonian limestones are interpreted as fossil karst inselbergs by V.PANOŠ (1964).

b) The Bobravská vrchovina (Highland) eastwards of the Boskovická brázda (Furrow) is characterized by block-faulted relief (horsts and grabens). Prevailing rocks are deeply eroded and intensively tectonized granites and granodiorites of the Brno Massif with narrow metabazite zones of N-S direction. The oldest sediments resting unconformably on the igneous rocks are Lower Devonian basal clastics of Old Red type.They are downfaulted into granites or metabazites.

The tectonic block-faulted relief with many small horsts and grabens in the Bobravská vrchovina (Highland) is very unusual in the Bohemian Massif and its origin is much discussed both in geological and geomorphological literature (J. KREJČÍ 1964, 1968).

In the most western part of the Bobravská vrchovina (Highland), east of the Boskovická brázda (Furrow) there is an assymetrical horst of Lipovská vrchovina (Highland, 478 m) up to 5 km wide. Remainders of planation surface on the top with low inselbergs are distinctly inclined to the East. Very interesting forms crossing the fault blocks are deep gorges of rivers of Svratka and Bobrava.

The most interesting part of the Bobravská vrchovina (Highland) is a not properly individualized complex morphostructure of the Brno Basin (A. IVAN 1993, M. HRÁDEK 1989, 1991). From the point of view of morphostructural analysis, the Brno Basin is a double graben with a central horst zone of S-N direction. The basin is up to 15 km wide in the S and has composite triangle-shaped groundplan determined by five important tectonic directions (NW-SE, SSW-NNE, N-S, W-E and SW-NE). Among five low-order morphostructures of the basin, there are two assymetric grabens, two partial basins and a middle, inner elevation zone of horst blocks with the highest point at 485 m above sea level. The floodplain of Svratka river in Brno is at the altitude of 200 m.

The Brno Basin is inner part of the Nesvačilka Graben originated probably in Mesozoic. This very important cross structure complicates the buried marginal flexure of the Bohemian Massif and is filled with Jurassic carbonates and Paleogene pellites up to some thousands metres thick. The graben is also interpreted as submarine canyon or aulacogen actively eroded in Paleogene. This was the route through which sediments from the Bohemian Massif were transported into Carpathian geosyncline (F. PÍCHA 1977, F. PÍCHA, E. HANZLÍKOVÁ, J. CAHELOVÁ 1978). This development was probably finished only in Miocene by formation of flysch overthrusts in the Carpathians and migration of foredeep towards the Bohemian Massif. Important rivers draining very planated Bohemian Massif probably debouched into estuary predisposed by the Nesvačilka Graben.

The Brno Basin is separated by a low threshold from the Tišnov Basin (part of the Boskovická brázda Furrow) northwest of Brno and towards SE it widely opens into the Carpathian Foredeep, geomorphological unit of Dyjsko-svratecký úval (Graben).

Thickness of Miocene sediments (mainly Lower Badenian sands and clays) in the Brno Basin is usually 100 - 200 m, in deeper parts near contact with the Carpathian Foredeep perhaps up to 500 m. Thus, high differences of basement surface in area of the Brno Basin can be more than 700 m.

Dating of block movements is a very complex issue and many contradictory ideas have been published. Neotectonic movements probably interferred with Miocene marine transgressions, but pre-Badenian sedimentary record was mostly destroyed. Our opinion is that the block tectonics was active before, in the course and also after the transgressions. After the last regression in Lower Badenian subaerial differential erosion gradually evacuated weak sediments and exhumed the rest of pre-faulting planation surface on uplifted blocks. Some small blocks were remodelled into inselbergs. Owing to deep subaerial erosion, small tectonic blocks of Jurassic limestone are visible too as karst inselbergs on the bottom of Brno Basin (e.g. Stránská skála).

c) East and North of the Brno Basin there is the third, greatest geomorphological unit of Brněnská vrchovina (Highland), the Drahanská vrchovina (Highland). Only its westernmost part built of granitoid rock is on the map. North of Brno downfaulted resistant Lower Devonian conglomerates form a narrow synclinal ridge above the planation surface on granite. Top of the ridge is the highest point in the surroundigs of Brno and also of the map sheet (Babí lom 562 m).

East of the deep gorge of Svitava river, which is about 30 km long, there is a large and more interesting part of the Drahanská vrchovina (Highland) built of mainly folded Paleozoic

sediments, Devonian limestones (Moravian Karst) and Lower Carboniferous graywacks, slates and conglomerates (Variscan flysch). Intense Hercynian tectogenesis was followed by deep denudation and planation. The post-Hercynian planation surface (Triassic ?) cut both resistant and weak folded rocks. Intensive tropical weathering of Devonian limestones in Mesozoic is demonstrated by deep fossil karst depressions (more than 100 m) filled with weathering products (Jurassic,Cretaceous ?). The remnants of Upper Cretaceous fresh-water and marine sediments (Cenomanian, Turonian) are preserved in the Blansko Graben in northeastern corner of the map.

Neotectonic dome-like structures characterized by a typically deformed planation surface are very interesting forms in the Drahanská vrchovina - Highland (M. HRÁDEK – A. IVAN, 1974). Very instructive example of this type structure is the Soběšická klenba (Dome) in the northern part north of Brno, analysed in detail by J. KREJČÍ (1964).

2.3 Českomoravská vrchovina (Highland)

Only a small eastern marginal part of the Českomoravská vrchovina (Highland) is presented in the map. From the geological point of view, this is Svratecká klenba (Dome), one of the most controversial structures in the Bohemian Massif. Here the conception of alpine type Hercynian tectonics was postulated at the beginning of this century. This conception of thrusting of older Moldanubicum over younger Moravicum was later rejected by many authors but new research confirms its general correctness (J. JAROŠ – Z. MÍSAŘ 1974). Later, the conception has been modified considerably by J. JAROŠ (1992). In his opinion the Moravicum is also nappe, thrusted over the Brunovistulicum. After deep erosion the Svratka Dome "may even represent a double tectonic window". In core of the dome the very resistant two mica augen gneiss (Bíteš gneiss) belonging to the Moravicum, as same as slightly tectonized and less resistant Svratka granite (Brunovistulicum) are truncated with little regard for lithology or structure. Phyllites and limestones are characteristic for pheripheral parts of the dome.

Geomorphological division of this part of the Českomoravská vrchovina (Highland) west of Brno includes the Bítešská vrchovina (Highland). A relatively flat relief with extensive, well preserved planation surface and deep narrow but broadly-spaced river valleys are most striking features especially in the centre of dome (Krajina 515 m). The longterm subaerial denudation is demonstrated by more than 100 m deep kaolines near village Lažánky (M. KUŽVART 1965) and also by fossil karst phenomena. The position of remnants of planation surface together with radial drainage pattern indicates neotectonic remobilization of ancient dome (M. HRÁDEK – A. IVAN 1974).

3. Anthropogenic relief transformations (ART)

Heterogeneous relief and geological structure have offered all main types of building materials directly in Brno in the past. Thus, together with plenty of sands, gravels, clays and loess, it was possible to mine at this place not only different types of bulding stones such as granite, diorite, diabase and sandstone, but also Jurassic and Devonian limestones. But aesthetic and environmental aspects as well as requirements as to quality of raw materials resulted in gradual ceasation of mining activities and their restriction to some suburbs at first, and later out in the country. The most disturbing effect on landscape aesthetics is evident in mining of limestone. Large quarries in Devonian limestone are in the northeastern part of Brno in southern tip of Moravian Karst and in the area of geomorphological map in the Tišnov Basin, where exploitation at the hill Čebínka in the 60's particularly destroyed very important botanical and geomorpological localities. In the paper of V. NOVÁČEK (1983) 85 mining places are mentioned in the area NW of Brno identical with the geomorphological map. But many loess-pits and gravel-pits mined out in the past were reclaimed and their localization is possible according to old maps or archives. Most mining forms were also used for waste deposition and damage of relief is not obvious in the present landscape. The relief of horst and grabens suppress impression of intensive urbanization but on the other hand represents a very complicating factor of traffic (J. KARÁSEK 1986).

Position of the town on the bottom of basin has caused that new settlements have been built mainly in the higher relief. At present, differences between the lowest and highest parts of the town are more than 200 m. The complicated topography contributes to very fragmentary and polyfunctional land-use. Even very steep slopes are terraced for building or agricultural purposes.

As to indirect ART the most interesting forms are induced abrasion cliffs and beaches

along the shore of Brno dam (J.LINHART 1964). Abrasion activity and retreat of cliffs continue up to now, more than fifty years after building of the dam. Accelerated soil erosion (mainly rills and gullies) and minor induced landslides are another indirect ART.

4. *Geomorphological map of relief types and some important forms*

The aim of geomorphological map of Brno surroundings is to give a true picture of relief and simultaneously intimate the main environmental geomorphological problems not only to geomorphologists but also to other specialists. Legend of the map lacks specialized terminology. Data about age of forms are ommited, too. Unfortunately, quality of the topographic base is rather poor, especially when compared to military topographic maps (confidential in the time of field mapping in 1988-9). Merely these oversimplified and purposely "anthropogenic" deformed maps (available "only for internal use of state authorities and socialist organizations") were approved for publishing at that time.

The presented geomorphological map is of a rather general type and takes into cosideration some forms important from the point of view of environmental geomorphology (valuable preserved forms and anthropogenic forms), too. Our opinion is that the maps of relief types provide more lucid information about the relief. The most important information about relief type and its origin is expressed by colour (e.g. deep brown designates denuded relief of dissected highland). Intention of colour scale consits in plasticity of the map to come close to reality. Importance of some anthropogenic forms is stressed by red colour. Types of hachure supply additional information mainly about genesis or geomorphological processes.

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Explanations to the map – Appendix No. 1

Relief types:

1-4 Dissected highlands
1 - with remnants of subhorizontal planation surface
2 - with remnants of dome-like deformed planation surface
3 - with remnants of inclined planation surface
4 - with preponderance of slopes

5-7 Gently undulated higlands
5 - with remnats of subhorizontal planation surface
6 - with remnants of inclined planation surface
7 - with preponderance of slopes

8 - dissected hilly land with remnants of subhorizontal planation surface
9 - erosion-denudation relief of foothills (piedmont hilly land)

10-12 hilly land in basins
10 - with erosion-denudation relief
11 - with erosion-accumulation relief
12 - built of loess
13 - riverine basins with erosion-accumulation relief

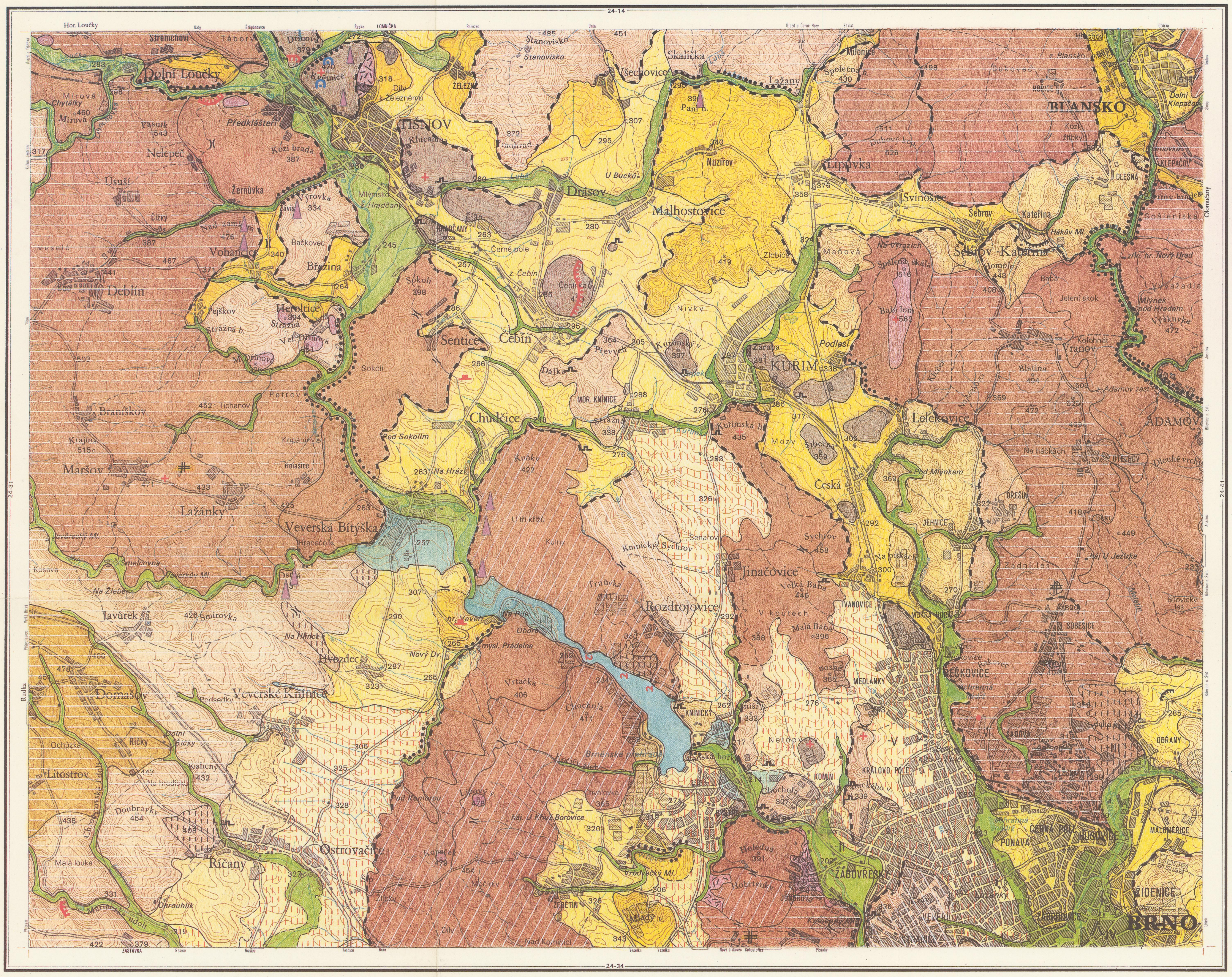
Selected forms
14 - floodplains
15 - inselbergs and knobs in basins
16 - structural ridges and knobs in elevated position
17 - solifluction cover and talus
18 - tors
19 - gorges
20 - saddles
21 - caves
22 - margins of elevated mezoforms connected with faults
23 - fossil weathering crust
24 - slopes disturbed by gully erosion
25 - great active open-mine
26 - small active open-mine
27 - great inactive open-mine
28 - small inactive open-mine
29 - abrasion processes in man-made lake
30 - agricultural terraces
31 - dumps of waste
32 - waste in inactive open-mine
33 - significant view-point
34 - distinct boundary of forms or relief types
35 - undistinct boundary of forms or relief types

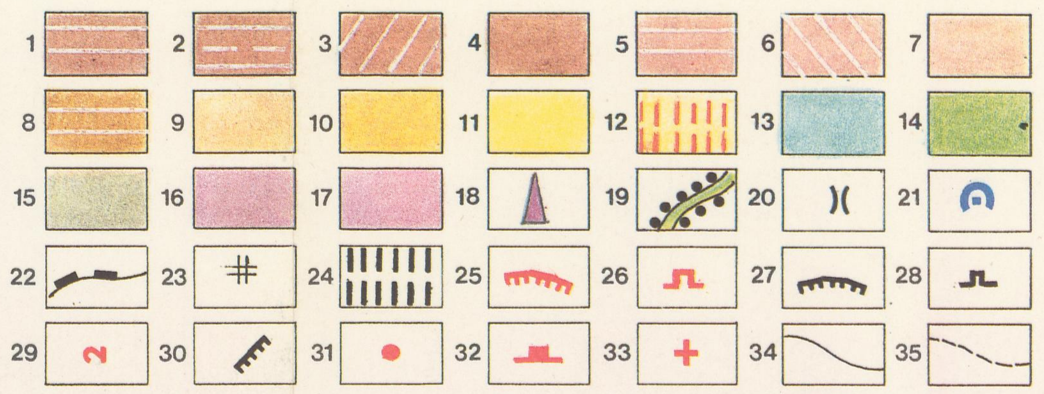
Babí lom *Photo: K. Kirchner*

The Brno Highlands. View of the western part of the Brno basin with colourful mosaic of partial tectonic blocs of various genesis. At foreground: margin of Bohunice plateau, left: margin Kohoutovice horst with subsided bloc, center: tilted horst of Masaryk quarter, left center backgroud: horst of Palacký vrch (hill), at background: ridge of Babí lom with faulted lower devonian sandstones of Old Red. Partial basins of Pisárky and Žabovřesky are hidden among the horsts.

Photo M. Hrádek

1 TYPY RELIÉFU A VYBRANÉ TVARY ČR



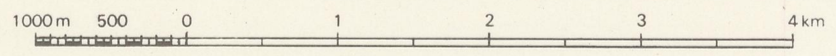


TYPY RELIÉFU:
1 - 4 členité vrchoviny: 1 - se zbytky subhorizontálních plošinných tvarů; **2** - se zbytky vyklenutých plošinných tvarů; **3** - se zbytky ukloněných plošinných tvarů; **4** - s výraznou převahou svahových tvarů; **5 - 7 ploché vrchoviny: 5** - se zbytky subhorizontálních plošinných tvarů; **6** - se zbytky ukloněných plošinných tvarů; **7** - s výraznou převahou svahových tvarů; **8** - členitá pahorkatina se zbytky plošinných subhorizontálních tvarů; **9** - úpatní pahorkatina s erozně-denudačním reliéfem; **10 - 12** kotlinové pahorkatiny: **10** - s erozně-denudačním reliéfem; **11** - s erozně-akumulačním reliéfem; **12** - sprašové; **13** - poříční kotliny s erozně-akumulačním reliéfem;

VYBRANÉ TVARY:
14 - údolní nivy, **15** - ostrovní hory a obdobné elevace ve sníženinách, **16** - strukturní hřbety a suky (ve vrcholových polohách), **17** - soliflukční pokryvy a úpatní haldy, **18** - izolované skály, **19** - průlomová údolí, **20** - sedla, **21** - krasové jevy, jeskyně, **22** - okraje elevačních jednotek spojené se zlomy, **23** - fosilní zvětraliny, **24** - svahy postižené stržovou erozí; **25 - 28 tvary vzniklé povrchovou těžbou: 25** - aktivní, velké, **26** - aktivní, malé, **27** - neaktivní, velké, **28** - neaktivní, malé; **29** - abrazní jevy na březích umělých vodních nádrží, **30** - agrární terasy, **31** - skládky odpadu, **32** - skládky odpadu v opuštěných těžebních tvarech;
33 - význačné vyhlídkové body, **34** - výrazné hranice tvarů reliéfu, **35** - méně výrazné hranice tvarů reliéfu (místy až konvencionální).

1 : 50 000

1 cm = 500 m



Základní interval vrstevnic 10 m

SOUBOR GEOGRAFICKÝCH MAP ŽIVOTNÍHO PROSTŘEDÍ

TYPY RELIÉFU A VYBRANÉ TVARY ČR. List 24-32 Brno.
Měřítko 1 : 50 000. Zpracováno v rámci dílčího úkolu SPZV II-7-4-01 „Geografické hodnocení stavu a vývoje životního prostředí na území ČR", odpovědný řešitel dílčí části RNDr. Evžen Quitt, CSc., autoři listu RNDr. Antonín Ivan, CSc., RNDr. Mojmír Hrádek, CSc., RNDr. Otakar Štelcl, CSc., kreslila Jana Honsová. Zpracoval Geografický ústav ČSAV Brno. Pro GgÚ ČSAV Brno vydal Ústřední ústav geologický Praha. Technická redakce J. Rudolský, ÚÚG Praha. Reprodukční zpracování a tisk OT Kolín. Tisk 1990.