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Geological research of Bohemian Forest
Geologický výzkum Šumavy

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Abstract
The geological structure of Bohemian Forest is generalized, so far, only in the 1:200,000 geological map covering the former Czechoslovakia (western part), published in 1962 (Fig.1) (KODYM & al. 1962). A map in a 1:50,000 scale is under preparation for this region, and will be published within a year. Progress in geological mapping reflects the rising need of geological information required for environmental monitoring, sustainable forest management, and rapidly developing tourism. – From the geological viewpoint, the Czech side of Bohemian Forest is feasibly divided into two main parts separated by the Studená Vltava river. (1) The northwestern part is built up mainly by the migmatites (i.e. partially molten gneisses) of a uniform character (i.e. only with few intercalations of other rock types). The smaller northern half of this NW-part is created by only slightly metamorphosed mica schists and phyllites of the Královský Hvozd Unit. Three granite massifs of this NW part (Prášily, Vydra and Strážný massifs) are spatially subordinated to the above mentioned gneisses. (2) South-eastern part of Czech Bohemian Forest is built principally by granitic massifs (Plechý and Vítkův Kámen massifs) and a syenitic (i.e. quartz-free granite) massif of Želnavské hory, further by orthogneisses, rimmed by granulites in the north (Křišťanov massif). The so-called Český Krumlov gneisses, with many intercalations of other rock types such as amphibolites, calc-silicate rocks, marbles and graphitic schists, are situated in the central part of the SE Bohemian Forest.

Key words: Šumava Protected Landscape Area, geological map, phyllite, mica schist, gneiss, orthogneiss, granite, syenite, granulite

Introduction

The main goal of environmental conservation and management in Bohemian Forest (Šumava Mts.) consists in maintenance of the equilibrium between a wide range of human activities and all factors of the biosphere. This endeavour would be imperfect without adequate knowledge and continual research of the earth's crust, of which the biosphere creates only a very thin coat. It is well-known that the present-day appearance of any landscape (including Bohemian Forest) has been determined by features of their geological formation. The soil cover, too, is a product of long-term weathering of the bedrocks. The primary influence of the underlying rocks is dependent both on their physical (hardness, porosity, tectonics, seismic activity, heat flow) and chemical (solubility, solutions' movement and gas emanations) characteristics.

From the geological viewpoint, the Czech Republic is situated in the so-called Bohemian Massif which represents a specific island on the geological map of Europe, being noted for its preservation of the Low Palaeozoic and Upper Palaeozoic mountain-building relics, with time spans about 500 Ma and 340–280 Ma, respectively.

Bohemian Forest is placed at the western edge of the central part of Bohemian Massif, so-called Moldanubicum. The gravimetrical map of Bohemian Massif, based on the principle of different densities of different rock types, reflects a deep structure of the earth's crust. This map characterizes Moldanubicum as a zone of negative weight anomalies. Such anomalies are typical of rocks with extremely low density, such as the granites. A geological map of Moldanubicum, incl. Bohemian Forest, shows prevailingly red and beige colour tinges (KODYM & al. 1967) suggesting that the main rock types here are granites (red colour) and also gneisses (beige colour) which are „granitized" (or molten by other terms) to a high degree, when the presence of granites is to be expected to a shallow depth level only.

Results

Geology of Bohemian Forest

Geological structure of Czech side of Bohemian Forest (marked by the boundaries of the Šumava Protected Landscape Area = Šumava Biosphere Reserve) is summarized at the 1:200,000 scale in a general geological map from 1962. From the geological point of view, Šumava Protected Landscape Area could be divided into two main parts, separated by the upper flow of the Studená Vltava river down to its confluence with the Teplá Vltava river, by a part of theTeplá Vltava river and further by Volarský potok and the western edge of Želnavské hory massif (Fig.1).

The north-western part of Bohemian Forest is mainly built up by the migmatized (i.e. partially molten) gneisses of a monotonous character (i.e. only with few intercalations of other rock types). The smaller northern half of the NW part of Bohemian Forest is created by mica schists and phyllites of the Královský Hvozd Unit, which represent exceptional rocks for the whole Moldanubicum. This exceptionality consists in the feature that these rocks are only little thermally affected, unlike the majority of the whole Moldanubicum. Furthermore, from Železná Ruda to Svatá Kateřina, the degree of thermal influence sinks very rapidly, so that at the northern border of the nature reserve we find rocks almost without thermal influence (so-called Rittsteig Phyllites). Here Silurian microspores of primitive plants have been found (REITZ 1992). The northern border of Šumava Bioshere Reserve is also an important geological boundary built up by a deep fault called „Central Bohemian Fault". To the north of this tectonic boundary, there is a different geological world marked by basic rocks (gabbros and diorites of Kdyně Massif). Farthermore to the north-east, there are sedimentary rocks of the Barrandian Proterozoic.

North-western part of Bohemian Forest is intruded by 3 granite massifs (Prášily, Vydra and Strážný Massifs) which are, however, spatially subordinated to the above mentioned gneisses. The most important peat sediments are also drawn on the map.

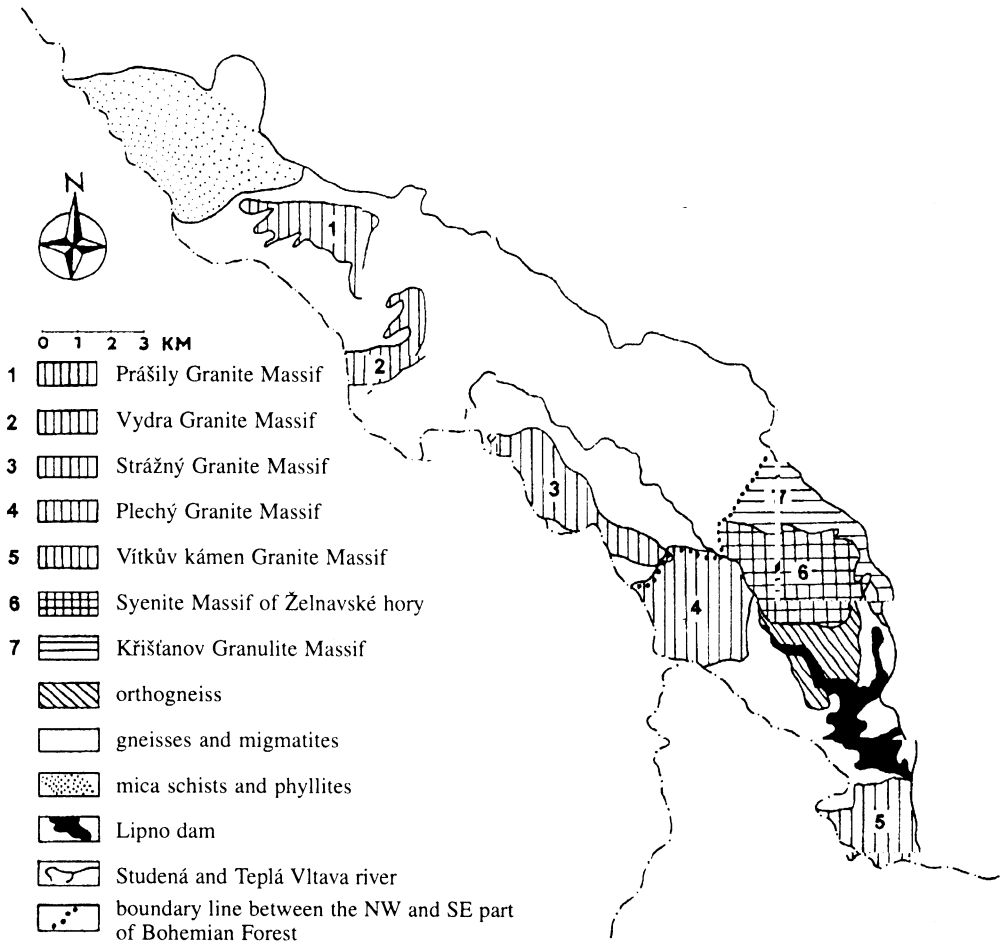
A view of the landforms of the north-western Bohemian Forest clearly shows, how the landscape morphology depends on the kind of the geological underground. While migmatites (advanced molten gneisses) and granites of the upper altitude levels build up flat plateaux, the mica schists and phyllites of the Královský Hvozd Unit (between Železná Ruda and Nýrsko towns) are recognizable by elongated mountain ridges with substantial altitudinal differences between mountain summits and river valleys (several hundreds of meters) which is anomalous for the whole Bohemian Forest (BABŮREK 1995). Basic rocks of the Kdyně Massif are noted for vast, rounded, symmetric and isolated mountains.

The second, south-eastern part of the Šumava Biosphere Reserve is built up mainly by granitic rocks of Plechý and Vítkův kámen Granite Massifs, and by syenitic (i.e., quartz-free)

rocks of Želnavské hory syenite massif; further by orthogneisses and granulites (Křišťanov Massif). The so-called Český Krumlov gneisses are situated in the central part of south-eastern Šumava. They are very varied in comparison with the gneisses in the north of Bohemian Forest due to many intercalations of different rock types, such as amphibolites, marbles, calc-silicate rocks and graphitic schists. The Kaplice mica schists are present in the southernmost part of the biosphere reserve only.

Characterization of geological maps in various scales

The 1:200,000 and 1:500,000 scales of general maps serve very well for a broad and multi-purpose overview. However, for special needs of administration, building organizations, forest management, tourism, etc., more precise map scales are required. The map accuracy should be reasonably high in order to enable readings of adequate informations for particu-



Obr. 1. – Geologická stavba Chráněné krajinné oblasti Šumava.
Fig. 1. – Geological structure of Šumava Protected Landscape Area.

lar sites of interest, e.g., rock type, tectonic situation, thickness and type of the Quaternary sediments.

In maps of the 1:50,000 scale, more detailed information about different rock types is included. For example, banded migmatitic gneisses are separated from the compact ones, and different granite types can be distinguished from light to dark porphyritic varieties (e.g. PELC 1990). Coincidence of several geological features can yield additional information. For example, flowing in the direction NNW-SSE the majority of rivers in Bohemian Forest copy tectonic faults. At the end of 1995, the whole area of Czech Bohemian Forest has been covered by maps of this scale.

A peak of the mapping skill in geology is achieved in maps at the 1:25,000 scale, whose single centimetre corresponds to 250 metres. Such a map is a product of the joint effort of several experts specialized in crystalline complexes, Quaternary geology, raw materials and industrial minerals, geophysics, geochemistry, etc. Detailed explanatory notes in the extent of several dozen of pages are added to each these map sheets. There is much space for precise localization of many varieties of rocks. Last but not least, a distinction of many types of Quaternary sediments, such as river sediments, deluvial deposits (e.g. slope loams), peats, aeolian deposits, is of practical use. Special symbols localize exploited quarries or quarries in work, mines, sand pits, faults, mylonitized zones, layer striking. Points with numbers signalize important outcrops from the geological viewpoint. Geological profiles (cuts) are drawn to each of these maps, thus offering 2 or 3-dimensional picture of the geological formation. So far, none of these detailed maps has been finished for the territory of Šumava Protected Landscape Area.

An example of geological research in Czech Bohemian Forest

Generally speaking, compilation of geological maps requires increasing qualification and skill of geologists working at still more detailed scale. To illustrate this challenge, let us choose outcrops on the Pancíř hill near Železná Ruda town where a detailed scientific research has been conducted. We shall zoom on the mountain peak ranging from a long distance to a close contact, i.e., from the general scale to a very detailed scale of geological maps; furthermore we shall view the geological material in the microscopic dimension of rocks and minerals.

On the 1:500,000 geological map we can see the Pancíř hill lying in the field of muscovite-biotite gneisses of the Královský Hvozd Unit (KODYM & al. 1967). However, even the smallest point on such a map represents in reality a circle of several hundreds of meters in diameter; one should never forget this high degree of generalization of the geological information.

The 1:100,000 geological map already yields some additional information: we can see that the gneisses of Pancíř hill are noted for a greywacke character (high amount of feldspars) and their striking direction is NE-SW (BABŮREK & PELC in press).

A gneiss sample collected on the peak of the Pancíř hill enables preparation of a thin section which can be studied under microscope and readily provides geological information of a higher order. We can thus identify the complete mineral composition of the rocks, i.e., presence of quartz, feldspar, biotite, muscovite, garnet and some ore minerals. Using still higher magnification, other small mineral inclusions enclosed in larger mineral grains (mainly in garnet) will appear (BABŮREK 1995).

The electron microprobe analyzer in connection with an electron microscope enables a still deeper penetration into the microcosm of the Pancíř gneiss. For example, the above mentioned mineral inclusions, several micrometres in size only, can be both observed and analyzed. As a garnet grain grows several tens of million years, our knowledge about mine-

rals included in the larger grains provides an information about the conserved old mineral composition preceding the minerals building up the groundmass of the rock; necessarily, the inclusions must be older than their host minerals (Babůrek 1995).

The contents of some specific elements in the minerals vary systematically in dependence on temperature and pressure during their crystallization. Hence, we can reconstruct a part of the temperature/pressure history for the Pancíř gneiss by means of extrapolation of the data for the inclusion minerals in garnet (e.g. 500 °C/5.5 kb) and the minerals of the groundmass (575 °C/6.5 kb) (Babůrek 1995). It is possible to conclude that the Pancíř gneiss was located during its crystallization (or solidification by other terms) in a depth of about 20 km, because the pressure recognized and still mentioned above (5.5–6.5 kb) is proportional to the depth in which the rock has been located. By means of such a detailed mineralogical research of selected rock types sampled across the mountain ridges, it is possible to reconstruct the history of the earth's crust in Bohemian Forest.

Conclusions

In Bohemian Forest, geological mapping provides complete coverage at the 1:200,000 scale of the area on the Czech side of these mountains. More detailed geological maps are under preparation. A transboundary continuity exists between the geological units recognized on the Czech, Bavarian and Austrian side of the mountains. There are few communication problems across the state boundaries concerning the geological research.

Some discrepancies still exist in communication between the geologists and experts dealing with environmental issues. One of the probable reasons for this misunderstanding is schematical opinion with regard to the geologist's role: his task is assumed to start and stop with drawing of a geological map. Geologists are seldom consulted in important matters of interpretation of their maps. Two aspects should be considered:

1) Geological maps include more information than the pattern of coloured fields of particular rock types. With the addition of certain geological experience, these maps enable to estimate the degree of rock weathering, direction of water circulation, impact of rock-forming minerals influencing chemistry of soil and water, etc. Interpretation of all geological maps requires consultation with pertinent experts.
2) Even the most detailed geological map is a generalized map, which means that with regard to a particular locality some data still exist in the geologists' notebooks and databank; many data are missing and require further geological expertise with respect to application in various environmental matters.

References

Babůrek J., 1995: High, medium and low pressure assemblages from the Czech part of the Královský hvozd unit (KHU) in the Moldanubian zone of SW Bohemia. *Journal of the czech Geol. Society, 40(1–2): 115–126.*

Babůrek J. & Pelc Z., (in press): Geologische generalkarte 1 : 200,000. Blllatt Deggendorf (Zwischenmaßstab 1 : 100,000).

Kodym O. & al., 1962: Geologická mapa ČSSR 1 : 200,000, list Strakonice. *ÚÚG Praha.*

Kodym O. & al., 1967: Geologická mapa ČSSR 1 : 500,000, západ. *ÚÚG Praha.*

Pelc Z., 1990: Geologická mapa ČSR 1 : 500,000, list Kašperské Hory, *ČGÚ Praha.*

Reitz E., 1992: Silurische microsporen aus einem Biotit – Glimmerschiefer bei Rittsteig, nördlicher Bayerischer Wald. *Neu. Jb. Geol. Paläont., Mh., 6 : 351–358.*