

SELECTED RESULTS OF THE GEOMORPHOLOGICAL RESEARCH IN THE ŠUMAVA MTS. IN 2005-2007

Project of the Grant Agency of the Academy of Sciences of the Czech Republic, No. KJB 300460501

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ABSTRACT

The article summarizes the most important findings achieved within the scope of the project KJB 300460501 "Comparison of the quaternary development of the Novohradské Mountains and the selected parts of the Šumava Mountains" and briefly informs about the methods, which were applied during the research. In this contribution, we present the results from selected localities, namely the catchment of the Losenice River and three formerly glacial cirques, currently occupied by Prášilské, Laka and Černé lakes.

KEYWORDS: geomorphological mapping, morphostructural analysis, monitoring, glacial cirques, Šumava Mts.

INTRODUCTION

There are few studies concerning the Šumava Mountains accomplished so far, including geomorphological and quaternary research. Nevertheless, this area represents a region connecting the Alpine area with significant extent of pleistocene mountain glaciation and the vast area of continental glaciation of the Northern Europe. Thus we deem the Šumava region has a great importance in the research of the Quaternary in the European dimension, particularly in respect to glaciation and the development of the landscape since the deglaciation. Improving and deepening of our knowledge on the quaternary development of this area will therefore contribute to general of the Central European relief's development in its wider consequences of the Pleistocene/Holocene transition.

The project *KJB 300460501* has been aimed on both parts of the Šumava subprovince (Šumava and Novohradské Mts.), this article describes the most important results reached in the research of selected areas of interest in the Šumava Mts., in particular the active outer slopes around the Losenice River and in the vicinity of formerly glacial cirques of Prášilské, Laka and Černé lakes (Fig. 1).

THE STUDY SITES

There were several areas studied within the Šumava Mts. and Pošumaví region, the most

important being the catchment of the Losenice River and surroundings of formerly glacial cirques, filled presently by the lakes of Prášilské, Laka and Černé. These represent the chief areas of interest (further AOIs).

LOSENICE RIVER CATCHMENT

In the catchment of the Losenice R., a detailed mapping in the scale 1 : 5 000 was performed, covering the whole AOI. Even in higher detail were examined the most interesting sites, such as the valley slopes and floor under Obří Hrad site or the outcrops on the Valy Hill (Zvelebil and Hartvich, 2006). This site is situated on a narrow ridge, outspurring northwards from the of the uplifted planation surface of the Šumavské pláně.

The Losenice catchment is an area where steep margins of the Šumava slope fall into a network of dissected valleys. The activity of current processes in this area is a result of common action of exogenous processes, reshaping a strongly structurally predisposed relief. As was found out earlier (Hartvich, 2005), the foliation planes orientation and dip together with dense network of tectonic joints predispose the sliding of the rock blocks on the slopes under the Obří Hrad site, aided by the undercutting of the slope by the Losenice River.

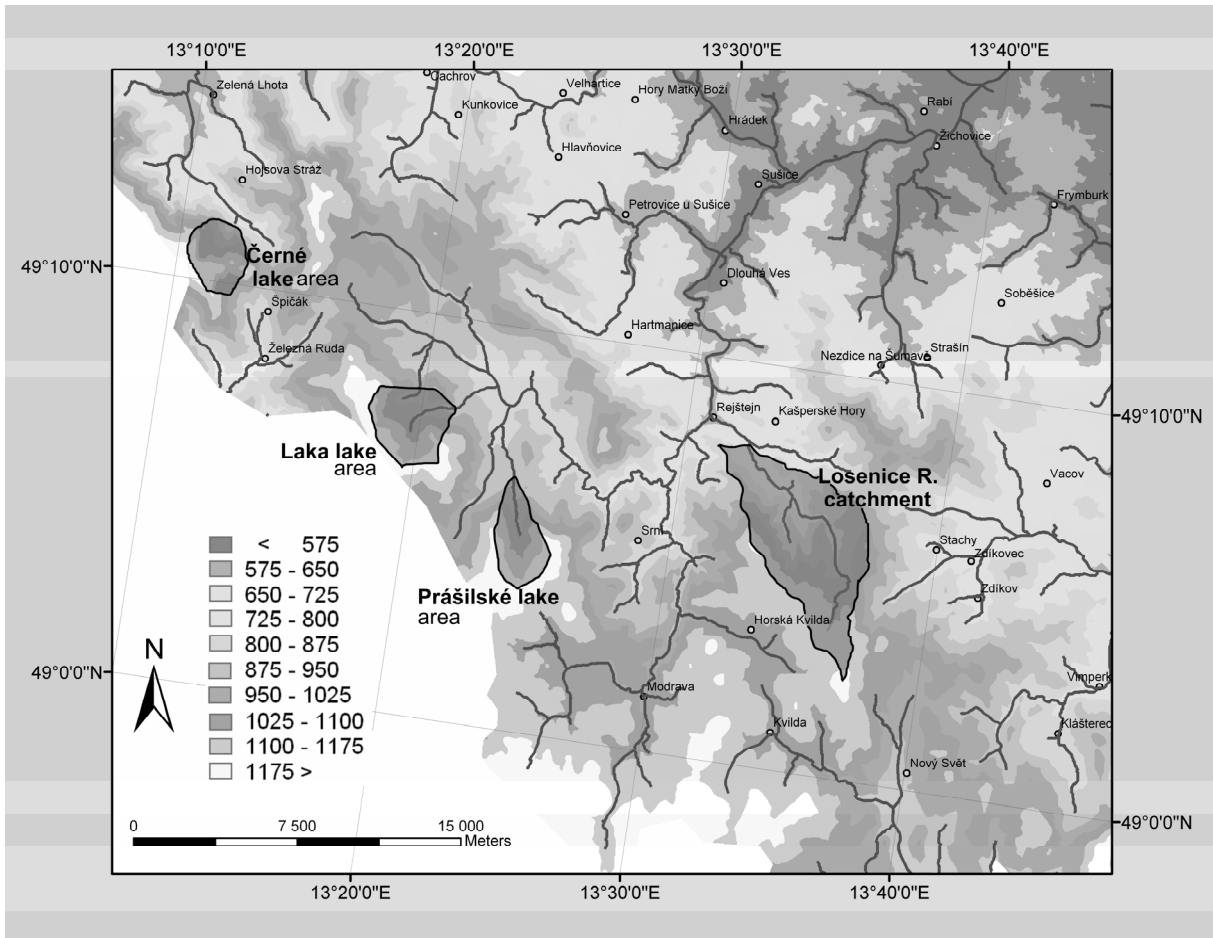


Fig. 1 Location of the studied sites in the NW part of the Šumava Mts.

GLACIAL LAKES SURROUNDINGS: LAKA, PRÁŠILSKÉ AND ČERNÉ

The three formerly glacial cirques are situated on the NE slopes of the main ridge of the Šumava Mts., forming for the most part a state border. The lake corries represent active parts of the relief, partly due to steep slopes - inclination of the 140 m high slope of the Prášilské lake wall exceeds 40°. The second aspect causing the high activity are densely varying geological conditions. Although crystalline rocks such as gneiss, migmatite and quartzite are predominant, relatively small granite areas are morphologically quite significant.

Also in this area, detailed geomorphological mapping was performed, in the case of the two former by the elementary forms technique and together with the development of the GmIS (Mentlík et al., 2006). The research here was aimed on the glaciation history (Mentlík, 2006a), using many auxiliary methods to assess the chronology and extent of the glaciation (Mentlík et al., 2007; Břízová and Mentlík, 2006). In the case of the Černé lake, the mapping is still on progress, although some results were already assessed (Vočadlová, 2006).

METHODS OF RESEARCH

MAPPING AND INVENTORY OF FORMS

The elementary and most used field method was the geomorphological mapping, assisted by GPS and digital data processing. As a pilot project, complex geomorphological mapping of elementary units (sensu Minár, 1996; Minár and Evans, 2008) was applied in selected AOIs. This is a new, progressive approach in the geomorphology, using defined „elementary“ units of the relief and a wide application of GIS. Advantages of this approach rests mainly in its ability to manage created maps (respectively database) in the framework of geomorphological information system (GmIS) and in using systematic approach in the framework of geomorphological analysis realized by GIS tools (Mentlík et al., 2006).

A detailed inventory of periglacial and glacial forms was created, on which the typology and comparison of morphological, morphometric, morphogenetic and morphochronological features was performed.

Special attention was paid to the distribution of glacial and periglacial forms (their morphometric characteristics will be recorded according to uniform

legend – length and width of platforms, height and character of frost cliffs). Based on the density, distribution and character of the geomorphological forms, typological areas were delimited in each relief type. Also, attention was paid to the lithological and structural characteristics of the rock formations and to their influence on the features of fluvial, periglacial and glacial relief forms.

SURVEYING AND DETAILED MAPPING

Using the GPS instruments, geological compasses and laser range-finders, in the case of favourable terrain conditions also with the use of a survey theodolite, a set of detailed plans 1 : 5 000 of documented rock exposures was created, thus revealing the fine structural and geometrical parameters of the most interesting sites. Comparison of these detailed maps allows establishing a typology of these forms and, together with results other research activities in localities, to formulate hypothesis about particular rock formations development.

Also, numerous field-measured profiles, both longitudinal and transversal, were created using a laser clinometer. From these, properties of the slopes were derived, necessary for assessing the development of the slope. The profiles were used also in detailed, specialized mapping of the corries and segments of the fluvial valleys to understand the microtopography of the sites.

MORPHOSTRUCTURAL AND MORPHOMETRICAL ANALYSES

Morphostructural and morphometrical relief analyses (MAR) were performed within the GIS environment (Jedlička; Mentlík, 2003). The MAR is based on both the data from the field research, basically from geomorphological GPS mapping (including the excavations, probing and laboratory analysis), and the digital data sources, particularly the DEM. The creation and critical analysis of DEM (digital elevation model) is a foundation for performing properly the MAR. Therefore, the DEM was built for the whole study area using unique rules and was based on the same input data (contour lines, water streams, elevations).

Outputs of this research phase included a delimitation of important linear elements of the relief and computation of basic morphometric characteristics of the area of interest, together with a general idea about distribution of the morphostructures. Analysis of planation surfaces' distribution, their morphology, and creation of auxiliary paleosurfaces by GIS tools are other important parts of the morphometric research, (Mentlík, 2001; Hartvich, 2002).

A morphostructural analysis in the GIS environment continued with the analysis of sheer

slopes and levelled surfaces distribution, analysis of river network typology, all with the use of additional geological, tectonic and morphometric inputs (e.g. longitudinal and transversal valley profiles, etc.). Finally, more advanced morphometrical analyses were introduced, such as hypsometric integral, morpholineament analyses or the subenvelope technique, which was improved during the process (Hartvich, 2006).

MONITORING OF GEODYNAMIC ACTIVITY

One of the approaches within the research of geodynamic processes was a direct monitoring of slope deformation by dilatometric and extensometric measuring (Fig. 2). This monitoring allows very precise observation of on-going relative movements of the rock blocks, from which the current activity of geodynamic processes in the study locality could be estimated. Principle of the rod-dilatometric measuring is a precise specification of distance (sensitivity reaches 0.05 mm) between heads of measuring points by means of swinging or sliding needle, movement of which is transmitted to the scale indicator. At every measuring it is necessary to measure temperature used for elimination of the influence thermal expansion of instrument.

Similar principles are employed for the extensometric measuring. Extensometer consists of a body with nonium scale and from a metal band with defined thermal expansion; the band is stretched by a spring, which assure consistent band tension. Extensometric measuring is performed between two metallic loops set in the measured object, possible span of measurement is between 2 and 30 meters (maximum distance depends on band length). Accuracy of the measuring reaches 0.1 - 1 mm.

SEDIMENT ANALYSES AND OTHER AUXILIARY METHODS

A research of the relief development is at present commonly realized as a multidisciplinary research (Raab and Völkel, 2003), including sediment analysis, numerical dating, complex geomorphological research, pollen analysis, etc. We applied the methods of sedimentological analysis and radiometric dating, dating of the slope deformation (using dendrochronology and radiocarbon dating), and pollen analysis in the area of Stará jímka, which will contribute to the knowledge of development in this area after the retreat of glaciation, i.e. during the whole Holocene period. These techniques helped to explain among other the chronology and cyclicity of the events in the case of a small peat bog, barred by several generations of debris flows (Fig. 3). Also, we applied the relative dating using the Schmidhammer, laboratory grain-size analyses, and other auxiliary methods.

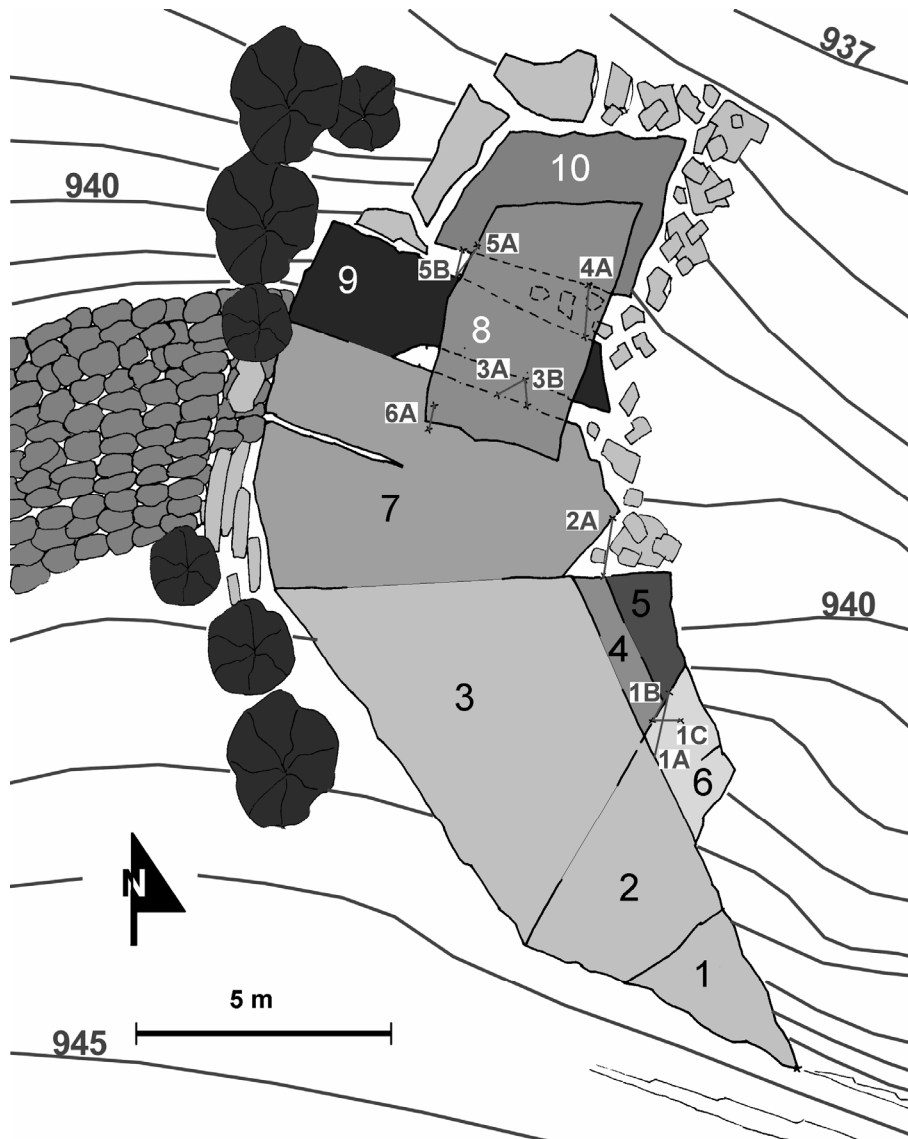


Fig. 2 Situation of the dilatometric measurements installed on the outcrop “the Gate” on the Obří Hrad site.

CONCLUSION: THE MOST IMPORTANT OBSERVATIONS AND CONCLUSIONS ACHIEVED WITHIN THE PROJECT

We have distinguished two groups of the chief results of the project: synthetic hypotheses on the relief development in the respective AOIs, the other are results of particular methods and techniques, which shall serve as inputs for further research or which improve the theoretical or methodological approaches. Among the most important results are following:

- the reconstruction of the course of the phases of glaciation in the area of Prášílské, Černé and Laka lakes and clarification of the relations between the geomorphological forms in the AOIs (Mentlík, 2006a; Vočadlová, 2006)

- the reconstruction of the development of the slopes and valley in the Losenice catchment around the Obří hrad site, particularly in connection to the Celtic site remnants
- the reconstruction of the development of the debris-flow system in the corrie wall of the Prášílské lake
- complete inventarization, description and systematization of the most important fluvial, slope, periglacial and glacial forms in the AOIs.

The second group of the results summarizes the crucial knowledge and observations gathered during the research. These carry the most important information from the respective methods and shall serve as inputs into further research. We can

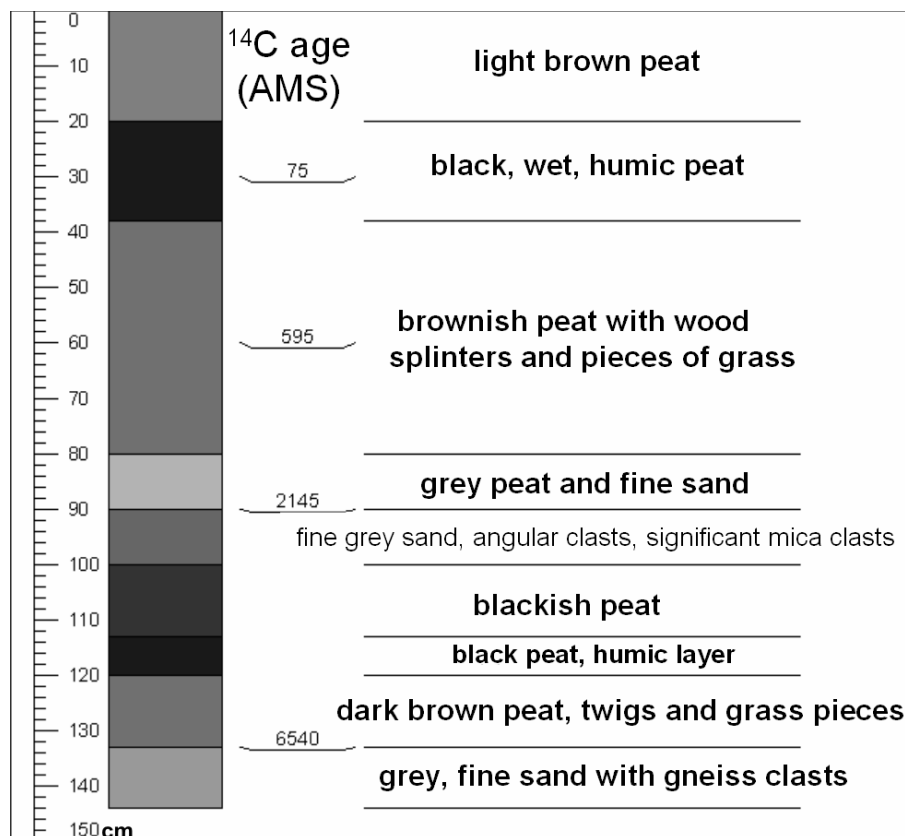


Fig. 3 A ¹⁴C and sedimentologically documented profile from a small peat bog, developed between accumulations of the debris flows in the corrie wall of the Prášílské lake.

distinguish two subgroups: the gathered data (measured, calculated, or mapped) and the theoretical backgrounds, including the improvements of the methods or techniques. Into the first subgroup we count following:

- Geomorphological information system in the vicinity of the Prášílské and Laka lakes and of the Polom and Hůrka area. Maps are based on the layers of the elementary relief forms. The database of the system contains the results of the geomorphological analysis and of the auxiliary methods, such as the numerical dating of the organic samples
- installation, maintaining and data collecting of the several monitoring systems, observing the slow slope movements of the rock blocks in the vicinity of the Obří Hrad site. The most valuable are the results of the dilatometric monitoring, which represents an uninterrupted record of more than 5 years of monthly readings (Fig. 4)
- geophysical verification of the presence and position of the faults on selected sites, particularly of the Pošumavský fault at Dešenice and fault system in the valley of the Losenice R. (together with Dr. Valenta)
- analysis of the development of the valley network in the Losenice and Dešenický brook catchments

- commencing of the systematic research of the blockfields, a database creation to gather the statistic information on the properties of the block accumulations throughout the Šumava Mts., the pilot sites being set in the Debrnická highland, surroundings of the Černé lake and on the Obří Hrad site
- creation of vast database of the structural measurements (strike and dip of joints, foliation dip and dip orientation), which up-to-date includes over 5000 measurements from more than 300 outcrops on more than 100 sites. Aside from that, a database of relative age of the outcrops and blocks was founded, collecting so far data from some 50 sites.

Finally, following points sum the most important methodological findings and applications:

- first practically applied of a new attitude to the geomorphological mapping in some of the studied areas: the application of the elementary relief forms mapping
- development and application of the Geomorphological information system (GmIS) in the vicinity of the Prášílské and Laka lakes
- the application of multidisciplinary attitude in the research of several particular sites – a mutually

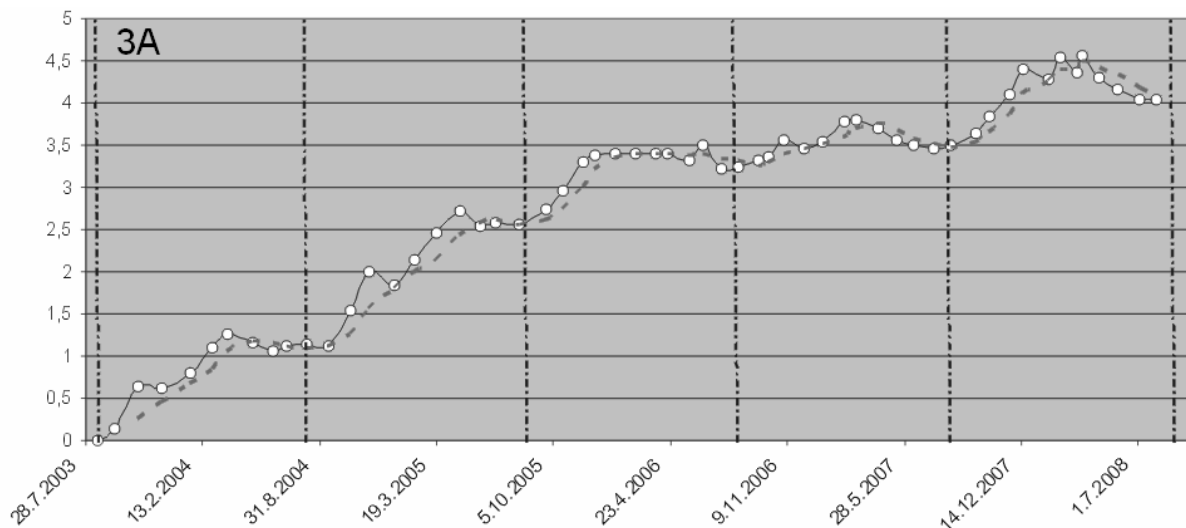


Fig. 4 Example of the record from the 5-years of measuring in the dilatometric network on the Obří Hrad site. The values are in mm.

useful cooperation with the archaeologists, geophysics and inorganic chemistry analysts (Obří Hrad; Hartvich et al., 2007), cooperation with the palynologists and sedimentologists (Prášily; Mentlík et al., 2006)

- development and application of a complex methodics for analysis of the material of the blockfields, which includes both the measuring of the clasts' properties and the monitoring system for observation of the current dynamics of the blockfields
- unique use of the powder X-ray diffraction in analysis of a slope deformation
- installation and testing of a system of automatic extensometric monitoring network including the data transfer and access (in cooperation with the project T110 190 504; Zvelebil and Hartvich, 2006)
- elaboration and application of a methodics for fast field measuring and construction of the transversal and longitudinal profiles using a laser clinometer.

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VYBRANÉ VÝSLEDKY GEOMORFOLOGICKÉHO VÝZKUMU NA ŠUMAVĚ V LETECH 2005-2007

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ABSTRAKT:

Článek shrnuje nejdůležitější zjištění a výsledky, dosažené v rámci projektu KJB 300460501 “Porovnání kvartérního vývoje Novohradských hor a vybraných částí Šumavy” a stručně popisuje metody, které byly při výzkumu využity. V tomto příspěvku se zabýváme výsledky z vybraných lokalit, konkrétně z povodí Losenice a z okolí tří v Pleistocénu zaledněných karů, dnes vyplněných jezery Prášilským, Černým a Laka.