the Lipnice type, lies in the eastern part of the massif near Dolní Město. Local rocks are represented by leucocratic granites composed of quartz, K-feldspar, plagioclase, biotite and muscovite exhibiting no solid-state deformation.

Detailed study of the outcrops shows that granite body is intensively fractured. We established several sets of fractures (joints and faults). Joints can be divided in to several sets basing on the field observations or statistically, using the orientation-based cluster method. Field analysis of joint sets allows determining of the density (or spacing), length and character of joints morphology (geometry of plume structures, twisted hackles, etc.). The temporal succession of the joints has been determined using criteria of relative joint age: i.e., younger joints terminate on the older ones, which can be assigned directly in the field. Sometimes, the relative geometrical relationships between joints cannot be established directly in the filed, so that the map of joints has been constructed using photographs. Such maps are further processed by special software.

The first (and oldest) determined set is nearly orthogonal system of vertical fractures commonly extending size of the outcrops (quarries). Individual fractures of two major directional groups non-systematically end-up on each other, so that we suggest their contemporaneous origin. Orientation of each group is spatially dependent and juridicates a concentric zonation of the massif. Origin of these fractures has been interpreted as a result of combined effect of isotropic thermal contraction, fabric anisotropy and/or regional stress.

The second determined set of fractures is represented by sub-horizontally oriented sheeted fractures and exfoliation planes. They are younger than vertical ones (as documented by systematic termination criteria) and their origin is related to an uplift and residual stress relaxation. The system of sheeted fractures developed deeper than the exfoliation. Exfoliation planes reach first tens of metres of depth, whilst sheeted fractures can range up to first hundreds of metres.

The final form of fracture network is intensively modified by tectonic (alpine?) reactivation. Surfaces of fractures are modified, showing numerous kinematic criteria (usually striations and fibers), and density of fractures locally markedly increases. Using the Angelier and Mechler (1977) method, generally north--south orientation of regional stress in time of reactivation was established.

References

ANGELIER J. and MECHLER P., 1977. Sur une méthode graphique de recherche des contraintes principales également utilisable en tectonique et en séismologie: la méthode des diédres droits. *Bull. Soc. géol. France*, 7: 1309-1318.

Metamorphic Evolution of the High Himalaya in the Makalu Region – Constraints from P-T Modelling and in-situ Th-U-Pb Monazite Dating

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The migmatitic gneisses in the Makalu – Arun Valley section (E Nepal) record a polyphase metamorphic evolution of the High Himalayan Slab. Syn- and post-kinematic garnet porphyroblasts in the gneisses are compositionally zoned and often contain inclusions of alumosilicates, plagioclase, micas, monazite and allanite that are suitable for P-T modelling and for Th-U-Pb spot-dating by laser ablation ICPMS.

An early high-pressure event is documented by the presence of kyanite relics in the garnet-biotite-sillimanite gneisses. The high-pressure event was followed by decompression and an increase in temperature that resulted in the kyanite to sillimanite transformation, and cordierite formation by reaction grt+sill+qtz+H_2O=crd. The partial melting of the High Himalayan rocks and their migmatitization is associated with decompression at the temperatures in the sillimanite stability field. The pressure and temperature conditions calculated for the garnet-biotite-sillimanite-cordierite-bearing gneisses correspond to 3.2–4.0 kbar and 600 ± 25 °C and they are interpreted as reflecting closure of the Fe-Mg exchange between garnet and biotite on the cooling path. Corresponding conditions (680 °C and ~ 4 kbar) have been reported from the host biotite-cordierite-sillimanite gneisses of the Makalu granite (Hubbard 1989).

In situ laser ablation dating of monazite inclusions in biotite, sillimanite, feldspar and quartz from the High Himalayan gneisses shows a record of polyphase metamorphic evolution between 35–21 Ma. The older monazites constrain a maximum age limit of ca 35 Ma for the sillimanite grade Barrovian metamorphism, while the younger monazite ages (~ 21 Ma) reflect a thermal event associated with the intrusion of the Makalu granite at 21.7–24.4 Ma (Schärer 1984). There is no correlation between the size of monazite inclusions in different metamorphic minerals, their ages, and location of samples relative to the granite intrusion. Maximum age of the Barrovian metamorphism recorded by Th-U-Pb isotopic systems in monazite from the Makalu region corresponds to the timing of prograde metamorphism reported from the Everest region (36–28 Ma; Simpson et al. 2000) and Garhwal and Zanskar Himalaya (37–29 and 35–25 Ma; Vance and Harris 1999). It is, however, somewhat younger compared to monazite ages from the Nanga Parbat – Haramosh Massif (44–36 Ma; Foster et al. 2000). The age difference may be a result of propagation of deformation and metamorphism from west to east related to diachronous collision of India and Asia.

References

FOSTER G., KINNY P., VANCE D., PRINCE C. and HARRIS N., 2000. The significance of monazite U-Th-Pb age data in metamorphic assemblages; a combined study of monazite and garnet chronometry. *Earth and Planetary Science Letters*, 181: 327-340.

HUBBARD M.S., 1989. Thermobarometric constraints on the thermal history of the Main Central Thrust zone and Tibetian Slab, eastern Nepal Himalaya. *Journal of Metamorphic Geology*, 7: 19-30.
SCHÄRER U., 1984. The effect of initial ^{230}Th disequilibrium on young U-Pb ages: the Makalu case, Himalaya. *Earth and Planetary Science Letters*, 67: 191-204.
SIMPSON R.L., PARRISH R.R., SEARLE M.P. and WATERS D.J., 2000. Two episodes of monazite crystallization during metamorphism and crustal melting in the Everest region of the Nepalese Himalaya. *Geology*, 28: 403-406.
VANCE D. and HARRIS N., 1999. The timing of prograde metamorphism in the Zanskar Himalaya. *Geology*, 27: 395-398.

Documentation of Geological and Archaelogical Featu-res Using the Lacquer-Film Method

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For eight years now, Dolmat has been the only company in the Czech Republic to produce lacquer-films, marketing them both in the domestic market and abroad. Lacquer-films usually represent attractive sedimentary formations. Our company specializes in producing films of moldavite-bearing sediments, rarely with moldavites in situ. Such films are taken immediately after a moldavite has been found in the sediment. Lacquer-films are suitable for scientific centres and museums, for decoration of offices, exhibition premises and other interiors, pleasing geologists, collectors and laymen alike. Being of a high aesthetic value, lacquer-films chequer technology-governed interiors, bringing a genuine and original touch of nature and its history to the place. The method employed makes it possible to take lacquer-films from any loose-material (unconsolidated soil, clay, sand, gravel, peat, and debris or deposits formed by erosion) profiles ranging from pits to walls to excavations. Special preservative procedures allow to move such films of outcrop to offices, outlets, classrooms or apartments, or store them as unique documentary samples in museum depositories.

The production method is quite simple. Having been smoothed, a selected section of the outcrop or profile is sprayed with diluted penetrative lacquer hardening the material without affecting its texture, colour, or mineral composition. After a while, the prepared area is hardened once more, with undiluted lacquer this time, and covered with a thin cloth. Having dried up, the cloth is carefully torn away with a thin screen of the lacquer-hardened soil preserving the natural appearance of the original with all its features. Such a sheet of several dm^2 to m^2 is then fitted to a board and framed, and can be treated as an ordinary picture hung on a wall.

Each lacquer-film is an original, a true and permanent representation of a piece of nature. Besides having indisputable scientific qualities, it can serve as a decoration. Thanks to the documentation method, which is used in archaeology, geology, sedimentology and pedology, one can admire what an artist nature is.

The Neoidic Fluorite Mineralization in the Brno Massif: Interaction between Fluid and Rock

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The Brno massif is the largest and oldest igneous massif at the eastern margin of the Bohemian Massif. From the mineralogical point of view, numerous small occurrences of fluorite are typical of this granitoid unit. Detailed mineralogical and formation conditions study allow to distinguish several types of fluorite mineralization in granitoid rocks. The youngest one is most likely a neoidic mineralization (Mesozoic?–Quaternary?). This type has been found at three sites (Tetčice near Rosice u Brna, Rakšice near Moravský Krumlov and Květnička Hill near Tišnov).

The studied hydrothermal veins containing fluorite trend NW-SE, to lesser extent NE-SW, with a steep dip. Drusy coating, inexpressive banding and breccias are typical structures of the mineralization. A mineral composition is very simple at all localities. The veins consist only of quartz, fluorite and calcite. Fine-grained quartz is minor. A light to dark violet, light green or colourless fluorite predominates. Considerable amount of calcite is present only in veins near Tetčice. Minerals precipitated in the following succession: quartz-fluorite--calcite.

Several methods were used to establish origin of the mineralization: cathodoluminescence microscopy, REE geochemistry of fluorite, fluid inclusion and stable isotope study.

Cathodoluminescence study

Fluorites often exhibit distinct growth zonation in CL microscope. Central parts of the crystals are green, margins show oscillatory zoning in blue hues. There are very interesting irregular, corroded boundaries between individual growth zones. Calcite