Nordabhang des Pfitschtales begründet. Diese erstreckt sich über eine Länge von 8 km von Kematen bis Stein und ist neben morphologischen Gegebenheiten auch durch strukturelle Hinweise belegt. Die große Tiefe der Massenbewegung kann durch den Nachweis der starken Übertiefung des Tales - eine Erkundungsbohrung erreichte erst bei 300 m unter der Oberfläche die Felsoberkante - angenommen werden. Die nach dem Dominosystem tiefgründig herausgekippten Schollen ("Toppling") wurden in ihrem Fußbereich mit ca. 300 m mächtigen, postglazialen Seesedimenten einsedimentiert. Massenbewegung und Toppling erschweren die Prognose der geologischen Verhältnisse auf dem etwa bei 800 m Seehöhe liegenden Tunnelniveau (Abbildung 1).

Ein wesentlicher Fortschritt bei der Auflösung des komplexen, isoklinalen D2 Faltenbaues am Südschenkel der D3 Tuxer Antiform gelang durch die Analyse von Oben-Unten-Kriterien in der Stratigraphie der hochmetamorphen permomesozoischen Abfolge der Unteren Schieferhülle. Sequenzstratigraphisches Denken und die Feststellung einer mächtigen, gemischt klastischen, karbonatischen und evaporitischen Serie der Obertrias (Anhydrit in den Bohrkernen), ähnlich der Keuperfazies der germanischen Trias, sind hier ausschlaggebend.

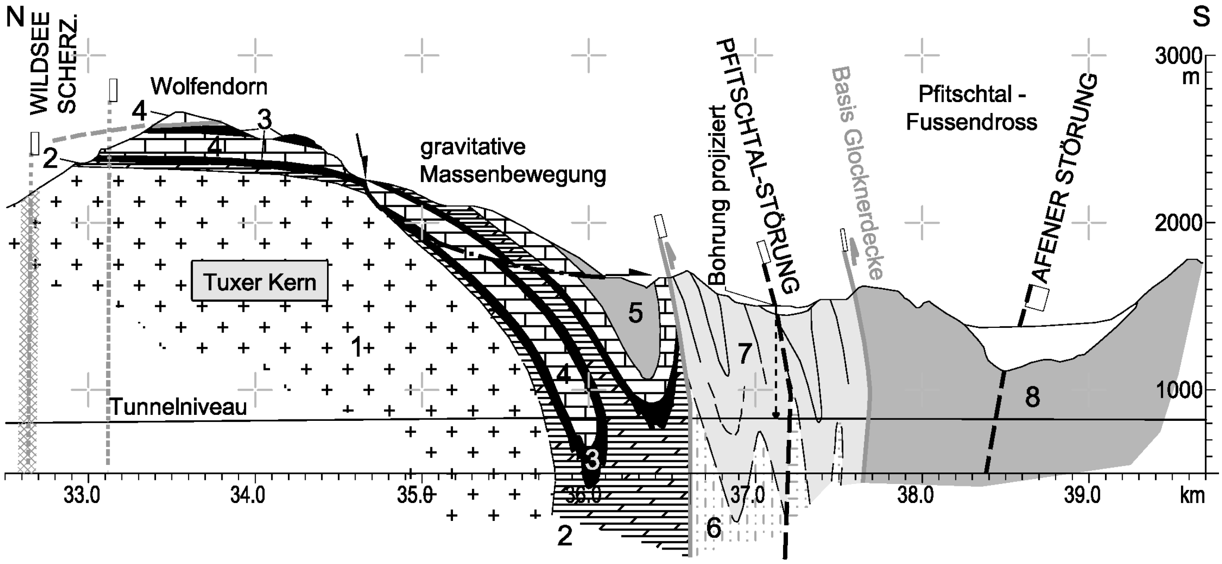

Abb. 1. *Pfitschtal-Querprofil. (1) Zentralgneis; Untere Schieferhülle: (2) Permomesozoikum, (3) Rhätizitschiefer; (4) Hochstegenmarmor,(5) Kaserer Serie; Kalkwandstangen-Einheit: (6) Furtschaglschiefer, (7) Permotrias; Glockner-Decke: (8) Bündner Schiefer.*

Structural evolution and cooling history of Himalayan Crystalline sheets in the Gori Ganga Valley, Kumaon, India

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A cross section along the Gori Ganga Valley between Martoli and Munsyari villages (northeastern Kumaoun Himalayas, India) includes four distinct blocks separated by major tectonic lines. These include from north to south (a) the Tethyan Zone and (b) the High Himalayan Crystalline (HHC), separated by the South Tibetan Detachment Zone (STDZ). The Vaikrita Thrust, an equivalent to the Main Central Thrust Zone (MCTZ), separates HHC from (c) the Lesser Himalayan Crystalline (LHC). The Munsyari Thrust represents an imbrication zone incorporating rocks from the LHC and sediments from (d) the Lesser Himalayan Krol Nappe. $^{40}Ar/^{39}Ar$ data from white mica as well as zircon and apatite fission track ages have been used to constrain the cooling history of HHC and LHC units.

The $^{40}Ar/^{39}Ar$ data can be arranged into groups that reflect either ages of tectonic activity or regional cooling below relevant Ar-retention temperatures. (1) Pegmatite dykes exposed immediately south to the STDZ are interpreted as decompression melts that evolved during exhumation of HHC. White mica from those dykes gave 13.5 ± 0.6 Ma and are interpreted to date closely the activity of the STDZ. (2) Syntectonically grown white mica from the Vaikrita Thrust and the Munsyari Thrust gave ages of 12.6 ± 0,6 Ma and 13.2 ± 0.5 Ma, respectively. They are interpreted to date southward thrusting. (3) Central migmatitic portions of the HHC cooled below ca. 350°C at 13.8 ± 0.8 Ma whereas (4) white mica cooling ages from the LHC gave 20.8 ± 0.8 Ma.

Five apatite fission track data from the HHC gave very consistent ages between 0.3 and 0.4 Ma. Slightly older ages between 0.7 and 0.8 Ma (three data) have been obtained from the LHC. The oldest apatite FT age (1.5 ± 0.5 Ma) is derived from highly deformed rocks of the Krol Nappe. No regional variation is evident from zircon FT data of the same section. Both, rocks from HHC and LHC gave ages between 0.9 and 1.1 Ma.

Based on structural and geochronological data a two-step cooling model for Himalayan crystalline rocks is proposed. During a first step (around 13 Ma), HHC and LHC cooled down to ca. 350-400°C (Ar-retention temperature of white mica) but retained for long time (ca 13 Ma) below the partial annealing zone of zircon (ca. 250°C). Simultaneous activity of normal faults (STDZ) and thrusts (Vaikrita, Munsyari Thrusts) suggest cooling during an early phase of extrusion. The regional cooling pattern with younger ages in the HHC and older ages in the LHC suggests that the HHC had been exhumed from deeper structural levels than LHC and/or at higher exhumation rates. During a second stage of exhumation, between 1.5-0.3 Ma, rocks have been rapidly exhumed from levels below the ca. 250°C paleo-isotherm close to the surface. Again the LHC cooled earlier and/or slower than the HHC. Exhumation was achieved by late thrusts that overprinted older Vaikrita and Munsyari structures.

Subvolcanic features in a Variscan granite from Bohemian Massif : Explosive Breccia and unidirectional solidification texture in the Podlesí granite stock, Krušné Hory Mountains.

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Magmatic breccia and evolution of magmatic layered texture with oriented quartz and K-feldspar (Kfs) crystals (unidirectional solidification textures – UST) are typical feature of subvolcanic porphyry-type intrusions with Mo-W-Sn mineralisation. While explosive-magmatic brecciation is a common feature of Late-Variscan rare-metal granites in the Krušné Hory/Erzgebirge and Slavkovský Les area (Krupka, Krásno, Seifen, Sadisdorf, Gottesberg), the magmatic layering with UST was for the first time found only recently in granite stock at Podlesí in the western part of the Krušné Hory Mts.

The Podlesí granite stock is composed of two tongue-like bodies of albite-protolithionite-topaz granite (stock granite) coalesced at depth, which were emplaced into Ordovician phyllite and the older biotite granite. The uppermost part of the intrusion is bordered by a layer of the marginal pegmatite (stockscheider). Within the upper 100 m, the stock granite was intruded with several generally flat-lying dykes of albite-zinnwaldite-topaz granite (dyke granite).

Explosive breccia was found as block near the contact of the stock. It consists of several mm to 5 cm fragments (some rounded) of phyllite cemented with fine-grained granitic matrix. The composition of the matrix is similar to the stock granite, but very fine-grained.

The sequences of magmatic layering with UST is developed in both the stock and dyke granites. It reached a maximum thickness of 1 m. Comb quartz crystals are only subordinately developed here, the most significant UST is defined by Kfs. The chemical bulk composition of the layered sequence of the major dyke with small individual comb quartz (4-5 mm) is similar to the bulk composition of the whole dyke. Nevertheless, the bulk composition of the Kfs-dominated UST layer is far from the bulk composition of the dyke granite melt: It is strongly enriched in K and Al and depleted in Si and Na. It can be modelled as a mixture of the dyke-granite melt with 25 % of Kfs added. This means that an another Kfs component was added to the granitic quartz-albite-Kfs matrix. At this point, it would be interesting to compare the Kfs-dominated UST layer with the stockscheider, which also contains many large Kfs crystals: The bulk composition of the stockscheider equals to the bulk stock granite. Consequently, the big Kfs in the stockscheider are well compensated by quartz-albite matrix, and no addition of Kfs or potassium was needed.

The explosive opening of the system caused rapid decrease of pressure followed by adiabatic cooling. The change of the isotropic fabric of the granite to anisotropic fabric of the UST layer reflects a change from equilibrium crystallisation of the granitic layer to disequilibrium crystallisation of the UST layer. The disequilibrium was caused especially by undercooling. The growth of large comb Kfs crystals was allowed by combined enrichment in fluorine, phosphorus and water. All these components increased the ability of the melt for undercooling, suppressed the nucleation density and made the lag time longer. As a result, the residual melt of the dyke granite was able to survive undercooling deep below 500 ^{o}C.

Thin veinlets in crystals of quartz and feldspars filled with residual, extremely specialised magmatic liquid are an other proof of rapid opening of the system. Residual liquids was soaked from interstices into opened cracks in