FRACTURE ANALYSIS AND FLUID INCLUSION PLANES IN PTP-3 BOREHOLE AT PODLESÍ GRANITE STOCK (KRUSNÉ HORY MTS., CZECH REPUBLIC)

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The Czech Geological Survey in cooperation with other organizations dealt with the project of geochemical interaction between fluids and fractured rock environment in period from 2000 to 2002. For this purpose two drillholes, PTP-3 and PTP-4A, were drilled in close vicinity of 10 m to a depth of 300 m in the granitic body of the Podlesí granite stock. Geological, geophysical, geochemical and hydrological methods were applied to characterize the fractured aquifer and associated fossil and recent fluids. This contribution shortly comprises the results of core scanning of the PTP-3 borehole with microscopic observations of fluid inclusion planes from oriented samples from the PTP-3 borehole.

The Podlesí granite stock is located in the western part of the Krusné hory Mts. in western Bohemia and represents the most fractionated part of the late Variscan Nejdek-Eibenstock pluton in the Saxothuringian zone of the Variscan orogen on central Europe (Breiter, 2002). The stock was emplaced into Ordovician phyllite and biotite granite of "younger intrusive complex" (biotite granite was found only in boreholes). The Podlesí granite body consists mainly of albite-protolithionite-topaz granite (stock granite). In the uppermost part, the stock granite is penetrated with several flat-lying dykes of albite-zinnwaldite-topaz granite (dyke granite). Phyllite surrounding the granite was strongly altered to protolithionite-topaz hornfels and is crosscut by aplite dykes and numerous steep topaz-albite-zinnwaldite-quartz veinlets, accompanied by greisenisation and tourmalinisation of the surrounding rocks.

Táborská and Breiter (1998) measured magnetic anisotropy of stock and dyke granite from outcrops. The magnetic fabric reflected a primary fabric produced during magmatic emplacement. The rocks were not affected by later deformations. Steep foliation and very steep lineation probably indicate a fabric that was formed during the ascent of magma.

Preliminary results of anisotropy of magnetic susceptibility of granite cores of the PTP-3 borehole showed a specific distribution patterns in magnetic foliation and lineation both in stock granite and biotite granite (Chlupácová, Mrázová, 2001). Steep foliations are prevailing in stock granite; lineations vary, being mostly subhorizontal. Two main clusters of magnetic foliation, very steep and/or subhorizontal, were found in biotite granite. Subhorizontal lineations are evidently prevailing in biotite granite.

The borehole PTP-3 was measured with acoustic borehole televiewer and the core was scanned with the ImaGeo mobile corescanner (Maros et al., 2002). The combination of these two methods offered the oriented distribution of the different geological phenomena, e.g. rock boundary, aplite and quartz veins, foliation, alteration, infillings and, especially the fractures cutting the core and their geometry (Fig. 1A). The fracture frequency was very low, 3.04 fractures per meter. The granite body cannot be termed as a fractured one, despite that a few remarkable fracture zones could be distinguished. Oblique to subhorizontal fractures of NW-SE strike with dip to the NE and of NNE-SSW strike with dips both to the NW and SE predominate. Steep fractures are mainly of NW-SE and NE-SW strike. Moreover, two theoretical paleostress field systems were determined, one with a NE-SW and one with a NW-SE main stress direction.

Fluid inclusion planes (FIP) result from the healing of former opened cracks and therefore appear to be fossilized fluid pathways (Cathelineau et al., 1994, Lespinasse, 1999). FIP are non-penetrative cracks interpreted as extensional cracks. 17 oriented samples were collected from the oriented core of the PTP-3 borehole (depth 20-348 m, interval 20 m) and length, dip and dip direction of FIP was measured in quartz and topaz of the oriented samples using standard microscopic table. The length of measured FIP is from 0.1 mm to 3.2 mm. The number of FIP in quartz is estimated to be 30 to 75 FIP/cm^2, both in stock and biotite granite. More than 1500 FIP were measured. Most of them are the steep FIP of various strike, however two orthogonal directions of the steep FIP are predominating: NNE-SSW and WNW-ESE (Fig. 1B). Subhorizontal FIP seem to be less frequent. The directions of FIP do not correspond entirely to the strikes of the scanned fractures.

Three generations of water-rich fluid inclusions were found along the FIP: 1) FIP with V>L fluid inclusions with homogenization temperatures (Th) from 350 to 430 °C, 2) FIP with inclusions with Th between 200 and 250 °C and, 3) FIP with inclusions with Th from 140 to 230 °C. The salinity of fluid inclusions is relatively low in all the samples and does not exceed 10 wt% NaCl equiv. Eutectic temperatures (Te) could have been measured only in several FIP of the third generation. Te are between –35.6 and –42.5 °C, indicating the presence of Na, K, Fe and Mg chlorides in solution.

Both vapor-rich and liquid-rich high salinity (up to 40 wt%) inclusions with NaCl and KCl daughter crystals were found in quartz of quartz-topaz veinlets. The data are in a good agreement with the data from greisen assemblages of the western Krusne hory Mts. (Durisová, 1984, Durisova et al., 1979).

Fluid inclusions of the generations 1 and 3 occur both along the steep FIP of NE-SW, NW-SE and E-W direction and along oblique FIP, the FIP of the second generation are not frequent and occur only in NE-SW direction. The origin of FIP of the

first generation is believed to follow the propagation of proto-tectonic subhorizontal aplite dykes and steep veinlets of greisen mineralization. The FIP are interpreted as a result of an early postmagmatic process connected with the origin of topaz-albite-zinnwaldite-quartz veinlets accompanied by greisenization at high temperature and pressure up to 1 kbar. The FIP with lower homogenization temperatures were likely trapped during repeated opening of fractures connected with late stage of granite evolution.

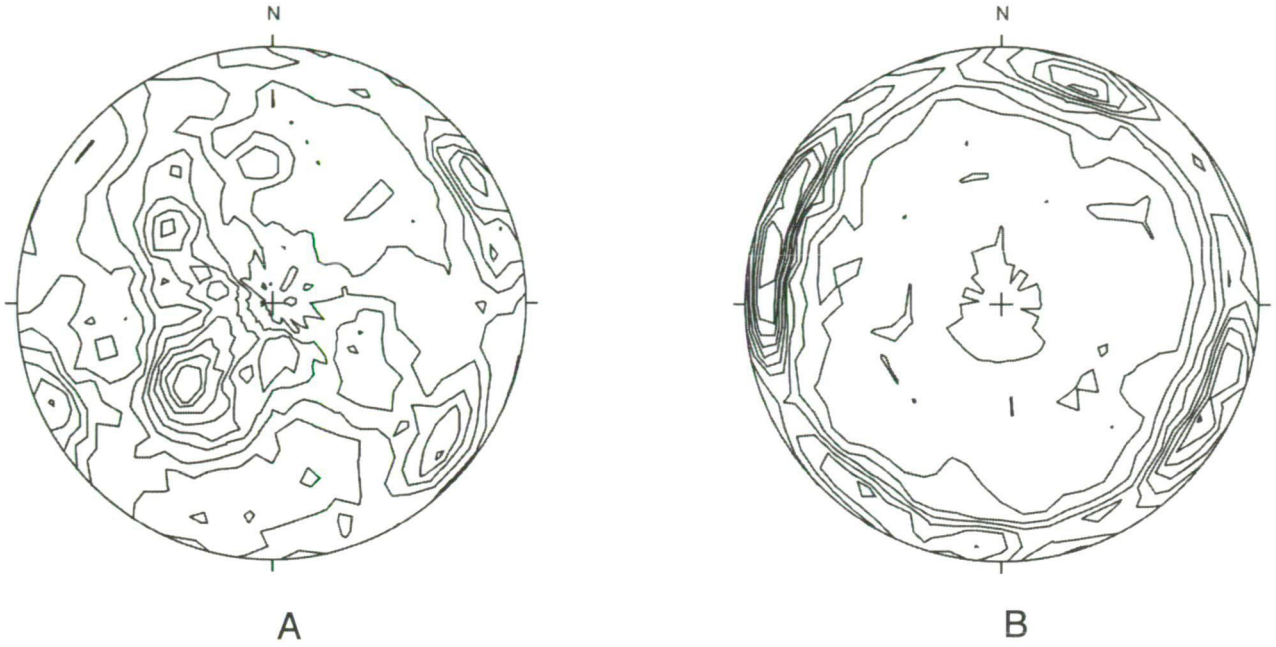

Fig. 1: A) Contour diagram of poles of the fractures from the PTP-3 borehole from depth 20 -348 m (lower hemisphere polar, equal area, number of points = 877)
B) Contour diagram of poles of the FIP from the PTP-3 borehole (lower hemisphere polar, equal area, 17 samples, total number of points = 1554)

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