Žulová Batholith: A Post-Orogenic, Fractionated Ilmenite – Allanite I-Type Granite

Kateřina ZACHOVALOVÁ[1], Jaromír LEICHMANN[1] and Jan ŠVANCARA[2]

[1] *Department of Geology and Palaeontology, Faculty of Science, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic*

[2] *Institute of Physics of the Earth, Masaryk University, Tvrdého 12, 602 00 Brno, Czech Republic*

Žulová Batholith forms a triangular body approximately 20 km cross at the northeastern margin of the Bohemian Massif, close to the Czech-Polish border. The Ar-Ar geochronological data (Maluski et al., 1995) on amphibole (292 ±3 Ma) and biotite (290 ±3 Ma) from granites and U-Pb data on monazite from a pegmatite vein (304 Ma) Novák et al. (submitted) indicate, that the Žulová Batholith ranks among to the youngest granite intrusions in the Bohemian Massif.

The major-element chemistry as well as mineralogy indicate that Žulová Batholith could be classified as a fractionated I-type granite. The interpretation of gravity data indicates a fair homogeneity of the batholith. The high amount of allanite and low abundance of monazite are typical for I-type granites as well. The high content of ilmenite and decrease of xMg in biotite with increasing total silica content are typical attributes of an ilmenite series batholith (Ishihara, 1981). The presence of ilmenite instead of magnetite, which is normally more common in I – type granites, could be explained by intrusion of the I-type magma in graphite -bearing rocks (Branná or Velké Vrbno groups) serving as a reducing agent (Ishihara, 1981).

The negative correlation between SiO2 and xMg, and Sr/Rb ratio, but positive correlation SiO_2 – K/Ba, increase in the magnitude of negative Eu anomaly with SiO_2 indicate a substantial role of fractionation processes in the evolution of Žulová Batholith. The whole-rock geochemical data are supported by the compositional evolution of individual minerals: Biotites from granites have much lower xMg, compared to those from tonalites. K-feldspar from tonalites is richer in Ba, and contemporaneously K-feldspars from granites exhibit much more complex internal structure, documenting a role of fractionation. Plagioclase from granites has a similar complex structure and is more albitic in composition than plagioclase from tonalites.

Nevertheless the observed cumulate structures affecting the mafic minerals and some accessory minerals e.g. apatite, biotite, titanite, zircone, allanite and xenotime indicate, that processes of crystal accumulation play an important role in the earliest stages of the evolution. Therefore we interpret the mafic enclaves as cumulates, which were trapped and disrupted by granitic melt. The accumulation of accessory minerals controlled the distribution of REE and HFS elements. Cumulates are strongly enriched on REE, Y, Zr, Nb, Ti and P, and granites are depleted in these elements. The genetic interpretations of tectonic diagrams like the Y/Nb plot seem to be misleading because Y and Nb were preferably concentrated in the cumulates and later granites are therefore strongly depleted in these elements.

The composition of parental magma was probably granodioritic, because it has to allow forming mafic tonalite cumulates together with fractionated granites. Since the ratio between cumulate and fractionated products could not have been established in the field due to a possible influence of erosion, the precise composition of parental magma remains uncertain. However, because the both cumulates, and fractionates, are metaaluminous, the parental melt was very likely metaluminous as well. Consequently, the protolith could be seen traced in the even strongly metaluminous rocks as amphibolites or chemically related rocks. The comparatively high contents of REE and HFS elements in the granites indicate, that their relatively refractory carrier-phases (O' Hara et al., 2001) e.g. zircon, apatite were involved in the melting of the protolith. Therefore it was probably a high-degree melting.

The emplacement of the batholith was probably related to the Westphalian extensional tectonics. The Upper Carboniferous and lower Permian extension seems to have been generally of great importance for magmatic history of the eastern margin of Bohemian Massif, as manifested in the Boskovice Furrow, where the extensional tectonics followed by magmatic activity could be also documented.

References

ISHIHARA S., 1981. The Granitoid Series and Mineralization. *Econ. Geol.*, 458-484.

MALUSKI H., RAJLICH P. and SOUČEK J., 1995. Pre-Variscan, Variscan and Early Alpine thermo-tectonic history of the north-eastern Bohemian Massif: An 40Ar/39Ar study. *Geol. Rundschau*, 84: 345-358.

NOVÁK M., KIMBROUGH D.L., TAYLOR M.C., ČERNÝ P. and ERCIT S.T., (submitted). Radiometric U/Pb age of monazite from granitic pegmatite at Velká Kraš, Žulová granite pluton, Silesia, Czech Republic. *Geologica Carph.*

O' HARA M. J., FRY N. and PRICHARD H. M., 2001. Minor Phases as Carriers of trace Elements in Non-Modal Crystal-Liquid Separation Processes I: Basic Relationships. *J. Petrology*, 42(10): 1869-1885.