TETRAD EFFECT IN THE WESTERN CARPATHIANS GRANITES AND THEIR PETROLOGICAL INTERPRETATION

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Rare earth elements generally show similar geochemical behaviour controlled by their charge and ionic radii. Chondrite normalized rare earth element patterns are often used to estimate fractionation trends in comagmatic suites and they usually show smooth pattern, except the often observable Eu-anomaly. In contrast to these smooth patterns also strongly kinked patterns can occur in evolved granitoid systems and in sedimentary regimes. Such patterns are generated by the tetrad effect, when the geochemical behaviour is not determined only by charge and ionic radii.

Tetrad effect can be characterized as the division of Rare Earth Elements into four segments called tetrads (MASUDA *et al.*, 1987: first tetrad = La-Nd, second tetrad = (Pm)Sm-Gd, third tetrad = Gd-Ho, fourth tetrad = Er-Lu). According to BAU (1996) the tetrad effect is caused by complexation of the REE with ligands *e.g.* H_2O, CO_2, F^-, and Li. If such complexation occurs, the behaviour of the REE is no longer simply dependent on the ionic radii, which are comparable for all REE, but is dependent on the filling stages of the 4*f* orbitals (IRBER, 1999). Thus REEs with 0/4 (La), 1/4 (Nd, Pm), 2/4 (Gd), 3/4 (Ho, Er) and 4/4 (Lu) filled 4*f* orbitals can be fractionated from the other REEs. Tetrad effect occurs in highly evolved igneous rocks and it is often interpreted as an indicator of the transition between magmatic to high-temperature hydrothermal systems. The tetrad effect can not be modelled as fractional crystallization (*e.g.*, BAU, 1996; IRBER *et al.*, 1997). Tetrad effect can be expressed graphically or numerically as the $T_{1,3}$ parameter and it can be controlled by the presence of accessory mineral phases.

No tetrad effect can be observed for Variscan I-type granitic rocks and only very slight tetrad effects are revealed by differentiated S-type granites. Only A-type post-orogenic granites show sometimes tetrad effects, but the strongest is developed in the Permian-Triassic special S-type granites in the Gemeric unit. Tetrad effect is present almost in the all special S-type granites and the most prominent in the granite cupolas or in the most evolved samples. This indicates the strong synmagmatic hydrothermal activity during their magmatic intrusion. Taking into account that the tetrad effect is the result of complexation of the rare earth elements in hydrothermal systems, its presence indicates a strong influence of fluids in the granite evolution.

A very intense tetrad effect can be observed in the granites of the Dlhá dolina area, but also in the Hnilec area. Data presented in this study suggests that the tetrad effect observed in the Gemeric granites and especially in the Dlhá Dolina area is in correspondence with similar evolved granitoid suites (GAAB *et al.*, submitted).

References

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