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REE and trace elements patterns of apatite from a diorite at Mt. Papuk, Croatia

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Apatite is an important carrier of trace elements in many rock types. In favorable circumstances this mineral can control the budget of trace elements in the host rock and can consequently point to the geological setting and related geodynamic processes, especially at the end of high-temperature tectonomagmatic activities.

Small (up to several tens of meters wide) igneous bodies of I-type granitoids from the eastern part of Mt. Papuk (Croatia; Tisia mega-unit; Pannonian Basin basement) are related to the (pre?)-Variscan volcanic arc (and syn-collisional) setting(s) and contain apatite crystals that were chemically examined by laser-ablation ICP mass-spectrometry. The host rock in this study is a cataclazed peraluminous (A/NK=2.19, A/CNK=1.02) diorite to monzonite composed of K-feldspar, plagioclase, biotite, amphibole and quartz. Ilmenite, zircon, and prismatic (size fraction 125-63 μm) apatite (calculated content: 0.7 vol.% according to 0.28 wt.% P2O5 content in the host rock) are accessory minerals. The total REE content of the host rock is low (80 ppm). The chondrite-normalized REE diagram shows a slightly positive Eu anomaly (Eu/Eu*=1.03) and a slight enrichment of the LREE (LaN/SmN=2.22, GdN/LuN=1.55). In addition, negative Th, Nb, Ce, Pr, Ti and positive U, Pb, Sr, Zr anomalies are discernable in the chondrite-normalized diagram which point to a collisional setting and the influence of crustal material according to trace elements geotectonic and classification diagrams.

Low contents of Sr (249-321 ppm) and Mn (214-317 ppm) were found in apatite. Yttrium contents (67-288 ppm) are also low but variable. Two groups of apatite were noted according to different total REE contents ranging either from 68 to 136 or 561 to 803 ppm and an enrichment of the MREE with respect to the HREE in chondrite-normalized REE patterns (GdN/LuN=1.2-1.4 and 3.2-3.6). Both groups show a negative Eu anomaly (Eu/Eu*=0.46-0.61) and a depletion of LREE (LaN/SmN=0.14-0.68) in contrast to the host rock. Chondrite-normalized diagrams for trace elements are concurrent in major points for host-rock and apatite.

The REE patterns of apatite differ from that of the host rock, which could be explained as follows: The negative Eu anomaly in apatite, which is missing in the host-rock pattern, is a typical feature for an apatite that reflects feldspar crystallization prior to apatite. This anomaly combined with Ce/Ce*=1.10-1.15 points to moderate oxidizing conditions during crystallization from the melt. The competition for REE with early crystallized accessory phases like monazite ($\pm$ titanite; not found in the rock) may explain the LREE depletion in apatite since monazite strongly favors LREE, producing a relative enrichment of Sm and Gd and reduced normalized contents of LREE from La to Nd in apatite. In addition, it is not clear if the REE-bearing phases have been partially recrystallized during a younger regional thermal event i.e. the Alpine orogeny. Such an event could have caused a redistribution of the REE. Possibly the two groups of apatite might reflect such a late thermal event or complex final stage of evolution that covers a broad temperature range.

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