Baddeleyite + W-bearing zirconolite + zircon-bearing veins as indicators for the polymetamorphic evolution of the eastern, lower Austroalpine nappes (Stubenberg Granite contact aureole, Styria, Eastern Alps, Austria)

P. Tropper (1), D. Harlov (2), E. Krenn (3), F. Finger (3), D. Rhede (2), F. Bernhard (4)

(1) Faculty of Geo- and Atmospheric Sciences, Institute of Mineralogy and Petrography, University of Innsbruck, Innsbruck, Austria, (2) GeoForschungsZentrum Potsdam, Telegrafenberg, D-14473 Potsdam, Germany, (3) Division of Mineralogy and Material Sciences, University of Salzburg, Hellbrunnerstrasse 54, A-5020 Salzburg, Austria, (4) Fasangasse 11, A-8073 Feldkirchen, Austria

Contact metamorphism during emplacement of the Permian Stubenberg Granite has led to the formation of the assemblage forsterite + calcite + titanian clinohumite ± phlogopite ± chlorite in the adjacent marbles. During intrusion of the granite, veins, rich in Ti, Zr, REE and actinides (U + Th) formed. These veins show a distinct mineralogical zoning sequence with four zones. Going from the center of the vein to the margin, these zones include: (1) geikielite + baddeleyite + zirconolite + apatite + calcite + chlorite ± magnetite ± pyrrhotite assemblage, (2) calcite + chlorite, (3) forsterite + titanian clinohumite + chlorite + calcite ± phlogopite and (4) calcite ± forsterite. Baddeleyite is always replaced by zirconolite, possibly via the model reaction baddeleyite + 2 geikielite + 3 calcite + CO₂ = zirconolite + 2 dolomite. Zirconolites (Zirc I) show a strong internal oscillatory zoning and distinct overgrowths (Zirc II), which have a different chemical composition. The chemical variation between the cores (Zirc I) and the rims (Zirc II) can be explained by using the substitutions: Me⁵⁺ + Me²⁺ (Ti + Me³⁺ and REE + Me⁵⁺ + Me²⁺ (Ca + 2Ti). In contrast to zirconolites from metacarbonates associated with contact aureoles, these analyses show elevated Nb contents of up to 4.5 wt.% Nb₂O₅ and unusually high W contents of 1 – 2 wt.% WO₃. The Zr-mineral sequence baddeleyite – zirconolite – zircon implies an increasing a(SiO₂) and fCO₂ during the growth of these minerals. A strong Eo-Alpine metamorphic overprint
led locally to the formation of the assemblage chlorite + dolomite + calcite ± ilmenite ± zirconolite II ± geikielite + Fe-sulfides. Late zircon grew locally, presumably as the last Zr-mineral in the carbonates during the Permian contact metamorphism. Electron microprobe U-Th-Pb dating of zirconolites (Zirc I) yields weighted average ages of 263 ± 16 Ma and indicates that the HFSE- and REE-rich assemblages formed during Permian emplacement of the Stubenberg granite. As a result of the subsequent high-P Eo-Alpine metamorphic overprint (111 ± 15 Ma), zirconolite recrystallization occurred, leading to dissolution of zirconolite I and re-precipitation of the REE and Nb-rich overgrowths of zirconolite II.