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Rodingites and metagranites as petrogenetic indicators for the Eo-Alpine metamorphic overprint in the crystalline complexes north of the Tauern Window (Eastern Alps, Tyrol, Austria)

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The area of investigation is located in the northern Zillertal (Eastern Alps, Tyrol, Austria) and is adjacent to the middle part of the TRANSALP section. The units, which are the focus of this investigation, are the Kellerjochgneiss and the Wildschönau Schists of the Greywacke Zone. At the southern border of the city of Schwaz (Tyrol, Austria) fine grained metarodingite bodies with a length of up to 40 m and a width of 30 m are tectonically embedded within quartzphyllites whereas it is not clear yet, if it is the Innsbruck Quartzphyllite or the Wildschönau Schists. Lower-Ordovician ultramafic rocks have so far been only described in the Austroalpine nappes north of the Tauern Window from the Greywacke Zone and not from the Innsbruck Quartzphyllites (Schauder, 2002).

The mineral assemblage of the metarodingites is garnet ($Gros_{23-47}Alm_{0-1}Pyp_{0-4}Spess_{0-2}Andr_{42-70}$Ti-Al Grt_{1-13}) + clinopyroxene ($Wo_{30-49}En_{31-54}Fs_{6-16}$ $Acm_{0-6}Jd_{1-4}$) + feldspar ($Kfs_{62-95}Ab_{0.5-5}An_{0-12}Cs_{1-21}$) + biotite + titanite + clinozoisite + spinel + chlorite + calcite. The main mineral assemblage of the blackwall is amphibole (actinolite) + clinozoisite + calcite + titanite + chlorite + biotite. Cr-bearing spinel is thought to represent a remnant of a pre-Alpine magmatic, ultramafic assemblage. BSE images and X-ray images of biotites reveal a complex chemical zoning pattern with up to three different growth zones based on different TiO_2 and BaO contents. The TiO_2 contents

range from 0.14 to 0.67 wt.%, the Ba contents range from 0.07 to 6.49 wt.%. The biotites are mostly associated with Feldspar, which shows a distinct growth sequence: the first generation of feldspars is hyalophane ($Kfs_{64-67}Ab_{4-5}An_{3-13}Cs_{19-25}$), followed by K-feldspar ($Kfs_{63-95}Ab_{3-5}An_{1-12}Cs_{1-20}$) and in the last stage, albite ($Kfs_{0.5-2}Ab_{97-98}An_1Cs_{0-0.5}$) grows. Small amounts of barite have also been found. Similar to the biotites within the metarodingite the biotites in the blackwall rocks contain Ba amounts of up to 1.72 wt%. Based upon thermobarometric data from biotite-bearing quartzphyllites and phase equilibrium constraints, the chemical zonation is thought to be a monitor for restricted, XCO_2-poor fluids, leading to episodic minor element (Ti, Ba) transport during Eo-Alpine low-grade metamorphism.

Within the Kellerjochgneiss a small, crosscutting, strongly deformed Ordovician (469 Ma) meta-pegmatite dike occurs. Field relations indicate that the pegmatite intersects the Kellerjochgneiss discordant and it contains the mineral assemblage of muscovite + biotite + albite + chlorite + quartz + garnet$_1$($Alm_{68}Spess_{27}Pyr_3Gro_2$) + garnet$_2$ ($Gros_{52}Alm_{33}Spess_{15}$) $\pm$ stilpnomelane. Textural investigations reveal a protolith assemblage comprised of K-feldspar, quartz and garnet. These garnets (garnet$_1$) are essentially almandine – spessartine solid solutions, which is comparable to garnet compositions from other pegmatites from the Eastern Alps (e.g. Koralm Crystalline complex).

Thermobarometry of the metapegmatite was performed with the Eo-Alpine assemblage garnet$_2$ + stilpnomelane + muscovite + chlorite + albite + quartz by calculating intersections with the program Thermocalc v 2.07 (Holland and Powell, 1998). Calculations of H_2O-absent intersections in the system KCNFMAS yield the best constrained $P-T$ estimates of 5.7 $\pm$ 0.6 kbar and 314 $\pm$ 28˚C. Preliminary H_2O-bearing calculations in the system KCNFMASH with the program TWQ v.1.02 (Berman, 1992, written comm.) yield very high pressures of 8.2 – 9.1 kbar at temperatures of 420 – 430˚C. Unfortunately, no other H_2O-absent calculations were possible. Application of the empirically calibrated muscovite + chlorite + stilpnomelane + quartz thermobarometer (Curie and van Staal, 1999) yields pressures of 7.3 – 8.1 kbar at temperatures of 283 – 307˚C. Garnet-chlorite thermometry yields a large spread of temperatures ranging from 280 – 400˚C.

These rocks not only provide important Eo-Alpine $P-T$ information within the quartzphyllites, which barely show suitable minerals assemblages for thermobarometric calculations, but they also provide information about the chemical composition of the fluid phase that lead to the rodingitization of the ultramafic protolith rocks during the Eo-Alpine metamorphic event.

References:

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