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The Role of $f\mathrm{H_2O}$ and $f\mathrm{O_2}$ on the Formation of Al-rich Titanite Reaction Rims on Ilmenite in Amphibolite-Facies Metamorphic Rocks: Constraints from Eequilibria among Clinopyroxene-Amphibole-Magnetite-Ilmenite-Quartz involving $CaTiSiO_4O$ and $CaAlSiO_4OH$

D. Harlov (1), P. Tropper (2), W. Seifert (2), T. Nijland (3), Hans-Jürgen Förster (4)

(1) GeoForschungsZentrum Potsdam, Telegrafenberg, D-14473 Potsdam, Germany, (2) Department of Earth- and Atmospheric Sciences, Institute of Mineralogy and Petrography, University of Innsbruck, Innrain 52, A-6020 Innsbruck, Austria, (3) Rooseveltlaan 964, NL-3526 BP Utrecht, The Netherlands, (4) Institute of Earth Sciences, University of Potsdam, PF 601553, D-14415 Potsdam, Germany

In this study, reaction rims of titanite on ilmenite are described in samples from four terranes of amphibolite-facies metapelites and amphibolites namely the Tamil Nadu area, southern India; the Val Strona area of the Ivrea-Verbano Zone, northern Italy; the Bamble sector, southern Norway, and the northwestern Austroalpine Ötztal Complex. The titanite rims, and hence the stability of titanite ($CaTiSiO_4O$) and Al–OH titanite ($CaAlSiO_4OH$), are discussed in light of $f\mathrm{H_2O}$- and $f\mathrm{O_2}$-involving equilibria among clinopyroxene, amphibole, biotite, ilmenite, magnetite and quartz in the systems $CaO–FeO/Fe_2O_3–TiO_2–SiO_2–H_2O–O_2$ (CFTSH) and $CaO–FeO/Fe_2O_3–Al_2O_3–SiO_2–H_2O–O_2$ (CFASH).

Depending on the presence of the accessory phases ilmenite and magnetite, mineral reactions are proposed as probable mechanisms for the formation of titanite reaction rims on ilmenite as a function of $f\mathrm{H_2O}$ and $f\mathrm{O_2}$. Textural evidence suggests that titanite reaction rims on ilmenite in these rocks originated most likely due to rehydration reactions such as clinopyroxene + ilmenite + quartz + H_2O = amphibole + titanite and oxidation reactions such as amphibole + ilmenite + O_2 = titanite + magnetite + quartz

+ H_2O. Overstepping of these reactions requires fH_2O and fO_2 to be high for titanite formation, which is also in accordance with similar equilibria involving Al–OH titanite.

However, comparing the four amphibolite-facies terranes, only the samples from Tamil Nadu contain magnetite and subsequently are the most oxidized of the four sample sets. The remaining three sample suites lack magnetite and in the case of the Val Strona traverse and Ötzal complex, contain rutile in addition to the ubiquitous ilmenite. Minimal hematite contents in the ilmenite would suggest that in all four samples, Fe (as Fe^{2+}) has been preferentially partitioned into coexisting ferromagnesium minerals such as amphibole and/or biotite, especially in the three sample suites which do no contain magnetite. The implication then would be that in the samples from Tamil Nadu, fO_2 conditions were above the QFM buffer though probably below the Ni–NiO buffer (cf. Harlov, 1992, 2000a). In contrast, fO_2 in the Bamble Sector, theVal Strona traverse, and the Ötzal complex were below QFM but above the iron-wüstite buffer (cf. Frost, 1991a,b; Lindsley, 1991).

This study shows that in addition to P,T, bulk-rock composition and composition of the coexisting fluid, fO_2 and fH_2O also play an important role in the formation of Al-bearing titanite in medium-grade metamorphic rocks.

References:

Frost, B.R. (1991a): Rev. Mineral. 25, pp. 1–9.

Frost, B.R. (1991b): Rev. Mineral 25, pp. 489–509.

Harlov, D.E. (1992): J. Geol. 100, 447–464.

Harlov, D.E. (2000a): Contrib. Mineral. Petrol. 139, 180-198.

Lindsley, D.H. (1991): Rev. Mineral. 25, pp. 69–106.