Rutile Replacement by Titanite (I): Natural Growth

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Titanite and rutile are important carriers of trace elements in various rock types. Both minerals are also used for isotopic dating. The redistribution and inheritance of trace elements, in particular Pb, is of special interest, as the trace element composition represents a fingerprint of the precursor mineral (even after its complete consumption) and inherited Pb influences the U-Pb system of the newly formed titanite, by suggesting the presence of an inherited component (cf. Romer and Rötzler, 2003; Rötzler et al., 2004). Growth of titanite at the expense of rutile up to complete consumption of the latter is a common phenomenon in metamorphic rocks. The reaction is fluid-mediated and involves considerable element transport (mainly Ca, Si, Al) to the respective site of titanite growth. Compositional heterogeneity occurs at various scales in the titanite rims. Coupled Al, Ti, and F variations of variable width (10 to 100 μm scale) in the broad titanite rims are not only due to the pressure and temperature condition, but likely monitor also changes in the element supply. A combined study of the major and trace element and isotope makeup of these heterogeneities by electron microprobe, LA-ICPMS, and TIMS is on the way. Compositional variations at the $\leq$ 1 μm scale were detected near the rutile - titanite phase boundary by high resolution electron microprobe technique employing a JEOL Hyperprobe JXA-8500F. Paired zones of well defined relative Al enrichment (1μm - 0.2μm) and diffuse, but slightly wider depletion of Al occur locally parallel to the grain boundary. In other segments of the same rim, Al variations may be less regular. Similar observations were made for the Fe distribution. TEM investigations, using the FIB preparation technique, show an approximately 200 nm wide phase boundary, partly filled with amorphous, partly with crystalline (possible Fe-Al-chlorite) material, which probably had acted as pathway for element transport via fluids. Similar pathways on the nm-scale were identified in the polycrystalline titanite rim.

References

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