Rutile Replacement by Titanite (II): Experimental Growth

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The aims of our experimental work on rutile replacement by titanite are (1) to study differences in the overgrowth patterns related to the duration of the experiment and (2) to study major and trace element variations in the new titanite. All experiments were performed in the presence of a H_2O + 50 wt% NaCl fluid at 600 $^\circ$C and 400 MPa in cold seal autoclaves. Starting materials were natural wollastonite (powdered) and natural rutile (grains of ˜0.5 – 3 mm), representing the (a) pure Ca-Si-Ti-O system. Compositional variations were obtained by the addition of small quantities of (b) γ-Al_2O_3 and (c) γ-Al_2O_3 and CaF_2. The natural rutile contained up to ˜ 900 ppm Nb, which can reliably be determined as a tracer by electron microprobe. Run durations of the experiments were 6, 30, 60 and 90 days. Some rutile grains were heated to 800°C and then quenched in cold water before the titanite-growth experiment to induce fractures. Incipient growth of titanite from composition (a) appears to be quick. A thin, near complete overgrowth ($<$ 20 - 30 μm) of small titanite crystals with variable crystallographic orientation was already observed on both the original rutile crystal faces and the fracture surfaces after 6 days. The 30 days run in the pure system (a) resulted in considerable coarsening of the titanite grains, i.e., consumption of some titanite crystals during Ostwald ripening. In quenched rutile grains, the growth of titanite in the pure system (a) occurs also along fractures and new titanite forms a network in these grains. Width of titanite-filled fractures reaches up to 100 μm in 30 day experiments. Niobium contents of the titanite are variable between ˜ 100 to 300 ppm. The distribution of Nb in the titanite shows no systematic distribution related to the phase boundaries. First high-resolution microprobe results for the Al (and Fe) distribution in titanite show variations on the μm scale. These variations include well defined growth (?) lamellae and diffuse, cloudy sections in the same sample.

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