

Conversion of titanite to rutile during the albitization of granitoids from the Sakar Batholith, SE Bulgaria: Experimental studies

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ABSTRACT

Petrological studies of the Sakar granitoid batholith (SE Bulgaria) have revealed that rutile-rich aggregates were formed from titanite during albitization and desilification of the granitoid at ~ 600 °C and ~ 300 MPa. Titanite conversion to rutile has been tested experimentally. Four experiments involving fluid-aided alteration of titanite in a granitic system were conducted using cold-seal pressure vessels on a hydrothermal line at 280 MPa and 600 °C. The starting material included titanite, fluorapatite, and a powdered, unaltered, natural granite from the Sakar Batholith. Four Na-bearing aqueous fluids ($\text{NaCl} + \text{H}_2\text{O}$, $\text{NaF} + \text{H}_2\text{O}$, $\text{Na}_2\text{Si}_2\text{O}_5 + \text{H}_2\text{O}$, and 2 M NaOH) were used. Rutile was formed from titanite in experiments involving $\text{NaCl} + \text{H}_2\text{O}$ (RT-1) and $\text{NaF} + \text{H}_2\text{O}$ (RT-2). The mineral assemblage formed in RT-1 consisted of rutile, Ti-Th-U oxides, and monazite, whereas in RT-2 rutile, fluorite, lorenzenite, albitized plagioclase, REE-enriched rims on fluorapatite, and a glass formed. Rutile did not form in experiments involving $\text{Na}_2\text{Si}_2\text{O}_5 + \text{H}_2\text{O}$ or 2 M NaOH. The comparison between natural observation and the experimental results supports the premise that a $\text{NaCl} + \text{H}_2\text{O}$ fluid could have been responsible for the conversion of titanite to rutile during albitization, which further supports the role of NaCl-bearing fluids during the albitization of granitoids in general at mid- to upper-crustal pressures in the presence of alkali-bearing fluids. This implies that the geochemical relationship between rutile and titanite is more a function of the chemistry of the fluid and host rock, especially if they are Na-rich, rather than the P - T conditions. Subsequently, rutile formed from titanite can be used as a geochronometer for dating the process responsible for both the formation of the rutile and the metasomatism of the rock. Detrital rutile is commonly thought to mostly originate from medium- to high-pressure igneous and metamorphic source rocks. Formation of rutile during albitization and desilification of granitoids under relatively high-temperature hydrothermal conditions in the upper crust has implications regarding rutile provenance studies of areas sourced by regionally albitized quartzofeldspathic rocks.

Keywords: Titanite, rutile, albitization, alkali-bearing fluids, granitoid, experimental petrology