

LETTER

Partial high-grade alteration of monazite using alkali-bearing fluids: Experiment and nature

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ABSTRACT

Recent advances in the dating of monazite using the electron microprobe indicate that ThSiO₄- and/or CaTh(PO₄)₂-enriched intergrowths in monazite can give ages younger than the original monazite. The morphology of the intergrowths suggests that the original monazite grain has been partly altered by a fluid in which Th, Si, and Ca are mobile. This hypothesis has been tested in the piston-cylinder apparatus at 1000 MPa and 900 °C utilizing a natural, unzoned, Th- and Pb-bearing monazite-(Ce) and Na₂Si₂O₅+H₂O. During the experiment, a subset of the monazite grains acquired ThSiO₄-enriched areas with sharp compositional boundaries devoid of Pb and show evidence of being a pseudomorphic partial replacement of the monazite rather than an overgrowth of the monazite. These experiments support the hypothesis that similar Th-enriched or Th-depleted patches with sharp compositional boundaries observed in natural monazite could be the result of fluid-induced alteration via coupled dissolution-reprecipitation. If so, such altered regions would yield information concerning the nature of the fluid responsible for their formation as well as allow for the dating of single or multiple metasomatic events assuming that all pre-existing radiogenic Pb is removed during alteration.

Keywords: Monazite, huttonite, alkali-bearing fluids, dissolution-reprecipitation, geochronology, experimental petrology, high-grade metamorphism, Th-U-Pb dating