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Review

Versatile Monazite: resolving geological records and solving challenges in materials science

Generalizations about monazite: Implications for geochronologic studies†

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Abstract

With the advent of techniques that preclude mineral separation, ages from specific compositional domains in monazite [$(Ce,La,Th)PO_4$] have provided a wealth of information regarding the timing of the geologic evolution of numerous regions. However, confusion can arise when single grains show large differences in age that fail to correlate to chemistry or location within the monazite. Generalizations that lead to incorrect age interpretations include that monazite zoning in Y, Th, and/or the rare earth elements (REE) always identify: (1) distinct tectonic events; (2) environment of crystallization; and (3) provenance of detrital grains. Increasing Th contents in monazite do not always reflect: (1) increasing grade in metamorphic grains; (2) changes in silicate melt composition in igneous grains; (3) make the mineral more susceptible to alteration; nor (4) control the mineral's uptake of REE. Metamorphic monazites from Himalayan garnet-bearing rocks with coexisting allanite show no relationship between Th content and REE. Instead, chondrite-normalized REE patterns of the allanite mirror those of the monazite, indicating the variations are related to the reactant that formed the mineral. Generalizations about Pb behavior in monazite remain problematic. Incorporation of Pb into monazite has thus far been precluded by experimental studies, yet common Pb has been measured in many studies of natural monazite. A clear understanding about controls of monazite composition and the role of the chemical and/or pressure-temperature (*P*-*T*) environment of the rocks in which it forms is required to correctly interpret the meaning of the mineral's age(s).

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