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VERSATILE MONAZITE: RESOLVING GEOLOGICAL RECORDS AND SOLVING CHALLENGES IN MATERIALS SCIENCE

Microprobe analysis and dating of monazite from the Potsdam Formation, New York: A progressive record of chemical reaction and fluid interaction†

JULIEN ALLAZ,[1,*] BRUCE SELLECK,[2] MICHAEL L. WILLIAMS,[1] AND MICHAEL J. JERCINOVIC[1]

[1]Department of Geosciences, University of Massachusetts, Amherst, 611 North Pleasant Street, 233 Morrill Science Center, Amherst, Massachusetts 01003, U.S.A.
[2]Department of Geology, Colgate University, 13 Oak Drive, Hamilton, New York 13346, U.S.A.

ABSTRACT

It has been recognized for several decades that REE-phosphates (monazite and xenotime) can grow during diagenesis and low-grade metamorphism. Growth of REE-bearing accessory phases at low-grade conditions commonly involves pervasive fluid-rock interaction, dissolution of detrital grains, transportation, and precipitation of REEs, typically facilitated by an increase in temperature. The occurrence of low-grade REE-phosphate offers a rare opportunity to date crystallization/mineralization and possibly fluid percolation.

We report here the results of in situ dating by electron microprobe of Paleozoic authigenic and low-grade monazite and xenotime overgrowths on detrital monazite and zircon, respectively. Samples are from the Potsdam Formation, a basal sandstone deposited uncomformably on Proterozoic basement of the Adirondack Mountains of New York State. This study also focuses on the textural and chemical relationships of these REE-bearing accessory phases. Textures include rounded and fractured detrital monazite and zircon, which contrast with new sub-euhedral REE-phosphate overgrowths. Monazite overgrowths are enriched in LREE and depleted in HREE compared to detrital cores. The U and Th concentrations are low, typical of low-grade metamorphic conditions.

Monazite core ages yield Proterozoic ages between 1.17 and 0.90 Ga (Shawinigan and Ottawan orogeny). Monazite overgrowth and xenotime ages indicate four to five major overgrowth events between ca. 500 Ma (shortly after the time of deposition) and ca. 200 Ma. As these ages are relatively young and the actinide content is low ($\Sigma < 2$ wt%), the radiogenic Pb content of monazite overgrowths and xenotime is low (<400 ppm). Therefore, EPMA dates have relatively large uncertainties. Nevertheless, the ages determined broadly correlate with major Paleozoic orogenic events recorded in the Appalachian Orogen to the East (Taconic, Salinic, Acadian, Neo-Acadian, and Alleghanian). Fluid percolation, driven by orogenic loading, may induce dissolution of detrital monazite and zircon. Subsequent precipitation of new monazite and xenotime probably results from changes in fluids or metamorphic conditions. This study demonstrates the power of the EMPA technique to resolve the fluid-related growth history of REE-phosphates in low-grade metasediments.

Keywords: Potsdam Formation, Paleozoic orogenies, monazite, xenotime, low-grade metamorphism, fluid pulse, REE speciation