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Evolution of layering in a migmatite sample: Implications for the petrogenesis of multidomain monazite and zircon

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Abstract

The timing of partial melting in high-grade metamorphic rocks is critical for constraining tectonic histories and processes. However, uncertainties exist about the behavior of monazite and zircon during partial melting, especially about the timing of crystallization with respect to melting reactions. This study is focused on a single sample (16TG143) of finely layered, migmatitic gneiss from the Adirondack Highlands, New York, interpreted to have undergone extensive biotite dehydration melting (i.e., Bt + Pl + Als + Qz = Grt + Kfs + melt). The rock contains one distinct leucosome layer. The non-leucosome (gray gneiss) portion of the migmatite has millimeter-scale sublayers with distinct differences in modes and mineralogy. The layers are interpreted to reflect the differential preservation of reactants and products formed during the forward and reverse progress of the melting reaction. Monazite and zircon modes, and to some degree, texture, composition, and geochronology all vary from layer to layer. Both minerals have up to three domains: ca. 1150 Ma anhedral cores, ca. 1050 Ma monazite mantles/fir tree textured zircon, and ca. 1030 Ma rims. The heterogeneous layered gray gneiss provides robust constraints on the timing of melting (ca. 1050 Ottawan orogenesis), melt crystallization, and post-melting retrogression, in addition to information about earlier metamorphic events. Early-formed monazite and zircon grains were largely dissolved during progressive melting, except where preserved as relicts or inclusions. Monazite mantles and fir tree zircon grains precipitated upon cooling during progressive melt crystallization between temperatures of 800 and 750 °C. Rims are interpreted to have precipitated during subsolidus, solid-state retrogression after ca. 1050 Ma. Correlations between the gneissic layering, melting reactions, and the character of geochronometers emphasize the importance of characterizing the layer-forming and chronometer petrogenesis processes as a critical part of deconvoluting the history of migmatitic gneisses.

Keywords: Petrochronology, migmatite, polymetamorphism, Adirondack Highlands, monazite, zircon, gneiss