A unique paragneiss-hosted monazite-xenotime mineralized zone in Highland Falls, New York: a petrogenetic analysis

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In southeastern New York State within the Mesoproterozoic Grenville Orogen, the Hudson Highlands is metamorphosed to granulite facies, consisting primarily of locally migmatitic paragneiss, and intruded by late tectonic granite and pegmatite. The study area is a 200 m-long road cut outcrop in which the dominant lithology changes from granite/pegmatite, to migmatite, and then to paragneiss. At the contact between the migmatite and paragneiss (apparently conformable), a narrow zone is composed almost entirely of monazite and xenotime (mzxn zone) with an average grain size of ~1 mm and enveloped by coarse biotite. This mz-xn zone is approximately 0.25–1 m wide and 4 m in extent in the outcrop. It is a weakly deformed, steeply dipping (80°), and striking NNE. Based on previous research and confirmed in this study, the mineralized zone contains 1.0% U, 3.8% Th, 35% total REE (enriched HREE), 19% Y, 0.2% Zr, and has a large negative Eu anomaly. A previous study identified cores and rims in the zircon, monazite, and xenotime, which were analyzed to develop a U-Pb geochronologic history. Detrital and xenocrystic zircon cores in the mz-xn zone have ages of 2065–1270 Ma. The proximal granite intrusion has an age of 1058 ± 14 Ma. Zircon, monazite, and xenotime cores in the mineralized zone formed between 1004–1034 Ma, as well as homogeneous rims on the paragneiss zircons. Over the next 130 Myr, three separate dissolution-reprecipitation rim populations were identified in each mineral. The petrogenetic process has been interpreted as metasomatic replacement of the paragneiss, based on the geochronologic constraints and intracrystalline zoning textures; the main objective of this study is to determine the source and nature of those metasomatic fluids. Mineral trace element analysis, including W zoning in molybdenite, shows high T characteristics typical of hydrothermal and magmatic systems, making the involvement of a late tectonic A-type, NYF-type pegmatite typical of the Ottawan phase of the Grenville Orogeny probable. A high temperature hydrothermal fluid or an immiscible hydrous phosphate melt, derived from a pegmatite at depth, are possibilities. This will be examined based on textural interpretation at multiple scales, microprobe analyses of biotite and other accessory phases, geothermometry, tracer isotope systematics, and compositional dynamics.

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