# Petrogenesis of a unique, massive monazite-xenotime vein-dike in Southern NY, USA

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In southeastern New York State, within the Mesoproterozoic Grenville Orogen, the Hudson Highlands inlier is metamorphosed to granulite facies, consisting primarily of locally migmatitic paragneiss, and is intruded by late tectonic granites and pegmatites. At a contact between the migmatite and paragneiss, there is a narrow vein-dike zone composed almost entirely of monazite and xenotime, and enveloped by a metasomatic biotite envelope. The mineralized zone contains up to 1.0% U, 3.0% Th, 25% total REE, and 13% Y, with Eu/Eu*=0.03 and $(La/Yb)_{CN}$=3.0. Previous U-Pb geochronology studies of this zone have shown that the vein-dike intruded at 1036±5 Ma, with a series of post-metamorphic events generating mineral rims between 1034-890 Ma. Vein-dike emplacement postdates the host paragneiss (2065-1270 Ma) and local granitic intrusions (1058±14 Ma).

In this study, petrography, lithogeochemistry, biotite mineral chemistry, and monazite/xenotime trace element mapping are used to investigate metasomatism of the host paragneiss, as well as ascertain the source and nature of the mineralizing fluid. Based on trace element geothermometry, zircon and biotite in the vein-dike formed at 732 ± 16 °C and 542 ± 24 °C respectively. The system is extremely enriched in incompatible elements, and the Zr/Hf ratio is very low (4.5), indicating a large degree of fractionation. It contains large amounts of ligands, indicated by salt-saturated fluid inclusions, and extreme Cl enrichment in the metasomatic biotite surrounding the vein-dyke (2.3 wt.% Cl). There is also low Ca in the system which prevented apatite saturation. The vein-dike is probably derived from a highly fractionated, late tectonic NYF pegmatite with crustal A-type granite affinity. Monazite and xenotime REE signatures show characteristics of both hydrothermal and magmatic systems. Depending on the amount of water in the system, the mineralizing fluid derived from this pegmatite may have been a hypersaline hydrothermal brine or an immiscible hydrosaline melt. This unique mineralization could greatly increase our understanding of immiscible salt melts.