Age, Petrology, and Geochemistry of an Appinitic Lamprophyre, Hjalmar Lake, South Rae Craton, NT

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Abstract

The Nonacho Lake area in the south Rae craton of the Northwest Territories, Canada, consists of Archean to Paleoproterozoic granites and gneisses that are unconformably overlain by the ca. 1.91-1.82 Ga alluvial-fluvial sequence of the Nonacho Group. Reconnaissance mapping of the Nonacho Lake area in 2018 revealed several NE-SW-trending, 500 m by 200 m, carbonate-bearing, hornblendite dykes on the eastern shore of Hjalmar Lake. These intrusions contain very coarse (up to 3 cm diameter), dark green to black, euhedral to subhedral hornblende crystals in a heterogeneous groundmass that varies from vitreous fine-grained greyish green (clinopyroxene + sodic plagioclase) to leucocratic granitic material (orthoclase + quartz). Based on mineralogy and amphibole compositions, these hornblende-rich intrusions are classified as lamprophyres, specifically the plutonic version of a calc-alkaline spessartite called an appinite. The amphibole phenocrysts are magnesiohornblende and are commonly rimmed by actinolite, a feature observed in some appinites; the actinolite rims are associated with increasing magnesium content from crystal cores to rims. The Hjalmar Lake lamprophyres are distinguished by very high abundances of primary incompatible element-rich accessory phases, especially titanite, allanite, and zircon. The dykes are characterized geochemically by high concentrations of magnesium, chromium and nickel combined with incompatible trace element enrichment, particularly the large ion lithophiles, and prominent negative Nb-Ta-Ti anomalies in normalized trace element patterns. Based on LA-ICP-MS U-Pb zircon geochronology, the crystallization age of the Hjalmar Lake lamprophyres is interpreted to be 2454 ± 18 Ma and two major lead loss events in zircon grains are identified at ca. 2.3 Ga and ca. 1.8 Ga. The lamprophyre geochemistry is consistent with an origin as small degree partial melts of a subduction-modified metasomatized subcontinental lithospheric mantle source. The Hjalmar Lake lamprophyres are inferred to originate from asthenospheric upwelling in the late stages of convergence in a continental arc or continental collisional setting associated with the 2.5-2.28 Ga Arrowsmith orogeny along the western margin of the Rae craton. The presence of these mantle-derived lamprophyres suggests the existence of deep lithospheric structures and metasomatized subcontinental lithospheric mantle at depth and highlights the potential for post-subduction epithermal or iron oxide-copper-gold deposits in the region.