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Evidence for a Neoarchean to earliest-Paleoproterozoic mantle metasomatic event prior to formation of the Mesoproterozoic-age Strange Lake REE deposit, Canada

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A complete suite of bulk major- and trace-elements measurements combined with macroscopic/microscopic observations and mineralogy guided by SEM-EDS analyses were applied on Nekuashu (2.55 Ga) and Pelland (2.32 Ga) intrusions in northern Canada, near the Strange Lake REE deposit, to evaluate their magmatic evolution and possible relations to the Mesoproterozoic Strange Lake Peralkaline Complex (SLPC). These Neoarchean to earliest-Paleoproterozoic intrusions, part of the Core Zone in southeastern Churchill Province, comprise mainly hypersolvus suites, including hornblendite, gabbro, monzogabbro/monzodiorite, monzonite, syenite/augite-syenite, tonalite/granodiorite, and mafic diabase/dyke. However, the linkage of the suites and their petrogenesis are poorly understood.

Geochemical evidence suggests a combination of 'intra-crustal multi-stage differentiation' -mainly controlled by fractional crystallization- (to generate mafic to felsic suites) and 'accumulation' (to form hornblendite suite) was involved in the evolution history of this system. Our model proposes that the pyroxene-hornblendite and mafic to felsic intrusive rocks of both intrusions share a common basaltic parent magma, generated from melting of a hydrous metasomatized mantle source that triggered an initial REE and incompatible element enrichment that prepared the ground for the subsequent enrichment in the SLPC.

Geochemical signature of the hornblendite suite is consistent with a cumulate origin and its formation during the early stages of the magma evolution, however, the remaining suites were mainly controlled by 'continued fractional crystallization' processes, producing more evolved suites:

gabbronorite/hornblende-gabbro→monzogabbro/monzodiorite→monzonite→syenite/augite-syenite→tonalite/granodiorite

In this proposed model, the hydrous mantle-derived basaltic magma was partly solidified to form the mafic suites (gabbronorite/hornblende-gabbro) by early-stage plagioclase-pyroxene-amphibole fractionation in the deep crust while settling of the early crystallized hornblende (+pyroxene) led to the formation of the hornblendite cumulates. The subsequent fractionation of plagioclase, pyroxene, and amphibole from the residual melt produced the more intermediate suites of monzogabbro/monzodiorite. The evolved magma ascended upward into the shallow crust to form monzonite by K-feldspar fractionation. The residual melt then intruded at shallower depth to form syenite/augite-syenite with abundant microcline crystals. Eventually, the most evolved suite, tonalite/granodiorite, was formed in shallower levels by quartz fractionation. Later mafic diabase/dykes were likely generated by further partial melting of the same source at depth that were injected into the other suites.