An integrated stable isotopic and textural study of the Little Nahanni rare-metal pegmatite system, NWT

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Understanding the origin and distribution of the increasingly more important strategic metals is paramount for both their exploration and exploitation. Here we present results of our ongoing work on the rare-metal (RM) rich (Li-Ta-Sn), Cretaceous (82 Ma) Little Nahanni Pegmatite Group (LNPG) in the Northwest Territories, Canada. Although studied in the past, the origin of this LCT-type pegmatite group, as well as its internal evolution, remain poorly understood. As with other LCT pegmatites, its RM (Ta-Sn±Nb) mineralization almost invariably occur in albite(-lepidolite) zones associated with sodium metasomatism. This project integrates petrographic, mineralogical and textural observations with stable isotopes ($\delta^{18}O$, δD) to investigate the internal evolution of the pegmatite, particularly the nature and origin of the sodium metasomatism and associated RM mineralization. The stable isotopes reveal a strong local isotopic disequilibrium reflecting the influence of meteoric fluids and wall rock contamination during its evolution; earlier fluid inclusion work supports both processes. Additionally, quartz, K-feldspar, albite and micas recorded ^{18}O enrichment through pegmatite evolution, which suggests exchange with the metasedimentary wall rock. Furthermore, albite also records a trend of ^{18}O depletion which indicates incursion of meteoric water during pegmatite evolution. Petrography and SEM-EDS (Scanning Electron Microscopy-Energy Dispersive Spectroscopy) study of the mineralogy and textures established the following significant observations: 1) absence of graphic and granophyric textures but extensive skeletal growth of primary K-feldspar and spodumene which suggest the pegmatitic melt underwent a particularly high degree of undercooling (ΔT) that apparently favoured the skeletal growth of minerals over formation of graphic and granophyric textures; 2) the lack of primary muscovite and tourmaline, combined with the scarcity of miarolitic cavities and pocket zones, suggest that the melt was H_2O-undersaturated and B-poor; 3) the co-spatial association of Sn mineralization with F-bearing muscovite and quartz intergrowth, typical of weak greisenization, is found in the samples with the highest $\delta^{18}O_{albite}$ values, suggesting an acidic alteration during Sn-mineralization; 4) absence of wall-rock xenoliths within the outer zones of the pegmatites suggest pegmatite-wall rock interaction was fluid-mediated; 5) the presence of SQUI texture (spodumene-quartz intergrowth after petalite) indicates a maximum pressure of 400 MPa at the time of emplacement; and 6) the presence of layered aplitic-pegmatitic dikes is interpreted as reflecting fluctuations between lithostatic and hydrostatic pressure (e.g. open system) and supported by earlier fluid inclusion work.