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Mafic-ultramafic melt inclusions in early magmatic apatite record low degrees of partial melting of a critical metal-enriched, suspected Neoproterozoic basement, Mersey Point, Nova Scotia, Canadian Appalachians

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The Mersey Point gabbronorite intrusion is one of several very small Late Devonian mafic intrusions coeval with voluminous ca. 380-370 Ma granitoids that host significant intrusion-related Sn-W-Mo deposits in Nova Scotia. Such rare mafic plutonic rocks afford an opportunity to characterize the nature of end-member mafic magmas in the Canadian Appalachians, particularly their role in the formation of the mineralized granitoids.

The gabbronorite at Mersey Point is an olivine (>Fo_{80})-plagioclase mesocumulate with poikilitic orthopyroxene, clinopyroxene, and phlogopite. Apatite, spinel, and sulfides (Fe-Ni-Co-Cu-S) are accessory phases. Apatite and contained melt inclusions were analyzed by field emission SEM-EDS and LA-ICP-MS. Apatite phenocrysts are texturally early and contain primary, high alkaline silicate melt inclusions (SMI) of basanitic-trachytic-tephritic composition with MgO contents of 5 to 27 wt%. Compatible major/trace elements in the SMI show behaviours consistent with differentiation. However, incompatible LILE/HFSE show no enrichment with differentiation and, instead, attain extremely high concentrations in the most primitive SMI. Notably, concentrations of critical metals W and Mo are 1-3 orders higher than in N-MORB or arc basalts; Sn concentrations are unremarkable.

Host apatite trace element compositions indicate growth from plagioclase-saturated mafic-ultramafic melt showing extensive crustal contamination. Halogen abundances in apatite (F ~ 1 wt%; Cl ~1-5 wt%; high X_{Cl}/X_{OH} and low X_F/X_{Cl}; by EPMA) indicate that the associated melt was very halogen rich, but volatile-undersaturated at the time of entrapment and became increasingly Cl-rich during fractionation. High S content in apatite (~0.4 wt% SO_3) suggests elevated oxygen fugacity.

The compositional characteristics of the apatite and associated SMI provide the first direct evidence for the onset of partial melting of lower crustal rocks by mafic magmas in the Meguma Lithotectonic Zone. Strong enrichment in W but very low Sn in the SMI indicates low degrees of partial melting (muscovite dehydration melting) of a phyllosilicate-rich crustal rocks by the mafic magmas. This suggests that in areas where larger volumes of such mafic magmas interacted with lower crust, larger degrees of partial melting (at higher T) may have led to biotite dehydration melting, producing halogen-Sn-W-rich felsic melts - a likely prerequisite for intrusion-related deposits in granitoids in the region.

