Postorogenic Paleoproterozoic Mafic Intrusions Within the Rae Craton

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The Paleoproterozoic Trans-Hudson orogenic belt is host to one of the world's largest nickel deposits, and yet due to its size and remoteness, many parts of the orogen remain relatively underexplored. The Repulse Bay block (RBb) of the Rae craton, Nunavut, Canada, exposes a 50,000 km^2 tract of Archean middle to lower crustal rocks that were reworked during, and exhumed at, the end of the Paleoproterozoic Trans-Hudson orogeny. Fieldwork in 2010–2012 identified that the block is host to a number of small (<1 km in diameter), previously unidentified post-Hudsonian gabbroic intrusions and pervasive pegmatite-aplite dikes. A high strain to mylonitic zone known as the Qaggitalik shear zone transects the block and transposes the anhydrous lower crustal granitoid rocks adjacent to hydrated middle-crust granitoid gneisses. It is along this boundary that undeformed gabbroic intrusions are preferentially located. Anhydrous lower crustal rocks are composed of Neoarchean charnockites and enderbites that are interpreted to be derived at the cratonic edge. Pyrite-rich metapelitic rocks are exposed across the block as discreet thrust imbricate-bounded domains.

Gabbroic plutons are medium grained and massive. Mafic minerals consist of clinopyroxene, orthopyroxene, minor biotite, and secondary hornblende. Inclusion-free garnet porphyroblasts up to 3 cm in diameter with coronas of diopside + plagioclase + minor amphibole vermicular symplectites are present at the edges of the intrusions, and ubiquitous layers of amphibole-bearing garnetite surround the gabbro intrusions. Undeformed allanite-magnetite-bearing aplitic to pegmatitic granite dikes cut gabbroic intrusions and are near-linear in nature with only minimal intermingling, indicating that they intruded the cooling gabbroic plutons in the middle to upper crust. The results of U-Pb geochronology demonstrate that pegmatite and aplite dikes crystallized at ca. 1760 Ma. This age window is combined with titanite, rutile, and apatite chronometers across the block to yield emplacement temperatures of 550° to 600°C.

Whole-rock and mineral chemistry from the gabbroic intrusions point to derivation from continental rift/rifted margin magmas. Magnesium numbers range from 30 to 44, with Cr and Ni concentrations of 170–470 and 70–170 ppm, respectively. The mafic intrusions are characterized by relatively flat primitive mantle-normalized trace element diagrams with slight negative Th and Nb anomalies and minor LREE enrichment. In addition, whole-rock geochemistry combined with geochronology demonstrate that pegmatite dikes are linked to the Nueltin plutonic suite, commonly exposed in downdropped corridors within the Rae and Hearne cratons. Based on these associations, basaltic underplating and the rise of mafic melts through the crust along extensional faults that developed during orogenic collapse and lateral escape is interpreted be the heat source for partial melting of the crust to form mafic and near contemporaneous felsic anorogenic magmas of the RBb.

This preliminary study outlines that the gabbroic suite was formed in an extensional environment at the edge of an ancient craton. Mafic magmas intruded into a crust that is locally rich in sulfide-bearing metapelitic rocks. It highlights the need for further work to better understand these mafic intrusions and their potential for Ni-Cu-PGE mineralization.