

Convergent margin origin of Neoproterozoic anorthosite-bearing layered intrusions in the Superior Province, Canada

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Summary

The Superior Province contains many fragments of Neoproterozoic anorthosite-bearing layered intrusions that are comprised mainly of anorthosite, leucogabbro and gabbro, with minor pyroxenite, peridotite and chromitite. Some of these major anorthosite-bearing layered intrusions include the Doré Lake, Shawmere, Bad Vermilion Lake, Pipestone Lake, Bird River, Mayville, Split Lake and Cauchon Lake complexes. These layered intrusions are spatially associated with and/or intrusive into basalt-dominated greenstones, amphibolites or high-grade, granulite-facies gneisses. Most anorthosite-bearing layered intrusions are intruded by younger granitoid batholiths and have experienced variable degrees of metamorphism and multiple phases of deformation yet still preserve primary, igneous minerals and cumulate textures. Anorthosite, leucogabbro and gabbro units in these intrusions typically contain high-Ca ($>An_{70}$) megacrystic (2-30 cm in diameter) plagioclase. Large degrees of partial melting (25-35%) in the hotter (1500-1600°C) Archean upper mantle beneath arcs and backarc basins might have produced shallow, kilometre-scale magma chambers that differentiated into plagioclase-, pyroxene- olivine-, and chromite-rich layers. Anorthosite, leucogabbro and gabbro layers in some of these intrusions contain abundant interstitial magmatic amphibole, indicating that they crystallized from hydrous magmas. The anorthosite-bearing layered intrusions and spatially associated greenstone belts and granitoids share many geochemical characteristics with Phanerozoic subduction zone magmas, suggesting that they formed mainly in a suprasubduction zone setting. On the basis of field observations, regional geology and trace element data, we suggest that the anorthosite-bearing layered intrusions and spatially associated greenstone belts of the Superior Province are fragments of Archean backarc oceanic crust or island arcs. Therefore, these layered intrusions and spatially associated greenstone belts are interpreted as dismembered slices of subduction-related ophiolites and suture zones, reflecting the operation of convergent margin tectonic and petrogenetic processes in the Archean.