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Fractionation of Mantle-Derived Melts in the Annieopsquotch Ophiolite, Newfoundland

C. Lissenberg [1], J.H. Bédard [2], C.R. van Staal [3]

[1] Department of Earth Sciences, University of Ottawa, 140 Louis Pasteur, Ottawa, ON K1N 6N5 Canada
[2] Geological Survey of Canada, 880 Chemin St.-Foy, Quebec, QC G1S 2L2 Canada
[2] Geological Survey of Canada, 601 Booth Street, Ottawa, ON K1A 0E8 Canada

The Annieopsquotch ophiolite exposes a tectonically bounded section through c. 5.5 km tholeiitic gabbros, sheeted dykes and pillow basalts. The gabbro zone is divided into three parts. The lower 500 m comprises massive cumulate gabbros with enclaves ($<$50 m) of partly-reacted and digested layered troctolite/leucotroctolite. These are interpreted as relics of the substrate into which the gabbro-sheeted dyke-basalt sequence was emplaced. Overlying this is 1500 m of cumulate olivine gabbros and gabbros which form sills c. 30 m thick that are oriented parallel to the ophiolite pseudostratigraphy. Finer grain sizes at contacts and inward-growing crescumulates indicate cooling from both top and bottom. Gabbros in the sill complex are characterized by cumulate textures with minor intercumulus amphibole and oxides, and rarely show shape-preferred orientations. The upper 500 m of the gabbro zone is dominated by massive gabbros with more abundant interstitial Fe-Ti-oxides, and diabasic pods that grade up into sheeted dykes, suggesting it represents a level of frozen melt. Incompatible element contents of cumulate gabbros in the sill complex generally increase upwards, and modeling indicates that the cumulate sills crystallized from melts with compositions similar to those of the overlying sheeted dykes and basalts. Trapped melt fractions are estimated to be c. 20%, consistent with the absence of compaction structures in these gabbros. Models indicate that the parental magmas of the gabbros, as well as lavas and dykes, can be produced by an average of c. 40-45% fractionation of mantle-derived melts. Both field- and geochemical data thus suggests the Annieopsquotch lower crust records repeated in-situ intrusion and fractionation during upward migration of mantle-derived melts towards the surface, with localized ponding in an axial melt lens at the base of the dyke complex. The similarity in composition and degree of fractionation between the lower and upper crust suggest that the axial melt lens played a limited role in fractionating melt compositions.