Mineralogical controls on rare metal enrichment in the Flowers River Igneous Suite, Nain Province, Labrador, Canada

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Mineralogical associations within rare metal-enriched igneous bodies provide insight into the late-magmatic cooling conditions and fluid evolution of these systems. Rare earth elements (REE) and high field strength elements (HFSE) collectively represent most of the elements known as rare metals. Highly differentiated peralkaline systems commonly achieve enrichment in rare metals sufficient to promote growth of exotic accessory minerals that are intrinsically composed of these elements. The REE-bearing fluorocarbonate mineral bastnäsite ($(Ce,La)CO_3F$) is one such accessory mineral commonly found in systems host to rare metal mineralization. The Flowers River Igneous Suite of north-central Labrador comprises an intrusive ring complex of rare metal-enriched alkali granites and their comagmatic volcanic equivalents. Both intrusive and extrusive Flowers River lithotypes exhibit the same geochemical and mineralogical hallmarks of other silica-oversaturated rocks that host rare metal occurrences. Bastnäsite (Ce) is the dominant repository of REE in the Flowers River Igneous Suite. The distribution of bastnäsite in Flowers River rocks displays three distinct associations: (i) as a pseudomorph of allanite in alkali granites; (ii) proximal to Fe-rich minerals interstitial to cumulate quartz and feldspar or within Ferich chloritized domains in plutonic and volcanic rocks, respectively; and (iii) filling elated exotic mineral phases such as parisite ($Ca(Ce,La)_2(CO_3)_3F_2$). Further, pervasive Na depletion in the Flowers River volcanic rocks has been observed to accompany the alteration of groundmass albite to chlorite. In-situ replacement of allanite by bastnäsite suggests a primary magmatic contribution to enrichment of rare metals that was followed by alteration and remobilization by CO_2-rich fluids. A sporadic association of bastnäsite with hydrothermal fluorite supports a high activity of F in these fluids, a property that would enhance the hydrothermal system's capacity to mobilize REE. These criteria, taken together, indicate a deuteric or secondary hydrothermal control on the alteration of primary host minerals and on the redistribution of rare metals within the Flowers River Igneous Suite.

Atlantic Geology, 2019, Volume 55
Atlantic Geoscience Society Abstracts – 45th Colloquium & Annual General Meeting 2019
https://doi.org/10.4138/atlgeol.2019.005