The amphiboles of the REE-enriched, Strange Lake peralkaline granitic pluton – fingerprints of magma evolution

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Major and trace element compositions of amphibole in igneous environments can reflect evolving magma composition. In this study, we use arfvedsonite ($NaNa_2(Fe^{2+})_4(Fe^{3+})Si_8O_{22}(OH,F)_2$) [1], a sodic member of the amphibole group, from the Strange Lake REE-enriched peralkaline granitic pluton to gain insights into the nature of the magma. This 1240 Ma old pluton [2] consists of two main intrusive facies, an early hypersolvus granite, which occurs as separate northern and southern intrusions in the centre of the pluton, and a more evolved subsolvus granite that surrounds them. In the hypersolvus granite, which contains a a single alkali feldspar (perthite), the arfvedsonite is a late interstitial phase, whereas in the subsolvus granite, it forms phenocrysts in a matrix containing two alkali feldspars. Arfvedsonite in the southern and northern hypersolvus intrusions, on average, contains 330 and 560 ppm REE, respectively, whereas in the subsolvus granite the average REE content is only 100 ppm. Chondrite-normalised REE profiles emphasise the wide range of REE content of the arfvedsonite. The profiles are flat for the LREE, and display strong HREE enrichment (crystal chemical effects). Low Ca^{2+}, high REE^{3+} and high Na^{+} contents in the arfvedsonite of the northern hypersolvus granite relative to the southern hypersolvus granite indicate progressive enrichment in the REE through the coupled substitution of 2 $Ca^{2+} \leftrightarrow Na^{+}$ + REE^{3+} in the octahedral B-site [3]. Ti^{4+} behaves similarly to the REE through substitution into the tetrahedral T-site for Al^{3+}. This inferred evolution of the hypersolvus granite from south to north is supported by an increase in incompatible elements, such as the LREE and HFSE in the bulk rock. Arfvedsonite in the subsolvus granite has low Ca^{2+}, low REE^{3+}, high Na^{+} and low Ti^{4+} values. This compositional anomaly is due to early crystallization (phenocrysts) from a correspondingly larger volume of magma relative to the hypersolvus arfvedsonite (interstitial), despite the more evolved nature of the subsolvus granite.

[1] Hawthorne, F.C., *et al*. (2012) *American Mineralogist*, **97**: 2031-2048 [2] Miller, R.R. *et al*. (1997) *Precambrian Research*, **81**: 67-72. [3] Botazzi P. *et al*. (1999) *Contrib Mineral Petrol* **137**: 36-45.