Fluid-rock interaction in the Strange Lake peralkaline granitic pluton, Canada: Implications for REE/HFSE mobility

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Alkaline and peralkaline intrusions, such as at Strange Lake [1] and Thor Lake [2] in Canada, are unusually enriched in rare earth elements (REE) and in the high-field strength elements (HFSE) yttrium (Y), zirconium (Zr) and niobium (Nb). Understanding the geochemistry of this type of intrusions is urgently required because of the need to develop resources of the REE/HFSE to meet increasing societal demands for new technologies employing these elements.

Previous studies have demonstrated the importance of hydrothermal remobilization in concentrating the HFSE and REE in alkaline and peralkaline intrusions [1,2,3]. These intrusions are typically enriched in fluorine, which other studies have shown substantially affects the geochemical behavior of HFSE/REE in fluids and melts. In the present study, we focus on the alteration observed in subsolvus granites and pegmatites located in the northwestern part of the Strange Lake pluton. This zone is strongly enriched in HFSE/REE and is characterized by intense fluid-rock interaction due to the infiltration of F-rich fluids. Field relations indicate multiple infiltration events with the formation of veins and breccias, and pervasive alteration of the granites. The infiltration was largely confined to a NE-SW trending zone enriched in pegmatites, which we suspect formed a porous path for focused fluid flow. Mineral textures provide strong evidence for hydrothermal fluid-rock interaction involving the co-precipitation of secondary HFSE/REE minerals with hydrothermal fluorite. Preleminary results indicate that zirconosilicates were the primary source for the rare metals, and suggest that upon dissolution of these minerals, the rare metals complexed with F^- present in the fluid and were remobilized. Previous studies have also shown the importance of other complexes including Cl^- and CO_2^{-3} in mobilizing HFSE/REE [1]. We have investigated the capability of such fluids to leach rare metals from the primary rock and control the remobilization and concentration of the HFSE and REE.

The availability of Ca is one of the major factors controlling fluoride activity (aF^-) and mobility of HFSE/REE in peralkaline granites. Two of the keys to successful exploration for HFSE/REE in F-rich igneous systems, such as Strange Lake, are understanding the mechanisms of fluid-rock interaction from the magmatic-hydrothermal transition to the final stages of fluid-rock interaction, and correctly evaluating the associated alteration assemblages.

[1] Salvi & Williams-Jones (2006) *Lithos* **91**, 19-34. [2] Sheard et al. (2012) *Econ. Geol.* **107**, 81-104. [3] Salvi et al. (2000) *Econ. Geol.* **95**, 559-576.