Fluid evolution within the Strange Lake peralkaline pluton

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Mid-proterozoic peralkaline granites and pegmatites at Strange Lake (Québec-Labrador, Canada) exhibit extreme enrichment in rare earth elements (REE). Concentration of the REE occurred magmatically due to separation of a fluoride melt that strongly fractionated the REE [1]. Here we show from fluid inclusion data that this concentration continued post-magmatically via hydrothermal fluids that mobilised REE from the fluoride source.

Four types of aqueous inclusions are observed. From earliest to latest they are: aqueous inclusions associated with 1) melt inclusions (Type 1), 2) CH_4 inclusions (Type 2), and 3) CO_2 inclusions (Type 3), and late aqueous inclusions associated with mineral pseudomorphs (Type 4). The salinity decreases from 16-25 wt.% NaCl eq. in Type 1 and 2 inclusions to 5-12 wt.% NaCl eq. in Type 3 inclusions; Type 4 inclusions contain15-22 wt.% NaCl eq. All inclusions except Type 4 inclusions show signs of re-equilibration ('implosive' halos) and decrepitate, if heated above 140-150°C. Approximately 70-80% of inclusions homogenised before decrepitation (at 90-150°C). Some Type 2 inclusions homogenise at 150-300°C. CH_4 inclusions homogenise to liquid at -70.5 to -95°C; partial homogenisation of CO_2 inclusions occurs in the range -10.2 to 29.6°C. In all aqueous inclusions there is a strong correlation between Ca and REE contents; REE content varies from <1 ppm to 300 ppm. Ca content does not correlate with that of Na.

We propose that sub-solidus hydrothermal activity commenced with exsolution of a saline (23-25 wt.% NaCl eq.) aqueous fluid. This fluid mixed with a CH_4 fluid at ~360°C and 1 kbar (calculated from the coexistence of CH_4 with the aqueous fluid). Upon further (isobaric) cooling, CH_4 gradually oxidised to CO_2 and the salinity of the fluid decreased (down to ~5 wt.% equiv.NaCl), both due perhaps to mixing with an external fluid. When the temperature reached ~160°C there was massive fracturing. This led to boiling and increased salinity. REE mobilisation is interpreted to have resulted from long-term interaction of the exsolved brine with the crystallising fluoride melt, thereby explaining the strong correlation of REE with Ca in this fluid and the resulting REE/Ca hydrothermal alteration.

[1] Vasyukova, O.V and Williams-Jones, A.E., 2014. *Geochimica et Cosmochimica Acta* **139**, 110-130.