Features of apatite in kimberlites from Ekati Diamond Mine and Snap Lake, Northwest Territories, Canada: modelling of kimberlite composition

R. Milligan[1], Y. Fedortchouk[1], P. Normandeau[2], and A. Fulop[3]

1. Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada <Rachel.milligan@dal.ca>

2. Northwest Territories Geological Survey, Yellowknife, Northwest Territories X1A 2L9, Canada

3. Kimberlite Petrology Unit, De Beers Canada, Toronto, Ontario M3C 3G8, Canada

Kimberlites are volcanic ultra-potassic rocks originating from the upper mantle, and some are diamond bearing. Due to assimilation of crustal material, loss of volatiles, and significant alteration, the primary composition of kimberlite magmas and the proportion of melt fluids (H_2O, CO_2) are unknown. Kimberlite composition and magmatic fluids have been shown to have significant effects on the quality and preservation of diamonds carried to the surface. In an attempt to gain knowledge of the economic viability of a kimberlite, it is important to understand the primary composition of kimberlites, and the behaviour of volatiles. Apatite is a common groundmass mineral in kimberlite, and has a composition sensitive to volatiles and trace elements [$Ca_5(PO_4)_3(F,Cl,OH)$]. Partitioning of trace elements into apatite greatly depends on the crystallization media. This study will use experimental partitioning data to estimate the composition of Ekati kimberlite magmas at the time of groundmass apatite crystallization.

The study uses polished sections from six kimberlites at Ekati Diamond Mine and Snap Lake kimberlite, Northwest Territories. Apatite grains in the kimberlite groundmass were analyzed for major and some trace elements with wavelength-dispersive spectroscopy mode of electron-microprobe analyses. The apatite grains range in morphology from zoned euhedral grains to anhedral and interstitial. As well, there was variation in composition and trace element content between different kimberlites. Grizzly apatite grains, which showed clear zonation in back scatter imaging, were analyzed for both core and rim compositions. Koala apatite and Grizzly apatite cores showed similar trends with very low concentrations of LREE and Sr. Leslie apatite and Grizzly apatite rims expressed higher LREE and Sr contents. Experimental partition coefficients determined in previous studies for apatite in various crystallization media (silicate melt, carbonate melt, aqueous fluid) were utilized to estimate concentrations of trace elements in potential melts at the time when apatite was crystallizing from Koala, Leslie and Grizzly. Initial results suggest that Leslie apatite grains could have crystallized from a carbonate melt. Koala and Grizzly apatite grains more likely crystallized from an aqueous fluid or silicate melt. Further studies will use LA-ICPMS to obtain data for the full spectrum of REE in apatite grains from Ekati and Snap Lake.

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