Petrology and Geochemistry of Mont Saint-Hilaire, Quebec, Canada: Volatiles in an Alkaline to Peralkaline System

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The Cretaceous Monteregian Hill intrusions form an East-West-trending magmatic province of alkaline character in South Quebec, Canada. Mont Saint-Hilaire is one of these intrusive complexes roughly 40 km east of Montreal. It shows a progression from alkaline gabbros and diorites/monzonites to peralkaline foid syenites, the latter of which outcrop in the world-famous mineral collecting site of Poudrette Quarry. To date, 371 minerals are described from Mont Saint-Hilaire, amongst them more than 40 type minerals. The major part of the minerals Mont Saint-Hilaire became famous for is restricted to pegmatites, veins and miarolitic cavities where fluid-rock interaction took part in late-magmatic to subsolidus stages in highly evolved foid-syenites.
Mont St. Hilaire comprises three different magmatic suites emplaced one after the other. The earliest Sunrise suite contains gabbroic rocks, while the later Pain de Sucre suite is made up of gabbros, diorites and monzonites. The latest East Hill suite contains autholiths of the earlier units and comprises different foid syenites. In the primitive alkaline gabbros and monzonites of the Sunrise and the Pain de Sucre suites (dated at 126.9 +/- 4.5 Ma) mineral assemblages consisting of olivine, pyroxene and two Fe-Ti oxides were used to estimate intensive crystallisation parameters by the QUILF method (Lindsley & Frost, 1988). If present, additional phase equilibria such as baddeleyite-SiO_2-zircon or clinopyroxene-SiO_2-plagioclase were included to further constrain intensive crystallisation parameters. In the higher evolved syenites of the East Hill suite (dated at 119.7 +/- 4.2 Ma), nepheline thermometry and phase equilibria including nepheline and sodalite where used to estimate the solidus conditions of this unit.
In terms of intensive crystallisation parameters like f_{O2}, a_{H2O} and a_{SiO2}, some alkaline to peralkaline magmatic complexes (e.g. Ilímaussaq) show closed-system behaviour during crystallisation and their phase assemblages are controlled by the interaction of melt, solid and fluid phases. In order to further characterise the fluid phase present during crystallisation and post-magmatic processes, fluid inclusion studies were carried out. We present results on changes of intensive crystallisation parameters within the different units of the Mont Saint-Hilaire complex, compare them with the results from fluid inclusion studies and derive a petrogenetic model for Mont Saint-Hilaire. As the wealth of unusual and exotic minerals is related to late-magmatic and subsolidus fluid-rock interaction, a special focus is put on the fluid phase responsible for the formation of these minerals. This includes evolutionary changes in composition and intensive parameters during the latest phase of the complex.
References
Lindsley HD, Frost RB (1988) Equilibria among Fe-Ti oxides, pyroxenes, olivine, and quartz: Part 1. Theory. Am. Min. 73: 727-740.

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