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Origin of REE Mineralization in the Saint-Honoré Carbonatite Complex (Quebec, Canada): New Petrographic and Mineralogical Insights

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Rare earth elements (REE) are critical minerals essential for the transition to a global low-carbon and digital economy. Carbonatites are the primary hosts of such rare metal deposits, and most of the world's light REE production comes from these igneous rocks. The Neoproterozoic Saint-Honoré carbonatite complex, located along the Saguenay graben in the Grenville Province (Quebec, Canada), hosts the world's third-largest Nb-producing deposit exploited by the Niobec mine. In addition to its niobium endowment, the complex contains significant REE mineralization, with indicated and inferred mineral resources of 1059 Mt at 1.74% total rare earth oxides (TREO) [1]. Despite its economic significance, the origin of the REE mineralization in the Saint-Honoré complex remains poorly constrained.

The Saint-Honoré complex is a steeply dipping intrusion (~ 5 x 6 km in plan view and >1250 m deep) composed of a nepheline syenite envelope surrounding a carbonatitic core with Ca- to Mg-carbonatite in its outer parts and Fe-carbonatite towards its center. This Fe-carbonatite unit hosts the REE mineralization. New petrographic and mineralogical data provide insights into the mineral paragenesis of the deposit. The main rock-forming minerals in the Fe-carbonatite are Fe-rich dolomite, barite and accessory minerals. However, the Fe-rich dolomite contains numerous micrometre-sized mineral inclusions that significantly affect carbonate chemistry. These minute inclusions are burbankite-group minerals (i.e., Na-Ca-Sr-Ba-REE carbonate) and their pseudomorphs (e.g., strontianite, ancylite), REE fluorocarbonates (e.g., bastnaesite, parisite), barite, fluorapatite, apatite, monazite, oxides (e.g., pyrochlore, Ti-Nb-rich oxides), sulfides (e.g., Fe-rich sulfides, Zn-Fe rich sulfides), quartz, zircon, and thorite. Furthermore, Fe-rich dolomite crystals are locally surrounded by barite, REE fluorocarbonates, monazite, Fe-oxides, Fe-rich sulfides, and quartz (e.g., Fig. 1). The REE fluorocarbonates and monazite commonly develop around the barite crystals. These preliminary results suggest that the parental carbonatitic magma of the Fe-carbonatite of the Saint-Honoré complex was initially enriched in Na, P, and REE. The subsequent destabilization and dissolution of primary REE-bearing minerals likely released REE into evolving fluids or melts, allowing for the formation of the late-stage REE mineral assemblages observed in the Fe-carbonatite.

[1] Grenier & Tremblay (2013), NI 43-101 technical report, IAMGOLD Corporation.

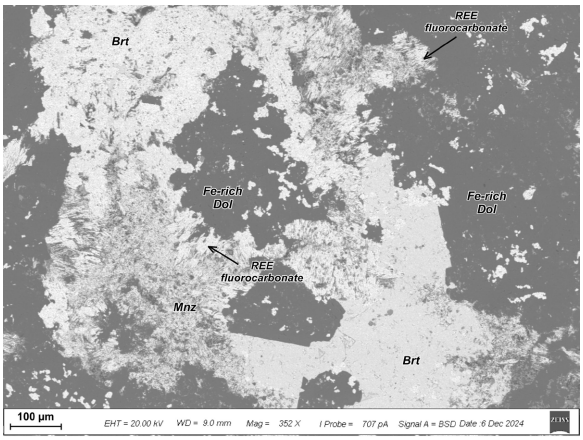

Fig. 1: Back-scattered electron (BSE) image showing barite (Brt), REE fluorocarbonates and monazite (Mnz) interstitial to Fe-rich dolomite (Dol) in the Niobec REE-mineralized zone.