A lithological context for stratabound REE mineralisation at the birthplace of REE – Bastnäs, Riddarhyttan, Sweden

Robert Dunst[a], Iain Pitcairn[a], Hein Raat[b], Nils F. Jansson[c] and Andreas Karlsson[d]

[a] Department of Geological Sciences, Stockholm University, Stockholm, Sweden, robert.dunst@geo.su.se; [b]EMX Royalty Corp., Vancouver, Canada; [c]Swedish School of Mines Divsion of Geosciences and Environmental Engineering, Luleå University of Technology, Luleå, Sweden; [d]Department of Geosciences, Swedish Museum of Natural History, Stockholm, Sweden

The Bastnäs deposit in Bergslagen is the place where Ce, the first rare earth element (REE) was discovered, and it was the world's first hard rock REE mine. Despite its historical importance the processes of ore formation are not understood well. Previous investigations have largely focused on detailed mineralogic and isotopic analysis of old mine samples and tailings, often lacking crucial stratigraphical context. Recent exploration in the Riddarhyttan field by EMX Royalty Corp. has produced new drill cores which were logged and sampled in this study producing thin sections and performing EDS analysis of the minerals.

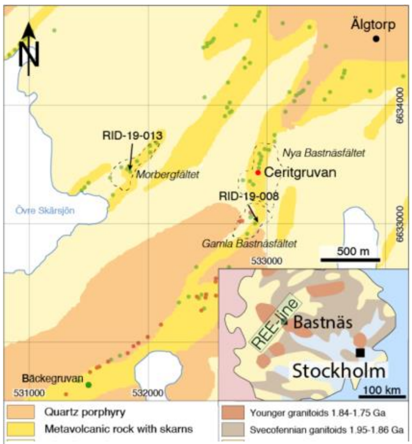

Figure 1 Geological map showing the location of the studied drill cores.

The Bastnäs deposit is one of several REE-enriched magnetite skarn deposits which occur in central Sweden. All of them are hosted in Paleoproterozoic felsic metavolcanic rocks with interbedded marble units. While previous studies mostly focused on the spatially confined but economically interesting cerite mineralization, this study focusses on two drill cores not directly associated with the cerite mineralization. The cores show that REE-enrichment occurs over large areas and throughout the stratigraphy. The first hole was drilled under the old Bastnäs mines ca. 400 m south of Ceritgruvan and the second drill hole is located 1km west (Figure 1) in a place where REE mineralization hasn't been described previously.

Geochemical data collected along the drill core by EMX Royalty Corp. reveal a close association of the REE enrichment with magnetite skarns. Within these magnetite skarns, REE concentrations peak at the contact to the felsic metavolcanic rocks. This suggests preferential flow of the mineralizing fluids along lithological contacts as described by Meinert et al. (1997). The mineralogically is dominated by epidote supergroup minerals (ESM), primarily ferriallanite-(Ce), dollaseite-(Ce) and dissakissite-(Ce). Notably, REE mineralization also occurs along faults, showing a slightly different mineralogy. While the ESM of the magnetite skarn associated mineralization contains inclusions of more REE-rich silicates such as britholite-(Ce) and gadolinite-(Ce), they are absent in the fault-related massive ESM. This is tentatively interpreted as indicating that allanite is a secondary mineral in this system and formed by recrystallisation of primary, more REE-rich silicates and phosphates which are products of earlier intense alteration of the stratigraphic succession. The fact that the mineralization along faults lacks inclusions of primary REE phases suggests that it is a result of late REE remobilization rather than the pathway of the fluids originally causing the REE mineralization.

Work on the characterization of the source of the ore-forming fluids is ongoing, with an emphasis on evaluating the potential contribution of hydrothermal fluids leaching the volcanic host rocks. This aspect is particularly relevant, given that the deposits are situated within metamorphosed, strongly Mg-altered felsic volcanic rocks, and since previous studies (cf. De Groot and Baker, 1983, Dunst et al. *in prep*) have demonstrated that the fluids causing this alteration type can leach REE from country rocks in Bergslagen and form REE-enriched hydrothermal fluids.

References

De Groot, P.A. & Baker, J.H., 1983: Proterozoic Seawater- Felsic Volcanics Interaction, W. Bergslagen, Sweden. Evidence for High REE Mobility and Implications for 1.8 Ga Seawater Compositions. *Contrib Mineral Petrol 82*, 119–130.

Meinert, L.D., Dipple, G.M., Nicolescu, S. 2005: World Skarn Deposits. In: One Hundredth Anniversary Volume. Society of Economic Geologists. 299–336.