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Rare earth element ore characterization and mechanisms of dissolution rates in near surface conditions at the Nechalacho Deposit, Northwest Territories, Canada

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Canada's only rare earth element (REE) project in production is the Nechalacho deposit. With the increasing market for green technologies to mitigate climate change, increased global production of REEs is a necessity. However there is limited knowledge regarding main ore minerals, bastnaesite ($REE(CO_3)F$) and parisite ($CaREE_2(CO_3)_3F_2$) and their environmental impacts related to mining activity. The objective of this research is to investigate the dissolution rate and mechanism of the fluorocarbonate ore minerals. These results will provide insight into the behaviour of REEs and fluoride that could be released to the near-surface environment during on-site crushing and ore sorting. The Nechalacho deposit has mineralization hosted in an assemblage of alkaline syenite and granite with multiple rare earth mineralization zones. In early 2021, a demonstration project began extracting bastnaesite-parisite-quartz-fluorite pegmatite ore from the T-zone of the deposit. Electron microprobe analyses of the ore indicated that the bastnaesite is more enriched in LREE than the parisite in the concentrate. Bastnaesite contains on average (n=91) 18.0 wt% La_2O_3, 36.1 wt% Ce_2O_3 and 12.6 wt% Nd_2O_3. Parasite contains on average (n=53) 13.7 wt% La_2O_3, 28.4wt% Ce_2O_3 and 10.8 wt% Nd_2O_3. Batch and mixed flow through experiments are being conducted to evaluate the elemental release and dissolution rate as a function of initial pH and grain size. The initial material for these experiments is disaggregated pegmatite which concentrates the bastnaesite-parisite and includes quartz and fluorite. The experiments are run at pH conditions of 2, 4 and 9 at a temperature of ~21°C and sampled over two weeks.

The results of the batch experiments indicated that cerium fluoride forms at pH values below 4. At pH 2, parisite and fluorite dissolved, leaving bastnaesite, quartz, and cerium fluoride at the end of two-weeks. At initial pH of 4 and 9, less bastnaesite-parisite dissolved over the duration of the batch experiments and at pH 9 no precipitates were observed. The application of these results will aid in mitigating the environmental impacts of REE mining activities.