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Strontium Isotope Geochemistry as a Potential Tracer for Contaminants Derived from Lithium Mine Wastes

GORDON WILLIAMS[1], ROBERT HILL[1], ZHEN WANG[1], MICHAEL WHITTAKER[2], WILLIAM STRINGFELLOW[2] AND AVNER VENGOSH[1]

[1]Duke University

[2]Lawrence Berkeley National Laboratory

Presenting Author: gordon.williams@duke.edu

Demand for batteries for electric vehicles and grid storage have led to increases in global exploration and extraction of lithium from various deposit types, including lithium-rich pegmatites. Spodumene, a pyroxene, is often the primary lithium-bearing mineral in such pegmatites and is separated from the bulk pegmatite for lithium extraction. Lithium extraction from pegmatites produces several waste sources, including: (1) residual pegmatite low in spodumene, and (2) solid and liquid wastes from lithium extraction. Both wastes could contain elements potentially environmentally hazardous such as Cs, Be, and F [1]. To evaluate the potential environmental effects of spodumene-rich pegmatites, we analyzed whole rock pegmatites, spodumene concentrate, and wastes generated from laboratory-simulated Li extraction experiments on samples from the Tin-Spodumene Belt (TSB) in North Carolina. Experiments show that, in addition to Li, some potentially hazardous elements (i.e., Cr, As, and Th) are also highly leachable (>65% of bulk concentrations) during simulated spodumene processing with an H_2SO_4 leach, and that even milder sequential leaching (via deionized water and 1N HCl) of spodumene can efficiently mobilize large portions of elements including V, Cr, Co, As, Sr, Th, and U. These results suggest that effluents from Li-pegmatite mine waste could be elevated in contaminants that pose environmental and human health risks. To distinguish between contamination from the different waste products induced from lithium mining, we evaluate the potential use of $^{87}Sr/^{86}Sr$ and Rb/Sr ratios as environmental tracers. We show large variations between whole rock pegmatites with relatively low Li/Rb (10-20), extremely high Rb/Sr (115-154) and $^{87}Sr/^{86}Sr$ (1.8156-2.7910) relative to spodumene concentrate with high Li/Rb (227), lower Rb/Sr (8.2) and $^{87}Sr/^{86}Sr$ (0.8423). Values for the sulfuric acid leachate of spodumene concentrate (Li/Rb=6844, Rb/Sr=0.79, $^{87}Sr/^{86}Sr$=0.7762) are largely different from natural variations as reflected by a local stream water sample flowing in the vicinity of the TSB (Li/Rb=3, Rb/Sr=0.23, $^{87}Sr/^{86}Sr$=0.7156). Overall, we demonstrate that $^{87}Sr/^{86}Sr$ and Rb/Sr ratios in liquid and solid wastes of lithium mining are distinct from natural variations and thus could be sensitive tracers for monitoring and delineating the environmental impacts of different wastes from Li-pegmatite mining.

[1] Bradley et al. (2017), USGS Report 2010–5070–O