Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36781

Geochemical fingerprints for tracing water quality impacts of legacy hard-rock lithium mining and processing

GORDON D.Z. WILLIAMS[1], MARIJA PETROVIĆ[2], ROBERT C. HILL[1], GRACE HALL[1] AND PROF. AVNER VENGOSH, PHD[1]

[1]Duke University
[2]Ruđer Bošković Institute

Hard-rock lithium (Li) pegmatite deposits are expanding globally, yet their hydrologic impacts remain poorly resolved. A key challenge is distinguishing natural geochemical signatures from those induced by mining and processing. We investigated surface water and groundwater across the Carolina Tin-Spodumene Belt (North Carolina, USA), a legacy Li mining district, and developed a suite of tracers (Rb/Sr, $^{87}Sr/^{86}Sr$, Ca/SO_4, K/Rb) to differentiate anthropogenic and natural controls on water chemistry. Streams draining former processing facilities exhibit elevated TDS, Li, and Rb, with $Ca/SO_4 \approx 1$, consistent with dissolution of gypsum residues generated during historical spodumene processing. These solute enrichments persist decades after ore processing ceased but do not exceed U.S. drinking water standards for regulated contaminants. In contrast, groundwater throughout the belt shows widespread Li, Rb, and Cs enrichment independent of distance from mine sites. Radiogenic $^{87}Sr/^{86}Sr$ and low K/Rb ratios indicate that groundwater chemistry is primarily governed by natural water–rock interaction with Li-rich pegmatites. Elevated arsenic occurs locally where pegmatites intrude As-bearing mica schist, reflecting geologic controls rather than direct mining inputs. Our results demonstrate that legacy processing wastes drive long-term surface-water salinization, whereas groundwater composition largely reflects regional geology. The global abundance of Li pegmatite deposits and the increasing demand for Li exploration suggests that similar water quality issues may become widespread as new mines and processing facilities open and expand. The tracers developed here may be broadly applicable to other hard-rock lithium mining regions.