Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29961

Behavior of Li and other Critical Minerals in the Hottest and Deepest Portions of the Salton Sea Geothermal Field

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The Salton Sea Geothermal Field (SSGF) hosts an array of "critical minerals", resources that are essential to the manufacturing of emerging technologies which have supply chains that are not certain to meet demand (e.g., Li, Ni, Co, Mn, & Zn). Specifically, the metalliferous geothermal brines within the SSGF that are already exploited for geothermal energy production contain, on average, 209 ppm Li, 1500 ppm Mn, and 507 ppm Zn, which makes them a potential target for direct extraction of these critical minerals. To quantitatively predict the reservoir response to direct extraction, the mineral hosts of these elements and their partitioning behaviors must be assessed. We present major and trace element compositions of key minerals in rocks from the California State 2-14 scientific drill core as well as in rock cuttings recovered during commercial drilling.

In the California State 2-14 scientific drill core at 2358 m depth, chlorite is the primary mineral host of Li (270-580 ppm), Ni (130-530 ppm), Co (128-202 ppm), and Zn (997-1468 ppm), and the groundmass is the primary host of Mn (0.2-0.6 wt%). At 2882 m depth, concentrations of Li (~100 ppm), Ni (~90 ppm), Co (~14 ppm), and Zn (~113 ppm) in chlorite decrease, and epidote becomes the primary host of Mn (0.2-0.3 wt%). These observations suggest that at depths ≥ 2885 m, the key critical minerals are likely present elsewhere in high concentrations. At temperature and pressure conditions exceeding ~2500 m depth and ~325 we hypothesize 1) brines may be more Li, Ni, Co, Mn, Zn-rich (in the case of Li, consistent with behavior in seafloor hydrothermal settings) and/or 2) Li, Ni, Co, Mn and Zn partition into a different mineralogical host(s). Samples from 3020 m depth lack chlorite and contain pyroxene, amphibole, biotite, K-feldspar, plagioclase, quartz, apatite, pyrite, Fe-Ti oxides, and epidote with allanitic reaction rims. These phases are consistent with the transition from greenschist to amphibolite facies, and temperatures > 325. Future work will assess the behavior of Li, Ni, Co, Mn and Zn in the deepest sampled rocks in the SSGF.