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Unconventional Lithium Resources and Recovery: Salton Sea Geothermal Brines

DR. MICHAEL A. MCKIBBEN[1], JENNIFER HUMPHREYS[1], MARYJO BROUNCE[1], PATRICK DOBSON[2], NOAH J. PLANAVSKY[3] AND BORIANA KALDERON-ASAEL[3]

[1]University of California, Riverside
[2]Lawrence Berkeley National Laboratory
[3]Yale University

Presenting Author: michael.mckibben@ucr.edu

The Salton Sea geothermal brines have reservoir temperatures ~300^{o}C, salinities ~25 wt%, pH ~ 5.3 and Li concentrations ~ 200 ppm. An estimated geothermal reservoir brine volume of 4 to 20 km^3 contains 4M to 21M metric tons of lithium carbonate equivalent (LCE), among the largest brine deposits of Li in the world. Even more Li is held in the reservoir rocks than in the brines, having implications for the potential of replenishment of Li to reinjected, Li-depleted processed brines. Current brine production from the field can support ~115 ktpa of recoverable LCE, with planned power plant expansion efforts ultimately supporting ~320 ktpa of LCE, sustainable for up to 66 years.

Over 40 geothermal wells recently sampled across the established field yielded a narrow range of brine del^{7}Li values of 4.2 + 0.5 $^{o}/_{oo}$, indicating that the brine reservoir is extremely well-mixed and internally homogeneous, consistent with prior H-O-S isotopic data. Internal convection and lack of significant mixing with other less saline fluids bodes well for sustainability of Li recovery. Surface Holocene and buried mid-late Pleistocene rhyolites contain < 90 ppm Li and range in del^{7}Li from 3.5 to 10.3 $^{o}/_{oo}$, while surface and buried sediments and metasediments exhibit del^{7}Li values from 1.5 to 10.1 $^{o}/_{oo}$. Surface and buried metamorphosed mudstones contain up to 250 ppm Li, implying that they are more likely than rhyolites to have been sources of Li to the reservoir brines.

LA-ICP-MS analysis of polished sections of reservoir rocks yields maximum Li values as high as 580 ppm in authigenic chlorite that forms reaction rims around pyrite, implying that this hydrothermal metamorphic reaction plays a major role in controlling current Li solubility and reactivity in the brines. Metamorphic phyllosilicates and their sedimentary precursors therefore may play a key role as both sources and sinks of Li to the brines. Replenishment of Li from abundant chlorite to reinjected, Li-depleted brines may prove feasible on a human timescale if the kinetics of brine-chlorite reactions are rapid enough, potentially improving the sustainability of Li production from the geothermal field.