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Lithium Enrichment in Oilfield Brines

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ABSTRACT

Lithium is a critical element for battery technology, particularly in the automotive sector, and consequently, demand is expected to increase sharply within the next decade. Although it has been long known that some oilfield brines have potentially economic Li concentrations, many do not. In addition, the processes responsible for Li enrichment are poorly understood, and there are no specific tools to predict whether brines in a particular basin are likely to be enriched.

Several oilfields brine contain significantly higher concentrations of Li than modern-day seawater (~0.1 mg/L) including, the Jurassic Smackover Formation in the Gulf of Mexico (median, 103 mg/L; 16th to 84th percentiles, 35 to 223 mg/L), the Middle Devonian Marcellus Formation (median, 67 mg/L; 16th to 84th percentiles, 45 to 229 mg/L) and the Upper Devonian Bakken Formation (median, 47 mg/L; 16th to 84th percentiles, 32 to 70 mg/L). In addition, formation waters from several other basins contain elevated Li, including the Michigan Basin and the Western Canadian Sedimentary Basin. Although there has been considerable research devoted to the hydrogeochemistry of these brines, the source of the Li is often ignored or only briefly discussed. In addition to seawater evaporation, other processes for Li enrichment include dissolution of Li-enriched evaporite sequences and fluid-rock interaction with silicates. Using publicly available compositional and isotopic datasets, we have evaluated these processes in considerable detail and compared the geochemistry of low and high Li brines to identify the critical distinguishing parameters. Given the low Li concentration in seawater, it is unlikely that evaporation would precipitate sufficient amounts of Li-enriched minerals to provide a viable source for subsequent Li enrichment by dissolution. Instead, lithium is more likely to be enriched from exchangeable and structurally bound sites from silicate minerals during diagenesis, the efficacy of which is controlled by the composition of the brine and the authigenic/detrital minerals.

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