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Lithium extraction in geothermal systems: high-pressure fluid-mineral experiments to study expected near-equilibrium concentrations and stimulated release during geothermal recirculation

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The rapidly increasing demand for electric vehicles and battery storage capacities for electricity from renewable energy sources challenges global lithium supply chains. Currently the majority of lithium production is from near-surface brine extraction operations and processing of mineral-based lithium sources. Therefore, alternatives for lithium production receive a attention in research and a significant acceleration in development. One alternative is the extraction of lithium from geothermal fluids as a byproduct of heat exploitation in geothermal power plants. In Germany, the two geothermal provinces of the North German Basin and the Upper Rhine Graben valley contain deep aquifer brines with Li concentrations of up to several hundred ppm. To asses the lifetime of an economic geothermal Li extraction operation, estimates of release of additional Li from the rock reservoir during recirculation is crucial [1].

In the context of the project Li^{+}FLUIDS we are investigating the release of Li from geothermal reservoir rocks at in situ conditions. To assess near-equilibrium concentrations of Li, we conduct experiments in closed gold capsules, for deriving kinetic data on release rates and identifying mineral dissolution as well as secondary precipitation reactions we utilize flexible Dickson-type gold-titanium cells in high pressure reactors. The reservoir rocks studied up to now include sandstones of the Buntsandstein formation (North German Basin) and a fractured granite (Upper Rhine Graben valley). A significant percentage of Li released on short times might be present in salt cements (halites, sulfates) in the sandstones. Most of the Li is released during dissolution of silicate phases. The dissolution reactions in a closed system are attaining near-equilibrium concentrations within two weeks. These results point to a high probability of additional Li release from rocks in the reservoirs during recirculation of geothermal fluids depleted in Li by previous extraction measures. Ongoing experiments and flow-through experiments will focus on possible stimulation measures to maximize the Li release into the fluids.

[1] Regenspurg et al. (2016): Fluid-rock interactions in a geothermal Rotliegend/Permo-Carboniferous reservoir (North German Basin). Applied Geochemistry, 69, 12-27.