

# **Lithium mobility due to geochemical interactions between unconventional reservoir rock and hydraulic fracturing fluid**

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A strategy for sustainable energy development couples recovery of critical metals to development of unconventional hydrocarbon reservoirs. Hydrothermal experiments were conducted at reservoir conditions (115°C, 35 MPa) to evaluate potential lithium mobility due to geochemical interactions between reservoir rock and hydraulic fracturing fluid spanning a range of chemical composition. Experiments replicated a shut-in well in the Wall Creek Member of the Cretaceous Frontier Formation, Powder River Basin, Wyoming, USA, an important unconventional reservoir composed of low permeability sandstones interbedded with organic-rich mudstones. Six samples representing the full extent of hydraulic fracture propagation across the Wall Creek Member (110 ft, 33.5 m) were collected from core and homogenized for use in the experiments. This rock mixture consisted of 33% quartz, 33% chert, 20% calcite, 6% illite, 5% albite, 1% kaolinite, 1% pyrite, 1% chlorite, and <1% TOC. Lithium was slightly above crustal abundance (20 ppm) in five samples (range 29-57 ppm); one sample contained lithium below crustal abundance. The rock mixture was reacted for ~650 hours (27 days) with 1) acidic hydraulic fracturing fluid (pH ~2.3) mixed from formation water spanning two orders-of-magnitude ionic strength (0.016, 0.16, and 1.13 mol/kg), and 2) hydraulic fracturing fluid (ionic strength 0.11 mol/kg) of circumneutral pH (7.3). The fracturing fluid initially contained no Li(aq). Trends of aqueous SiO<sub>2</sub>, K, and Mg are consistent with dissolution of feldspar±quartz and precipitation of clay; mineralogic evidence for dissolution was limited to calcite and feldspar, no secondary clay was observed. Ionic strength was more important than acidity for feldspar-clay equilibrium. Progressively greater ionic strength of the hydraulic fracturing fluid, from 0.016 to 0.16 to 1.13 mol/kg, increased Li(aq) concentrations, from 132 to 201 to 250 ppb, at the time the final sample was collected from the experiments. Hydraulic fracturing fluid of circumneutral pH contained 167 ppb Li(aq) at the time the final sample was collected. Hydraulic fracturing fluids extracted lithium from the reservoir, but little harvestable lithium was produced in flowback and produced water.