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The first experimental assessment of sustainability of lithium extraction from geothermal fluids: a new evaluation tool.

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Globally, many geothermal brines are known to contain lithium (Li), and much research is currently focussed on potential solutions for economically extracting lithium. However, the source(s) of Li in geothermal systems is not well known and is frequently debated. Early studies concluded that Li is present, to differing degrees, in many different rock forming minerals, and that Li could be derived solely from water-rock interaction. However, it is not understood to what degree each of the mineral phases will release Li into geothermal fluids and at what conditions (i.e. pH, salinity, temperature, pressure). We have conducted experiments to measure the Li released by a rhyolite rock from the Taupo Volcanic Zone in New Zealand, during progressive heating. The rock used is a dark grey rhyolitic rock, hydrothermally unaltered, and composed of plagioclase surrounded by devitrified, spherulitic glass and rare siderite and hematite in a matrix of microspheroids with patchy siderite. The rock was crushed, sieved and cleaned ultrasonically to remove fine material. The experiment was conducted using a high temperature and pressure fluid-rock interaction simulator. Temperature ranged from ambient to 400˚C and pressure from 21 to 413 bar. The flow rate was maintained at 1 ml hr^{-1} throughout the experiment. A diluted geothermal fluid representative Ohaaki-Broadlands reinjection brine depleted in SiO2 and Li was used in this study. The fluid samples were analysed for major cations, sulfide, sulfate, fluoride and chloride. A correlation was observed between temperature change and subsequent peaks in Li concentration. Above 200˚C, lithium is mobilised and remains within solution. After the temperature was increased to 350˚C, lithium concentration in the fluid decreases though remained above detection limits. There is a positive corelation between lithium, fluoride and aluminium concentration. The rhyolite rock was also analysed by LA-ICP-MS before and after the experiment, which provided insight into which mineral phase(s) the lithium was being mobilised from. Two observations can be made from the experimental results. Firstly, most lithium appears to be removed from the rock before temperatures reach 350˚C. Secondly, lithium is being preferentially leached from devitrified glass with lithium concentrations in other mineral phases remaining relatively unchanged.