

Assessing the potential of magmatic brines as lithium-snatchers in evolved shallow magma reservoirs

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Lithium (Li) is an alkaline metal that has increasingly become the cornerstone of the current energy revolution owing to its particular chemical and physical properties. As with other metal commodities, Li is scarce in Earth's crust and requires selective enrichment to concentrate quantities that can be economically extracted. Brine deposits have, so far, the greatest resources of Li. Although the occurrence of Li-bearing brines requires the overlapping of multiple conditions and processes, shallow silicic magma reservoirs seem to play an important role as Li source due to a near-ubiquitous spatial-temporal link with brine deposits. The mobilisation of Li to a fluid which then might form a brine deposit is still a matter of research. Experimental studies, even at low pressures ~ 200 MPa, have not yet found strong evidence of partitioning of Li into magmatic single-phase fluids. We propose that Li partitions in favour of magmatic fluids at shallow conditions where the fluid is present as two immiscible phases, a low density vapor and highly saline liquid. The hypothesis behind this approach is that Li makes complexes with Cl and while magmatic brines are formed lithium is mobilised from the magma. To evaluate the reliability of this hypothesis, we perform a set of melting experiments on haplogranitic melts between 60-150 MPa and 750-950 °C, involving fluids with salinities ranging 0.3 to 4.4 NaCl_{eq} m in externally heated MHC pressure vessels, with oxygen fugacities close to the Ni-NiO buffer equilibrium (NNO) employing an argon-methane mixture as pressure medium. Quartz cores were used in all experiments to trap synthetic fluid inclusions at equilibrium conditions, by a thermal-shock technique whereby fractures are created in the quartz core due to changes in volume during cooling (phase transition), and then healing of the fractures by returning the capsule to the equilibrium temperature. $D_{\text{Li}}^{\text{quartz/melt}} \sim 0.02$ shows that Li is incompatible with quartz at 100MPa and 750-950°C, similar to published data from Oruanui rhyolitic magma, Taupo, New Zealand. Li content in the synthetic brines exceeds by an order of magnitude the abundance in run glasses ($D_{\text{Li}}^{\text{brine/melt}} \sim 5-12$), suggesting a moderate affinity of Li for a 2-phase fluid.