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Lithium element partitioning among haplogranitic melt, fluid and quartz

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Lithium (Li) is a key element in the production and development of high energy density storage technology. The boost in production of battery-powered vehicles has, as a result, increased Li demand. Felsic magma reservoirs are commonly linked to Li-bearing ore deposits as their major source of Li. Understanding the processes that may affect the Li inventory in magmas is, thus, crucial to improve exploitation of Li resources. We performed experiments using haplogranitic glass shards and quartz cores 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. Quartz cores were used in all experiments to trap synthetic fluid inclusions at equilibrium conditions by in-situ thermal-shock. Li partitions weakly into quartz, $D_{Li}^{quartz/melt}$ ~ 0.02, with no apparent variation with studied pressures and temperatures within analytical error. LA-ICP-MS analyses on natural quartz from this study and published data show that Li concentrations in quartz from “hot and dry” rhyolites (e.g. Mesa Falls Tuff, Lava Creek Tuff, Weinheim Rhyolite) are higher than “cold and wet” rhyolites (e.g. Kos Plateau Tuff, Bandelier Tuff, Bishop Tuff, Young Toba Tuff, Oruanui Rhyolite), 25 ± 6 and 6 ± 5 ppm (n = 5300) in average respectively. Our $D_{Li}^{quartz/melt}$ experimental results are one order of magnitude lower than natural dry-rhyolites but similar to the apparent $D_{Li}^{quartz/melt}$ derived from natural samples in H_2O-saturated systems, where hydrogen seems to play a more important role charge-balancing Al in point defects of quartz than Li. While Li is slightly incompatible with single-phase intermediate density fluids, Li partitions relatively strongly into hydrosaline fluids (HSF), $D_{Li}^{HSF/melt}$ 5-12, within the two-phase fluids coexistence surface, with the highest values in the high temperature experiments. Although Li in HSF increases with temperature and, in turn, with chlorinity of the HSF, such a scenario does not affect greatly the inventory of Li in the run melts. The higher the temperature of the studied system at a given pressure, the lower the proportion of HSF with respect to low density vapor fluid (LDVF) in the system. Such topological consequence limits the “effective” extraction of lithium by fluids in felsic magma reservoirs to very constrained regions in pressure, temperature and fluid composition. As a result, extremely and ubiquitous high Li degassing from rhyolitic melts based on the Li concentration offset between re-homogenised melt inclusions and groundmass glass must be carefully revisited.