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Processes influencing the behaviour of Li concentrations and isotopic composition in magmatic system

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In the last two decades an increasing number of studies have focused on the behaviour of Li in different geological reservoirs. However, the behaviour of Li in magmas at mid- to upper-crustal levels remains poorly understood. To address this, we employed various *in-situ* techniques (e.g., LA-ICPMS, SIMS, EPMA) combined with MC-ICPMS measurements to analyse major/trace element contents and Li isotopic compositions in key mineral phases (biotite, plagioclase), melt inclusions and groundmass glass fom a suite of samples spanning from rhyolites (Mesa Falls Tuff, USA; Bishop Tuff, USA; Caetano Tuff. USA; Kos Plateau Tuff) to phonolites (Astroni pyroclastics and Campanian Ignimbrite from Campi Flegrei, Italy; Granadilla ignimbrite, Canary Islands).

Plagioclase crystals from the Mesa Falls Tuff show rimward depletions in Li (~25 ppm in cores vs. ~3-5 ppm in rims) with a corresponding δ^7Li zonation within the crystals (avg. -4.3‰ in cores vs. avg. +0.1‰ in rims). The higher δ^7Li in rims are interpreted to result from diffusive fractionation during degassing. Quartz-hosted melt inclusions from MFT support partitioning of Li into the volatile phase. Melt inclusions exhibit δ^7Li as low as -8.0‰ whereas groundmass glass exhibits higher δ^7Li (9.0 to +20.5‰), indicating large Li isotopic fractionation between the entrapment of melt inclusions and the formation of groundmass glass due to open-system degassing prior to quenching upon eruption.

A study on biotites indicates that a magmatic volatile phase can be trapped between layers of biotite crystals. An exceptionally low δ^7Li of biotites (down to -27.6‰) and correspondingly large isotopic fractionation between biotite and bulk samples ($\delta^7Li_{bt–bulk}$ as low as -36.5‰) has been found for rhyolites; this is not observed for biotites from phonolitic systems ($\delta^7Li_{bt–bulk}$ of -10.9‰). We interpret biotites from the rhyolitic samples to had crystallised at low temperatures and trapped a coexisting magmatic fluid phase.

Collectively, these studies showcase Li as a powerful tool to investigate shallow magmatic and eruptive processes and open exciting new research avenues for magmatic petrology.