

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

J. NEUKAMPF^{1,2}, B.S. ELLIS¹, O. LAURENT^{1,3}, T. MAGNA⁴, O. BACHMANN¹

¹ETH Zürich, Switzerland

²CNRS, Université de Lorraine, France

³CNRS, Géosciences Environnement Toulouse, France

⁴Czech Geological Survey, Prague, Czech Republic

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 from 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 $\delta^7\text{Li}$ zonation within the crystals (avg. -4.3‰ in cores vs. avg. +0.1‰ in rims). The higher $\delta^7\text{Li}$ 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 $\delta^7\text{Li}$ as low as -8.0‰ whereas groundmass glass exhibits higher $\delta^7\text{Li}$ (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 $\delta^7\text{Li}$ of biotites (down to -27.6‰) and correspondingly large isotopic fractionation between biotite and bulk samples ($\Delta^7\text{Li}_{\text{bt-bulk}}$ as low as -36.5‰) has been found for rhyolites; this is not observed for biotites from phonolitic systems ($\Delta^7\text{Li}_{\text{bt-bulk}}$ of -10.9‰). We interpret biotites from the rhyolitic samples to have 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.