Li isotopic variations between magmatic minerals and indications of degassing of a rhyolitic magma (Mesa Falls Tuff, Yellowstone)

JULIA NEUKAMPF [1*], BEN S. ELLIS[1], TOMAS MAGNA[2], OSCAR LAURENT[1] AND OLIVIER BACHMANN[1]

[1]ETH Zürich, Inst. of Geochem. and Pet., Zürich, Switzerland (*correspondence: julia.neukampf@erdw.ethz.ch)

[2]Czech Geological Survey, Prague 1,Czech Republic

Lithium (Li) has become an important raw material during the past decade. The moderate incompatibility of Li in common rock-forming minerals results in slightly elevated Li contents in evolved melts and fluids, with pegmatites being an important economic source of Li.

Here we present the first detailed study of Li concentrations and isotopic composition from a rhyolitic ignimbrite from Yellowstone (USA). The main focus is on one of three Yellowstone caldera-forming eruptions, the Mesa Falls Tuff (MFT) containing an anhydrous mineral assemblage of sanidine, quartz, plagioclase, clinopyroxene, fayalite, orthopyroxene and accessory phases. All mineral phases were analysed for trace elements by LA-ICP-MS, Li concentrations of mineral separates by solution ICP-MS and Li isotopic ratios by solution MC-ICP-MS. The aim is to compare trace element inventory with Li concentrations and δ^7Li for multiple mineral phases.

Quartz, clinopyroxene, fayalite and orthopyroxene are homogeneous in major and most trace elements across individual grains. Plagioclase and sanidine show a limited major element variability. In constrast, the new data shows a significant variability in Li contents and δ^7Li values among the co-existing phases. Silica-rich glass (SiO_2=73–76 wt.%) has the highest Li concentration (35.6–54.8 ppm) and exhibits among the heaviest δ^7Li values (6.5–6.9‰). Quartz and fayalite (Fa_{87-88}) have similar Li contents (12.8–24.5 and 13.9–19.4 ppm, respectively) whereas their δ^7Li values differ (5.7–7.2‰ vs. 3.1‰). Other phenocryst phases such as clinopyroxene (Li=8.9–12.6 ppm) and orthopyroxene (Li=8.0–10.1 ppm) have lower Li abundances; they also have the lowest δ^7Li values (−0.1 to +1.0‰ and ~−2.0‰ respectively). In feldspars, Li is preferentially incorporated into plagioclase (An_{18-29}; Li=6.1–28.5 ppm; −2.3 to −1.4‰) over sanidine (Or_{57-60}; Li=2.8–7.8 ppm; −0.6 to −0.1‰). In addition, both plagioclase and sanidine show negative Li gradients towards crystal margins. This drop in Li is inferred to reflect degassing processes immediately prior to, or synchronous with, eruption. Such kinetic effects would likely also impart measurable Li isotopic shifts.