Major and trace element geochemistry of Icelandic apatite: A case study at Torfajökull Volcano

TL CARLEY[1*], L CONNORS[2], IMT REIN[1], ECV RUGER[1], J GROSS[3], P BURGER[3]

[1]Lafayette College, Geology & Envi. Geosciences, Easton, USA, carleyt@lafayette.edu (*presenting author)
[2]University of Oregon, Earth Sci., Eugene, USA, lconnors@uoregon.edu
[3]Rutgers University, Earth & Planetary Sci., New Brunswick, USA, jgross@eps.rutgers.edu

The potential contributions of apatite to investigations of magmatic and volcanic processes in Iceland are profound due to its unique ability to incorporate rare earth (REE), volatile (F, Cl, S), and redox-sensitive (S, Mn, Fe) elements. Despite its ubiquity as an accessory mineral, studies of Icelandic apatite are exceedingly recent and rare (Connors et al., in press and Bergþórsdóttir, 2018). Here, we aim to establish a baseline for the trace element and volatile compositions of Icelandic apatite using perspectives from active volcanic systems (Askja, Hekla, Krafla, and Torfajökull) and modern river systems (Miðá; Markarfljót; Jökulsá í Loní, and Lagarfljót). Against this contextualizing background, we use apatite to explore the geochemical evolution of Torfajökull.

Apatites are found as individual phenocrysts (>100 μm) and as inclusions (<10 μm) in plagioclase and zircon. Preliminary EMPA results suggest that Icelandic apatite are fluorapatite with low but variable Cl (~0.05 to 0.5 wt%) and total LREE (La_2O_3+Ce_2O_3+Nd_2O_3: ~0.1 to ~0.6 wt%; cf. Torfajökull). The variable compatibility of S^{2-} vs S^{6+} in apatite (e.g., Parat et al. 2005 and Konecke et al. 2017) leads to wide-ranging S concentrations (< LOD to ~1000 μg/g).

We use five eruptions to represent Torfajökull's uniquely complicated magmatic history (384 ka – 1477 AD; higher Si peralkaline to lower Si metaluminous). Apatites from the oldest, coolest, peralkaline eruptions have exceptionally high LREE (~5 to 19 wt% total oxides); LREE in apatite from younger, warmer, metaluminous eruptions are lower (0.5 to 3 wt% total oxides), as is more typical of other Icelandic apatite. Volatile contents also change through time, especially Cl, which increases from <LOD to 0.4 wt%. S concentrations are low in apatites from the oldest and youngest units (< LOD to 100 μg/g S), as is expected in reduced environments. S concentrations in apatites from a 67 ka eruption indicate a change in the S speciation of the melt (n = 10: < LOD to < 80 μg/g S, reduced; n = 46: 80 to 570 μg/g S, oxidized). This change is perhaps due to degassing and separation of an S-rich volatile phase preceding or during apatite crystallization.