Icelandic zircon: investigating felsic magmatism in a unique oceanic environment

T L Carley[1], C F Miller[1], J L Wooden[2], I N Bindeman[3], R C Economos[4], A K Schmitt[4], C M Fisher[5], J M Hanchar[6]

[1]Vanderbilt U, Earth and Environmental Sciences, USA, [2]Stanford-USGS, Microanalysis Center, USA, [3]U of Oregon, Geological Sciences, USA, [4]U of California at Los Angeles, Earth and Space Sciences, USA, [5]Washington State U, Earth and Environmental Sciences, USA, [6]Memorial U, Earth Sciences, CAN

E-mail: tamara.l.carley@vanderbilt.edu

Iceland is home to the greatest-known concentration of silicic rock in the modern ocean. Abundant low-density material, coupled with the unusual thickness of the island's crust, hints at continental nucleation and permanent crust construction in an oceanic environment. Understanding Icelandic silicic petrogenesis may thus lend important insight into Earth's early history, as well as magmatic processes at large ocean islands.To investigate this silicic magma genesis, we have analyzed >700 zircons from 8 volcanoes, 4 intrusions, 6 rivers and 3 sedimentary units spanning Iceland's history (15 Ma to present) and tectonomagmatic settings (e.g., on and off rift). Our growing database includes high spatial resolution determinations of trace elements, U-Pb and U-Th ages, and O isotopes (SIMS) and Hf isotopes (LA-MC-ICPMS), and complementary data (host rocks, mineral assemblages).

Icelandic zircons form a distinct and coherent compositional population compared to zircons from other environments (cf. Grimes et al. 2009). They are clearly distinguishable from zircons from MORB and continental arcs but show some similarities to zircons from continental rifts (some overlap with Miocene Colorado River, close similarity to East African Rift). They are relatively high in Ti and Nb and low in Hf compared to typical continental zircons. Relative to MORB zircons, they have high U/Yb and low Yb/Nb. More subtly, elemental compositions can be used to distinguish zircons from Icelandic volcanoes in distinct tectonomagmatic settings.

Zircon Hf isotope compositions (114 analyses) range from 10-16 (eHf), spanning most of the variability observed in Icelandic basalts (Peate et al. 2010). Zircons from individual magmatic centers have relatively uniform eHf but zircons from distinct tectonic settings appear to be distinguishable by eHf (13-16 on rift, 10-13 off rift).

Icelandic basalts and rhyolites are known for d18O that is low relative to mantle values, a characteristic commonly attributed to hydrothermal alteration of source material by meteoric water. Zircon corroborates the importance of reprocessed hydrothermally altered crust in Icelandic felsic petrogenesis. Of 620 oxygen isotope analyses (averaging 2.9 permil), only 14 fall within or above the accepted range of d18O mantle values (5.3 +/- 0.3 permil). We observe increasing d18O from active (0-2 permil) through propagating (0-4) to off (3-5) rift settings at modern central volcanoes. Despite pronounced cooling and presumably falling d18O of meteoric water through Iceland's climate history (temperate through peak glaciation to the present), there is no evidence for changing d18O of zircon with time (15 Ma to present).

Compositions of Icelandic zircons distinguish their tectonic settings and petrogenetic histories. Overall, their common characteristics link their genesis and distinguish them from the global zircon record.