Evolution of the Austurhorn Intrusive Complex revealed by zircon elemental and isotopic geochemistry and geochronology

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The Austurhorn Intrusive Complex (AIC) is a small silicic intrusion along the SE coast of Iceland comprising large bodies of granophyre, gabbro, and a mafic-felsic composite zone that exemplifies mafic-felsic interactions common in Icelandic silicic systems. Despite being one of Iceland's best-studied intrusions (Blake 1966; Furman et al 1992a,b; Thorarinsson and Tegner 2009), zircon studies are notably lacking for the AIC, as well as for other Iceland plutons. The value of zircon as a tracer of the history and evolution of its parental magma(s) has been widely recognized. Here, we present the first detailed chronologic, elemental, and isotopic study of Icelandic plutonic zircon, likely Iceland's dominant zircon population.

The elemental composition of AIC zircons form a broad but coherent array that partly overlaps with the well-constrained signature of zircons from Icelandic silicic volcanic rocks (Carley et al 2011). The broader range of AIC zircon is likely due to the effect of crystallization down to the solidus in plutonic environments (absent in volcanic environments). With some exceptions (see below), Ti concentrations range from 6-25 ppm (Ti-zirc temperatures 730-870 deg.C), and Hf concentrations are low (below 10,000 ppm), typical of Iceland zircon. Epsilon-Hf values are well-constrained at +13(+/-)1 epsilon units, falling between epsilon-Hf for Iceland basalts from rift and off-rift settings and suggesting a single source for the different units of the AIC. Similarly, d18O values are generally well-constrained at +3 to +4 per mil, consistent with Icelandic magmatic zircon (Bindeman et al 2012) and suggesting contribution from hydrothermally-altered crust to the petrogenesis of the parental silicic magmas.

The notable exceptions to the trends described above are analyses of zircons from a high-silica miarolitic granophyre that display CL-dark zones with convolute and irregular zoning. These fall well outside the AIC elemental and isotopic arrays, and are primarily distinguished by extreme Hf (up to 24,000 ppm) and lower Ti (down to 2 ppm [630 deg.C]), far higher and lower, respectively, than other analyzed Icelandic zircon, as well as generally higher U and Th. Their d18O values range from normal (+4) to extremely low (-6 per mil). We interpret these unusual analyses to reflect hydrothermal recrystallization.

Field relationships provide clear evidence that the AIC was constructed by repeated mafic and felsic intrusions. In-situ (SHRIMP) dating of 5 zircon samples yields a pooled age of 6.43(+/-)0.04 Ma for the entire complex. However, the relatively high MSWD (1.6) suggests real spread in ages, and UNMIX analyses and subtle peaks in probability-density plots are consistent with multiple ages ranging from 6.3 to 6.6 Ma. Assuming this interval is real, it may reflect prolonged lifetime of a periodically rejuvenated mush, or re-melting events that revived earlier-solidified magmatic increments to the AIC.