Noble gases and halogens in Icelandic basalts

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We present noble gas and halogen data from a suite of samples taken from across Iceland. Iceland combines hotspot volcanism, a spreading ridge and abundant sub-glacially erupted basaltic sampes. This combination allows for samples which erupted under high enough presssures to retain a measurable noble gas content, and also display signatures representing interaction between ocean island and mid-ocean ridge basalt mantle sources. In terms of the isotopic composition of the light noble gases, this interaction has been the subject of a number of studies. However, the elemental heavy noble gas composition of Icelandic basalts has been less well investigated. Studies are hampered by the large, isotopically atmospheric component typically found in Icelandic sub-glacial samples; this late-stage contamination can swamp other signatures. In addition, the degassing process results in both elemental fractionation and loss of the noble gases. Taking full account of both these processes is crucial to resolving the elemental noble gas composition of Iceland's source mantle: Evidence for volatile recycling, volatile sources during the Earth's history and the nature of different mantle source zones are just a few topics that require elemental data as well as isotopic.

Isotopic neon and argon ratios show mixing between air and mantle components, allowing corrected abundances of krypton and xenon to be calculated: Although isotopically indistinguishable from air, these are elementally non-atmospheric, allowing the fit of the data to degassing models to be assessed. We use a variation on the model of Gonnermann and Mukhopadhyay to define possible degassing trends for these samples [1]. Known mantle production ratios for $^{4}He/^{40}Ar$ and $^{4}He/^{21}Ne$ then allow limits to be placed on elemental ratios from Iceland's source mantle.

In contrast to the noble gas analyses, elemental fractionation is not apparent in the halogen data; for example, I/Cl ratios are consistently close to the bulk earth value of 72×10^{-6} across a broad range of samples [2]. However, halogen concentrations vary widely, with the highest values found towards central Iceland. Combined with the noble gas results, this data can provide an insight into the halogen composition of the different mantle sources interacting at Iceland.

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C-solubility in magmas at low fO_2

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Available evidence suggests that in the absence of water, carbon is the element responsible for generating the gas phase that drives fire-fountain eruptions in low oxidation-state magmas [1, 2]. For example, recent experiments show that C forms a CO-rich gas phase in ascending lunar picritic magmas at 40 MPa [3]. Indigenous H (H_2O), discovered in a range of lunar picritic glasses [4], affects this conclusion. Our study was designed to determine the solubility and speciation of C in H-bearing graphite-saturated picritic magmas and the effect of H on the initial gas phase generated.

Experimental A15 green glass samples were pre-set at IW, enclosed in graphite, and run in an IHPV. C and H contents determined by SIMS show 3-150 ppm C and 6-140 ppm H at lower pressures and up to 1400 ppm C and 1250 ppm H at 1 GPa. Carbon in the green glass has a strong positive correlation with pressure. Analyses also show a positive correlation between dissolved C and H in the experimental glasses. Raman spectroscopy indicates CH_4 present in the melt, which confirms the observed trend between C and H in the glasses. These results are consistent with experiments on Na-silicate [5] and haplobasaltic [6] melts. Magmatic C contents greater than ~20 ppm will cause the first gas phase to form from C-H (CH_4) species saturation assuming H contents were in the range 200-1000 ppm. Thermodynamic models [7] predict a CH_4- and H_2-rich gas phase in equilibrium with a reduced melt at P>40 MPa and CO-rich gas at lower pressures.

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