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The Origin of Air-like Noble Gases in MORB and OIB

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The noble gas composition of different terrestrial reservoirs provides one of the key constraints in understanding the accretionary origin of the volatiles, the timing and rate of atmosphere formation as well as providing evidence for large-scale geochemical heterogeneity in the mantle system. Our understanding of different mantle reservoir noble gases is heavily weighted by data obtained from fluid inclusions trapped in basaltic glass. Nevertheless, interpretation of the noble gas (Ne, Ar, Kr and Xe) isotopic and elemental composition of Ocean Island and Mid Ocean Ridge basalt (OIB and MORB) glass is complicated by the near surface addition of atmosphere-derived noble gases. Although the noble gas elemental composition in these samples is often similar to modern air, equilibration between a seawater vapor phase and a basalt melt can produce similar values in the melt phase (Patterson et al., 1990). With the assumption that laboratory handling must reverse any surficial modern air contamination, it has often been concluded that the measured 'air-like' noble gases are either introduced into MORB and OIB glass by variable interaction of the magma with seawater, either before or during eruption, or represent a recycled atmosphere component.

Harrison et al. (1999) have recently demonstrated that both MORB popping rock and sub-glacially erupted Iceland OIB glass contain a component with $^{130}Xe/^{22}Ne$ indistinguishable from modern air. $^{84}Kr/^{22}Ne$ and $^{36}Ar/^{22}Ne$ are also indistinguishable from modern air for air values of $^{20}Ne/^{22}Ne$. Assuming that the mode of this 'air-like' component addition is the same in both systems we show that calculated fractionation values for melt/seawater and melt/freshwater-glacier systems respectively cannot produce the observed elemental abundance pattern. We argue that the dominant source of 'air-like' noble gases in both the MORB and OIB is contamination by unfractionated modern air during sampling or sample preparation within the laboratory. We show that this is related to vesicularity and does not appear to be fully removed by current laboratory techniques. Because vesicularity is related to eruption depth and volatile content (Moore, 1979), recently observed correlations between atmosphere-derived noble gases with radiogenic Pb, water content or other trace element pairs (Sarda et al., 1999; Bach and Niedermann, 1999) may not reflect a relationship between these species in the magmatic source. Similarly, the conclusion from the existing MORB and OIB data set that the terrestrial mantle heavy noble gases have many similar features to modern air (Ozima and Igarashi, 2000) is premature. These observations can be equally well accounted for by vesicularity related air contamination.

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