Relationship Between Volatiles and Noble Gases in Icelandic Lavas: Evidence for Crustal Recycling

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The anomalously high volume of magma erupted on Iceland relative to elsewhere along the Mid-Atlantic Ridge historically has been attributed to an unusually hot mantle. More recently, compositional gradients in the underlying mantle, established during much earlier melting events, have also been invoked. We propose a third alternative, namely, significant quantities of volatiles in the melt source.

Olivine-hosted melt inclusions from Miðfell in Iceland's Western Volcanic Zone have major oxide compositions that place them among the most primitive lavas (highest MgO and lowest SiO_2) on the island. Trace-element-abundance patterns for these inclusions define two end-member compositions – depleted and enriched mantle sources –suggesting intimate spatial association between the two. These end-member compositions are observed even between melt inclusions from the same individual hand sample, indicative of the survival of mantle heterogeneity within an incompletely mixed magma chamber.

Although degassing is common among the inclusions, some have exceptionally high H_2O concentrations of up to 3.0 wt. %, by far the highest water concentrations ever reported in basalts from an ocean island. A subset of the olivine separates from Miðfell and Eldborg, previously analysed for Ne and He isotopic compositions, have melt inclusions which show that when $^{20}Ne/^{22}Ne$ and $^{3}He/^{4}He$ R/R_a in the host olivine are relatively low (10.39 and 18 R/R_a, respectively), the H_2O, CO_2 F, S and Cl concentrations are all elevated. In contrast, when $^{20}Ne/^{22}Ne$ and $^{3}He/^{4}He$ are high – 11.10 and 29 R/R_a, respectively – the concentrations of the five volatiles are low. This suggests that crustal recycling was an important process in mantle melting beneath Iceland.

Exceptionally high-water concentrations in some of the melt inclusions suggest that part of the uniqueness of Iceland's geochemistry and eruptive nature is due to a hydrated source rather than solely the presence of a large thermal anomaly. This has important implications for the concentration of water in mantle materials, and thus the geophysical properties that govern the nature of flow in the mantle and the magma generation that produces ocean islands.

The results of metal mercury solubility in water study

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Correctly determine of the metal mercury solubility in the form of $Hg^o(aq)$ results [1,2] have set us the task to adjust the Henry's constants for a wide range of temperatures and in accordance with our published data. It is well known that the process of dissolution for inert and unhydratable gases in water temperature dependence of the Henry's coefficients has an extreme [3].

For Hg^o temperature dependence of the Henry's constant has a distinct, but little extreme at the temperature range 120-130 ºC, which is close to the position of extrema in systems with inert gases (Ar, Kr). We considered our new results, data of Sorokin *et al.* [4] for Hg^o and to compare - data for such hydratable gases like CO_2 and H_2S [3].

Thus, we see that the dissolution of elemental mercury vapor in water has an extreme by temperature, and, obviously, their interaction with water is very similar to that of the inert gases, but at lower equilibrium partial pressure of the vapor. This fact provides a virtually constant value of Henry's law constant in the range $\log K_H = -2{,}40 \div -2{,}43$ in a wide temperature range.

The obtained values of the Henry's constants for Hg^o show that these values are close to the values characteristic of weak hydratable gases as Ar, CH_4, CO, H_2, N_2, O_2, etc. [3]. Obviously, the data presented in [4] characterize Henry's Law constant, calculated based on the total concentrations of mercury, including the dominant to 100-150 ºC oxidized forms.

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