Halogen solubility in silicate melts

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The Halogens (F, Cl, Br and I) are typically found as minor components in many magmatic and hydrothermal systems. Despite their relatively low abundances, they are thought to influence greatly the chemical and physical properties of melts [1], the genesis and evolution of magmas and their eruptive processes [2]. Understanding these effects requires knowledge of the thermodynamic properties of halogens in silicate melts and determining these properties is the principal aim of our study. In order to measure halogen activities, we added halogen buffers such as Ag/AgCl and Ag/AgBr in which the metal (as oxide) is virtually insoluble in silicate melt under the conditions of the experiment. The buffer controls the fugacity of the halogen of interest. Experiments were performed at 1.5GPa and temperatures of 1300-1500°C in a piston-cylinder apparatus. Oxygen fugacity in most experiments was controlled at the C-CO_2 buffer.

Our experiments show (1) that chlorine solubility in haplobasalt at 1.5GPa/1400°C can reach 5 weight%, even at Cl_2 fugacities as low as 0.0035 bar. (2) reducing the oxygen fugacity increases the Cl content significantly. This indicates that Cl and O occupy similar sites in the silicate melt. (3) The chlorine content, at fixed Cl_2 fugacity, increases with CaO and FeO contents of the silicate. The former observation is consistent with XANES spectroscopic measurements indicating the presence of Ca-Cl complexes in the silicate melt. The latter finding may bear particular importance for petrogenesis on Mars (where melts are known to have a higher relative abundance of Cl and Fe than terrestrial magmas [3]).

Preliminary additional measurements indicate (1) that Br is significantly less soluble than Cl when Br_2 and Cl_2 have similar fugacities and (2) that Cl content is a strong positive function of temperature.

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