Solubility and role of iodine and xenon in silicate glasses

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Abstract

Iodine is the heaviest stable halogen element. In spite of its low natural abundance, iodine is interesting in Geosciences, mainly because of its link to xenon. Indeed, most of the iodine isotopes become xenon isotopes by β- radioactive decay and this relationship is helpful in various research fields. In cosmochemistry, the now-extinct 129I-129Xe radioactivity is used as a geochronometer to date meteorites and provide information on the formation of planetary atmospheres. 129I is also of particular concern because it will be a major contributor to the radioactivity released by a geological repository site for nuclear wastes. In the context of the Comprehensive Nuclear-Test-Ban Treaty, the detection of underground nuclear explosions is allowed by seismic, acoustic, and radionuclide techniques. Atmospheric radioxenon analyses provide the only distinctive signature of a nuclear explosion. For all these reasons, it is important to understand the mechanisms related to the solubility of iodine depending on the composition of the glass, the temperature or the pressure and to analyze its solubility, redox state, and distribution in the glass network.

First, a series of glasses with simplified chemical compositions is synthesized. Then, alkali iodate or iodide is added to the glass in a welded platinum capsule. Different conditions of pressure and temperature are tested, and a hot isostatic press is used to experiment the influence of relatively high pressures (until 2000 bar). The redox state of iodine is determined by Raman and X-ray Absorption Spectroscopy.

Our study on alkali borosilicate glasses, wherein iodate (IO3-) is incorporated at 1000 bar and 1000∘C, shows that iodine can take various redox forms (I-, I2 and IO3- with degrees of oxidation -I, 0 and +V, respectively) within the same glass. Iodine concentrations are up to 3.3 wt.% in the glass with 20 mol% B2O3.

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