Experimental and spectroscopic approach to chlorine incorporation in alumino/boro/silicate glasses

Summary:

Chlorine is the most important halogen element in magmatic systems and one of its isotopes (36Cl) is a by-product of nuclear activity. The latter represents a major environmental problem because it has a long half-life (0.3 Ma) and is extremely mobile in the environment. Chlorine appears to be a major volatile element in magmatic systems such as silica-undersaturated kimberlites or iron-rich basalts typical of Martian magmatism. Currently our knowledge of the behaviour of chlorine in the above mentioned systems and more generally in glasses remains poor. A deepening of our fundamental knowledge is necessary with in particular the understanding of 1) the mechanisms of dissolution of chlorine under various redox conditions and in extreme conditions, and 2) the impact of chlorine on the structure of glasses and its physical properties; for the benefit of the different scientific communities: Earth and Universe Sciences and Materials Sciences.

This multidisciplinary thesis aims at identifying chemical compositions of glassy matrices capable of dissolving a large amount of chlorine. Basically, we will aim to determine the solubility and speciation laws of chlorine as a function of 1) matrix composition (silicate versus borosilicate), 2) intensive conditions (pressure and temperature), and 3) redox conditions for chlorine (from -1 to +7). From these results, we will be able to establish the mechanisms of chlorine dissolution according to the conditions studied. The impact of chlorine on the structure of glassy matrices (silicate or borosilicate) will be discussed. The final objective will be to propose a model of the solubility of chlorine as a function of the composition of the glassy matrix and which integrates the identified mechanisms of chlorine dissolution.

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