**Halogen Chemistry by LA-ICP-MS**

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**Introduction**

 The halogen (F, Cl, Br and I) cycle on Mars has gained a lot of interest recently, due to the identification of chlorate and perchlorate salts on the Martian surface by the NASA *Phoenix* and *Curiosity* missions. On Earth, volcanic emissions of halogens end up as halide salts, like NaCl, or dissolved in water. Mars lacks water and has a very oxidized surface. Accordingly, halogens are redistributed between halides and oxy-halide compounds in different ratios. Further, alkali perchlorates are highly insoluble so that Br and Cl can be fractionated, i.e. separated into distinct rocks, by the action of water. A search for evidence of these processes might be found in minerals within Martian meteorites that contain trace levels of halogens, but the analytical techniques required to achieve such a measurement are still under development. Bromine and Cl are not routinely measured by LA-ICP-MS, due to their high ionization energies, and suitable standards are rare. In this study, we have analyzed scapolite grains (BB1) with reported Cl and Br concentrations [1] using LA-ICP-MS to show that scapolite can be used as a halogen standard (Cl and Br) for LA-ICP-MS.

**Experimental**

 In this study, we analyzed stoichiometric potassium halide salts by LA-ICP-MS to calibrate the halogen abundances in scapolite and compared these results with data obtained by the noble gas method used by [1].

**Results and Discussion**

 The chlorine content increases with the Marialite component (Na and Cl-bearing end member) in Fig. 1a as expected. Figure 1b shows the Cl/Br ratios from several measured pieces of scapolite BB1 as well as the value from [1]. Our measurements show a consistent Cl/Br ratio independent of the Marialite component.

**Conclusions**

 For the identification of geochemical processes on the Martian surface utilizing Martian meteorites, the determination of the Cl/Br ratio, rather than absolute abundances, is important to determine fractionation processes. Our scapolite standard shows a consistent Cl/Br ratio while the absolute composition varies slightly due to the solid solution. Thus, we conclude that we have successfully characterized scapolite BB1 as a standard for determining Cl/Br ratios by LA-ICP-MS.

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**Fig.1** Halogen concentrations with respect to scapolite composition are shown. The reference value BB1 from [1] is shown by a star. Several pieces taken from the exact same mineral used by [1] were obtained from the Museum Victoria collection. Measurements of the chlorine concentration as well as the Br/Cl with respect to the Marialite component on 5 different pieces are shown by the symbols.

**References**

[1] Kendrick, M.A., Chemical Geology, **292-293**, 116-126 (2012).



B

A