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In-situ measurements of magmatic volatile elements, F, S, and Cl, by electron microprobe, secondary ion mass spectrometry, and heavy ion elastic recoil detection analysis

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Abstract

Electron probe and ion probe are the two most used instruments for in situ analysis of halogens in geological materials. The comparison of these two methods on widely distributed glass standards (example: MPI-DING glasses, Jochum et al., G-cubed, 2006) provides a basis for establishing laboratory method, independent geochemical data sets for these elements. We report analyses of F, S, and Cl concentrations in three geological glass samples (EPMA) and 10 referenced standards (EPMA and SIMS). Furthermore, F and Cl absolute abundances have been determined independently for three of the standards (KL2-G, ATHO-G, and KE12), via heavy ion elastic recoil detection analysis (HIERDA), to certify the accuracy of the cross-calibration EPMA-SIMS. The detection limits for EPMA are a 150 $\mu g \cdot g^{-1}$ for F, 20 $\mu g \cdot g^{-1}$ for S and Cl, and for SIMS < 48 $\mu g \cdot g^{-1}$ for F, < 3 $\mu g \cdot g^{-1}$ for S, and <19 $\mu g \cdot g^{-1}$ for Cl. On SiO_2-rich glass-standards, F and Cl measurements by HIERDA highlight a weak matrix effect during SIMS analysis of F and Cl. With the HIERDA independently measured value, we therefore propose an alternative calibration function to empirically correct this matrix effect on the SIMS measurements of F, S, and Cl.

Keywords: F, Cl, SIMS, EPMA, ERDA, melt inclusion; Halogens in Planetary Systems