Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.5082

INVESTIGATING THE MECHANICS OF FLUORINE SPECIATION IN LOW-PRESSURE SILICATE MELTS USING ^{19}F MAGIC ANGLE SPINNING NUCLEAR MAGNETIC RESONANCE SPECTROMETRY

MR. FILIPPO FORMOSO[1], BASTIAN JOACHIM-MROSKO[2], JÜRGEN KONZETT[2], GEOFFREY BROMILEY[3], DANIEL M. DAWSON[1], SHARON E.M. ASHBROOK[1] AND SAMI MIKHAIL[1]

[1]University of St Andrews
[2]University of Innsbruck
[3]University of Edinburgh

Presenting Author: ff43@st-andrews.ac.uk

Halogens are highly reactive non-metallic elements of the periodic table. Fluorine is the lightest of the halogens, the most enriched in the bulk silicate Earth, and above the predicted trend for all moderately volatile lithophile elements relative to condensation temperature, including the other halogens [1]. To address fluorine's distinction among the halogens we focus on the incorporation mechanism for fluorine in silicates. We investigate the speciation of F in low-pressure (1 atm) F-enriched CMAS silicate melts (CaO + MgO + Al_2O_3 + SiO_2). Speciation was analysed using solid-state magic angle spinning nuclear magnetic resonance (MAS NMR) spectroscopy.

One possible mechanism is the substitution fluorine and hydroxyl anions in mafic minerals frameworks [2]. However, this process alone fails to explain the differences in compatibility between fluoride and hydroxyl anions in mafic phases [3]. Our data show that fluorine bonds in silicate melts in a model CMAS system (Fig. 1). These data suggest a potential preference for F incorporation in Mg-rich phases during melt crystallisation and for F sequestration in Mg-rich silicate melts, which speaks to fluorine's relative enrichment in enstatite-type chondrite relative to CI-type chondrite [4].

[1] Clay, P. L., Burgess, R., Busemann, H., Ruzié-Hamilton, L., Joachim, B., Day, J. M. D., & Ballentine, C. J. (2017). Halogens in chondritic meteorites and terrestrial accretion. Nature, 551(7682), 614–618. https://doi.org/10.1038/nature24625

[2] Crépisson, C., Blanchard, M., Bureau, H., Sanloup, C., Withers, A. C., Khodja, H., Balan, E. (2014). Clumped fluoride-hydroxyl defects in forsterite: Implications for the upper-mantle. Earth and Planetary Science Letters, 390, 287–295. https://doi.org/10.1016/j.epsl.2014.01.020

[3] Grützner, T., Kohn, S. C., Bromiley, D. W., Rohrbach, A., Berndt, J., & Klemme, S. (2017). The storage capacity of fluorine in olivine and pyroxene under upper mantle conditions. Geochimica et Cosmochimica Acta, 208, 160–170. https://doi.org/10.1016/j.gca.2017.03.043

[4] Lodders, K., & Fegley, B. J. (1998). The planetary scientist's companion. *Oxford University Press*.