Using H and Cl isotopes to constrain lunar magmatic processes

J. J. BARNES[1*], R. TARTÈSE[2], M. ANAND[13], C. R. NEAL[4], F. M. MCCUBBIN[5] AND I. A. FRANCHI[1]

[1]Planetary & Space Sciences, The Open University, UK
[2]IMPMC, Muséum National d'Histoire Naturelle, Paris, FR
[3]Dept. Earth Sciences, Natural History Museum, London
[4]Dept. Civil & Env. Eng. & Earth Sci., Uni. Notre Dame
[5]Institute of Meteoritics, University of New Mexico, USA

We report new Cl isotope and abundance (Cl, F, H_2O, S) data for apatites from a range of Apollo lunar samples, including mare basalts and highlands rocks. The Cameca NanoSIMS 50L at the Open University was used to make these measurements. Apatites in the mare basalts (both high- and low-Ti) are characterised by relatively low abundances of Cl (< 0.4 wt.%) that are associated with δ^{37}Cl compositions ranging from +2 to +13 ‰. In contrast, apatites in the highlands samples studied display a wide range of Cl contents (0.7 to 1.4 wt.%) and elevated δ^{37}Cl values > +27 ‰. We have combined this new dataset with an existing H-isotopic dataset for apatites that were previously analysed in our laboratory from the same samples in order to place constraints on the processes influencing the volatile inventories of lunar magmas.

In the case of apatites from the mare basalts, the elevated δD values have been attributed by some (e.g., [1]) to be the result of H_2 degassing from the parental melts. These apatites also display low- to moderate δ^{37}Cl values which can be ascribed to the loss of isotopically light Cl in the form of metal chloride vapour during degassing [2]. In contrast, apatites in highlands samples are globally characterised by elevated δ^{37}Cl signatures, advocating for additional processes/components to explain these unique Cl-isotopic signatures. For example, apatites from two lunar samples that are known to have undergone metasomatism, display H-isotope and H_2O systematics that appear to be consistent with H_2 degassing, and δ^{37}Cl values for apatite in the granulite may indicate apatite crystallised during Cl degassing/fractionation [3]. Furthermore, apatites in a cumulate norite (78235) which are considered to preserve a primordial H-isotopic composition, also display elevated δ^{37}Cl values. It is possible, given the petrological history of this sample, that both the H and Cl isotopic compositions may record the signature of the urKREEP component that the parental magma (to this sample) is purported to have assimilated.

[1] Tartèse R. et al., (2013), *GCA* **122**, 58-74. [2] Sharp Z.D. et al., (2010), *Science* **329**, 1050-1053. [3] Barnes J.J. et al., (2015) *LPSC XLVI*, #**1352**.