Using lunar apatite to assess the volatile inventory of the Moon

Conference or Workshop Item

Using Lunar Apatite to Assess the Volatile Inventory of the Lunar Interior

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Lunar petrology, most notably the absense of hydrous minerals (such as micas and amphiboles) and the lack of Fe_2O_3, imply a low oxygen activity for the Moon [1]. The anhydrous nature of the Moon is consistent with observed depletions in volatile elements compared to the Earth [2]. Recent analytical developments have led to the re-investigation of lunar samples. In volcanic products, heterogeneous water contents in volcanic glass beads [3] olivine-hosted melt inclusions [4] and in the accessory phase apatite [5] [6] [7] [8] [9] indicate a wetter lunar interior than previously thought. Analysis of lunar apatite has produced OH contents as high as ~12000 ppm [5] and volatile contents of olivine-hosted melt inclusions appear to be similar to terrestrial mid-ocean ridge basalts values [4]. However, analysis of Cl isotope compositions from a range of lunar rocks (basalts, glasses, apatite grains) identified a Cl fractionation 25 times larger than on Earth [10]. This has been interpreted as reflecting a relatively dry lunar interior. The coupled nature of Cl and H, together with this high fractionation of Cl has been used to suggest the Moon's mantle has H values as low as 10 ppb [10].

To calculate the volatile contents of lunar melts, the partitioning behaviour of volatiles into apatite must be considered. Very little work has been done on the partition of volatiles under lunar conditions, however to fully constrain the H content of the magmatic source regions based on apatite grain measurements, determination of accurate partition coefficients is required.

Experimental work using a piston-cylinder assembly at VU, University Amsterdam, is being carried out to derive these partition coefficients for volatiles (F, OH, Cl) between apatite and melts. Measurements of the volatile contents in experimental synthesised apatites are being carried out using a Cameca NanoSIMS 50L ion probe at the Open University. Primary experiments have looked at the temperature effect of F partitioning into apatite. This experimental work will be combined with measurements of Cl, F, and OH concentrations as well as Cl and H isotope compositions in mare basalts. This will provide better constraints on the volatile budget of the lunar magmatic source regions.

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