Quantitative SIMS analysis of OH in lunar apatite: Implications for water in the lunar interior

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For the past 40 years, the Moon has been widely reported to be 'bone dry', with estimates of the bulk lunar water content typically being less than 1 ppb [1]. However, recent results from both remote sensing and SIMS analyses of lunar volcanic glasses have indicated that the water budget of the Moon may have been underestimated [2-5]. In this study we report on quantitative SIMS analysis of apatite grains from several lunar rock types. Apatite is a phosphate mineral that typically contains hydroxyl within its crystal structure, and this mineral is present in a large number of lunar rocks. Our SIMS results indicate that there is on the order of hundreds to thousands of ppm H_2O in lunar apatite. Moreover, apatite is an igneous mineral, so it can provide insight into magmatic water contents. The apatite/melt partition coefficient for water is less than 1, indicating that the late-stage liquids from which the apatites crystallized also had at least hundreds to thousands of ppm H_2O.

Calculations are currently underway that will allow us to re-estimate the bulk lunar water content based on our results and the reults published by others. Preliminary results of these calculations suggest that the previous estimates of water in the lunar interior have been underestimated by several orders of magnitude, however the lunar interior is also at least an order of magnitude drier than the Earth and Mars.

[1] Taylor *et al.* (2006) *Reviews in Mineralogy & Geochemistry*. **60**, 657–704. [2] Saal *et al.* (2008) *Nature*. **454**, 192–195. [3] Clark (2009) *Science*. **326**, 562–564. [4] Pieters *et al.* (2009) *Science*. **326**, 568–572. [5] Sunshine *et al.* (2009) *Science*. **326**, 565–568.

Compositional models of the Earth, mantle and core revisited

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Much is made these days of compositional models for the Earth, its mantle and core, particularly in the light of ^{142}Nd isotopic studies and the nature of chondrites as a reference frame for planetary models. It is my assertion that, in the absence of a highly contrived differentiation condition, the composition of the primitive mantle can be reasonably assessed at better than the ±10% level (1σ) for elements at concentration levels of about 1000 µg/g using available mantle samples.

A principle finding of the McDonough and Sun 1995 study [1] was that mantle peridotites showed differentiation trends that intersected uniquely chondritic compositions when ploting multiple, independent ratios of refractory lithophile elements. These plots used only the measured abundance data of a suite of peridotites, filtered to avoid (as much as possible) products of melt metasomatized material. That these data arrays cross chondritic space provides evidence that primtive mantle initially started from a chondritic precursor.

Increasingly, studies of chondritic meteorites are providing insights into their compositional diversity and, to some extent, the radial distribution of material heterogeneities in the early solar system. Likewise, remote sensing studies of accreting nvebular disks are also yielding evidence of the radial distribution of material heterogeneities in other early-forming solar systems. The importance of compositional variance in chondrites is underappreciated.

[1] McDonough & Sun (1995) *Chem. Geol*. **120**, 223–253.