

**NEW ESTIMATES OF THE WATER CONTENT OF THE MOON FROM APOLLO 15 PICRITIC GLASSES.** E. H. Hauri<sup>1</sup>, A. E. Saal<sup>2</sup>, J. Van Orman<sup>3</sup>, M. J. Rutherford<sup>2</sup>, B. Friedman<sup>2</sup>. <sup>1</sup>Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Road, NW Washington, DC 20015. <sup>2</sup>Department of Geological Sciences, Brown University, 324 Brook St., Box 1846, Providence, RI, 02912. <sup>3</sup>Department of Geological Sciences, Case Western Reserve University, Cleveland, OH 44106.

**Introduction:** The importance of water in planetary magmatic systems is of particular importance; even at low concentrations, water will influence the temperature of mantle melting and magma crystallization, and influence the style and violence of volcanic eruption. The water content of the lunar interior has been a subject of great interest since the return of the first lunar samples [1]. Tantalizing indirect evidence has long indicated that water might have played a role in the generation and eruption of the lunar volcanic glasses [2], but definitive measurements of dissolved magmatic water in lunar magmas remained elusive until the study of Saal et al. in 2008 [3]. In this abstract, we report the results of new measurements on over 200 new samples of picritic glasses recovered from the Apollo 15 mission. Our new measurements suggest an upward revision of current estimates for the water content of lunar magmas.

**Samples and Analytical Techniques:** Spherical glass beads from three Apollo 15 samples (sample 15427,41, 15426,21, 15426,138) were chosen for this study. The glass spherules range in size from 100-200 $\mu\text{m}$  and were individually selected and mounted in indium. The abundances of volatiles dissolved in the interior of the lunar picritic glasses were measured by SIMS using a Cameca IMS6F at DTM, Carnegie Institution of Washington, employing methods recently developed for the microanalysis of trace amounts of H<sub>2</sub>O, CO<sub>2</sub>, F, S, Cl in glasses and nominally anhydrous minerals [4]. A typical 10-min SIMS measurement for volatile abundances is made on a singly polished specimen using a Cs<sup>+</sup> primary beam (~14 nA accelerated to 10 kv) with collection of negatively charged secondary ions. We used a 10  $\mu\text{m}$  primary beam rastered at 25 $\mu\text{m}$ , which results in a 35  $\mu\text{m}$  crater. We pre-sputter for 3-5 min prior to analysis, during this time, we monitored secondary ion images of <sup>12</sup>C, <sup>17</sup>OH, <sup>19</sup>F <sup>32</sup>S and <sup>35</sup>Cl projected on the channel plate. This procedure helped avoid inclusions and cracks, which appear as bright features on the projected image (especially <sup>12</sup>C image), and dendritic crystals (dark shapes on <sup>32</sup>S image). After each beam spot was carefully examined a field aperture was inserted to permit transmission of ions only from the central 10  $\mu\text{m}$  of the 35 $\mu\text{m}$  crater (i.e., always 25  $\mu\text{m}$  away from the crater edge) thus avoiding transmission of ions from the edge of the sputter crater and the surface of the sample. Counting times were 10 s for <sup>12</sup>C and 5 s for all other

elements. Pressure in the ion probe sample chamber was  $<5 \times 10^{-10}$  torr during the analyses. The samples were placed in the ion probe sample chamber for  $>24$  h before analysis; this approach allowed the best detection limits for H<sub>2</sub>O. Improved detection limits for water and carbon were obtained in this study over those of Saal et al. [3] due to improvements in sample preparation (2.5 ppm H<sub>2</sub>O, 0.6 ppm C by weight). Particular care was taken to select spherical beads with a limited range of diameters and to mount and polish the beads in an attempt to expose the precise geometric centers of as many beads as possible, given that our previous study [3] showed the highest volatile concentrations in the bead centers.

**Results:** Over 200 new measurements of water in these glasses reveal an extended range of water contents; five of the glasses show higher water contents than reported previously [3], up to 70 ppm H<sub>2</sub>O. High abundances of water are seen in glasses with high abundances of the other volatiles (C, F, S, Cl). Core-rim profile measurements of these new samples are in progress, but from these results we anticipate an upward revision in our estimates for the maximum pre-eruptive water content of lunar magmas.

**Conclusions:** New water abundance measurements for the lunar picritic glasses show maximum abundances of 70 ppm H<sub>2</sub>O, a factor of two higher than previously reported. These measurements confirm the presence of magmatic H<sub>2</sub>O in primitive lunar basalts, and solidify the conclusion that the ancient lunar mantle contained significant abundances of water. Our results suggest that, contrary to prevailing ideas, the bulk Moon is not entirely depleted in water; our results suggest that the ancient lunar mantle was once as wet as the upper mantle of the modern Earth, despite the abundant evidence for the formation of the Moon by giant impact [5].

#### References:

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