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ORIGIN OF LUNAR WATER AND EVIDENCE FOR A WET MOON FROM D/H AND WATER IN LUNAR APATITES.

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Introduction: We have recently reported the first D/H measurements of lunar water from ion microprobe measurements of D/H in apatite from Apollo rock samples. A recent study of Cl isotopes in lunar materials has cast doubt on the estimates of lunar mantle water derived from apatite OH contents, and has called for a dry Moon during lunar petrogenesis. Here we report new measurements of water and D/H in lunar apatite from 12039,43 measured using the Hokudai ion microscope. Results: In this study, we have measured D/H and 1H/18O in eight apatite grains from 12039,43, bringing our total to thirteen apatite grains in 12039. The combination of plentiful and large apatite grains in coarse-grained pigeonite basalt 12039 have allowed us to make multiple measurements of D/H and H2O (presumably OH) in individual apatite grains from multiple thin-sections. We find that the water contents of individual apatite grains are homogeneous, but vary among different grains. Only one grain in 12039,43 was large enough for multiple spots, and dD values for those two spots were identical (dD=+765 +-42permil and +765 +-34permil). Discussion: D/H of the Moon. The mean and standard deviation of dD analyses of mare basalts 10044, 12039, and 75055 are +681 +-132permil (n=27). The mean and standard deviation of dD of 12039,43 are +698 +-61permil (n=9). This is almost identical to the mean dD of 12039,42 (mean dD=+689 +-180permil (n=13)), but with much less variability. Clearly the data are dominated by 12039, but the mean dD of 10044 is similarly elevated relative to Earth (10044: mean dD=+606 +-30permil (n=4)), as is the lone analysis of 75055 (dD=+735 +-36permil). That the D/H of these 3 mare basalts from different landing sites should be so similar argues that the mare source region is also similarly elevated in D/H. Other possibilities to explain the similarity in D/H of these 3 samples are likely untenable, but are considered below. The dD of two analyses of an intrusive highlands alkali anorthosite clast (14305,303) are also elevated relative to Earth (dD=+238 +-72permil; +341 +-53permil), but less so than those of mare basalts 10044, 12039, and 75055. An important point of an elevated D/H for this intrusive sample is that it would seem to argue against late-stage assimilation of regolith material (derived from comets or asteroids) by the extrusive mare lavas to explain the elevated D/H of the Moon. Origin of lunar water. If the D/H of water in lunar apatite is not formed by the processes of degassing, diffusion, or dehydration, then the D/H of lunar apatite may serve as a constraint for the nature of the late-accretionary population of material. If so, the only solar-system materials with D/H similar to that of mare basalt apatite would be bulk carbonaceous chondrites or comets. D/H of water from carbonaceous chondrites is similar to the D/H of water in the Earth mantle, suggesting cometary material as a source of water to the Moon.

Keywords: lunar, apollo, water, SIMS