Water-rich lunar glasses in Apollo 17 basalt 75055: Evidence for a ‘wet’ Moon

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Current inventories of volatile elements and their isotopes in lunar materials can be considered to be evidence of a ‘dry’ or ‘wet’ Moon depending on the nuclide chosen [1]. Elevated amounts of heavy isotopes of K, Zn, Cl, and Rb all provide evidence that the Moon has a unique signature that can be explained as loss of the lighter isotope during the Giant Impact or degassing of the lunar magma ocean [1]. Inherent in this volatilization scenario is near-complete loss of highly volatile elements such as H.

High concentrations of H2O (>1000 ppm) in olivine-hosted melt inclusions of the picritic glass beads of 74220 is considered evidence of volatile levels in the lunar mantle similar to Earth [2]. F, Cl, and S in olivine-hosted melt inclusions from other lunar samples are similar to 74220, confirming that 74220 is not an anomalously volatile-enriched sample [3,4].

Here we report the highest water contents yet found for lunar glasses, as trapped melt pockets in apatite of high-Ti basalt 75055. We find the glasses have >5000 ppm H2O, but with δD varying between ~0‰ and +1250‰. Co-existing apatite has δD=+1100‰ to +1500‰. Based on the water contents and δD, we develop a model to explain the water and δD systematics of trapped glasses in basalt 75055. A starting magma at depth with 1500 ppm H2O and δD=+300‰, similar to the olivine-hosted melt inclusions of 74220 [2], can explain the high water and elevated δD of the trapped glasses of apatite in 75055 via early degassing of H2 and then closed system crystallization without volatile loss. Glasses with low δD likely were altered by vapor transport of hydrogen from regolith heated by lava flow [5].