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 H_2O (>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 H_2O, 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 H_2O 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 H_2, 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].

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