Water in the Moon and Origin of the Moon

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The moon was thought to be "water"-free prior to 2008. (There is no liquid water on and in the moon. "Water" is used colloquially to refer to all H associated with oxygen, including H_2O in the form of ice and absorbed on grain surfaces, and OH in glasses and minerals.) For example, in a 2006 Review Volume titled "New Views of the Moon", Taylor et al. (2006) wrote that "The moon is dry, with less than one ppb water, except for some possible amounts trapped in permanently shadowed craters at the lunar south pole". Just two years later, this "new" view of the moon became the old view of the moon. Saal et al. (2008) used SIMS and nanoSIMS to measure H in degassed lunar volcanic glasses and discovered that they contain up to 45 ppm water, which is 45,000 times the amount given in Taylor et al. (2006). A flurry of discoveries followed (in publication dates, though not necessarily in idea conception). Remote sensing spectroscopic studies (Clark 2009; Pieters et al., 2009; Sunshine et al., 2009) showed that lunar surface rocks contain of the order 100 ppm water (absorbed on grain surfaces or as hydroxyls in glasses or minerals). NASA's LCROSS mission crashed a rocket into a crater near the south pole of the moon, and detected water vapor and ice in the resulting plume (Colaprete et al., 2010). Significant amount of OH in lunar apatite was found through SIMS measurement of H (Boyce et al., 2010, McCubbin et al., 2010a,b, and Greenwood et al., 2011). Using SIMS measurement of H, Hauri et al. (2011) reported up to 1410 ppm water in olivine-hosted melt inclusions in lunar basalts. Liu et al. (2012) were the first to use IR (and SIMS) to determine the species of H and found that agglutinate glasses in lunar regolith contain on average 177 ppm water in the form of OH. Hui et al. (2013) discovered that even plagioclase, a nominally anhydrous mineral, can also contain measurable amount of OH, up to 6.4 ppm water. These findings (especially Hui et al. 2013) and their implications on the origin of the moon will be discussed.

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