Goldschmidt Medal Abstract

Water in the Moon: Abundance, Origin and Evolution

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The "dry" view of the Moon has been held since the Apollo era [1]. This paradigm, however, has been challenged by the detection of indigenous water in lunar pyroclastic glass beads [2]. Thereafter new measurements of water in lunar apatites [e.g., 3], olivine-hosted melt inclusions [e.g., 4], agglutinates [e.g., 5], and nominally anhydrous minerals [6] have confirmed that there is water in the lunar interior. Some parts of lunar mantle may even have as much water as Earth's upper mantle [4]. Detection of water in ferroan anorthositic plagioclase has implied that the Moon contained water at the time of the lunar magma ocean [6].

Hydrogen isotopic composition has been proved to be important to fingerprint the sources and processes of lunar water. The large variation of hydrogen isotope compositions (δD = -202 to +1010 ‰) in lunar apatite from mare basalts and highland rocks has been taken as evidence that water in the lunar interior comes from lunar mantle, solar wind protons, and/or comets [3]. The major source of the lunar regolith water has been proved to be the solar wind protons [5,7]. The similar hydrogen isotope compositions of apatites in highland norite and some "undegassed" KREEP with that of the proto-Earth mantle have been interpreted as evidence for a common origin for water in the Earth-Moon system [8,9]. New SIMS water data and hydrogen isotope composition of ferroan anorthositic plagioclase, combined with literature hydrogen isotope data, demonstrate that the hydrogen isotope compositions of the LMO could have evolved due to degassing until the formation of the lunar primordial crust [10]. The results further suggest that the initial LMO could have contained a water content comparable to that of the Earth's primitive mantle [10].

[1] Taylor et al. (2006) Rev Mineral Geochem 60, 657-704. [2] Saal et al. (2008) Nature 454, 192-195. [3] Greenwood et al. (2011) Nat Geosci 4, 79-82. [4] Hauri et al. (2011) Science 333, 213-215. [5] Liu et al. (2012) Nat Geosci 5, 779-782.[6] Hui et al. (2013) Nat Geosci 6, 177-180. [7] Stephant et al. (2014) PNAS 111, 15007-15012.[8] Barnes et al. (2014) Earth Planet Sci Lett 390, 244-252.[9] Tartèse et al. (2014) Geology 42, 363-366.[10] Hui et al. (2015) In preparation.