A Primitive Hydrogen Reservoir in the Lunar Interior?

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While the total abundance of water in the bulk Moon is still unclear, it seems to be heterogeneously distributed between sources of higher and lower H abundance, as well into reservoirs with different ratios of deuterium to hydrogen (D/H or δD) [1]. The D/H ratio is a useful tool for determining solar system water sources, and has been applied to samples from the Moon, Mars, and asteroid 4 Vesta, as well as terrestrial rocks.

Intriguingly, some of the least water-rich rocks from the Moon are those most enriched in incompatible trace elements such as K, Rare Earth Elements, and P. The mantle source region of a basaltic melt enriched in this KREEP component, Apollo sample 15358, was estimated to contain ~10 times less water than the source of the Apollo 17 orange pyroclastic glass (~10 vs. ~100 ppm) [1,2]. Late-stage fractional crystallization products of KREEP-basaltic magmas, such as the quartz monzodiorites (QMDs) are even more incompatible-element rich. However, their only H-bearing phase is apatite.

Our measurements show apatite in QMDs from Apollo 15 contains less than 300 ppm H_2O [1, this work]. Unfortunately, estimates of parental melt water content using apatite are unreliable [3], but the most interesting aspect of the Apollo 15 QMDs are their ultralow D/H ratios (δD as low as -749 ‰) [1]. Due to their intrusive origins and short (~11 My) exposure ages, these QMDs are not thought to contain D-depleted solar wind H and, so, may represent an ultralow D reservoir in the lunar interior [1]. This complements recent melt inclusion H data from terrestrial primitive Baffin Island basalts, which are also D-depleted (as low as -218 ‰) and seem to trend towards an even lower, more primitive δD [4]. Could these data indicate a common low δD reservoir in the interiors of the Earth and Moon? We will present new H and Cl data from apatite in additional Apollo 15 QMDs in an effort to clarify the origin and extent of this potentially primitive, low D reservoir in the lunar interior.

[1] Robinson et al. (2016) *GCA* **188**, 244-260. [2] Saal et al., (2008) *Nature* **454**, 192-195. [3] Boyce et al. (2014) *Science* **344**, 200-202. [4] Hallis et al. (2015) *Science* **350**, 795-797.