WATER CONTENT OF LUNAR ALKALI FELDSPAR.

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Introduction: Detection of indigenous hydrogen in a diversity of lunar materials, including volcanic glass [1], melt inclusions [2], apatite [3, 4], and plagioclase [5] suggests water may have played a role in the chemical differentiation of the Moon. Spectroscopic data from the Moon [6] indicate a positive correlation between water and Th. Modeling of lunar magma ocean crystallization [7] predicts a similar chemical differentiation with the highest levels of water in the K- and Th-rich melt residuum of the magma ocean (i.e. urKREEP). Until now, the only sample-based estimates of water content of KREEP-rich magmas come from measurements of OH, F, and Cl in lunar apatites, which suggest a water concentration of < 1 ppm in urKREEP [3]. Using these data, [7] predict that the bulk water content of the magma ocean would have <10 ppm. In contrast, [5] estimate water contents of 320 ppm for the bulk Moon and 1.4 wt % for urKREEP from plagioclase in ferroan anorthosites.

Results and interpretation: NanoSIMS data from granitic clasts from Apollo sample 15405,78 show that alkali feldspar, a common mineral in K-enriched rocks, can have ~20 ppm of water, which implies magmatic water contents of ~1 wt % in the high-silica magmas. This estimate is 2 to 3 orders of magnitude higher than that estimated from apatite in similar rocks [8]. However, the Cl and F contents of apatite in chemically similar rocks suggest that these melts also had high Cl/F ratios, which leads to spuriously low water estimates from the apatite [9].

We can only estimate the minimum water content of urKREEP (+ bulk Moon) from our alkali feldspar data because of the unknown amount of degassing that led to the formation of the granites. Assuming a reasonable 10 to 100 times enrichment of water from urKREEP into the granites produces an estimate of 100-1000 ppm of water for the urKREEP reservoir. Using the modeling of [8] and the 100-1000 ppm of water in urKREEP suggests a minimum bulk silicate Moon water content between 2 and 20 ppm. However, hydrogen loss was likely very significant in the evolution of the lunar mantle, e.g.[1].

Conclusions: Lunar granites crystallized between 4.3-3.8 Ga [10] from relatively wet melts that degassed upon crystallization. The formation of these granites likely removed significant amounts of water from some mantle source regions, e.g. later mare basalts predicting derivation from a mantle with <10 ppm water [3]. However, this would have been a heterogeneous process based on K distribution. Thus some, if not most of the mantle may not have been devolatilized by this process; as seen by water in volcanic glasses [1] and melt inclusions [2].

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