

D-poor hydrogen in lunar mare basalts assimilated from lunar regolith

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ABSTRACT

Apatite grains in lunar mare basalts contain hydrogen that ranges in D/H ratio by more than a factor of two. For most of these basalts, the D/H ratios in their apatite grains decrease with measures of the host basalts' time spent at elevated temperature, specifically the Fe-Mg homogenization of their pyroxenes. Most basalts with homogeneous pyroxenes (i.e., with constant Fe/Mg ratio) have apatite grains with low D/H ($\delta D \approx -100\%$), whereas most basalts with heterogeneous pyroxenes (i.e., varying or zoned Fe/Mg) have apatite with high D/H (δD up to $\sim +1100\%$). This relationship suggests that low D/H values were acquired during thermal processing, i.e., during Fe-Mg chemical equilibration, during or after emplacement. This light hydrogen is likely derived from solar wind implanted into the lunar regolith (with δD from -125% to -800%), and could enter basalts either by assimilation of regolith or by vapor transport from regolith heated by the flow. If a basalt could not interact with regolith rich in solar wind (e.g., it was emplaced onto other fresh basalts), its apatite could retain a magmatic D/H signature. The high D/H component (in the apatites of unequilibrated basalts) is most reasonably that indigenous magmatic hydrogen, i.e., representing hydrogen in the basalt's source mantles, or magmatic hydrogen that was residual after partial degassing of H_2 .

Keywords: Mare basalt, hydrogen isotopes, lunar regolith