

D-POOR HYDROGEN IN LUNAR MARE BASALTS ASSIMILATED FROM LUNAR REGOLITH. A.H. Treiman¹, J.W. Boyce^{2,3}, J.P. Greenwood⁴, J.M. Eiler², J. Gross⁵, Y. Guan², C. Ma², E.M. Stolper². ¹Lunar & Planetary Institute, 3600 Bay Area Boulevard, Houston, TX 77058 USA (treiman@lpi.usra.edu), ²Division of Geological & Planetary Sciences, Caltech. ³Dept. Earth, Planetary, and Space Sciences, UCLA. ⁴Dept. Earth & Environmental Sciences, Wesleyan University, Middletown, CT 06459. ⁵Dept. Earth and Planetary Sciences, Rutgers University, 610 Taylor Rd., Piscataway NJ 08854.

Introduction: Apatite grains in lunar mare basalts contain hydrogen that ranges in D/H ratio by more than a factor of two [1-4]. This range has been interpreted to represent: multiple indigenous components including mantle and KREEP [5], degassing during emplacement [2,4], cometary infall [1], meteoritic infall [2,5,6], and/or solar wind from the regolith [7,8].

Samples & Methods. Six thin sections of five mare basalt samples were analyzed by ion microprobe for this study: two high-Ti basalts (10044,12, and ,644; 75055,55); and three low-Ti basalts (12039,42; 12040,211; MIL 05035,6). All contain small grains of apatite (>100 μm) in their mesostases, consistent with late crystallization of apatite from their magmas. We also analyzed the gabbro lithology of NWA773, and the KREEP-rich lithology in NWA 4472. Analyses for H, D/H, and Cl and ³⁷Cl/³⁵Cl in their apatites were obtained at the Caltech Center for Microanalysis using a Cameca 7f-GEO SIMS with standard protocols [10,11].

Results: For most of these basalts, the D/H ratios in their apatite grains decrease with a measure of the basalts' time spent at elevated temperature. We use the Fe-Mg homogenization of their pyroxenes (Fig. 1) as a proxy for integrated thermal history, and use the spread of Mg# (molar Mg/(Mg+Fe)) in their pyroxenes from literature data (Fig. 1). Most basalts with homogeneous pyroxenes (i.e., low Mg#_{max}/Mg#_{min}) have apatite grains with low D/H ($\delta\text{D} \approx -100\text{‰}$); most basalts with heterogeneous pyroxenes (i.e., varying or zoned Fe/Mg; high Mg#_{max}/Mg#_{min}) have apatite with high D/H (δD up to $\sim +1100\text{‰}$). This relationship suggests that low D/H values were acquired during thermal processing, i.e. during Fe-Mg chemical equilibration, during or after emplacement. Chemical exchange or metasomatism like this has been documented in other lunar samples [9,13].

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 [14]. 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, which could explain the data for 12018 [12]. The high D/H component (in the

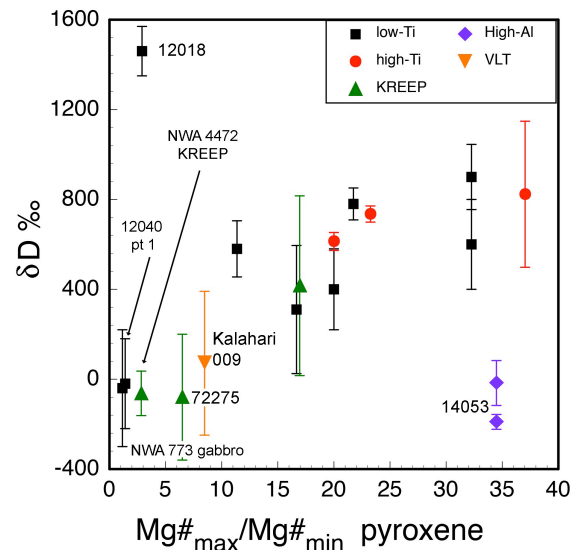


Fig. 1. δD in apatites from lunar mare basalts versus $\text{Mg}\#_{\text{max}}/\text{Mg}\#_{\text{min}}$ in their pyroxenes. δD values are averages by sample and data sources [1-8,10,12], bars are 2σ of the distribution or of single analyses, whichever is larger. Uncertainties on $\text{Mg}\#_{\text{max}}/\text{Mg}\#_{\text{min}}$ are not given, as these values from the literature are of uneven and unknown qualities.

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 .

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