Supplementary information

Hallis et al. (2025) The D/H ratio of the Martian Mantle: Evidence from the Lafayette Meteorite. Advances in Geochemistry and Cosmochemistry 1(2): 761,
https://doi.org/10.33063/agc.v1i2.761

S1. Hydrogen isotope measurements – additional information.

The amount of H_2O background contamination within the analytical chamber was determined via analysis of the nominally anhydrous San Carlos olivine standard, which was analysed twice each day throughout the analytical session. The average background value was subtracted from all standards and unknown phases analysed in this study; the calibration line was corrected for this H_2O background and forced through the origin. The H_2O background within the analytical chamber averaged ~7 µg/g. However, since the Lafayette thin-section was not co-mounted with the standards, it was not possible to estimate the background on the sample in this manner. Instead, a background of approximately 263 µg/g was estimated via analysis of pyroxene in this sample assuming that the H^-/O^- calibration remained consistent between mounts. The higher H background most likely results from both the epoxy mounted nature of the sample producing H contamination and a real water signature present within the Lafayette pyroxene. Hence, this value serves as a maximum background value, which is in any case more than an order of magnitude lower than the Lafayette apatite with lowest H_2O abundance. Based on repeated analyses of the Durango apatite standard throughout each analytical session, errors from counting statistics, and uncertainty in the instrumental background, we estimate the external reproducibility (2σ SD) of the H_2O concentrations presented here to be on average ±15 %, similar to Mane et al. (2016), Stephant et al. (2018) and Davidson et al. (2020).

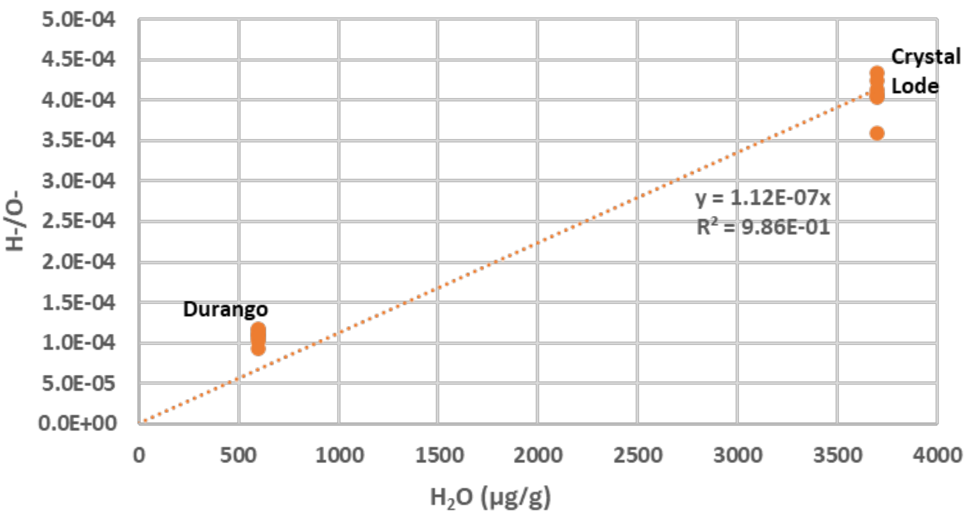

Figure S1: H^-/O^- vs. H_2O (μg/g) calibration line calculated using Durango and Crystal lode standard apatite crystals. This calibration line is background corrected and forced through the origin.

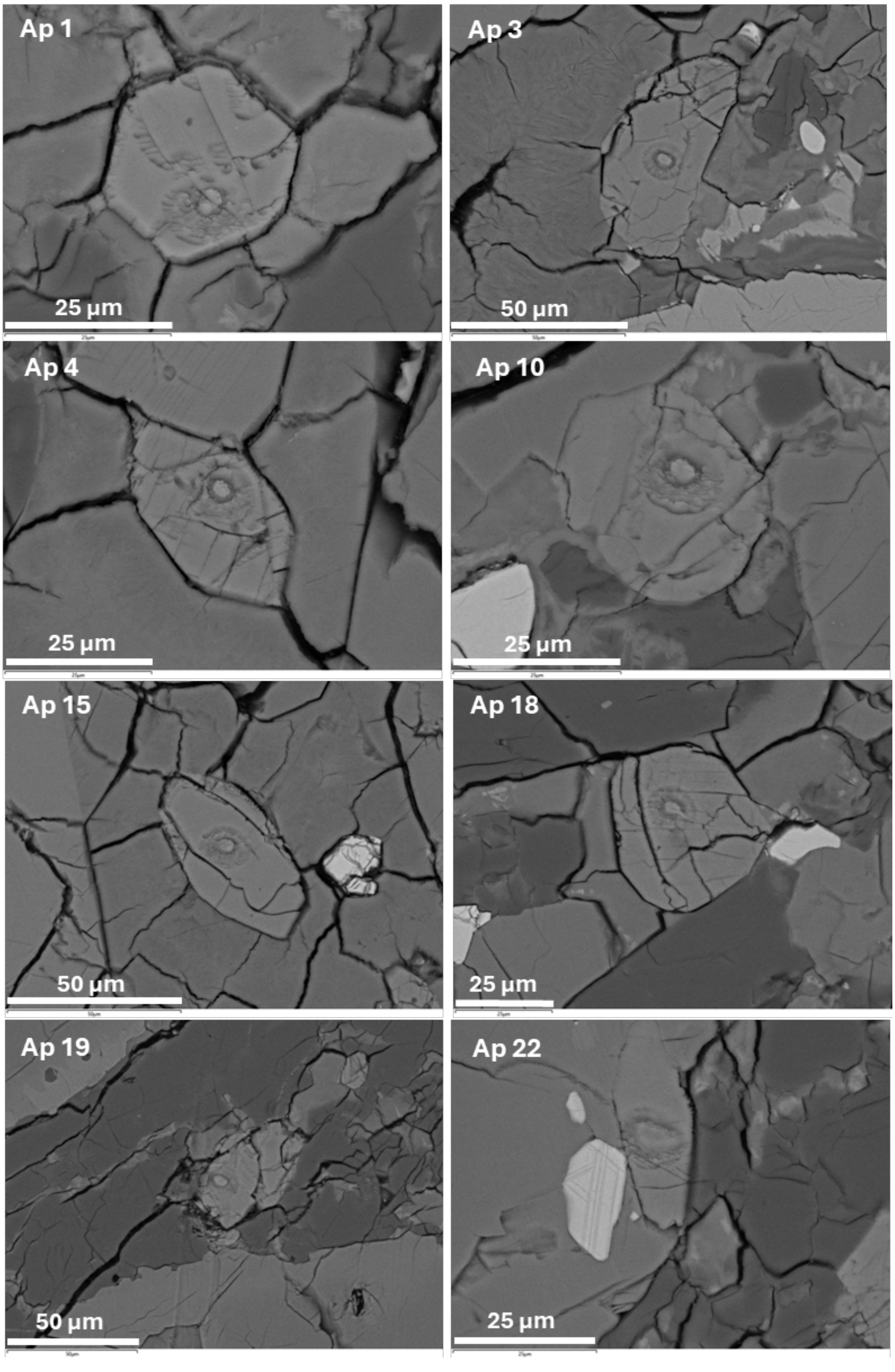

Figure S2: Backscatter electron images of the Lafayette apatite SIMS pits.

Table S1: Electron microprobe uncertainties and detection limits for each measured element (wt %)

Element	Uncertainty (2σ)*	Detection limit (μg/g)
P	0.328	913
Si	0.017	57
Ti	0.005	131
Al	0.004	57
Cr	0.024	81
Fe	0.020	124
Mn	0.009	122
Mg	0.002	79
Ca	0.270	669
Na	0.023	805
K	0.007	62
S	0.022	56
F	0.216	1972
Cl	0.032	57

*n=3 analyses of standard apatite

Supplementary References

Davidson J., Wadhwa M., Hervig R.L. and Stephant A. (2020). Water on Mars: Insights from apatite in regolith breccia Northwest Africa 7034. Earth and Planetary Science Letters 552, 116597. https://doi.org/10.1016/j.epsl.2020.116597

Mane P., Hervig R., Wadhwa M., Garvie L. A. J., Balta J. B. and McSween Jr H. Y. (2016). Hydrogen isotopic composition of the Martian mantle inferred from the newest Martian meteorite fall, Tissint. Meteoritics and Planetary Science 51, 2073-2091. https://doi.org/10.1111/maps.12717

Stephant A., Garvie L. A. J., Mane P., Hervig R. and Wadhwa M. (2018). Terrestrial exposure of a fresh Martian meteorite causes rapid changes in hydrogen isotopes and water concentrations. Scientific Reports 8, 12385. https://doi.org/10.1038/s41598-018-30807-w