

D/H of Lunar water: Implications for the origin of the Earth's water

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We have used a new ion microprobe technique that combines quantitative spot analyses with semi-quantitative 2-D ion imaging to study ¹H and D distributions in individual apatite grains {Ca₅(PO₄)₃(F, Cl, OH)} in a range of lunar rocks collected during the Apollo program. We find the Moon has abundant water and a distinct range of D/H compared to known water sources in the solar system. Our results suggest a significant delivery of cometary water to the Earth-Moon system shortly after the giant impact. A 10% contribution of cometary water to the Earth's oceans is indicated by our data.

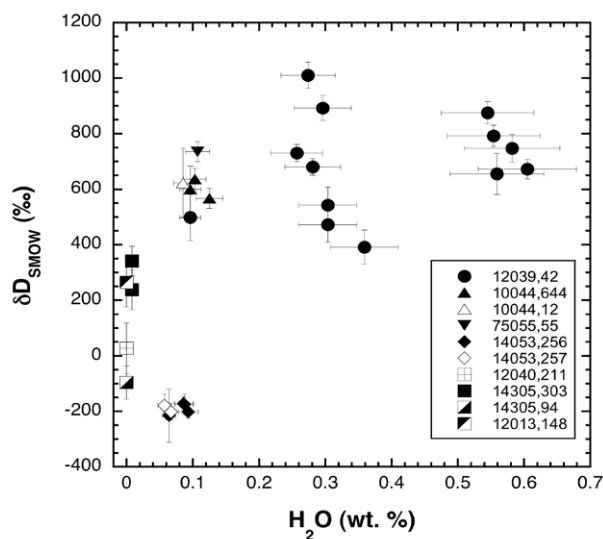


Figure 1: δD vs. H_2O (wt.%) of lunar apatite grains from mare basalts, highland alkali anorthosite clast (14305, 303) and two highlands breccias (14303, 94 and 12013, 148).

Seawater calcium isotope record over the Paleocene-Eocene Thermal Maximum

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Calcium carbonate ($CaCO_3$) sedimentation in the ocean represents the largest calcium (Ca) and carbon (C) sink in the combined atmosphere, biosphere, and ocean system, thus connecting the global C and Ca cycles. The Ca isotope record over the Paleocene-Eocene Thermal Maximum (PETM) will be examined at high resolution (20ky) using coeval marine barite and bulk marine $CaCO_3$ from ODP Leg 199, Site 1221C from 55.1 to 54.9 Ma. The marine barite Ca isotope record decreases briefly at the P-E boundary and then immediately increases in values to a maximum at the highest accumulation rates of $CaCO_3$ in this core; and quickly returns to values near modern day seawater. This record will be compared to a bulk carbonate Ca isotope record from the same site.

Short term imbalances in marine Ca sources and sinks could have resulted from extreme shoaling of the CCD and may be reflected in seawater Ca concentrations and Ca isotopic composition. It has been shown that theoretically [1] in a 'buffered' ocean dominated by biogenic pelagic $CaCO_3$ sedimentation, as long as the pelagic flux of $CaCO_3$ (sink) remains greater than the riverine flux (source) of CO_3^{2-} , the deep ocean CO_3^{2-} concentration and thus $CaCO_3$ saturation remains stable. Moreover, the global marine Ca cycle is likely stabilized (as is the case at the Eocene-Oligocene Transition [2]). However, during the PETM when the pelagic flux could have significantly decreased relative to the riverine flux, large changes in the marine Ca (and C) cycles could occur. A simple isotopic mass balance model is constructed to compare predicted and observed isotopic fluctuations over a range of potential scenarios.

[1] Zeebe & Westbroek (2003) *Geochem. Geophys. Geosyst.* **4**, 10.1029/2003GC000538. [2] Griffith & Paytan (2009) *EOS Trans. AGU*, Abstract PP31B-1314.