Differentiated Precursor Bodies as a Source of Earth's Water

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Differentiated planetesimals possibly were Earth's main rocky precursors [1], and Earth's volatiles acquired during accretion [2] may stem from such differentiated materials. Achondrite meteorites provide direct information as to the amount of water accreted before a late veneer. We measured ^{1}H in pyroxene in 5 achondrites to estimate total H_2O in Vesta, the angrite (APB), and ureilite (UPB) parent bodies. Our results demonstrate that differentiated planetesimals had abundances of water similar to Earth's upper mantle.

The Cameca ims 1270 ion microscope at Hokkaido University with live SCAPS 2-D ion imaging was used to measure ^{1}H in pyroxene in eucrites Juvinas and Pasamonte, volcanic angrite D'Orbigny, plutonic angrite NWA 4590, and ureilite PCA 82506. Spots were pre-sputtered for 30 sec with a 10keV Cs+ primary beam over a 20x20 μm area and $^{1}H/^{30}Si$ was determined from a central 5x5 μm area in 20 cycles. Six pyroxene standards [3] and 1 ppm wt H_2O glass were mounted in low-temperature metal for calibration. We compare whole-chip mounting of Juvinas (3±3 ppm wt H_2O), D'Orbigny (10±2 ppm wt H_2O), NWA 4590 (4±3 ppm wt H_2O), and PCA 82506 (12±2 ppm wt H_2O) to grain mounting of Pasamonte (2±3 ppm wt H_2O), and confirm previous estimates of eucrite and angrite H_2O [4].

Clinopyroxene-melt partition coefficients, batch melting equations, and literature models of meteorite genesis were used to calculate a range of parent body H_2O contents. Predicted water contents for Vesta (0 to 90 ppm wt H_2O), the APB (50 to 230 ppm wt H_2O) and the UPB (200 to 500 ppm wt H_2O) overlap with estimates of Earth's upper mantle, and support the idea that during the planetesimal-embyro stage of growth, 10's to 100's ppm H_2O could have been accreted by Earth.

[1] Young E. D. (2017) *Nature*, **549**, 461-462. [2] Dauphas N. & Morbidelli A. (2014) http://arxiv.org/abs/1312.1202. [3] Kumamoto K. M. et al. (2017) *Am. Mineral,* **102**, 537-547. [4] Sarafian A. R. et al. (2017) Phil. Trans. R. Soc. *A, 375:* 20160209.