Inner Solar System D/H Ratios: Implications for Planet Formation

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Once all secondary processes have been stripped away, inner Solar System D/H ratios appear to be relatively homogeneous compared to the variation in D/H ratios reported from the outer Solar System. Meteorites from Vesta, C-type asteroids (C-chondrites) and Mars, along with terrestrial primitive deep mantle material, indicate the initial D/H ratios of water in these planetary bodies lie between ~δD +200 ‰ and −590 ‰ [1]. This range can be narrowed if the most negative values from the Martian mantle (δD approx. −100‰ [e.g., 2]) are assumed to be the most representative (with the least input from the D-enriched Martian atmosphere). In addition, the CR chondrites have higher water D/H ratios than the other C-chondrite groups, which may be a product of oxidation rather than a reflection of the original parent body D/H ratio [e.g., 3]. If this is the case, the range of inner Solar System water D/H can be reduced to between ~ δD −100 ‰ and −590 ‰ [1]. This range does not include the S-type asteroids (O-chondrites), which can have very high D/H ratios – up to δD 12000 ‰ in ordinary chondrite IOM [4]. These high ratios appear to be a product of oxidation in the meteorite, rather than a reflection of the original parent body D/H ratio.

Numerous studies have attempted to recreate Earth from different types and proportions of chondritic meteorites. However, none of these studies have successfully recreated the abundances of all elements. $^{15}N/^{14}N$ appears to be relatively homogeneous between Vesta, the Moon, Mars and Earth, but the C-chondrites, particularly the CRs and CMs, have heavier N isotope ratios [1]. In addition, terrestrial noble gas (Ne and Xe) signatures from primitive mantle sources suggest the presence of a solar component [1]. This talk will focus on recent research, which suggests that accretion of some nebula gas or solar wind is the only way to explain the bulk Earth, Mars, and probably the other terrestrial planet, volatile isotopic compositions.

References: [1] Hallis (2017) *Phil. Trans. A (in press), and references therein*. [2] Hallis et al. (2012) *EPSL* 359-360, 84-92. [3] Le Guillou C. et al. (2015) *EPSL* 420, 162–173. [4] Alexander CMO'D, et al. (2010) *GCA* 74, 4417–4437.