

HYDROGEN ISOTOPIC EVOLUTION OF WATER AND ORGANIC COMPOUNDS ON CARBON-RICH ASTEROIDS. L. Piani¹ and L. Remusat², ¹Department of Natural History Sciences, Hokkaido University, Japan (laurette@ep.sci.hokudai.ac.jp). ²IMPMC, UMR CNRS 7590 - Sorbonne Universités - UPMC - IRD - MNHN, France.

Introduction. Organic matter and hydrated minerals found in primitive meteorites (chondrites) are the remnants of organic and water components of the protoplanetary disk 4.6 billion years ago. These phases show systematic but variable enrichments in the heavy isotopes of hydrogen comparing to the Sun. Although at least a part of these enrichments argues for low temperature ion-molecule reactions in the protoplanetary disk or in the molecular cloud, it is unclear how these isotopic signatures might have been modified by chemical reactions (kinetic fractionation or isotope exchanges) occurring on the asteroidal parent body.

In situ variations of hydrogen isotope compositions at the micrometer-scale in chondrites can help to trace the chemical processes on water- and carbon-rich asteroids. By constraining the extent of these reactions, the composition of the initial water and organic components before incorporation in meteorite parent asteroids might also be constrained.

Method. We are measuring the D/H and C/H ratios of matrices in different carbonaceous chondrites (CCs) at the scale of some micrometers by using SIMS IMS-1280 at Hokkaido University. Depending on the position of the primary beam in the matrix, the D/H and C/H ratios vary as a function of the relative amount of organic matter to hydrated minerals. The presence of correlation between the two ratios allows the water isotopic composition to be estimated for each chondrite.

Results and discussion. Using multiple measurements in a first set of CCs included Orgueil (CI), Murchison (CM) and Renazzo (CR), we estimated the δD of water to be -15 ± 90 , -75 ± 84 , and $647 \pm 182\%$ (2σ), respectively. As far as we know, this is the first direct measurement of water δD in individual carbonaceous chondrites. So far, water δD value was calculated by subtraction of the organic matter contribution to the bulk with an uncertainty difficult to estimate [1, 2]. Relative to the δD of initial water in CM and CR parent bodies (at the time of the accretion), i.e. -444 and 96% , respectively [3], the higher δD values we measured for water after parent body processing show that interactions between water and organic matter probably occurred during aqueous alteration. However, the δD of water being still lower than the one of the organic compounds in a given chondrite, it seems that isotopic equilibrium was not reached between the two phases in agreement with previous observations [4].

Finally, other CCs are under investigation in order to cover a larger range of different degrees of parent body aqueous alteration and/or metamorphism.

References. [1] Robert and Epstein, 1982. *GCA*, 46, 81-95. [2] Alexander et al., 2010. *GCA*, 74, 4417-4437. [3] Alexander et al., 2012. *Science*, 337, 6095, 721-723. [4] Remusat et al., 2010. *ApJ*, 713:1048-1058.

LIGHT ELEMENT ISOTOPE ABUNDANCE OF CHONDRITIC ORGANIC SOLIDS: A SIGNATURE OF INCOMPLETE ISOTOPE EXCHANGE? G. D. Cody¹, Y. Kebukawa², and C. M. O'D Alexander³. ¹Geophysical Laboratory (5251 Broad Branch Rd. NW, Washington DC, USA, 20015 gcody@ciw.edu), ²Yokohama National University. ³Department of Terrestrial Magnetism, Carnegie Institution of Washington.

The isotopic (hydrogen, carbon and nitrogen) abundances in chondritic organic matter and comets (observed as Interplanetary Dust Particles IDP's) has long fascinated cosmochemists. H and D abundances have enjoyed the greatest scrutiny. It is generally understood and agreed upon, that deuterium enrichment signals a connection to cold environments, such as in molecular clouds, what is less agreed upon is at what stage does deuterium enrichment imprint on the organic solids.

Over the past several years we have been studying the mechanism of organic solids synthesis. We find that formaldehyde (a very common molecule in the galaxy and ubiquitous in molecular clouds) polymerizes with itself yielding complex organic solids that, at a functional group level, are identical to organic solids observed in chondrites, IDP's and comets [1-3].

We now understand how organic solids form from formaldehyde and over what temperatures they can form [1-3]. In previous studies [4] no systematic relationship between organic molecular structure and δD was observed. This was surprising, as there exists a clear trend in molecular evolution of organic solids that reflect parent body processing [5,6]. This appeared to imply that there was no connection between processing within planetesimal interiors and bulk isotope compositions (δD , $\delta^{13}C$ or $\delta^{15}N$); further suggesting that variation in light element isotope compositions were primordial, i.e., inherited from the beginning- i.e., before the organic solids formed.

The recent studies of the so-called Tagish Lake (TL) lithologies [7-9] provide a completely unique perspective on at least the δD content of organic solids. Surprisingly, within a single meteoroid, one finds the full range molecular structural variation observed across all primitive meteorite classes (CR, CI, and CM)[5] in a single object [7,8]. However, within the TL lithologies one now observes a very clear relationship between molecular structure and δD [8]. More significantly, a recent study comparing the deuterium abundance in mineral bound water and D abundance in isolated organic solids in the TL lithologies, appears to very clearly show evidence of incomplete isotope exchange [9]. These data suggest that isotope exchange is a fundamental process that affects isotope abundance in chondritic organic solids. This suggests that what happens in the parent body interior is key towards understanding light element stable isotopic abundance-this not a majority point of perspective.

We now think we understand how formation and subsequent alteration affects change in intrinsic isotope abundance (δD , $\delta^{13}C$ and $\delta^{15}N$). In this talk we will discuss these matters and their significance.

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