

HYDROGEN ISOTOPIC RATIO IN IRON METEORITES

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Introduction: Even though a possible condensation from the Solar Nebula is sometimes considered [1], it is generally assumed that Iron Meteorites are samples of cores from differentiated parent bodies [2]. The D/H ratio being significantly different between the protosolar Hydrogen ($(D/H)_{H_2} = 20 \pm 5 \times 10^{-6}$ [3]) and Hydrogen coming from water reduction during planetesimal differentiation ($(D/H)_{\text{condritic water}} = 150 \times 10^{-6}$ [3]) it can be used as an indicator of the origin of Hydrogen in the Iron Meteorites. Therefore, an analytical technique for measuring the D/H ratio of Iron meteorites using ion microprobe has been developed.

Method: Hydrogen isotopic composition is determined with the CAMECA IMS 3f at the National Museum of Natural History in Paris, France. Samples are mounted either in epoxy and Au-coated or as polished thin sections and sputtered with a primary positive Cs^+ beam. Entrance and Exit slits as well as the Energy slit are kept wide open. Under these conditions, the mass resolution is <400 (note that with the Cs^+ primary beam, the possible mass interference between H_2^+ and D^+ is negligible).

To reduce to a minimum the contribution of absorbed water at the surface of the sample, we use a large ion spot ($500 \mu m$) combined with a $150 \mu m$ aperture field, so that the ions from the center of the “crater” are selectively collected. The intensity has to be increased up to 40 nA in order to reach 10^4 cps for H and 10 for D. Data were collected in peak jumping mode, with counting time of 5 and 15 sec. for H^+ and D^+ respectively.

Results: 5 Irons and the Bencubbin Meteorite have been analysed so far. The D/H ratio lies between $113 \pm 5 \times 10^{-6}$ and $158 \pm 30 \times 10^{-6}$ for [H] concentrations between 2 and 50 ppm. [H] and D/H are not correlated. H from the IAB Iron meteorite Copiapo has been pyrolyzed under vacuum at $1200^\circ C$; its D/H ratio calibrated relative to SMOW is used as our “house” standard [2]. The 1 sigma error calculated from the reproductibility on 100 D/H determinations (2 hours of depth profiling; about 0.6 microns) is somewhat higher than the statistical precision i.e. $\pm 8\%$ and $\pm 2.7\%$, respectively.

A particular care was taken to assess any possible source of terrestrial contamination. Several experiments were carried out to measure the depth of penetration of the terrestrial contamination. First, a sample from the IIA Coahuila meteorite was polished with deuterated alcohol. The polluted area did not exceed 100 nm in depth. Secondly, a sample from the Ungrouped Mont Dieu meteorite has been immersed in water to identify the geochemical signature of the rust. A depth profile of the O/Fe and H/Fe ratios clearly shows that the rusty zone is confined to the surface. However, the same experiment performed with D_2O shows that hydrogen diffuses deeply in the sample; the D/H ratio varies from 1×10^{-1} at the surface to 2×10^{-3} at 100 μm depth corresponding to a contribution of 2‰ of terrestrial water in our analyzed samples.

On the contrary, the same experiment carried out on a gold foil, showed that the deuterium stays strictly on the surface.

References: [1] Varela M. E. et al. 2010. Abstract #1316, 41th Lunar & Planetary Science Conference. [2] Defouilloy C. et al. 2010. #1340 41th Lunar & Planetary Science Conference. [3] Deloule E. and Robert F. 1995. *Geochimica and Cosmochimica Acta* 59: 4695 – 4706.