Extreme H isotopic anomalies in chondritic organic matter

Conference or Workshop Item

EXTREME H ISOTOPIC ANOMALIES IN CHONDRITIC ORGANIC MATTER. H. Busemann[1], C. M. O'D. Alexander[1], P. Hoppe[2], L. R. Nittler[1], and A. F. Young[1]. [1]DTM, Carnegie Institution of Washington, Washington DC, 20015, USA. E-mail: busemann@dtm.ciw.edu. [2]MPI for Chemistry, Mainz, Germany.

Introduction: Organic matter in meteorites and interplane-tary dust particles (IDPs) show isotope enrichments in D and ^{15}N testifying to the partial origin of this material in the protosolar cloud [1]. Spatial correlations, carriers and associated minerals of these anomalies are not well characterized. We have conducted ionprobe (IMS6f and NanoSIMS) imaging studies of various samples for H, D, C, ^{14}N and ^{15}N. These will ultimately be correlated with micro-analytic techniques such as FIB/TEM or STXM/XANES. We analyzed matrix fragments from Bells (CM2), Al Rais (CR2) and Tagish Lake (unique) [2], high purity insoluble organic matter (IOM) [3] extracted from EET92042 ("EET", CR2), Bells, Murchison (CM2), Allende (CV3), Krymka (LL3.1) and, for comparison, 3 IDPs.

We have found extreme enrichments in D in the IOM of EET, ^{15}N excesses (correlated and uncorrelated with D) in the same material and in Bells matrix fragments [4]. These anomalies exceed all but one of the enriched hotspots found in IDPs. Hence, the IOM in primitive meteorites retained a memory of interstellar chemistry that is comparable to that found in IDPs.

Ionprobe calibration: We measured a range of well-characterized organics including coals, a lipid and meteoritic IOM [3] to assess potential matrix effects that may hamper the *absolute* determination of D/H and C/H by ionprobe raster imaging with the IMS6f ionprobe. While the instrumental mass fractionation for D/H is within 15 % for all samples, we found variations in C/H that depend on the samples' elemental compositions. Samples with low C/H (e.g. EET) are well behaved, but those with large C/H (e.g. Allende) have proved difficult to calibrate.

Results and Discussion: While the bulk IOM in EET is δD~3000 ‰ [3], about 1 area% of the material exhibits larger D isotope anomalies. We found 22 regions (diameter ≥1.4 µm, ~beam size) that show δD values of 5000–16000 ‰. C/H in these regions is comparable to the bulk IOM value. D "hotspots" were also found in the Murchison IOM, reaching values of ~1700 ‰, indicating that some primitive material has survived the parent-body processes that have modified the IOM in CM chondrites [3]. The highest δD values (~16000 ‰) in the EET IOM exceed those found in all but one IDP [5,6] and approach the δD value obtained for cometary HCN [7]. This IOM is an agglomerate of matter assembled by the demineralization of bulk rock. The actual D "hotspots" could well be much smaller than our beam size and the δD accordingly higher. The results show that the parent bodies of the most primitive carbonaceous meteorites acquired an assemblage of IOM as primitive as the parent bodies of the IDPs.

References: [1] Ehrenfreund P. & Charnley S. B. 2000 *Annual Review Astronomy Astrophysics* 38:427-483. [2] Young A. F. et al. 2004. #2097. 35th Lunar Planetary Science Conference. [3] Alexander C. M. O'D. et al. 2005. *Meteoritics and Planetary Science* 40: this volume. [4] Nittler L.R. et al. 2005. *Meteoritics and Planetary Science* 40: this volume. [5] Aléon J. et al. 2001. *Geochimica and Cosmochimica Acta* 65: 4399-4412. [6] Messenger S. 2000. *Nature* 404: 968-971. [7] Meier R. et al. 1998 *Science* 279: 1707-1710.