Extensive microscale N isotopic heterogeneity in chondritic organic matter

Conference or Workshop Item

EXTENSIVE MICROSCALE N ISOTOPIC HETEROGENEITY IN CHONDRITIC ORGANIC MATTER. L. R. Nittler[1], P. Hoppe[2] , C. M. O'D. Alexander[1], H. Busemann[1], and G. Cody[1]. [1]Carnegie Institution of Washington, Washington DC, 20015, USA, lrn@dtm.ciw.edu, [2]MPI for Chemistry, Mainz, Germany.

Introduction: H and N isotopic anomalies (mainly excesses of D and ^{15}N) in organic matter from primitive meteorites and IDPs suggest preservation of presolar molecular cloud material [1-3]. However, there have been very few spatially correlated H and N studies for either chondrites or IDPs [4, 5]. We report C and N isotopic imaging data for organic matter from four meteorites and three IDPs. D/H imaging data for many of the same samples are presented in [6, 7] and bulk organic isotope data in [8].

Samples and Methods: We used the Mainz NanoSIMS to acquire C and N isotopic ratio images from matrix fragments of Tagish Lake and Al Rais (CR2), purified insoluble organic matter (IOM) from EET 92042 (CR2) and Bells (CM2) and three IDPs. Except for the Bells IOM, 5-20 μm particles were pressed into Au foil and first analyzed by D/H isotopic imaging [6, 7]. Microtomed (S-embedded) slices of Bells IOM were deposited directly onto a Au mount. NanoSIMS techniques were very similar to those used by [5]. Isotopic ratios were calculated for individual 0.2-1μm diameter regions within images and data were calibrated using the measured bulk isotopic compositions of the Bells IOM [8]

Results and Discussion: We found few resolvable C isotopic anomalies, most of which appear to be associated with presolar SiC grains. All samples showed mostly homogeneous $^{15}N/^{14}N$ ratios within 10-20% errors on <0.5 μm scales, with a few percent of the imaged areas showing significantly different ratios (both high – "hotspots" and low –"coldspots"). The highest $\delta^{15}N$ values in Tagish Lake, Al Rais, EET 92042 and the IDPs are similar to those previously observed in IDPs and CR2 chondrites (≥1,000‰, [3, 9]). In contrast, Bells IOM has significantly higher $\delta^{15}N$ values. Although its bulk value (+415 ‰ [8]) is comparable to typical bulk IDPs, several regions have values >2,000‰, with one 200 nm region reaching ~3,000‰. Bells also showed a ~3μm diameter coldspot ($\delta^{15}N = -65‰$). SEM examination revealed no difference in composition or morphology for the isotopically unusual areas, compared to the bulk IOM. Although some D hotspots are clearly associated with enhanced ^{15}N, there is little spatial correlation between the H and N isotopic ratios. In fact, most of the highest D and ^{15}N hotspots are not associated with each other, indicating that, for the most part, presolar D and ^{15}N anomalies are contained in distinct organic carriers. Moreover, Bells reaches $\delta^{15}N$ values higher than can be explained by low-temperature interstellar chemistry, perhaps reflecting contributions from stellar nucleosynthesis or UV self-shielding.

References: [1] Messenger S. 2000. *Nature*, 404: 968-971. [2] Alexander C. M. O'D. et al. 1998. *Meteoritics and Planetary Science*, 33: 603-622. [3] Floss C. et al. 2004. Science, 303: 1355-1358. [4] Aléon J., et al. 2003. *Geochimica et Cosmochimica Acta*, 67: 3773-3783. [5] Messenger S. et al. 2004. #1347. 35th Lunar and Planetary Science Conference. [6] Young A. F. et al. 2004. Abstract #2097. 35th Lunar and Planetary Science Conference. [7] Busemann H. et al. 2005. this conference. [8] Alexander C. M. O'D. et al. 2005. this conference. [9] Floss C. and Stadermann F. J. 2005. Abstract #1390. 36th Lunar and Planetary Science Conference.