NITROGEN ANOMALIES IN CARBONACEOUS METEORITES: IMPRINT FROM A SOLAR SYSTEM PROCESS?
Maitrayee Bose[1] and Sandra Pizzarello[2], [1,2]Department of Chemistry and Biochemistry, Arizona State University, Tempe AZ 85287. Corresponding authors: maitrayee.bose@asu.edu, sandra.pizzarello@asu.edu.

Introduction: The nitrogen-bearing organic molecules observed in the local interstellar medium, protosolar environments, and comets can be a source of the life's building blocks on earth [e.g., 1, 2]. The nitrogen isotopic composition of extraterrestrial materials can help decipher the origin of these molecules, and their possible evolution in these primordial environments. A large portion of the organics in carbonaceous chondrite meteorites is in the form of insoluble organic matter (IOM), which is isolated from a piece of meteoritic rock by HF-HCL treatments, and therefore deemed resistant to chemical treatment and contain abundant submicron-sized 'hotspots' with ^{15}N excesses [e.g., 3]. Other laboratory analysis of IOM extracted from meteorites has revealed the complexity of this material [e.g., 4]. More recent work has shown that IOM releases ammonia under hydrothermal treatment (HT), the lost ammonia displays ^{15}N enrichments from +45‰ to +455‰, and is related closely to the mineralogy and classification of the meteorites [5].

In order to better understand the characteristics of the IOM, we analyzed the IOM from several meteorites before and after HT to evaluate possible relationship between the ^{15}N-rich hotspots and the released ^{15}N-rich ammonia.

Analytical Details: The carbonaceous chondrites that were studied include Murchison (CM2), Ivuna (CI1), Bells (C2-ung), Tagish lake (C2-ung), GRA 95229 (CR2), Allende (CV3), Sutter's Mill (C-ung). Hydrothermal experiments were conducted in sealed gold tubes and degassed water at 300°C and 100MPa for 6 days.

Fragments of IOM and HT-treated IOM were mounted, documented and imaged in the NanoSIMS 50L. A 16 keV, <1pA Cs^+ primary ion beam with a beam diameter of <50nm scanned and sputtered the sample surface while acquiring mass filtered images of $^{12}C^-$, $^{13}C^-$, $^{12}C_2^-$, $^{12}C^{14}N^-$, $^{12}C^{15}N^-$, $^{28}Si^-$, as well as secondary electrons in multicollection mode. The instrument was operated at high mass resolving powers so as to separate isobaric interferences from $^{13}C_2$, $^{10}B^{16}O$, $^{13}C^{12}CH$ and $^{11}B^{16}O$, $^{13}C^{14}N$ at mass 26 and 27, respectively. A 50−100 pA Cs^+ beam achieved by the D1-1 aperture was used to pre-sputter for ~5 minutes to achieve steady state sputtering. Each ion image is composed of a stack of 6-10 cycles. For each cycle, a $10\times10\mu m^2$ or $15\times15\mu m^2$ areas decomposed into 256×256 pixels is measured for 10−15 ms/pixel dwell time. About $4000\mu m^2$ areas on each IOM and HT-treated IOM mount covered with >75% material were measured. Isotopically anomalous 'hotspots' defined by micron-sized regions in the ion images that exhibit ^{15}N excesses were identified after applying a threshold. The $\delta^{15}N$ value of the hotspots is >3σ away from terrestrial ratios, the anomaly is present in more than 3 consecutive layers for a given measurement, and regions with C/Si ratios of ~1 & C-anomalies are ignored because they are possibly presolar grains.

Results: The $\delta^{15}N$ of the hotspots upon HT appears to be related to the $\delta^{15}N$ of the ammonia released upon HT (Figure 1). The average $\delta^{15}N$ of the hotspots is inversely correlated to the $\delta^{18}O$ of the meteoritic matrix. Implications of these data will be discussed at the meeting.

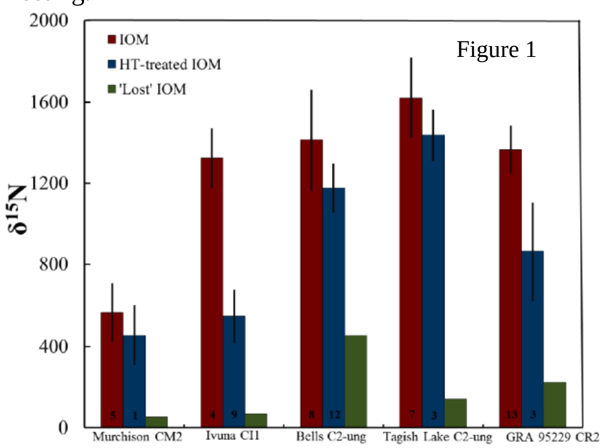

Figure1: Histograms showing the extent of ^{15}N excesses in carbonaceous meteorites before and after HT, and the $\delta^{15}N$ of the ammonia from [5]. The meteorite names and the number of hotspots identified in each sample are listed at the base of the plot.

References: [1] Adande G. R. & Ziurys (2012) *ApJ* 744:194-208. [2] Bockelée-Morvan D et al. (2008) *ApJL* 679:L49-L52. [3] Busemann H. et al. (2006) *Science* 312:727-730. [4] Cody G. D. et al. (2002) *GCA* 66:1851-1865. [5] Pizzarello S. & Williams L. B. (2012) *ApJ* 749:161-166.