NITROGEN CARRIER IDENTIFIED IN ^{15}N EXTREME HOTSPOTS IN THE ISHEYEVO (CH/CB) METEORITE.

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Introduction: The metal-rich CH/CB-like meteorite, Isheyevo, has remarkably large ^{15}N enrichments: whole-rock enrichments reach $\delta^{15}N \approx 1500‰$ [1]. Rare chondritic clasts, incorporated in the Isheyevo parent body, contain anhydrous silicates and poorly ordered aromatic CI/CM-like organic matter [2,3]. These show uniform ^{15}N enrichments of ~1000–1300‰ with micron-sized hotspots approaching 5000‰ [2,3]. The $\delta^{15}N$ values for Isheyevo clasts are the highest measured in any solar system material. Due to the fine-grained nature of the clast matrix, we initiated FIB/TEM/NanoSIMS correlated petrographic-isotopic studies to identify the carrier(s) of bulk and hotspot ^{15}N enrichments to provide context for establishing possible origin(s) of these clasts and their extreme ^{15}N anomalies. TEM petrographic studies [4] have shown that these clasts, although retaining anhydrous silicates, are heavily hydrated with large quantities of amorphous ferrihydrite, highly disordered phyllosilicates (1–2 layer packets), oxidation of metal to framboidal magnetite and goethite and sulfides to tochilinite. The association of these ^{15}N hotspots with carbon-bearing, ferrihydrite-rich veins in the clasts strongly suggests a significant role for fluid on the clast parent body and, at a minimum, fluid involvement in redistributing and potentially concentrating ^{15}N-rich material [4].

Methods: Regions of clasts were isotope-mapped using the UH Cameca ims-1280 ion microprobe [2,3]. Outgassing from the polished section prevented higher-spatial-resolution isotope imaging with the Cameca NanoSIMS 50. Mapped areas were imaged by high-resolution secondary electron microscopy (JEOL JSM7401F FE-SEM) to correlate $\delta^{15}N$ and ^{28}Si maps with local mineralogy and textures. Focused ion beam thin sections with bulk and hotspot materials were extracted (FEI Nova600 NanoLab FIB) [4] for transmission electron microscopy analysis (FEI 300kV Titan TEM) followed by NanoSIMS mapping.

Results: TEM energy filtered imaging and electron energy loss spectroscopy (EELS) on the FIB sections demonstrate that N is spatially correlated with C both in the vein associated with the ^{15}N hotspot and in the less-enriched surrounding bulk region. Carbonaceous regions in the bulk region are diffuse whereas those in the hotspot-associated vein are concentrated with distinct morphologies. Briani et al. [5] excluded nanoglobules [6] from consideration as a ^{15}N carrier due to size and lack of correlated D enrichments but did not correlate high resolution TEM and isotopic results. In contrast, we determined that aromatic organic globules are, indeed, present in the vein and are interconnected by carbonaceous strands together capable of producing observed ~micron-sized hotspots. For the first time, N has been quantitatively measured *in situ* in a meteoritic sample by EELS. A globule in the hotspot vein contains N:C ≈ 5:95.

References: [1] Ivanova et al. 2008. *Meteorit. Planet. Sci.* 43: 915. [2] Bonal et al. 2009. Abstract #2046. *40th Lunar Planet. Sci. Conf.* [3] Bonal et al. 2010. *Geochim. Cosmochim. Acta* submitted. [4] Ishii et al. 2009. *Meteorit. Planet. Sci.* 44: A97. [5] Briani et al. 2009. *Proc. National Acad. Sci.* 106: 10522. [6] Nakamura-Messenger et al. 2006. *Science* 314: 1439.