A NEW MECHANISM FOR THE FORMATION OF CHONDRITIC INSOLUBLE ORGANIC MATTER FROM INTERSTELLAR FORMALDEHYDE

Y. Kebukawa[1], G. D. Cody[1] and C. M. O'D. Alexander[2]. [1]Geophysical Laboratory and [2]Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5251 Broad Branch Road NW, Washington, DC, 20015, USA. E-mail: ykebukawa@ciw.edu.

Primitive chondritic meteorites contain up to a few wt. % organic carbon, the majority of which consists of insoluble organic matter (IOM). The origin of IOM is still controversial. The high concentrations of deuterium and ^{15}N indicate that IOM preserves are signatures of low temperature chemistry in the interstellar or outer solar nebula [e.g. 1]. Cooper et al. [2] identified low molecular weight sugar-related compounds in the Murchison meteorite, and speculated that these compounds, and possibly IOM, were derived from interstellar formaldehyde via the formose condensation reaction. More recently, Cody et al. [3] suggested that IOM synthesis from formaldehyde through the formose condensation reaction could explain certain molecular spectroscopic features observed in primitive chondritic IOM.

Here we conducted formose condensation reaction experiments and compared the formose solids to chondritic IOM using various spectroscopic methods; solid state ^{13}C nuclear magnetic resonance (NMR), Fourier transform infrared (FTIR) spectroscopy and carbon X-ray absorption near edge structure (C-XANES).

The formose reaction involves polymerization of formaldehyde into sugars under basic conditions, and proceeds first through the condensation of formaldehyde to form glycolaldehyde. However, this step is kinetically very slow. So we initially added glycolaldehyde, which acts as an autocatalyst, and the reaction proceeds rapidly to form a black solid. The solids were collected after incubation for 3 days at 90ºC to 250ºC, with and without the presence of ammonia. We also conducted formose experiments using deuterated formaldehyde with H_2O and normal formaldehyde with D_2O, in order to evaluate isotopic exchange between organic matter and water, and D enrichment of each functional group by comparing ^{1}H-^{13}C and ^{2}H-^{13}C cross polarization NMR. We propose the formose condensation reaction as a new mechanism to produce large complex organic molecules found in chondritic meteorites.

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References: [1] Yang J. and Epstein S. 1983. *Geochimica et Cosmochimica Acta* 47:2199–2216. [2] Cooper J. et al. 2004. *Nature* 414:879–883. [3] Cody G. D. et al. 2009. Abstract #2325. 40th Lunar & Planetary Science Conference.