

**EVALUATION OF THE METEORITIC ALTERATION LEVEL USING THE SOLID-STATE CP/MAS  $^{13}\text{C}$  NMR ANALYSES OF MACROMOLECULAR MATERIAL IN THE ANTARCTIC CARBONACEOUS CHONDRITES**

H.Yabuta<sup>1</sup>, H.Naraoka<sup>2</sup>, K.Sakanishi<sup>3</sup> and H.Kawashima<sup>3</sup>.  
<sup>1</sup>Arizona State University, Tempe, AZ 85287 USA. E-mail: H-karu.Yabuta@asu.edu <sup>2</sup>Okayama University, Okayama, 700-8530, Japan. <sup>3</sup>National Institute of Advanced Industrial Science and Technology, Tsukuba, 305-8569, Japan.

**Introduction:** Most of the organic matter in carbonaceous chondrites is present as insoluble macromolecular material which is known to be structurally and isotopically heterogeneous [1]. The chemical properties and structures of this insoluble material have been investigated by pyrolytic [2] or oxidative degradation [3] and solid-state  $^{13}\text{C}$ -NMR [4,5], however, the history and the relationships between its constituents have not been revealed yet. In the present study, different carbon types were identified and quantified in the macromolecular material from Antarctic CM2 chondrites: [Yamato (Y) 74662, 791198, 793321; Belgica (B) 7904; Asuka (A) 881280, 881458]; and the Murchison meteorite by the solid-state CP/MAS  $^{13}\text{C}$  NMR. The ratios of aromatic to aliphatic carbon (*Aro/Al*) were estimated to evaluate the alteration level of each meteorite.

**Experimental:** Each powdered meteorite sample was demineralized repeatedly with 6N HCl and 8N HF/ 3N HCl, and then the carbonaceous material obtained was washed with methanol and dichloromethane. Elemental analyses were carried out by CHN elemental analyzer (Carlo Erba EA-1180).

**Result and Discussion:** The spectra of the macromolecular material of Murchison and Y791198 showed two broad peaks. One peak at 30 ppm was assigned to aliphatic carbon (*Al*-C) that is a sum of  $\text{CH}_2$  (at 33 ppm) and  $\text{CH}_3$  groups (at 15 ppm). Another peak at 130 ppm was assigned to aromatic carbon (*Aro*-C). The spectra of the other meteorites showed only one major peak of *Aro*-C. Its width and a shoulder at the 60-80 ppm range probably corresponded the *Al*-C linked to heteroatoms. Also, shoulders in the 150-180 ppm and 180-200 ppm ranges indicated the presence of carboxyl and carbonyl carbons, respectively.

The *Aro/Al* was plotted to the H/C ratio from elemental analysis and a linear relationship was observed. The meteorites with lower H/C showed higher *Aro/Al* and the ones with higher H/C showed lower *Aro/Al*. Naraoka, et al. [6] proposed a new parameter for the thermal alteration event using H/C ratio of the macromolecular material. The correlation between *Aro/Al* and H/C obtained in this study suggests that chemical structures of the macromolecular material in meteorites may reflect the thermal alteration level. It is proposed that aliphatic structures of the macromolecular material could have been aromatized or depleted during thermal alteration.

**References:** [1] Kerridge J. F. 1985. *Geochimica Cosmochimica Acta* 51:2527-2540. [2] Komiya, M. et al. 1993. *Geochimica Cosmochimica Acta* 57:907-914. [3] Hayatsu, R. et al. 1977. *Geochimica Cosmochimica Acta* 41:1325-1339. [4] Cronin, J. R. et al. 1987. *Geochimica Cosmochimica Acta* 51:299-303. [5] Cody, G. et al. 2002. *Geochimica Cosmochimica Acta* 66:1851-1865. [6] Naraoka H. et al. 2004. *Meteoritics & Planetary Science* 39: in press.