

VARIETIES OF CARBON MINERALS IN ANTARCTIC CARBONACEOUS CHONDRITES BY TEM AND THEIR IMPLICATIONS

Junji AKAI¹, Takayuki AOKI² and Hikaru Ohtani¹ ¹Department of Geology, Faculty of Science, Niigata University, Niigata, Japan; ² Asahi Carbon Co., Niigata, Japan

A variety of fine-grained carbonaceous materials are contained in Carbonaceous Chondrite (CC) matrix. However, Antarctic meteorites have not always been examined in detail. Eight Antarctic carbonaceous chondrites (Asuka-882094 (CO3), Yamato-86751 (CV3), Yamato-790992 (CO3), Yamato-81020 (CO3), Yamato-74662 (CM2), Yamato-86720 (CM2), Yamato-793321 (CM2), Belgica-7904 (CM2 or "CI1")), and Allende and Murchison were systematically examined in more detail. We developed a sample separation procedure of chemical dissolution, using HF (48% nitric acid) and aqua regia, at 348 K for 30 minutes.

TEM used is JEM-2010 (JEOL) and JEM-200CX with EM-SHH4 (heating holder). Zinc powder was used for temperature calibration. Multi-slice TEM simulation (MssC) was carried out.

Nano-diamond and "carbonaceous globules" were found from seven Antarctic chondrites. Diamond grains are clearly more abundant than well-crystallized graphite in the CC. About the origin of nano-diamond, a presolar CVD formation model has been widely accepted (e.g., [1]). Although some possibility of its formation on parent body is also suggested [2], the results of this study suggest that the presolar origin is more likely than the parent-body origin. As Nakamura-Messenger et al. (2006) [3] suggested, carbonaceous globules may be primitive carbon material formed in the outermost cold regions of protoplanetary disks. The results of this study indicate that nano-diamond and carbonaceous globules are very common constituents in CC. We carried out heating and cooling experiments of carbonaceous globules in electron microscopic observation mainly to examine their thermal stability and changes. Neither graphitization nor significant changes in shape and size were observed in heating at 773 K. ED patterns show that the globule remains amorphous even after heating. This result suggests that these carbonaceous globules can survive strong thermal metamorphism. Detailed TEM observation of boundary part of the doughnut-like globules was carried out. The carbonaceous globules are similar in size to the smallest bacteria in the recent Earth environments. If much carbonaceous globules were supplied onto the Earth surface in the early stage of its evolution, we suggest the possibility that they played some role in the birth and/or early evolution of life on the Earth.

Well crystallized graphite with 2H and 3R polytypes was also found mainly from CV3 and CO3 chondrites, whereas poorly crystallized graphite was found mainly from CM2 chondrites. Characteristic carbon structures similar to tetrahedral carbon on-ion etc. were found from a CM2 chondrite. Finally, correspondence of carbon mineral types to petrological classification of CC is summarized. We will discuss more about the implications.

References [1] Daulton, T. et al., 1996. *Geochimica et Cosmochimica Acta*, 60, 4853-4872. [2] Kouchi, A., et al., 2005. *The Astrophysical Journal*, 626, L129-L132. [3] Nakamura-Messenger, K., et al., 2006. *Science*, 314, 1439-1442.