ISOTOPE VARIATION AT NANOMOLAR CARBONATE IN THE MURCHISON METEORITE

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Introduction: Carbonate occurs in carbonaceous chondrites by up to ~0.3 wt% of the whole-rock sample with the ^{13}C-enriched composition (~+24 - +80‰ relative to PDB: [1]). The carbonate has been supposed to be formed as a secondary product through aqueous alteration from other carbon-bearing materials on the meteorite parent bodies. The C-bearing precursors have been unclear, although the ^{13}C-enriched species of organic matter as well as minor "exotic" components such as presolar graphite and SiC grains could play an important role for the δ^{13}C distribution [2]. For example, ^{13}C-enriched component has been generated by hydrous pyrolysis of macromolecular insoluble organic matter (IOM) [3]. The δ^{13}C variation in a single meteorite is relatively small compared to that for all classes of carbonaceous chondrites probably due to the different degree of aqueous alteration of the meteorites. However, δ^{13}C of the Murchison carbonate still ranges widely from +31.6 to +41.9‰ [1]. Because organic matter and presolar grains distribute heterogeneously in a meteorite, the detailed spatial examination can provide additional insights into processes of carbonate formation as well as aqueous alteration. As we have recently developed carbon and oxygen isotope analysis at nanomolar level CO_2, the isotope distribution is examined with relevance to its textures.

Sample and Analytical Procedures: The Murchison meteorite (CM2) is used in this study. In the preliminary examination, 0.2-2.3 mg samples of Murchison are treated with 100% phosphoric acid in an evacuated and sealed glass tube to give CO_2. The cryogenically purified CO_2 is analyzed by gas chromatography/isotope ratio mass spectrometry. For carbon isotope, analytical accuracy (±0.3‰) and precision (±0.3‰) have been established for a few nanomolar CO_2.

Results and Discussion: The CO_2 content in this study ranges from 15 to 89 ppm with the δ^{13}C value of +23.4 to +42.9‰. The δ^{13}C range of this study is consistent with that of previous report (+31.6 to +41.9‰) [1], showing a little wider variation. Because the meteorite amount used in this study (0.2-2.3 mg) is smaller than that used by previous study (19.5-52.9mg) [1], this wider isotope range could attributable to heterogeneity of carbonate. If the carbonate is a secondary product via aqueous alteration, this ~20‰ variation within a single meteorite specimen suggests that not only the precursor materials are present heterogeneously but also the aqueous activity is locally limited. Further investigations of small-scale isotopic variation with respect to meteorite textures promise better understanding for formation processes and origins of carbonate in meteorites.

References: [1] Grady M. M. et al. 1988. *Geochimica et Cosmochimica Acta*: 52, 2855. [2] Grady M. M. and Wright I. P. 2003. *Space Science Review*, 106, 231. [3] Oba Y. and Naraoka H. 2008. *Meteoritics & Planetary Science* submitted.