

## Stable isotope variation of carbonates and organic matters with relevance to textures in the Murchison meteorite

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### [Introduction]

Carbonaceous chondrites are most primitive meteorites that had experienced aqueous alteration on the meteorite parent body. Water has been believed to play a key role in the early evolution of solar system. Carbonate in the carbonaceous chondrites occurs by up to ~0.3 wt percent of the whole-rock sample with the  $^{13}\text{C}$ -enriched composition (+20 to +80 permill, VPDB: Grady et al., 1988) which has been supposed to be a secondary product from other carbon-bearing materials during aqueous alteration. The C-bearing precursors have been unclear, although they have been expected to be  $^{13}\text{C}$ -enriched materials such as presolar graphite and SiC grain as well as a part of organic matter. Within a single specimen of the meteorite, concentration and isotopic composition of the carbonate are highly heterogeneous (e.g. Grady et al., 1988). The detailed examination can provide insights into processes of carbonate formation as well as aqueous alteration. In this study, as the carbonate is likely to occur in different textures in carbonaceous chondrites, we have measured amount and isotope distributions of carbonate and organic matter in different textures for sub-mm scale to discuss the relationship between carbonate and organic matter.

### [Sample and Analytical Procedures]

A piece of the Murchison meteorite (CM2) was drilled to obtain powder samples (~0.5 to ~2.0 mg) selectively from multi-points of the following three texture types: 1) black area (predominantly matrix), 2) white area (predominantly CAI and/or chondrule), 3) boundary area between 1) and 2). In addition, the samples of arbitrary undistinguished grains (~0.4 to ~2.3 mg) were also used. The samples were reacted at 25 degrees Celsius for 18 hours to extract  $\text{CO}_2$  from carbonate with 100 percent phosphoric acid. After cryogenic purification, carbon and oxygen isotopic analyses of the  $\text{CO}_2$  were conducted by gas chromatography/isotope ratio mass spectrometry. Our developed isotope analysis gives analytical errors (1 sigma) of carbon and oxygen isotope ratios of plus or minus 0.3 permill and plus or minus 0.7 permill at more than 0.8 nmol for working-standard  $\text{CO}_2$  gas, respectively. Carbon isotopic composition of the acid-residue (mainly organic matter as carbon) after washing and drying was determined by elemental analysis/ isotope ratio mass spectrometry.

### [Results and Discussion]

The carbonate content in the Murchison meteorite ranges from 3 to 90 ppmC with the  $\text{d}^{13}\text{C}$  value of +23 to +48 permill in this study. This range of carbonate content is very lower than previous reports (80 to 2260 ppmC, Grady et al., 1988 and references there in). This result may mean different extent of aqueous alteration and heterogeneous existence of precursor materials of the carbonates in the meteorite parent body. The range of  $\text{d}^{13}\text{C}$  (+23 to +48 permill) is wider than previous reports (+31.6 to +45.4 permill: Grady et al., 1988 and references there in), indicating that isotopic composition of carbonates is more isotopically heterogeneous for smaller scale. The  $\text{d}^{13}\text{C}$  of the matrix part (i.e. black area) is relatively larger relative to that of CAI and chondrule area (i.e. white area). These isotope signatures may reflect isotopic difference of precursor materials and/or different isotope fractionations under different conditions. There is a negative correlation between the  $\text{d}^{13}\text{C}$  of carbonates and organic matters, suggesting a possibility that carbon source of carbonate is organic matter, as  $\text{CO}_2$  generated from organic matter had been precipitated as carbonate during aqueous alteration on the meteorite parent body.