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Correlations between D and ^{15}N-rich organic matters in a carbonaceous chondrite

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Carbonaceous chondrites contain organic matters that are enriched in D and/or ^{15}N [1-2]. The D and/or ^{15}N-rich organic matters are believed to have formed in molecular cloud or outer protoplanetary disk in early solar system [1-2], however, relationship between the D and ^{15}N enrichment is unclear. Previous study suggests that there are good correlation between D-rich and ^{15}N-rich region in organic matters of carbonaceous chondrite [1], but other studies suggest that the D and ^{15}N enrichment are not correlated [2].

In this study, we tried to analyze D and ^{15}N-rich organic matters in carbonaceous chondrite by in-situ analysis. We determined spatial distribution of D and ^{15}N enrichments of organic matters in NWA 801 CR2 chondrite by isotope imaging. Our previous study reported that the NWA 801 contains many D-rich organic matters [4]. The isotope imaging was performed using isotope microscope of Hokkaido university (Cameca ims-1270 + SCAPS [5]). The sample surface was homogeneously irradiated over a field area with a broad Cs^+ primary beam of ˜50 micron in diameter. Secondary ion images of H^-, D^-, $^{12}C^-$, $^{12}C^{14}N^-$ and $^{12}C^{15}N^-$ were obtained from a field. We obtained $^{12}C^-$ images before and after the analysis for a field to check whether carbonaceous matter was disappeared during the isotope analysis. Total integration time for a field was ˜10 minutes. After the isotope analysis, morphological observations of isotopically anomalous materials were performed by FE-SEM-EDS (JEOL JSM-7000F, Oxford INCA Energy).

Seven D-rich materials and six ^{15}N-rich materials were found in NWA 801 matrix of approximately 0.2 mm^2. ^{12}C were detected from the five D-rich materials and six ^{15}N-rich materials during measurements. The continuously D and ^{15}N enrichments were observed from different spots. Hydrogen isotopic compositions of the D-rich carbonaceous matters are 2,300-7,900 permil in delta-D. Nitrogen isotopic compositions of the ^{15}N-rich carbonaceous matters are 1,100-1,200 permil in delta-^{15}N. The morphologies of D-rich or ^{15}N-rich carbonaceous matters are determined by FE-SEM analysis. The D-rich and ^{15}N rich matters have similar morphology, which are round or irregular shaped carbonaceous globules, or aggregate of some carbonaceous globules.

The carbonaceous matters with D or ^{15}N enrichment might be organic matters that have formed in molecular cloud and/or outer protoplanetary disk in early solar system. Large D-rich and ^{15}N enrichment believed to have occurred in extremely cold region [6, 7]. The D or ^{15}N enrichments signatures suggest that they have survived through alteration on parent body of NWA 801. The lack of correlation between D and ^{15}N anomalies may be due to different origin for D and ^{15}N-rich carriers.

Other than these carbonaceous matters, two D-rich materials have not detected for ^{12}C peak in isotopography. Possibility of the carbonaceous matters for the D-rich materials are ruled out, because carbon was not detected in $^{12}C^-$ images obtained before and after the measurement. N related peaks were not detected at the D-rich spots. Hydrogen isotopic compositions of these D-rich materials are 3,400 and 3,800 permil. Si, O, Mg, Fe and Al were detected from these D-rich materials by the X-ray analysis. The results suggest that the D-rich materials are silicates and plausibly phyllosilicate because previous study revealed that phyllosilicates in Rennazo CR2 chondrite were enriched in deuterium [7].

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