

Assessing the irradiation effects by a synchrotron X-ray micro-computed tomography on the organic materials in carbonaceous chondrite: Examination at SPring-8 facility

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X-ray micro-computed tomography (μ CT) using a synchrotron light source is a strong tool to reveal the three-dimensional (3D) structure of the small particle including its mineralogy and the textures. It was applied to the regolith particles on the asteroid Itokawa, which were returned by the Hayabusa spacecraft, and helped to understand the origin and the evolution of the particles [1]. The subsequent Hayabusa2 mission succeeded in returning the samples (> 5 gram for a twice touchdown [2]) from the carbonaceous-type asteroid Ryugu in December 2020. The μ CT is planned as one of the initial analysis procedures of the Ryugu samples [3]. However, there is a concern about the effect of X-ray irradiation caused by μ CT on the organic materials in the Ryugu samples. The organic materials are generally sensitive to X-ray irradiation due to potential alteration and/or degradation processes. Thus, we performed an assessment to examine the effect of the μ CT procedure prior to the initial analysis. Friedrich et al. (2016) examined the effects of X-ray irradiation by μ CT to amino acids in Murchison meteorite (CM2) at the GeoSoilEnviroCARS (GSECARS) facility at the Advanced Photon Source (APS), Argonne National Laboratory and reported that there was no significant effect observed for the abundance of the amino acids [4].

The purpose of the study is to investigate the potential effect on the soluble organic materials, inorganic ions, and bulk element profiles in a carbonaceous chondrite caused by the X-ray irradiation of μ CT at the synchrotron SPring-8 [3]. We conducted the two sets of the irradiation experiments using a homogenized Murchison meteorites (CM2) powder. The one sample was irradiated with the typical condition as the usual μ CT analysis. The total irradiation time was around 5 minutes. The second sample was irradiated for a longer time (8.5 hours) at the same energy. These irradiated samples and the non-irradiated control samples were investigated using several analytical techniques. We analyzed the concentration of the amino acids, which are labile but important target molecules in Ryugu samples. We also analyzed the soluble ion components using ion chromatograph and inductively coupled plasma-mass spectrometry (ICP-MS) and the bulk carbon and nitrogen abundances using an elemental analyzer connected to isotope ratio mass spectrometer (EA/IRMS). In this presentation, we will overview the present organic and inorganic assessments for the sampling process of the μ CT description at SPring-8.

References:

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