

Combined XRD-XCT-FIB-TEM analysis of experimentally heated Murchison CM chondrite

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Hayabusa2 spacecraft succeeded to touchdown on the surface of C-type asteroid 162173 Ryugu and brought Ryugu surface materials to the earth in the last December. Spectroscopic observations [1] suggested that Ryugu surface consists of materials which are similar to partially dehydrated carbonaceous chondrites. This means that heated hydrous carbonaceous chondrites are the closest analogues to Ryugu surface material. Recently, we performed synchrotron radiation-based X-ray diffraction (SR-XRD) and X-ray computed nanotomography (SR-XCT) of unheated and experimentally heated (400 °C-50 hrs and 600 °C -50 hrs) Murchison CM chondrite particles (~50 μm in size) [2] as rehearsal analyses [3]. The SR-XCT results will be presented by Matsuno et al. and Sun et al. in this JpGU meeting. The synchrotron analyses revealed that hydrous phases, tochilinite-cronstedtite intergrowth (TCI) and Mg-rich serpentine, in the Murchison matrix were partially decomposed by 400 °C -50 hrs heating without significant changes in CT images. In this study, we extracted an ultrathin section from a 400 °C -50 hrs heated Murchison particle, which was previously analyzed by SR-XCT, using a focused ion beam system (FIB), and analyzed it by transmission electron microscopy (TEM) to investigate microstructural changes in the matrix caused by the heating.

The target slice section in the 400 °C -50 hrs heated Murchison particle for TEM observation was selected based on CT images. In the selection, we set a few mineral grains (0.5 to a few μm in size) in the CT images as specific phases which should be included in the ultrathin section. Then, the Murchison particle was mounted on the FIB sample stage appropriately and sliced carefully by comparing the FIB cutting surface images and the CT slice images one by one. Finally, we successfully obtained an ultrathin section (~20 × 20 μm) containing all the specific grains.

TEM observation revealed that the ultrathin section contains partially decomposed TCIs, which were replaced by relatively large (a few hundred of nm) Fe-Mg rich silicates and clusters of 10-20 nm sized magnetite. Previous SR-XRD analysis [3] suggested the presence of abundant magnetite in 400 °C -50 hrs heated Murchison samples, and is consistent with the TEM observation. The XRD peaks of magnetite were characteristic to 400 °C heated samples and were not found for unheated and 600 °C heated Murchison samples [3]. Therefore, the magnetite nano-grains replacing TCIs may be able to use as an indicator of relatively low degrees of heating for CM type chondrites. We will perform further FIB-TEM analysis and summarize microstructural changes in the Murchison matrix by 400 °C -50 hrs heating and other degrees of heating.

[1] Kitazato et al. (2019) *Science* **364**. [2] Mogi et al. (2017) *The 80th Annual Meeting of the Meteoritical Society*, Abstract #6225. [3] Matsumoto et al. (2020) *The JpGU-AGU joint meeting 2020*, Abstract PPS10-P09.

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