THE FORMATION OF A CARLOSTURANITE-LIKE PHASE DURING THERMAL DECOMPOSITION OF SERPENTINE IN C-COMPLEX ASTEROIDS.

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Introduction: Some Mighei-like carbonaceous chondrites (CMs) underwent post-hydration heating on their parent C-complex asteroid(s). This can result in the decomposition of serpentine, and the recrystallization of olivine and enstatite from its remnants [1]. In heated CMs, a transitional structure has been identified; it forms between the breakdown of serpentine and recrystallization of olivine and enstatite [2]. This phases's structure is unknown. In a prior heating experiment with X-ray diffraction (XRD) analysis of a bulk powdered CM, a peak at ~3.56Å associated with this phase was observed at 525°C; however due to peak overlaps with other phases, no other peaks of the transitional phase were identified [3]. To further characterize this phase, we heated two polished rock slices of the CM2 Murchison at 400–550°C and collected *in situ* micro XRD (µXRD) data to minimize peak overlap during heating.

Methods: The rock slices of Murchison (100 µm thick, ~1.8 mm^2 in area each) were heated in an inert N_2 atmosphere using a THMS600 Linkam cell connected to a TMS 94 temperature controller and an ECP water circulation pump. The samples were kept in place by a pair of Kapton disks and Linkam's vertical sample holder. The I18 beamline at the Diamond Light Source (DLS) was used to collect µXRD data for an array of points for a select area in each sample using a spot size of 2 µm and a wavelength of 0.826 Å. µXRD patterns were taken at room temperature prior to heating each sample 400-550°C in 25°C steps. The samples were held for two hours at each step and µXRD patterns were collected after an hour. Heating stopped at 550°C due to the disintegration of the securing Kapton. µXRD patterns of a set of standards were taken for comparison. The µXRD data was processed with Dawn-2.27 [4,5] and Rigaku SmartLab II software.

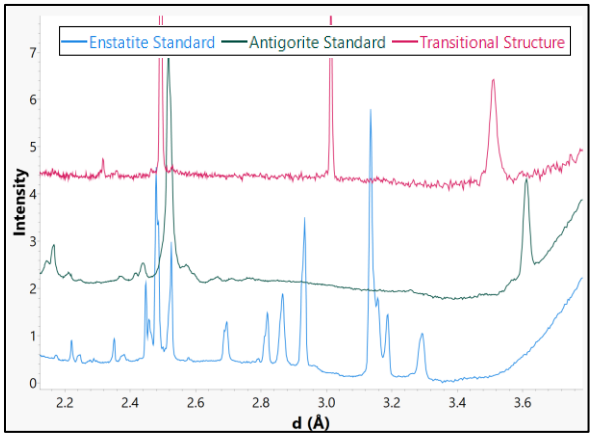

Fig. 1. Comparison of peak shapes for the transitional structure, and enstatite and antigorite standards.

Results: At 525°C, targets yielding a broad peak at ~3.51Å associated with the transitional phase were identified. The transitional structure was found to have additional peaks at 2.28Å, 2.31Å, 2.35Å, 2.49Å, 2.54Å, 3.04Å, and 3.51Å (Fig. 1). The peak shapes were most similar to that of the antigorite standard (Fig. 1), however their d-spacings best matched carlosturanite ($(Mg, Fe)_{21}Si_{12}O_{28}(OH)_{34}\cdot H_2O$), a phase related to antigorite [6].

Discussion: Because carlosturanite decomposes at 400°C and lacks a 3.04Å peak [6], it is not the transitional structure. However, the transitional structure likely shares structural similarities with carlosturanite, accounting for the similarities in their XRD patterns. It likely formed in the process of serpentine decomposition outlined by [7], wherein acceptor regions receive Mg^{2+} and Si^{4+} from donor regions, which in turn receive H^+ from the acceptor regions to form H_2O. The H_2O is expelled while the acceptor regions form a partially disordered transitional structure [7]. This likely results in serpentine's tetrahedral sheet breaking up into strips similar to what is found within carlosturanite [8]. Other aspects of the crystal structure are not likely to be maintained due to the lack of OH^-, resulting in a partially disordered structure, accounting for differences in the XRD patterns between it and carlosturanite.

Conclusions: When CMs are heated to 525°C, their serpentine decomposes into a partially disordered transitional structure with structural similarities to carlosturanite. This phase may be diagnostic of moderately heated CMs.

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