Recent studies of C2 carbonaceous chondrite matrices using high resolution transmission electron microscopy (HRTEM) have shown that structural details of the matrix minerals can be imaged. The Murchison and Mighei matrices contain minerals having ordered and disordered mixed-layer structures in addition to chrysotile- and lizardite-type structures.

Selected area electron diffraction (SAED) patterns and images have been obtained from ion-thinned regions of the Murchison and Mighei matrices. In addition to the common serpentine minerals, these C2 matrices contain a mineral with a layer repeat of \( \approx 17 \text{Å} \). Earlier X-ray diffraction studies of Murchison and Mighei matrices do not report the presence of a \( \approx 17 \text{Å} \) peak, although this may be a consequence of the difficulty in detecting such large spacings by X-ray powder diffraction techniques. Theoretical models of a mixed-layer mineral containing serpentine- and brucite-type structures or, alternatively, serpentine- and talc-type structures both have a layer repeat of \( \approx 17 \text{Å} \). Structure factor calculations based upon idealized models of SBB and ST mixed layer structures do not allow a distinction between either model. Nevertheless, the occurrence of unusual dimension (\( \approx 17 \text{Å} \)) layer structures suggests that the matrix history may be more complex than common terrestrial layer silicate occurrences or than are suggested by primary condensation models for the solar nebula.

Two types of textural relationships in the Mighei matrix are suggestive of the formation of matrix layer silicate by secondary processes: (i) A narrow vein of disordered, mixed layer material (containing \( \approx 5 \text{Å}, \approx 7 \text{Å} \) and \( > 7 \text{Å} \) layer spacings) cutting an ordered serpentine-type (lizardite?) mineral. Both layer minerals are oriented with \( c^* \) in the same plane of the thin section. Structural continuity of the two mineral grains implies that they are genetically related. The structural and textural relationships are compatible with formation of the disordered mixed layer material by a secondary alteration process. (ii) A large clinopyroxene grain (several microns across) with an SAED pattern that shows a diffuse diffraction ring at \( \approx 7.3 \text{Å} \) in addition to pigeonite diffraction spots. The corresponding high resolution image reveals that the clinopyroxene is uniform in structure, but that along its edges it contains serpentine-type crystals, corresponding to
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the ~7.3 Å diffraction. Although much of the serpentine-type mineral has suffered radiation damage, vestiges of a cylindrical layer structure (typical of chrysotile) can be seen along the edge of the pyroxene grain. HRTEM examination of an ion-thinned specimen of Ivuna, a C1 carbonaceous chondrite, shows that its matrix differs substantially in texture and character to the C2 matrices that have been studied. The Ivuna matrix contains thin (~100 Å) intergrown fibers and larger areas of non-crystalline material. The matrix of Ivuna undergoes extremely rapid radiation damage - much more rapid than has been observed for any of the C2 matrices. As a result, it has been difficult to characterize the crystalline regions in Ivuna. However, ~7Å spacings have been imaged and are considered to be the layer spacings of a serpentine-type mineral.

References