UBIQUITOUS NANOPHASE FE,NI CARBIDES IN MURCHISON FINE-GRAINED RIMS: POSSIBLE RELICTS OF NEBULAR FISCHER-TROPSCH REACTIONS. A. J. Brearley, Dept. of Earth & Planetary Sciences, University of New Mexico, Albuquerque, NM 87131, USA. brearley@unm.edu.

Introduction: An understanding of the distribution and mineralogical associations of solid organic material in carbonaceous chondrites can provide important clues as to the possible origins of this material. We have been studying the Murchison CM2 chondrite to determine exactly where organic material is located *in situ* using EFTEM techniques. We [1] reported the presence of putative Fe,Ni metal grains in fine-grained rims in Murchison that are associated with carbonaceous material. Further TEM studies show, however that the identification of these phases as Fe,Ni metal is incorrect and that they are in fact Fe,Ni carbides. Here we report the detailed occurrence and possible implications of these Fe,Ni carbides.

Results: Fe,Ni carbide grains have been found in three different fine-grained rims. Although their abundance is not high, they are encountered frequently in ion-milled samples. The carbides occur as isolated grains, but clusters of several grains are most common. The grain size of the carbides varies from 10 to 38 nm and they typically have a rounded morphology, although elongate grains are sometimes found. All the carbide grains are surrounded by continuous rims of nanocrystalline magnetite (6-7 nm in thickness) that is separated from the carbide core by a very thin layer of low-Z material. EFTEM imaging shows that this layer is carbon-rich and appears to be amorphous based on HRTEM imaging. EDS analysis indicates that two different carbide phases are present, one with Ni contents of 1-2 wt% and the second with higher Ni contents, close to 8 wt%. We have not yet been able to definitively identify the carbide phases based on the available electron diffraction data. However, our preliminary data are most consistent with cohenite and possibly haxonite. EFTEM imaging shows that the carbide grains are commonly associated with regions of carbonaceous material, that show enrichments in nitrogen immediately adjacent to the carbide grains.

Discussion: Fe carbides such as haxonite and cohenite can form as a result of carburization of Fe,Ni metal within an asteroidal environment during mild thermal metamorphism [2,3]. Temperatures in excess of ~400°C are required to stabilize cohenite [4], values that are clearly unreasonable for the CM chondrites, which have estimated alteration conditions < 50ºC [5]. At these conditions, Fe-carbide phases that are stable at low temperatures, such as ε-carbide and Hägg carbide should form, not cohenite. Neither of these phases appear to be present in Murchison indicating that an asteroidal origin is unlikely. It is well-known that cohenite can form during Fischer-Tropsch catalysis reactions as a result of progressive carburization of Fe metal [4] and can be associated with amorphous carbon. The clear association of carbon-rich material with the carbides in Murchison appears to be consistent with the formation of the carbides during nebular Fischer-Tropsch reactions. This is generally consistent with the presence of nitrogen-rich carbonaceous material that is probably organic in character, rimming the carbide grains. The rims of magnetite indicate that Fe carbides underwent oxidation after their formation, probably in the CM parent body. This is consistent with the observations made by [3] for carbides in Semarkona. Alteration of the carbides probably did not go to completion because of the build up of an impermeable layer of amorphous carbon released during the oxidation of the carbide.

References: [1] Brearley,A.J. (2003) *LPS* **XXXIV** Abst #1364 CDROM; [2] Krot, A.N. *et al.* (1997) *GCA* **61**, 219. [3] Keller, L.P. (1998) *MAPS* **33**, 913. [4] Unmuth, E.E. *et al.* (1980) *J. Catalysis* **63**, 404. [5] Zolensky, M.E. *et al.* (1993) *GCA* **57**, 3123. **Acknowledgments:** Funded by NASA grant NAG5-9798 (A.J. Brearley, PI).