**KAMACITE GRAINS AS AQUEOUS ALTERATION INDICATORS IN CM CHONDRITES.** E. E. Palmer[1*] and D. S. Lauretta[1]. [1]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA. [*]epalmer@lpl.arizona.edu.

**Introduction:** Kamacite grains corrode into tochilinite, an iron sulfide-hydroxide, if exposed to S-bearing water [1]. We evaluated this reaction in CM chondrites in order to determine the extent of aqueous alteration in these meteorites.

**Method:** We looked at thin sections of Murchison, Cold Bokkeveld, Nogoya and Murray using optical microscopy and electron microprobe analysis (EMPA). We collected EDS spectra, EMPA point analyses, and elemental x-ray maps (Fe, Mg, Ca, Ni, Si, and S). For each thin section, we reviewed 12 or more 50-200 µm regions that contained kamacite assemblages.

We established a relative indicator of aqueous alteration for CM meteorites by measuring the thickness of tochilinite rims around exposed kamacite grains. We require that the kamacite grains be in physical contact with the matrix and not embayed by coherent minerals. Embayed kamacite grains are not likely to be exposed to the same amount of water, and thus, not be altered at the same rate. We assign an index of alteration based on the thickness of the tochilinite rim from 0 (no alteration) to 4 (tochilinite rim >20 µm). Fully altered kamacite grains set a lower bound. Our index correlates well with other indicators of aqueous alteration [2 - 3].

**Results:** Using this alteration index, Murray and Murchison clearly show that different regions have undergone different amount of alteration. Both meteorites have several 10 to 80-µm kamacite spheres that have seen no alteration (index 0). However, they both have large regions in where all kamacite grains have been altered fully into tochilinite (index 4).

Neither Nogoya nor Cold Bokkeveld has any unaltered kamacite grains. It appears that all of Nogoya's kamacite grains have been fully altered (index 4). Cold Bokkeveld's kamacite grains have also been fully altered except for a large breccia clast with alteration rims of 10 to 15 µm (index 3)

**Discussion:** Some CM meteorites have been slightly altered, such as Murray and Murchison. Typically, these samples do not exhibit a homogenous level of alteration. Over short distances (<1 mm), there are large variations in the thicknesses of the tochilinite rims. CM meteorites that have seen extensive alteration, such as Cold Bokkeveld and Nogoya show very little spatial variation in alteration.

One hypothesis is that the different alteration regions are different breccia clasts. CM chondrites are frequently brecciated [3]. This scenario would require that alteration occurred before brecciation and constrains the timing of early solar system events. An alternative hypothesis is that the amount of water available to alter the meteorites varied over short distances meaning alteration was water-limited. We are working on techniques to discriminate between these two hypotheses.

Finally, kamacite alteration is not a useful system for all CM meteorites but only ones with moderate alteration. Alteration of taenite and pyrrhotite may extend this scale because they are less susceptible to alteration in the CM chondrites.

**References:** [1] Tomeoka, L. and Buseck, P. R. 1985. Geochimica et Cosmochimica Acta 49:2149-2163. [2] Browning, L. B., McSween, H. Y., Zolensky, M. E. 1996. Geochimica et Cosmochimica Acta 60:2621-2633. [3] Rubin, A. E. et al. 2007. Geochimica et Cosmochimica Acta 71:2361-2382.