THE MINERALOGY OF MATRIX AND CHONDRULE RIMS IN CM CHONDRITES.

M.E. Zolensky[1], R.A. Barrett[2], W. Klock[3] and J.L. Gooding[1], [1]Planetary Science Branch, NASA Johnson Space Center, Houston, TX 77058, [2]Lockheed Engineering and Science Co., Houston, TX 77058, [3]NRC, Johnson Space Center, Houston TX 77058.

INTRODUCTION: The CM chondrites contain a record of condensation, accretion, brecciation, reaccretion, aqueous alteration and metamorphism. However, the order and extent to which these processes occurred is not always clear. For example, how many stages of aqueous alteration are recorded by the CM chondrites, and did all of these reactions occur on (or in) the parent body? Here we will examine this question through a comparison of the mineralogy of CM matrix mineralogy with that of the dark rims typically present about chondrules in these same meteorites. The chondrule rims we describe here have variously been called "dark", "fine-grained" and "accretionary". We will avoid genetic labels, and merely refer to them as "chondrule rims". We have previously reported that for each CM chondrite so examined the variation in bulk composition of its matrix is always a subset of that of its chondrule rims, with the averages of each being similar [1]. We have now extended this comparison to 8 CM chondrites and 2 CVs, with the same result. These compositional results suggest that the mineralogies of matrix and chondrule rims are similar. To test this hypothesis we prepared ultramicrotomed sections of pre-selected matrix and chondrule rim samples (2 each) from Murchison, Mighei, Nogoya, and Murray. All sections were characterized using a JEOL 100CX STEM equipped with a PGT EDX detector (for compositions) and a JEOL 2000FX STEM (for HRTEM imaging). We examined mineralogy, structural state, grain size variations and petrological relationships.

RESULTS are summarized in the Table below. All textural terms used are described by Barber [2]. We have finally verified that the frequently observed 18A phase is coherently interstratified tochilinite and serpentine (TS) [3]. We have also noted a 25A coherently interstratified tochilinite-serpentine-serpentine (TSS) phase within Nogoya matrix. In all cases, matrix and chondrule rims were observed to consist mainly of serpentine of varying composition, with coarser crystals being relatively more iron-rich [see 2]. There is no correlation between olivine and serpentine grain size, and none between the presence of tochilinite and olivine or serpentine grain size. The observed grain size distributions of tochilinite and TS are identical. Tochilinite is only present among flaky and cylindrical serpentine, never the coarser-grained platy variety. Only TS and TSS are associated with platy serpentine. Therefore, if the coarser-grained platy serpentine formed from the recrystallization of finer-grained varieties, then the tochilinite must have recrystallized concurrently.

CONCLUSIONS Despite the compositional similarities, there are significant mineralogical differences between CM matrix and rim materials, including (1) a paucity of tochilinite, TS and TSS in rims, (2) presence of zoned low-iron high-manganese (LIME) [4] olivines in some rims and absence of same in matrix, and (3) presence of smectite in one chondrule rim in Murray, and absence of same in any matrix examined. These mineralogical differences establish that CM matrix and chondrule rims had somewhat different pre-alteration mineralogies, and suggest that some rims may have experienced locally different alteration conditions than the host matrix. Further work will be necessary to establish whether chondrule rims experienced significant aqueous alteration before being incorporated into their final CM parent body, or whether their differences in alteration mineralogy are due merely to their initial mineralogical differences.

REFERENCES: [1] Zolensky et al. (1989) Lunar and Planetary Science 20, 1149; [2] Barber (1981) Geochim. Cosmochim. Acta 45, 945; [3] Mackinnon and Zolensky (1984) Nature 309, 240; [4] Klock et al. (1989) Meteoritics, in press.

METEORITE	MATRIX		RIMS	
	Morphology	Maximum Grain	Morphology	Maximum Grain
Mineral	(Dominant form in upper case)	size (um)	(Dominant form in upper case)	size (um)
MURCHISON				
Olivine	ROUNDED, no low-Fe, high Mn* observed	1	ROUNDED, zoned low-Fe, high Mn*	1.5
Sulfides	ROUNDED	.25	ROUNDED	.5
Serpentine	SPONGY, Flaky, Cylindrical, Platy	.25	SPONGY, Flaky, Platy	.4
Tochilinite	PLATY	.03	Not observed	-
Toch-Serp#	Not observed	-	Not observed	-
MIGHEI				
Olivine	ROUNDED, no low-Fe, high Mn* observed	.03	ROUNDED, no low-Fe, high-Mn* observed	.05
Sulfides	ROUNDED	.06	ROUNDED	.2
Serpentine	SPONGY, Flaky, Platy	1	SPONGY, Cylindrical, PLATY	.6
Tochilinite	PLATY	.15	Cylindrical, PLATY	.05
Toch-Serp	PLATY	.15	PLATY	.07
NOGOYA				
Olivine	ROUNDED, no low-Fe, high Mn* observed	.05	ROUNDED, no low-Fe, high Mn*	2.0
Sulfides	ROUNDED	.4	ROUNDED	.25
Serpentine	SPONGY, Flaky, CYLINDRICAL, Platy	.5	SPONGY, FLAKY, Platy	.5
Tochilinite	Not observed	-	Not observed	-
Toch-Serp	FLAKY	.05	Not observed	-
Others	Clinochlore, Toch-Serp-Serp@			
MURRAY				
Olivine	ROUNDED, unzoned low-Fe, high Mn*	1	ROUNDED, zoned low-Fe, high Mn*	2.0
Sulfides	ROUNDED	1	ROUNDED	.25
Serpentine	SPONGY, FLAKY, Platy	.2	SPONGY, FLAKY, Platy	.15
Tochilinite	CYLINDRICAL	.03	Not observed	-
Toch-Serp	PLATY	.02	FLAKY	.01
Others			Smectite present locally	.2

* Low-iron, high manganese olivines, called LIME [4], in addition to normal olivines

Coherently interstratified tochilinite-serpentine

@ Coherently interstratified tochilinite-serpentine-serpentine