EVIDENCE FOR SHOCK MELTING AND PARENT BODY HEATING IN CR AND CV CHONDRITES; M.E. Zolensky[1] and P.C. Buchanan[2]; [1]SN2, NASA Johnson Space Center, Houston, TX 77058 USA; [2]University of Houston, Houston, TX 77204 USA.

Mini-Abstract: Carbonaceous (C) chondrites are generally reputed to have led low-temperature, low-shock, mundane parent body lives. However, a few CR and CV chondrites contain lithologies which apparently experienced, variously, significant parent body heating and shock-melting. It is likely that evidence of these processes were routinely erased by later aqueous alteration in other C-chondrite samples.

Shock Veins: The CR chondrite Al Rais and one clast from the largely CR chondrite Kaidun contain large "veins" filled with phyllosilicate laths enclosed within a more Fe-rich phyllosilicate groundmass (Figure 1) (these phyllosilicates are all mixtures of serpentine and saponite). Examination of representative microprobe compositions of these two phases in the largest Kaidun vein (Table 1) reveals: (1) The lath phyllosilicates have atom Mg/Fe ratios twice as high as the groundmass phyllosilicates. This conflicts with our original interpretation that groundmass phyllosilicates replaced lath phyllosilicates [1]; in other C-chondrites, second-generation phyllosilicates generally are more Mg-rich than those they replace; (2) The minor element abundances in the lath-shaped phyllosilicates are very low.

Several individuals pointed out the petrographic similarity of these CR veins to shock melt veins in SNC meteorites, where olivine and/or pyroxene skeletal/lath crystals are observed to project into a glassy mesostasis. Accordingly, we examined several SNCs, and provide microprobe analyses of these in Table 1, and a photo of the probed vein (from EETA79001,77) in Figure 2. Our results from these SNC veins are entirely consistent with previous work [2]. Allowing for the very different starting materials (EETA79001 is a basaltic rock) the petrographic similarities are striking, and the Mg/Fe trend of lath crystals/mesostasis are also similar (as would be expected for any shock melt). We therefore suggest that the Kaidun vein resulted from shock melting of CR chondrite material, followed by aqueous alteration. The low minor element composition of the Kaidun laths is a probable result of its formation from fairly pure olivine.

Heating: Why aren't shock-melting or heating textures more commonly observed in C chondrites? Perhaps because post-heating aqueous alteration has generally erased the evidence. Therefore, if we wish to learn more about the changes effected in C chondrites during heating we need to look at situations where water wasn't available following the shock/heating event. The three heated C chondrites from the Antarctic (B7904, Y82162, Y86720) are well known. Kojima et al. [3] have recently described heated CV3 clasts found in Allende. These particular clasts experienced considerable aqueous alteration followed by heating, dehydration and extensive recrystallization. The lack of water in the vicinity of Allende on its parent body prevented subsequent aqueous alteration. (However, Kojima et al. suggest that the original aqueous alteration could have occurred elsewhere on the Allende parent body) We describe here another Allende clast with a similar history.

Dark clast 16-S-1 from Allende was originally described by Fruland et al. [4]. It is composed of ~60 vol.% coarse-grained silicates as individual mineral fragments, inclusions and chondrules in ~40 vol.% matrix. Chondrules include porphyritic and some barred types: some devitrified glass is present. Pyroxenes (often twinned) and olivines in chondrules and inclusions apparently retain some primary zoning. In contrast, some larger, magnesian olivine fragments in the matrix of this clast have been altered around the edges to more Fe-rich compositions. The matrix of this clast is predominantly composed of granoblastic-granular olivine with minor opaques contained in rounded masses, resembling fluid drops, and in partial chondrule rims (encystments). In some peripheral areas the clast matrix consists of anhydrous silicates with textures reminiscent of phyllosilicates (fibers, curved plates) - grain sizes are on the order of 1-5μm. These distinct textures contrast with porous and lath-shaped to equant olivine matrix olivines found in typical Allende matrix [5]. We interpret clast 16-S-1 to be a C-chondrite fragment affected by minor aqueous alteration (compared to that experienced by the clast described by Kojima et al., where original phyllosilicates were more extensively developed and coarser grained). A late thermal event produced olivine pseudomorphs of phyllosilicates, and redistribution of Fe/Mg around the edges of magnesian olivine fragments in the clast matrix.

We have also examined Bench Crater, a CM chondrite recovered from the Moon, and previously described by McSween [6]. This 3mm sample greatly resembles the pyrrhotite-rich CM1 clast from Kaidun [7], consisting of lath-shaped crystals of pyrrhotite, magnetite framboids, calcite/dolomite, Mn-rich ilmenite, apatite and Mg-Fe silicate clasts set within a ferromagnesian matrix. Microprobe totals for matrix and clasts are 94-100% (Table 1), and textures suggest heated phyllosilicates. Impact onto the moon (and heating) caused dehydration of phyllosilicates and other changes, preserved because no later aqueous alteration occurred on the desiccated Moon.

Summary: We suggest that C chondrites suffered parent body heating, shock and melting to a greater extent than now recognized (further support for this comes from the results of Sneyd et al. [8]), but evidence of these processes was routinely erased by later aqueous alteration in most situations.

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References: [1] Ivanov et al. (1994) *Meteoritics 29*, 477; [2] McSween et al. (1979) *Science 204*, 1201-1203; [3] Kojima et al. (1993) *Meteoritics 28*, 649-658; [4] Fruland et al. (1978) *Proc. Lunar Planet. Sci. Conf. 9th*, 1305-1329; [5] Clarke et al. (1970) *The Allende, Mexico, Meteorite Shower, Smith. Contib. Earth Sci. 5*, 1-53; [6] McSween (1976) *Earth Planet. Sci. Letts. 31*, 193-199; [7] Zolensky et al. (1994) LPSC XXV, 1565-1566; [8] Sneyd et al. (1988) *Meteoritics 23*, 139-149.

Table 1

Species	Kaidun Vein Phyllosilicates		EET 79001 Melt Vein		Bench Crater	
	Lath	Groundmass	Olivine[2]	Glass Mesostasis[3]	Silicate Clasts[4]	Matrix[6]
Na_2O	0.03	0.48	0.03	0.35	0.40	0.68
MgO	36.87	26.06	36.65	20.95	31.92	28.86
Al_2O_3	1.20	1.81	0.62	2.46	3.46	3.35
SiO2	43.05	33.62	37.17	40.03	48.14	43.06
S	0.01	0.14	0.01	0.05	0.05	2.07
K_2O	0.01	0.06	0.01	0.03	0.12	0.17
CaO	0.01	0.20	0.60	3.49	0.20	1.23
Ti_2O	0.00	0.02	0.19	0.34	0.05	0.05
P_2O_5	0.06	0.67	0.15	0.47	0.03	0.81
Cr_2O_3	0.01	0.00	1.06	0.25	0.85	0.66
MnO	0.09	0.19	0.50	0.75	0.02	0.01
FeO[1]	10.77	15.93	24.36	31.59	10.27	12.09
NiO	0.01	0.02	0.07	0.02	0.00	1.25
Total	92.11	79.19[5]	101.42	100.77	95.53	94.29
Mg/Fe	6.00	2.88	3.01	1.21		

[1]All Fe as FeO [2]Average of 6 analyses [3]Average of 3 analyses [4]Average of 28 analyses
[5]Low total due in part to filamentary nature of this phyllosilicate [6]Average of 7 analyses

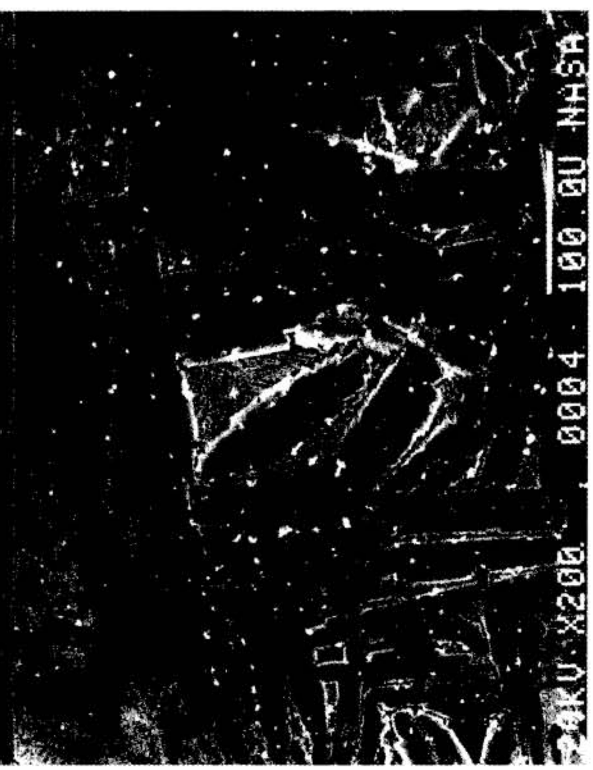

Figure 1: Phyllosilicate vein in Kaidun

Figure 2: Shock melt vein in EETA79001