CARBONACEOUS CHONDRITE FRAGMENTS IN THE POLYMICT EUCRITE YAMATO 791834. P. C. Buchanan[1] and M. E. Zolensky[2], [1]Antarctic Meteorite Research Center, National Institute of Polar Research, Tokyo 173-8515 JAPAN e-mail: buchanan@nipr.ac.jp. [2]Mail Code: ST, NASA Johnson Space Center, Houston, Texas 77058 U.S.A.

Introduction: Buchanan et al. [1] and Zolensky et al. [2] described carbonaceous chondrite fragments in a variety of howardites and concluded that the majority are CM2 and CR2 materials. Gounelle et al. [3] also described similar, but very small, fragments in these meteorites. These clasts are important because they represent materials that were in orbital proximity to the HED parent body (4 Vesta) and they may be similar to the primitive materials that originally accreted to form this body [2]. The present study describes two carbonaceous chondrite clasts in the Yamato 791834 (Y791834) polymict eucrite.

Data: Y791834 was collected by the Japanese Antarctic Research Expedition (JARE) in 1979. Although it is classified as a polymict eucrite and Y793497 is classified as a howardite, perusal of the range of pyroxene compositions in the Catalog of the Antarctic Meteorites [4] suggests that they may be paired. Zolensky et al. [2] discussed carbonaceous chondrite fragments contained in Y793497 and suggested that these include fragments of CR2 materials.

Clast 1 (Fig. 1) is approximately 500µm x 400µm in size and is composed of fragments of olivine grains and opaque minerals in a fine-grained matrix. No chondrules are present. Boundary of the clast with the brecciated matrix of the meteorite is sharp.

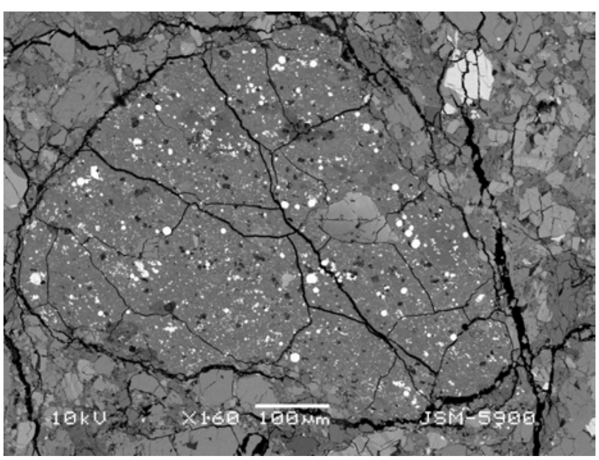

Fig. 1. Backscattered electron image (bsei) of clast 1 from Y791834. The small dark grey areas are holes from which magnetite grains were apparently plucked.

Opaque minerals include oxides and sulfides. Pentlandite contains significant, but small, proportions of Co and Pb (Table 1). Pyrrhotite contains Ni and significant amounts of Co and Pb (Table 1). Magnetite occurs as relatively large, rounded to polygonal grains, which are reminiscent of plaquettes in CI and CR meteorites. This magnetite is almost pure Fe_3O_4 with minimal proportions of other components. Carbonates were not found.

Table 1. Representative compositions of pyrrhotite and pentlandite in clasts 1 and 2.

	Clast 1		Clast 2	
	pyrrho.	pent.	pyrrho.	pent.
wt. %				
Cr	0.13	0.02	0.01	0.02
Fe	53.9	32.1	59.4	38.7
Mg	b.d.	0.01	b.d.	0.11
Mn	b.d.	b.d.	b.d.	b.d.
Co	0.44	0.86	0.28	2.09
Ni	6.89	34.6	2.41	26.1
Cu	0.01	0.03	0.02	0.03
Pb	0.68	0.46	b.d.	b.d.
S	37.5	33.6	37.4	32.5
Total	99.6	101.7	99.5	99.6

b.d.=below detection limits

Some olivine grains are zoned, including one large fragment that ranges from Fo_{81} to Fo_{52}. Smaller unzoned olivine grains also occur and have compositions that range from Fo_{45} to Fo_{73}. Low-Ca pyroxenes are present as single grains and have a range of compositions $Wo_{1-4}En_{94-97}$.

Matrix material is extremely fine-grained. In an effort to elucidate the mineralogy of this matrix, we made a series of ~30 focused beam analyses by electron microprobe, avoiding large grains of opaque minerals, including oxides and sulfides. The spectrum of compositions suggests that this matrix is composed of a mixture of phyllosilicates, probably predominantly saponite, with very fine-grained iron oxides and sulfides.

Clast 2 (Fig. 2) is approximately 500µm x 300µm in size and is composed of opaque mineral grains and anhydrous silicates in a fine-grained matrix, which, in contrast to clast 1, has a flowing texture. Boundary of the clast with the brecciated matrix of the host meteorite is sharp.

Opaque minerals are predominantly sulfides. Pyrrhotite contains much smaller proportions of Ni than that in clast 1 and pentlandite contains somewhat higher proportions of Co (Table 1).

Rare aggregates of olivine grains with compositions Fo_{54-58} may represent altered chondrules (see arrow in Fig. 2). Individual low-Ca pyroxene grains are rounded to angular and have compositions Wo_1En_{90-98}.

The flowing textures of the matrix of clast 2 are typical of those seen in CM2 carbonaceous chondrite clasts in HED breccias [e.g., 1, 2]. This texture is predominantly composed of sinuous phyllosilicates and opaque minerals. Clast 2 is distinctive because phyllosilicate grains are somewhat coarser-grained than those in other clasts with individual grains as large as 20-30 µm. These phyllosilicates are also distinctive because they have a heterogeneous, vaguely layered appearance when observed by SEM using back-scattered electron imaging.

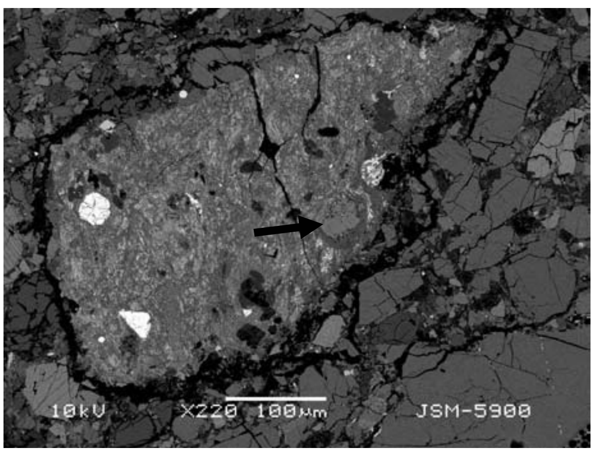

Fig. 2. Backscattered electron image (bsei) of clast 2 from Y791834. The aggregate of olivine grains in the middle of the right side of the clast (arrow) is probably an altered chondrule.

In an effort to elucidate matrix mineralogy, we made a series of ~25 focused beam analyses by electron microprobe, avoiding large grains of opaque minerals. The spectrum of compositions suggests that this matrix is composed of a mixture of phyllosilicates, probably predominantly serpentine, and very fine-grained iron oxides and sulfides. Tochilinite may also be present.

Discussion: The characteristics of clast 2 are consistent with classification as CM2 material. Because of the large grain size of the phyllosilicates in this clast, these materials are particularly appropriate for TEM analysis, which is presently underway. The back-scattered electron images of these phyllosilicates suggest that they may be variable in structure and composition on a very fine scale.

In contrast, as has been discussed previously [e.g., 1, 2, 3], the classification is more difficult for fragments similar to clast 1. Texture and mineralogy of the matrix in these fragments are most similar to those of materials related to CR2 meteorites. However, in contrast to most CR2 meteorites, clast 1 does not contain any carbonates. Chondrules also are not present and we could find no evidence for the Al-rich phyllosilicates that occur in some altered chondrules in these meteorites [5]. These materials are similar, in some respects (e.g., lack of chondrules), to dark clasts in some CR2 meteorites and the most reasonable interpretation is that they are petrogenetically related [2]. However, it is also possible that they represent anomalous materials that are different from previously described carbonaceous chondrite meteorites, interplanetary dust particles (IDPs), or micrometeorites.

References: [1] Buchanan P. C. et al. (1993) *Meteoritics* **28**, 659-669. [2] Zolensky M. E. et al. (1996) *Meteoritics* **31**, 518-537. [3] Gounelle et al. (1999) *LPSC* **XXX**, CD Rom #1134. [4] Yanai K. and Kojima H. (1995) Catalog of the Antarctic Meteorites, National Institute of Polar Research, Tokyo, Japan, 230p. [5] Weisberg et al. (1993) *Geochim. Cosmochim. Acta* **57**, 1567-1586.