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THE ANATOMY OF A CLUSTER IDP (I): CARBON ABUNDANCE, BULK CHEMISTRY AND MINERALOGY OF FRAGMENTS FROM L2008#5; K.L. Thomas[1], L.P.Keller[2], W. Klock[3], J. Warren[1], G.E. Blanford[4], and D.S. McKay[5] [1]Lockheed, 2400 Nasa Rd.1 Houston, TX, 77058, [2]MVA Inc., 5500/Suite 200 Oakbrook Pkwy, Norcross, GA 30093 [3]Institute fur Planetologie, Wilhelm-Klemm-Str.10, 4400 Munster, Germany, [4]University of Houston, Clear-Lake, Houston, TX 77058, [5]NASA/JSC, SN, Houston, TX 77058.

Chondritic anhydrous interplanetary dust particles (IDPs) are among the most pristine solar system materials known, and despite their small size, have been intensely studied. Multidisciplinary studies of IDPs have traditionally been restricted to cluster particles, where individual fragments of the same cluster are allocated to several researchers. In this manner, different analyses can be performed on essentially the same material, assuming that individual fragments are representative of the whole cluster. Our preliminary work, however, indicated that fragments from cluster particles can show mineralogical and chemical heterogeneities at the 10 μm scale [1].

The objective of this study was to determine whether or not cluster particles are sufficiently homogeneous to enable observations from one fragment of the cluster to be extrapolated to the entire cluster. Here we report on the results of a consortium study of the fragments of a large cluster particle. Multiple fragments from one large cluster were distributed to several research groups and were subjected to a variety of mineralogical and chemical analyses including: SEM, TEM, ion probe, SXRF, noble gas measurements, and microprobe laser mass spectrometry of individual fragments. The mineralogy and bulk chemistry of the cluster fragments are discussed below and the trace element geochemistry, isotopic data, and other results are given in a companion abstract [2].

Methods We were allocated ~95% of the fragments from cluster L2008#5 (originally ~40-50 μm in diameter), which contained many large fragments and fines: three fragments are ~15 x 15 μm, six are ~12 x12 μm, 30-40 range from 5-10 μm in diameter, and many fragments (called fines) were <5 μm in diameter. We have determined bulk compositions for elements with Z > 5 of 53 particles from one large cluster. Our procedures and extensive analytical checks for quantitative SEM EDX light element analysis are described in detail elsewhere [3]. Following the chemical analysis, several of the particles were embedded in epoxy, thin sectioned using an ultramicrotome, and examined in the TEM.

Chemistry We analyzed 53 fragments from cluster L2008#5 for major, minor, and light elements (carbon and oxygen). The cluster average and major element ranges for all fragments are shown in Fig. 1. The average element abundances were found to be chondritic (within 2xCI) for L2008#5 with the exception of Na and P which were ~4xCI and 5xCI, respectively. Large ranges for major elements C, Si, Mg, S, Fe, and O suggest that compositional differences exist (Fig. 1). Only 24 (45%) of the analyzed fragments have the "same" composition for major elements (C, O, Mg, Si, S, Fe) within one standard deviation. Of the 29 remaining fragments, 31% have significantly higher Fe or Fe and S with lower O; 17% have significantly higher C.

Mineralogy Table 1 lists mineral assemblages found in large fragments and fines from cluster L2008#5. Fragments have been classified according to the most abundant mineral phase. A variety of mineral phases are present in this cluster particle and minerals with similar compositional ranges are found in large fragments and fines. For example, olivine compositions range from Fo 57-99 in large fragments and from Fo 66-98 in fines. However, several olivine-dominated fragments have very narrow ranges of olivine compositions which differ from one fragment to another. Pyroxenes range in composition from enstatite to those high in Ca. Amorphous material, such as glass and carbonaceous material, is present in some fragments. Glass compositions range from Si-rich to feldspathic with minor amounts of Mg and Fe occasionally present; glass regions can have either a smooth or a vesicular texture. Amorphous, C-rich material is observed in particles with C >3xCI (~11 wt.% C). Mineral grain sizes vary from fragment to fragment: some fragments are predominantly coarse-grained (μm in diameter), some are predominanty fine-grained (<50 nm in diameter) and

some contain a mixture of coarse and fine grains. Partial magnetite rims are present on some fragments, indicating they were heated during atmospheric entry [4]. The relative range of mineral abundances in the large fragments is also duplicated in the fines.

Discussion Cluster L2008#5 is composed mainly of chondritic (within ~2 x CI) fragments that differ significantly in mineralogy (Table 1). Non-chondritic fragments (e.g., those dominated by sulfides or magnetite) make up 25% of this cluster. A representative sampling of material from the cluster for mineralogical and chemical analyses would require analyses of a minimum of four large fragments. Attempts to extrapolate analyses from one fragment to an entire cluster will be misleading if all cluster particles show similar levels of heterogeneity as L2008#5.

References: [1] Thomas K.L. *et al.* (1993) *Meteoritics* **28**, 448. [2] Thomas K.L. *et al.* (1994) This volume. [3] Thomas K.L. *et al.* (1993) *GCA* **57**, 1551. [4] Keller L.P. *et al.* (1992) *LPSC* **23**, 675.

Figure 1. Mean values and range of element abundances for 53 fragments from cluster L2008#5. Chemical heterogeneity of fragments is shown by the ranges for major elements (bars); mean values are represented by lines located to the right of the bars.

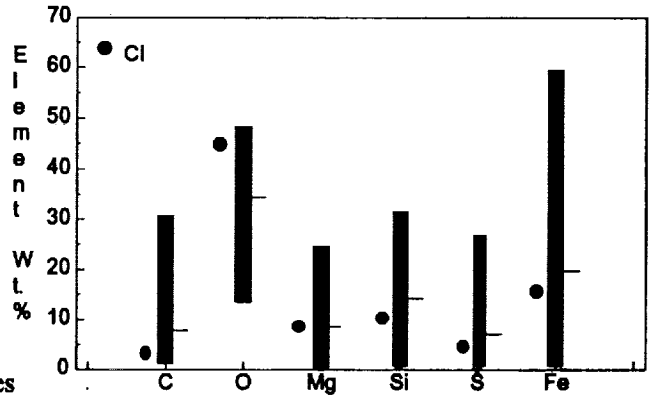

Table 1. Mineralogy of 10 large fragments and fines from cluster L2008#5. Fragments have been classified according to the most abundant mineral phase. Ranges of mineral compositions are given for each group (e.g., olivine-dominated) as a whole, but some individual fragments have narrow ranges of mineral compositions.

Fragments (> 5 μm)	**Fines (<5 μm)**
Olivine-Dominated (4 fragments)	**Olivine-Dominated (3 fragments)**
* Fo 57-84, Glass, Enstatite, high Ca pyroxene, Fe-sulfide with Ni; 3 have magnetite rims. Coarse, fine, and mixed grain sizes.	* Fo 78-86, Glass, Enstatite, high Ca pyroxene, Fe-sulfide with Ni; all have magnetite rims. Mostly coarse and mixed grain sizes.
Pyroxene-Dominated (3 fragments)	**Pyroxene-Dominated (2 fragments)**
* Enstatite, glass, few Fo 88-95, Fe-sulfide with Ni, Carbonaceous material; 2 have magnetite rims. Mostly fine and mixed grain sizes.	* Enstatite, glass, high Ca pyroxene, Fe-sulfide with Ni; all have magnetite rims. Coarse and fine grain sizes.
	Olivine-Pyroxene Mix (1 fragment)
	* Fo 66, Glass, Enstatite, few fine-grain aggregates; Magnetite rim, mixed grain sizes.
FGA (Fine-grain aggregate) Dominated (1 fragment)	**FGA Dominated (1 fragment)**
* Fine-grain aggregates, Fo 79-99, enstatite, glass, Abundant Fe-sulfides with Ni; magnetite rim. Fine grain sizes.	* Fine-grain aggregates, Fo 98, Enstatite, Augite, Fe-sulfide; no magnetite rim, fine grain sizes.
Others (2 fragments)	**Others (3 fragments)**
*Large Fe-sulfide, few Fo 65-76, No magnetite rim, coarse grain sizes.	* 2 Large magnetites, Fo-68-91, few Fe-sulfides with Ni, 1 has lg. kamacite; no magnetite rims, coarse grain sizes.
*Large magnetite grain, few fe-sulfides with Ni, Si-rich glass; magnetite rim, coarse grain sizes.	*Large Fe-sulfide with Ni, glass, kamacite, ferrihydrite; magnetite rim, coarse grain sizes.