ANALYTICAL SEM/TEM STUDIES OF INDIVIDUAL GRAINS OF DISSAGGREGATED CP INTERPLANETARY DUST, J. P. Bradley and D. E. Brownlee, Dept. of Astronomy, FM-20, University of Washington, Seattle, WA 98195

CP micrometeorites are particles which have chondritic elemental abundances and are porous aggregates of submicron grains. Of the different types of interplanetary dust the CP's are those that are most conspicuously different from established meteorite types. For example they are much more porous and fragile than any meteorite type and they are texturally and mineralogically distinct from their closest meteorite relatives the CI and CM chondrites. These particles are of special interest because their properties are compatible with models of low density cometary meteoroids.

The most porous CP particles fragment during collection with high-altitude aircraft, often separating into thousands of individual pieces. The fragments consist either of individual mineral grains or micro-aggregates of amorphous and crystalline materials. We have begun an intensive investigation of these fragments using combined SEM, STEM and CTEM techniques. The rare highly fragmented CP particles are located on collection surfaces as regions containing dense populations of micron and sub-micron debris within an impact area of approximately 100 μm in diameter. This debris is then removed and mounted onto a substrate where different fractions can be separated for various purposes without compromising the entire sample. Selected fractions of the debris are then removed and transferred to nuclepore filter SEM mounts and holey-carbon TEM grids. Individual fragments are characterized by energy-dispersive X-ray analysis (EDX), high-resolution lattice fringe imaging, electron energy loss spectroscopy (EELS) and electron diffraction.

EDX analysis has shown that in typical CP particles most of the submicron fragments of dissaggregated particles have roughly chondritic elemental compositions. Such fragments are aggregates of very small crystalline grains and possibly amorphous silicate materials. A minor fraction of submicron fragments are individual mineral grains but accurate elemental analyses of them is often difficult because of small adhering surface grains. In typical particles most of the fragments which are single mineral grains are silicates or sulfides. The most conspicuous silicate grains are pure enstatite laths which are usually very thin but range in length up to several microns. The laths are rare within a given particle but nearly all CP particles contain at least a few of them. Another conspicuous silicate is olivine. The olivine grains are usually irregular and range in composition from forsterite to roughly Fo_{50}. Quantitative EDX analyses of the most common 0.2μm and 1μm silicate grains do not yield compositions compatible with either olivine or pyroxene. Further TEM studies will test whether or not these grains are truly single minerals or are multi-phase materials possibly containing amorphous components. The sulfides in some particles are complex even on a micron and submicron scale. Quantitative EDX analysis of sulfides within a single particle often show that most are mixtures of a Ni rich sulfide (pentlandite), a low Ni sulfide (troilite or pyrrhotite) and a high Fe phase (metal or magnetite). Without future tests however it will not be known whether the complexity in the sulfides is original or an artifact of heating during atmospheric entry. In addition to the common ferromagnesian silicates and nickel bearing sulfides, rare crystalline grains of other materials are also found. These include Mg and Ca phosphates, in very high Si mineral, nickel iron, and Mg/Si material with a Mg/Si atom ratio of two and a high aluminum calcium mineral that appears to be melilite. Our TEM studies of different CP particles indicate

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diversity between samples generally in agreement with that reported by Fraundorf et al. (1).

Of special interest in the CP particles is the abundance, distribution and form of low-z material, specifically carbon. This problem is being approached by electron-probe microanalysis, oxygen plasma ashing, EELS and high-resolution lattice fringe imaging. Oxygen plasma experiments with dissaggregated particles on SiO thin films has shown that some of the sub-micron fragments contain high carbon contents and have silicate crystallites either on the surfaces of the carbon or dispersed in its interior. High-resolution imaging by conventional TEM has indicated that the carbon exhibits a range of structural features, including both amorphous and graphitic material, the latter with characteristic 3.4Å (002) interplanar spacings. However, since the support substrate and various contaminants on it are composed of carbonaceous material it is not yet totally certain that the carbon measurements have not been influenced by substrate artifacts.

1) Fraundorf, P. (1981) Geochim. Cosmochim. Acta 45, 915.

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