AEM CHARACTERIZATION OF PHASES IN A HYDRATED IDP;

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Interplanetary Dust Particles (IDPs) represent an important class of extraterrestrial materials through which a knowledge of pre-solar system history may be obtained. However, the small size of individual particles (~5-50 µm) and the even smaller size of the individual grains making up the particles (~10-1000 Å), make detailed petrographic analysis of phase relations, fabric, and metamorphic / diagenetic history difficult. We describe here the preliminary results of a study of microtomed sections of a hydrated IDP by TEM and STEM / EDS microanalysis. The use of microtome thin sections allows the detailed study of phase relationships otherwise disturbed by techniques such as bulk crushing.

IDP# Ames-Dec86-11, a hydrated particle, was selected for study from a number of Interplanetary Dust Particles captured by U-2 aircraft from Ames Research Center. The particle, approximately 30 µms in size, was prepared and microtomed[1]. Sections were floated onto holey carbon support films on 3mm gold electron microscope grids. After coating with a thin layer of evaporated carbon, conventional TEM and SAED were performed using a Hitachi H-500 TEM. Semiquantitative EDS X-ray analyses, to corroborate electron diffraction results, were performed on a JEOL JEM-2000FX equipped with a Kevex EDS detector sensitive to all elements above atomic number 9.

Hydrated particles are a subset of IDPs which contain hydrated minerals similar to those found in C1 and C2 meteorites[2,3]. This particle consists of a relatively nonporous aggregate of fine-grained layer lattice silicates which appear to have been *in-situ* hydrous alteration products of pre-existing grains (fig. 1). The particle shows no detectable alteration due to its deceleration upon reentry. Although bulk analyses of the particle were not performed, quantitative analyses of individual phases within it indicate a low abundance of Ca which has been previously reported for hydrous IDPs[3,4] The layer lattice silicates have a bimodal size distribution, in which phyllosilicates which have replaced matrix have a grain size of 300-1,000 Å, and phyllosilicates which have pseudomorphically replaced pre-existing grains have a grain size much less than 100 Å (fig. 2). Despite this order of magnitude difference in crystallite size, both phases appear to be smectites, with semiquantitative compositions (assuming 20% total water) of MgO, 8.5%; Al_2O_3, 5.3%; SiO_2, 47.9%; and FeO, 18.3% (matrix, shown in fig. 3) and MgO, 5.9%; Al_2O_3, 6.1%; SiO_2, 47.2%; and FeO, 20.6% (grain, shown in fig. 2). Both smectites have major spacings of 5.2, 4.42, 2.53, 1.93, 1.65, and 1.51 Å, determined from powder patterns recorded from small areas of the material. The dark portion of the grain shown in fig. 2 has a composition of $Fe_{0.74}Ni_{0.08}S$. It is possible that this is a relict phase of the alteration process. Pre-existing grains which have been pseudomorphed by clays are commonly surrounded or decorated with fine-grained crystalline materials (fig. 4). While it was impossible to analyze individual grains due to their small size, semiquantitative analyses (ignoring a small silicon peak due to surrounding matrix) yield an average composition close to FeS, with some Ni substituting for Fe. Very fine grained (10-100 Å) clusters of magnetite grains (fig. 2) were identified by SAED and qualitative EDS microanlaysis. Additional phases identified in the particle include a large (~1 µm) pyrrhotite 4C grain, which has a composition of approximately

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$Fe_{0.77}S$ (Fig. 3), and a bladed, acicular enstatite grain which has a few percent Fe in solid solution.

We cannot demonstrate a unique origin for the hydrous CP particle at this time. The particle may be akin to carbonaceous chondrites where the alteration process occurred in a manner similar to that described by (5,6). More information on submicron textures in carbonaceous chondrites by techniques employed here is needed for better comparison. In contrast, the particle may have a cometary origin, in which case the diagenesis / alteration of the particle may be consistent with low temperature alteration processes proposed for protoplanetary bodies[7].

1. Bradley, J.P., and D.E. Brownlee (1986) Science, **231**, 1542-1544.
2. Brownlee, D.E. (1978) IN: Protostars and Planets (T. Gehrels, Ed.), 134-150. Univ. of Arizona Press, Tuscon.
3. Fraundorf, et al, (1981) Icarus **47**, 368-380.
4. Tomeoka, K. and P.R. Buseck (1984) EPSL **69**, 243-254.
5. Bunch, T.E., and S. Chang (1980) Geochim. Cosmochim. Acta, **44**, 1543-1577.
6. Barber, D.J. (1981) Geochim. Cosmochim. Acta **45**, 945-970.
7. Reitmeijer, F.J. M. (1986) Nature **313**, 293-294.

Fig. 1 Low magnification view of Hydrous IDP. Scale Bar=10 µm.

Fig. 2 Bright field TEM micrograph of partially replaced grain. S=sulfide relict phase, SG=smectite replacing grain, SM=smectite replacing matrix, SD=sulfide decorating grain, M=magnetite in matrix. Scale Bar=1,000 Å.

Fig. 3 Pyrrhotite grain in matrix. P=pyrrhotite, SM=smectite replacing matrix. Scale bar= 1.0 µm.

Fig. 4 Interior of pseudomorphed grain, showing structure of replacement smectite. Scale bar= 500 Å.