ELECTRON MICROSCOPY OF STRATOSPHERIC PARTICLES. Ian D.R. Mackinnon*, GeorgAnn Nace[+], Andrew M. Isaacs[+] and David S. McKay* (*SN6; [+]C23),NASA Johnson Space Center, Houston, TX 77058.

A recent NASA program to collect stratospheric dust particles using high-flying WB57 aircraft has made available many more potential candidates for the study of extraterrestrial materials. This preliminary report provides an interpretation of the types of particles returned from one flag (W7017) collected in August, 1981 using a subset of 81 allocated particles. This particular collection period is after the Mt. St. Helen's eruptions. Therefore, the flag may contain significant quantities of volcanic debris in addition to the expected terrestrial contaminants (1). All particles were mounted on nucleopore filters and have been examined using a modified JEOL 100CX analytical electron microscope. For most of the particles, X-ray energy dispersive spectra and images were obtained at 40kV on samples which have not received any conductive coating. However, in order to improve resolution (to ∿30A) some images are recorded at 100kV. In addition, 16 samples have been coated with a thin layer (<50A) of Au/Pd.

A summary of the 81 allocated particles using a non-genetic classification scheme is given in Table 1. The morphology of the particles can be conveniently divided into three groups: spheres (26%), aggregates (31%), and others (43%). This morphological division suitably places many terrestrial contaminants in the "others" group, although some mafic particles (2) assigned to this group require further analysis for identification. In addition to morphology, bulk compositional analyses allow a positive identification of such terrestrial contaminants as quartz or clay (15%), calcite (7%), Ca- and/or Mn-rich phases (7%) and gold (4%). Another source of terrestrial contamination is rocket fuel exhaust (1). These aluminium-rich particles are usually smooth spheres with a consistent size range ($\bar{x}$ = 7.7 μm; s = 1.2 μm) and comprise about 42% of the allocated sphere population. The remainder of the spheres are classified as "enigmatic", following the general description given by Esat et al. (2) for the U-2 sampling program. The size distribution for enigmatic spheres shows a much greater range than that of Al-rich rocket exhaust particles. Two enigmatic spheres have rough surfaces and contain significant Fe, Cr, Si and Ni, but are not of "chondritic" composition. Two other spheres are smooth, opaque and contain Fe, S and Ni only. Some of these spheres may be meteorite ablation products. Particles which are not aggregates or spheres and which do not have "chondritic" elemental abundances are considered unknown terrestrial contaminants.

Approximately 14% of the allocated population is of "chondritic" composition. These "chondritic" particles are mostly aggregates with morphologies similar to those described by Brownlee (3). Figures 1a and 1b are high resolution SEM images of two "chondritic" aggregates (Au/Pd coating; 100kV) which show characteristic highly porous morphology (Fig. 1a) and very fine grain size (<1000A; Fig. 1b). Small grains in some "chondritic" aggregates also show euhedral morphology. In general, images taken at 100kV are of better resolution than those taken at 40kV. However, the grains shown in Figs. 1a and 1b have poor definition when compared with terrestrial contaminants under identical conditions. This property may be due to the presence of low-Z coatings on some "chondritic" aggregates (4). The remaining "chondritic" particles are classified as mafic particles.

All aggregates are not necessarily of "chondritic" composition. In keeping with previous usage, a small group of enigmatic "non-chondritic" aggregates (5% of total population) is defined. These particles are usually black, opaque aggregates containing Al, Si, Fe and other elements in lesser

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abundance. Enigmatic aggregates may be (a) rocket exhaust particles coated with fine grained silicates and sulphides or (b) the remains of high temperature condensates formed in early solar system processes. A probable source for these "non-chondritic" aggregates may be revealed with further detailed study.

REFERENCES: (1) Brownlee, D., et al. (1976) Science, 191, 1270-1271; (2) Esat, T.M. et al. (1979) Science, 206, 190-197; (3) Brownlee, D. (1978) Protostars and Planets, 134-152; (4) Fraundorf, P. (1981) Geochim. Cosmochim Acta, 45, 915-943.

TABLE 1.

	Spheres	Aggregates	Other
Si-rich	5	9	14
Al-rich	16	12	4
Other	5	10	25

Classification of all 81 allocated particles from Flag 7017. Values are percentages of the total number of particles.

Figure 1