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REFINEMENTS AND DEVELOPMENTS ON THE STRATOSPHERIC DUST DATABASE AND CLASSIFICATION SCHEME; Ian D. R. Mackinnon, Department of Geology, University of New Mexico, Albuquerque, NM 87131 and David S. McKay, Mail Code SN4, NASA Johnson Space Center, Houston TX 77058.

Greater than 750 individual particles have now been selected from collection flags housed in the JSC Cosmic Dust Curatorial Facility and most have been documented in the Cosmic Dust Catalogs [1]. As increasing numbers of particles are placed in Cosmic Dust Collections, and a greater diversity of particles are introduced to the stratosphere through natural and man-made processes (e.g. decaying orbits of space debris [2]), there is an even greater need for a classification scheme to encompass all stratospheric particles rather than only extraterrestrial particles. The fundamental requirements for a suitable classification scheme have been outlined in earlier communications [3,4]. A quantitative survey of particles on collection flag W7017 indicates that there is some bias in the number of samples selected within a given category for the Cosmic Dust Catalog [5]. However, the sample diversity within this selection is still appropriate for the development of a reliable classification scheme. In this paper, we extend the earlier works on stratospheric particle classification to include particles collected during the period May 1981 to November 1983.

The methodology for classification of stratospheric particles between 2μm and 50μm in size is based upon particle morphology (sphere, aggregate or fragment) and bulk elemental chemistry. Major categories of bulk chemistry are defined by the presence (or absence) of specific elements such as Si, Al, Fe, low atomic number (e.g. carbon; "Low-Z") or other elements. Thus, five major chemistries "Si-rich", "Al-rich", "Fe-rich", "Low-Z" and "Other" can be combined with the morphologies to give a 3 x 5 matrix within which 15 major particle categories may be defined. The first three chemistry categories can be further divided into sub-groups: Silicate, Chondritic, Ca-Al-Silicate; Al-only and Al-prime; Fe+S and Fe-S. Definitions for these sub-groups have been given in previous publications [3,4]. The category previously termed "Other" [3] has also been divided into two major groups (Low-Z and Other) to accommodate the increased number of low atomic number particles in recent collections. A compilation of data for 744 particles from the JSC Collection using 3 x 5 matrix, with sub-groups for a 3 x 9 matrix, is given in Table 1. Values in Table 1 are absolute numbers for each particle category. The distribution of particle types in Table 1 agrees well with that reported for only 433 particles [4], and argues for the use and continued development of a morphology x chemistry classification matrix for stratospheric particles.

Particle size data is also documented in the stratospheric dust database and can be used to identify size distributions within each particle category. Size distributions for three sphere categories, Fe-, Si- and Al-rich, are shown in Figure 1. A markedly bimodal distribution is noted for Fe-rich spheres and there is some indication that a bimodal distribution occurs for Al-rich spheres. On average, opaque Al spheres and Al' spheres are larger (8.1μm and 8.3μm, respectively) and show a greater variation in size ranges than Al-only spheres (6.2μm). The bimodal plot for Fe-rich spheres is related to differences in average size of Fe+S and Fe-S spheres. The average size for Fe+S spheres is 7.40μm while that for Fe-S spheres is 4.0μm. Relative values for dispersion in these sample sets indicate that the Fe-S spheres show less variation in size. In contrast, the size distribution for Si-rich spheres is relatively flat and shows no specific size modality. The average size for

Si-rich spheres is 7.8μm. If one assumes there is minimal selection bias within these groups of spheres in the JSC database (N=193), then these relative size distributions may provide some insight into processes of sphere formation, or, alternatively, the nature of sphere/micrometeoroid sources.

For example, optically opaque Al spheres and Al' spheres may be incompletely (or partially) oxidised rocket fuel, and hence, on average may show a size distribution different to spent rocket fuel. Alternatively, the possible bimodal size distribution for Al spheres may represent two different sources of spent rocket fuel (e.g. tactical vs. orbiter rockets) at the collection altitude. An indication of more interesting atmospheric dynamics phenomena may be gleaned from the Fe-rich and Si-rich sphere size distributions. Many of these sphere types are similar in bulk composition to larger (∿100μm) micrometeorite spheres collected from deep-sea sediments [6]. Ablation and/or melting is a significant process for the larger micrometeorites on atmospheric entry [6]. Analysis of chondrite meteorites suggests that these processes also promote the formation of smaller sized (Fe- and Si-rich) spheres (<15μm) on fusion crusts [7]. Hence, many Fe- and Si-rich spheres collected from the stratosphere are probably ablation products from large meteors entering the Earths' atmosphere [3,7]. Yet the average sizes (and size distributions) of Fe-S and Fe+S spheres are considerably different. Similarly, size distributions for Si- and Fe-rich spheres do not correspond over the same size range. Important parameters (e.g. entry velocity, inclination, composition, mass and density) will influence the atmospheric heating characteristics of an incoming meteor(s), and there is an indication that some of these parameters may be embedded in a stratospheric dust database. A larger, statistically significant sample set may provide the experimental control necessary for a more detailed understanding of the upper atmospheric dynamics of solid particles.

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TABLE 1

	SPHERE	AGGREGATE	FRAGMENT
CAS	10	0	3
Sil	30	52	77
Chon	2	95	57
Si Sub-tot.	42	147	137
Al	114	17	17
Al'	10	47	9
Al Sub-tot.	124	64	26
Fe + S	13	7	22
Fe - S	15	5	12
Fe Sub-tot.	28	12	34
Low Z	4	38	26
Other	10	19	33
TOTAL:	208	280	256

Fig.1: