AUGER SPECTROSCOPY OF STRATOSPHERIC PARTICLES: THE INFLUENCE OF AEROSOLS ON INTERPLANETARY DUST

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Particle collections from the stratosphere via either the JSC Curatorial Program or the U2 Program (NASA Ames) occur between 16km and 19km altitude and are usually part of ongoing experiments to measure parameters related to the aerosol layer. Fine-grained aerosols (<0.1μm) occur in the stratosphere up to 35km altitude and are concentrated between 15km and 25km altitude [1]. All interplanetary dust particles (IDP's) from these stratospheric collections must pass through this aerosol layer before reaching the collection altitude. The major compounds in this aerosol layer are sulfur rich particulates (<.1μm) and gases and include H_2SO_4, OCS, SO_2 and CS_2 [2]. In order to assess possible surface reactions of interplanetary dust particles (IDP's) with ambient aerosols in the stratosphere, we have initiated a Surface Auger Microprobe (SAM) and electron microscope study of selected particles from the JSC Cosmic Dust Collection.

Particles selected for SAM study included two spheres listed as sample numbers W7017E8 and W7017E18 in the Cosmic Dust Catalog [3]. Both particles were processed by standard methods in a Class 100 clean room at the JSC Curatorial Facility [3] and included gentle hexane washing of each specimen to remove adhered silicone oil used in the collection process. Scanning electron microscopy (SEM), transmission electron microscopy (TEM) and bulk elemental analyses were obtained with a JEOL 100CX analytical electron microscope (AEM) and attached energy dispersive spectrometer (EDS) at an accelerating voltage of 100kV. The morphology, texture, composition and size of sample number W7017E18 is typical of Al_2O_3 spheres collected in the plumes of solid-fuel rockets [4]. Sample W7017E8 is a silicate sphere, probably derived by ablation during atmospheric entry of a larger (~cm size) meteoric body. Bulk EDS analyses for W7017E18 and W7017E8 are shown in Figures 1a and 1b. For both samples, the presence of minor elements (such as S or Cl) are not evident in these spectra. Thus, at the ~1 weight % level, elements possibly associated with aerosols are not detected by EDS.

A high resolution Model 595 SAM was used for Auger spectroscopy at accelerating voltages of 3kV and 5kV after preliminary light sputtering to remove adsorbed atmospheric carbon or oxygen. At the top surface of the samples, a few monolayers of carbon were present, probably due to both adsorbed CO_2 and the remains of the hexane rinse from processing at the JSC Curatorial Facility. Elemental profiles from the top surface layer can be obtained for each sample by sucessive cycles of argon sputtering and spectral analysis at regular depth intervals. Surface elements monitored using this procedure for particles W7107E8 and W7017E18 are Al, Si, O, Cl and S. Figures 2a-c show reduced spectra for sample W7017E8 at sampling intervals of 0, 24 and 144 seconds respectively. At 24 seconds, a small but statistically significant S peak is present in the spectra (Fig.2b and inset). After additional sputtering, the S peak is absent, while the low energy Al peak is well defined (Fig. 2c). In addition, spectral lines corresponding to surface and/or experimental contaminants (C and In) noticeably decrease at the deeper profile interval. Similar spectra are observed for successive sputterings of the Al_2O_3 sphere (W7017E18). The presence of this small (<100A) layer of sulfur (between 30A and 175A beneath the surface) on both spheres suggests that aerosol-particle surface reactions have occurred prior to collection in the strato-

sphere. These SAM studies on anthropogenic and extraterrestrial samples suggest that the top surface layers (~150A) of all particles collected from the stratosphere will contain some of the major elements from the aerosol layer. In terms of typical analyses currently performed upon stratospheric particles (including IDP's; [5]), this level of surface contamination does not compromise geochemical interpretations of IDP's or other stratospheric particles.

A detailed modal analysis of 235 grains present in an allocated sample of chondritic porous aggregate (CPA) W7029*A [6] shows the presence of five particles between 0.2 and 2.2μm with morphologies and elemental signatures typical of sulfur-rich aerosols from the stratosphere [7,8]. We suggest that minor amounts of small H_2SO_4 aerosol droplets which accumulate on the surfaces of incoming IDP's will be observed in all IDP samples. These droplets will tend to be concentrated by the washing procedure during sample processing (hexane and H_2SO_4 are immiscible). As we have suggested above, on the basis of a more precise surface analytical technique, the level of aerosol contamination of stratospheric particles is negligible (<1% for modal analysis) for geochemical studies. In addition, the characteristic morphology and chemistry of sulfate aerosols enhances ready identification using a conventional AEM.

References: 1. Rosen, J.M. (1969) Space Sci. Rev., 9, 58-59; 2. Turco, R.P. et al., (1980) Nature, 283, 283-286; 3. Clanton, U.S. et al., (1982) Cosmic Dust Catalog, Vol.1, NASA JSC; 4. Brownlee, D.A. et al., (1976) Science, 191, 1270-1271; 5. Mackinnon, I.D.R. et al., (1985) LPSC XVI; 6. Rietmeijer, F.J.M. and I.D.R. Mackinnon, (1985) submitted GCA; 7. Rose, W.I.Jr. et al., (1980) Am. J. Sci., 280, 671-696; 8. Mackinnon, I.D.R. et al., (1984) J. Vocanol. Geotherm. Res., in press.

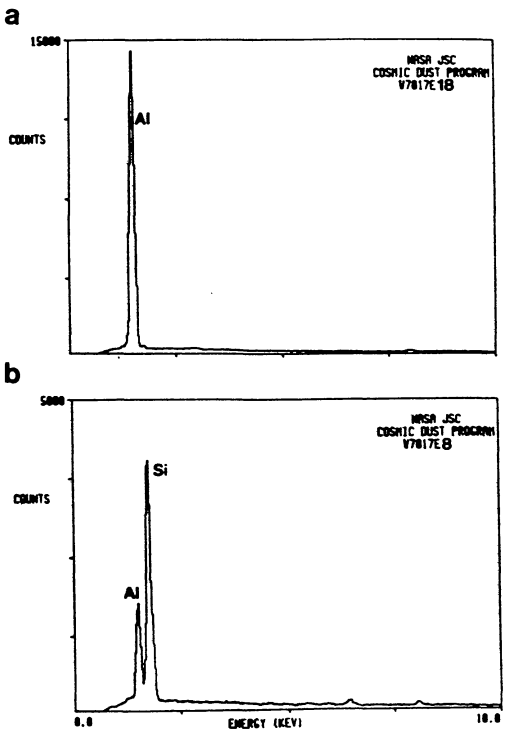

Fig.1

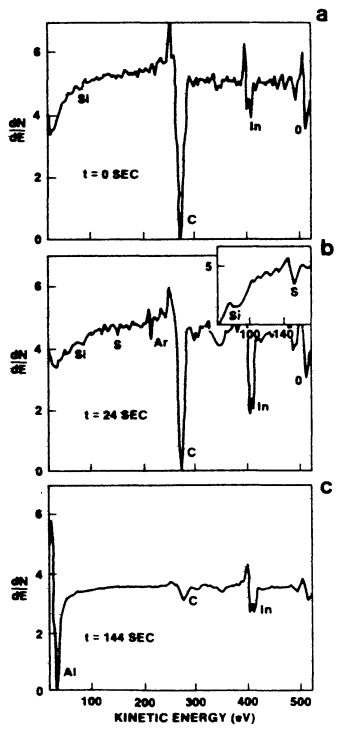

Fig. 2