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IDENTIFICATION AND CHARACTERIZATION OF EXTRATERRESTRIAL NON-CHONDRITIC INTERPLANETARY DUST

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Interplanetary Dust Particles (IDPs) are among the most pristine and primitive extraterrestrial materials available for direct study. Most of the stratospheric particles selected for study from the JSC Curatorial Collection have been chondritic in composition (major element abundances within a factor of two of chondritic meteorites) because of this composition virtually ensures that the particle is from an extraterrestrial source.

It is likely that some of the most interesting classes of IDPs have not been recognized simply because they are not chondritic or do not fit established criteria for extraterrestrial origin. Indeed; mass spectroscopy data from the Giotto flyby of comet Halley indicate that a substantial fraction of the dust is in the sub-micron size range and that a majority of these particles contain C,H,O, and/or N as major elements.

The preponderance of CHON particles in the coma of Halley implies that similar particles may exist in the JSC stratospheric dust collection. However, the JSC collection also contains a variety of stratospheric contaminants from terrestrial sources which have these same characteristics. Because established criteria for extraterrestrial origin may not apply to such particles in individual cases, an integrated approach is required in which a variety of analysis techniques is applied to the same particle.

Non-chondritic IDPs, like their chondritic counterparts, can be used to elucidate pre- and early solar system processes and conditions. The study of non-chondritic IDPs may additionally yield unique information which bears on the nature of cometary bodies and the processing of carbonaceous and other low atomic number materials.

We will utilize a suite of complementary techniques, including Low Voltage Scanning Electron Microscopy (LVSEM), Energy-Dispersive X-ray Microanalysis (EDX), Secondary Ion Mass Spectrometry (SIMS) isotope-ratio imaging and Analytical Electron Microscopy (AEM) to accomplish the following two objectives: 1. Develop criteria for the unequivocal identification of extraterrestrial non-chondritic IDPs, and 2. Infer IDP parent body, solar nebula and pre-solar conditions through the study of phases, textures and components contained within non-chondritic IDPs. The general approach we are taking is designed to maximize the total information obtained from each particle. Techniques will be applied in order from least destructive to most destructive.

LVSEM is the premier technique for the high resolution non-destructive surface imaging of particles. The powerful combination of LVSEM with Secondary Ion Mass Spectroscopy (SIMS) isotope ratio imaging allows for the first time the identification of isotopic hot spots and their correlation with original phases and/or morphological features within intact particles.

The application of SIMS isotope ratio imaging to ultramicrotome thin sections of particles allows for the first time the complete characterization by Analytical Electron Microscopy (AEM) of phases which harbor isotopic anomalies.

The result of this investigation will be a data set on a variety of non-chondritic IDPs including surface morphology, bulk composition, D/H isotopic ratios and nanometer-scale phase identification using AEM.

From these date we anticipate that objective criteria can be established for the extraterrestrial and/or interstellar origin(s) of non-chondritic carbonaceous IDPs. Using known stability relationships, phase equilibria and the like, it should be possible to constrain interstellar, pre- and early solar system condition extant during formation and aggregation of the parent bodies represented by the IDPs.