Point Count Analysis of Interplanetary Dust and Fine-Grained Meteoritic Materials. D.E. Brownlee, M.M. Wheelock and J.P. Bradley, Dept. of Astronomy, FM-20, University of Washington, Seattle, Washington 98195.

Many interplanetary dust particles have chondritic elemental compositions on the scale of a few microns. They are fine-grained and are difficult to characterize, or compare with other fine-grained extraterrestrial materials that have similar bulk compositions. High resolution electron microscopy has been successfully used to study the dust particles but this approach cannot be adequately applied to a large enough sample of grains in a heterogenous particle to provide a meaningful material characterization.

Microprobe "point count" analysis of the elemental composition of a statistical set of random grains in a single particle is a technique that can provide a powerful means of comparing materials that have similar bulk compositions but are heterogenous on a fine scale. In particular, it is hoped that this approach may be used to detect possible genetic links between various types of collected interplanetary dust and fine-grained fractions of meteorites or comet particles that will be analyzed in-situ on the 1986 European and Soviet missions to Halley and the SSEC comet rendezvous mission anticipated for the late 1990s. The Halley missions will carry time-of-flight mass spectrometers developed at MPI-Heidelberg that will measure the composition of a large number of micron and submicron dust grains. The rendezvous spacecraft may include an autonomous SEM-EDX designed to measure elemental compositions for a large number of micron and submicron grains.

To evaluate the point count approach and develop a data base for comparison with future comet data, we have begun analyses of stratospheric micrometeorites and fine-grain fractions of carbonaceous and unequilibrated ordinary chondrites. The dust particles are gently disaggregated, without crushing large mineral grains, and mounted on 100A carbon films so that very small particles can be analyzed with minimal substrate background. For each particle, high fidelity EDX spectra are collected in the SEM so that good relative abundances can be determined for major and minor elements with the Armstrong-Buseck particle ZAF correction procedure. A good characterization requires analysis of fifty or more randomly selected 0.1-1 μm grains per particle. The meteorite samples are analyzed in polished section because of the need to positively identify regions of bona fide fine-grained matrix and because any crushing technique would produce small grains from abundant large ones. To minimize the excitation volume only 10kv was used for the meteorite analyses.

The result of these analyses has been very encouraging. As shown in the figure, the distribution patterns even for the major elements are distinctly different for the various types of materials. Surprisingly, the carbon-rich C chondrites have the least abundance dispersions on the micron scale. They are distinctive, however, in that certain elements such as Ca and S show systematic deviations from bulk CI composition. The distributions in most of the interplanetary particles are distinct from the C chondrites and they fall into several classes. Extreme cases are particles where most of the submicron grains have chondritic abundances (SP56A) and particles (CP23A) where most submicron grains are single minerals or are composed of only a few minerals. Most of the grains in CP23 have compositions that can be produced by simple mixtures of olivine, enstatite, diopside and albite. Diffraction and lattice fringe imaging has

shown that some of the grains are these phases, but that some of the grains on mixing lines between these minerals are actually a yet unidentified Mg, Fe silicate.

It appears that the elemental composition point count approach is a very effective technique for comparing very fine-grained chondritic materials and the data from meteoritic samples will provide a powerful data set for comparison with future individual comet grain analyses to be made with spacecraft. This approach also is an unbiased method for determining phase composition data vital to understanding the genesis of complex fine-grained particles.

Figure 1. Atom ratios for one micron volumes of matrix in three carbonaceous chondrites and submicron grains in three chondritic micrometeorites collected in the stratosphere. The size of the plotted points is proportional to the S/Si ratio. All the samples have similar bulk compositions and their mean compositions would plot near the centers of the ternary diagrams. Sulfides and other nonsilicate points were measured but not included in the plots.