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A COMPARISON OF HALLEY DUST WITH METEORITES, INTERPLANETARY DUST AND INTERSTELLAR GRAINS

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The Giotto, Vega 1 and Vega 2 spacecraft carried nearly identical instruments designed to measure the elemental and isotopic compositions of dust from comet Halley. The time-of-flight mass spectrometers measured mass spectra of positive ions generated during the hypervelocity impact of individual submicron particles. The thousands of spectra produced by the instruments provided a direct analysis of the bulk elemental composition of Halley solids and information on molecular and isotopic composition. The variations between spectra yielded an intimate view of the nature of Halley at the submicron scale.

The averaged composition of Halley is consistent with chondritic elemental abundances for elements heavier than sodium (Jessberger *et al.* 1986). The abundances of C and N in the Halley solids appear to be higher than those observed in the most carbon rich meteorites. Jessberger *et al.* estimate that carbon is enhanced by a factor of eight above its abundance in CI chondrites. The abundance of different types of carbon rich particles varied during the Giotto flyby indicating possible large scale heterogeniety in the nucleus (Clark *et al.* 1986). For the most part, molecules were disassociated during impact with the instruments but analysis of apparent molecular fragments has been used to estimate the molecular composition of the organic component in Halley (Kissel and Krueger 1987).

The variability of the mineral forming elements in the submicron Halley grains provides a powerful basis for comparison of Halley with the different classes of meteoritic materials that have been studied in the laboratory. The degree of variability in the Halley samples is larger than that seen in chondrites implying that Halley is more heterogenous at the submicron scale. A critical distinction is that Halley contains abundant pure Mg silicates at this size scale while the carbon rich meteorites do not. The submicron compositional dispersion seen in Halley is dramatically different from the narrowly constrained compositions seen in the CI and CM (type 1 and 2) carbonaceous chondrites. These meteorites are carbon rich but are dominated by a serpentine-like hydrated silicate with a very narrow range of Mg/Si ratio. The Halley results are also unlike the compositional variations seen in the majority of interplanetary dust types that are dominated by hydrated minerals. The only known class of meteoritic material that appears to closely resemble the

Halley data is a class of interplanetary dust that is composed entirely of anhydrous minerals. These particles are black, porous aggregates of submicron grains. Some of the component grains in these aggregates are single minerals such as Mg_2SiO_4, $MgSiO_3$ and FeS while others are compact masses of very small crystals and amorphous material imbedded in a low atomic weight matrix. If these particles are identical to Halley this would imply that Halley is dominated by olivine, pyroxene, iron sulfide, glass and amorphous carbonaceous matter. Carbon in these particles occurs as discrete grains and as films not generally exceeding 200 A in thickness. As the minerals in these particles are anhydrous the only means of storage of water or OH in the material would be as ice filling the open voids. Because the pore spaces are submicron in size, ice and black dust should be intimately mixed even at the micron size scale.

A key issue in cometary studies is the relationship between comet dust and interstellar grains. Some authors (Kissel and Krueger 1987) have heavily interpreted the Halley results in favor of the Greenberg core-mantle model for interstellar grains. The Halley results do indicate high carbon abundances, consistent with the Greenberg model, but there is little definitive evidence to really substantiate the assertion that Halley is a mixture of preserved presolar grains that have silicate cores surround by thick radiation processed organic mantles. If Halley particles are identical to the anhydrous interplanetary particles, the core-mantle model does not describe their structure. These particles are more complex than an assemblage of elongated silicate cores mantled with thick organic films. An interesting approach for comparison of cometary, interstellar and interplanetary particles is the shape of the 10 μm silicate feature. Structure observed in the Halley 10 μm feature appears to correlate with that observed in the anhydrous interplanetary particles measured by Sandford and Walker (1987). Such measurements can distinguish materials dominated by low temperature minerals like hydrated silicates from high temperature minerals such as Mg silicates.

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