COMETARY DUST AFTER DEEP IMPACT

Diane H. Wooden[1], David E. Harker[2], Charles E. Woodward[3]

[1] *NASA Ames Research Center*
[2] *University of California, San Diego/CASS*
[3] *University of Minnesota*

When the Deep Impact Mission hit Jupiter Family comet 9P/Tempel 1, an ejecta crater was formed and an pocket of volatile gases and ices from 10-30 m below the surface was exposed (A'Hearn et al. 2005). This resulted in a gas geyser that persisted for a few hours (Sugita et al. 2005). The gas geyser pushed dust grains into the coma (Sugita et al. 2005), as well as ice grains (Schulz et al. 2006). The smaller of the dust grains were submicron in radii (0.2–0.3 micron), and were primarily composed of highly refractory minerals including amorphous (non-graphitic) carbon, and silicate minerals including amorphous (disordered) olivine $(Fe,Mg)_2SiO_4$ and pyroxene $(Fe,Mg)SiO_3$ and crystalline Mg-rich olivine. The smaller grains moved faster, as expected from the size-dependent velocity law produced by gas-drag on grains. The mineralogy evolved with time: progressively larger grains persisted in the near nuclear region, having been imparted with slower velocities, and the mineralogies of these larger grains appeared simpler and without crystals. The smaller 0.2–0.3 micron grains reached the coma in about 1.5 hours (1 arc sec = 740 km), were more diverse in mineralogy than the larger grains and contained crystals, and appeared to travel through the coma together. No smaller grains appeared at larger coma distances later (with slower velocities), implying that if grain fragmentation occurred, it happened within the gas acceleration zone. These results of the high spatial resolution spectroscopy (GEMINI+Michelle: Harker et al. 2005, 2006; Subaru+COMICS: Sugita et al. 2005) revealed that the grains released from the interior were different from the nominally active areas of this comet by their: (a) crystalline content, (b) smaller size, (c) more diverse mineralogy. The temporal changes in the spectra, recorded by GEMINI+Michelle every 7 minutes, indicated that the dust mineralogy is inhomogeneous and, unexpectedly, the portion of the size distribution dominated by smaller grains has a more diverse mineralogy. The lower spatial resolution, high sensitivity Spitzer IRS data reveal resonances of refractory minerals (those seen by GEMINI+Michelle plus ortho-pyroxne), as well resonances that can be attributed to phillosilicates (layer lattice silicates such as Montmorillonite) (Lisse et al. 2006).

Pre- and post-impact, micron to submicron grains were deciphered to be present in the coma by the modeling the high spatial resolution images to account for nucleus plus inner coma fluxes (Wooden et al. 2005, 2006; Harker et al. 2005, 2006a). Note also that crystalline silicates were released from the interior of 73P-B/SW-3 as it disintegrated (Harker et al. 2006b).

From the Deep Impact and the disintegration of 73P-B, we are led to ask the questions: Why is the mineralogy of the dust released from a volatile-rich pocket beneath the surface different from the dust that is released from the nominally active areas? Could the most volatile pockets be exhausted quickly? Why would crystalline silicates be associated with more volatile materials? Perhaps the structure of the comet is so inhomogeneous, e.g., the layered pile model of the nucleus (Belton et al. 2006), that a reservoir of crystalline silicate and submicron grains just happens to not be released by the nominally active areas of comet 9P? Perhaps comets lose matter through their mantles from below their surfaces, thus preserving ancient topographic structures and radiation damaged silicates and carbon? We will discuss and ponder different scenarios. We will discuss future directions for coordinated observations of JF comets.