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## OVERVIEW OF THE RESULTS OF THE ORGANICS PET STUDY OF THE COMETARY SAMPLES RETURNED FROM COMET WILD 2 BY THE STARDUST MISSION.

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**Introduction:** STARDUST is the first mission designed to bring samples back to Earth from a known comet [1]. The captured samples were successfully returned to Earth on 15 Jan 2006, after which they were subjected to a preliminary examination by a number of teams of scientists from around the world [2]. This abstract describes the efforts of the Organics Preliminary Examination Team (PET). More detailed discussions of specific analyses of the samples can be found in other papers presented at this meeting by individual members of the Organics PET (see the author list above for team members).

The studied Wild 2 gas and dust samples were collected by impact onto aerogel tiles and Al foils when the spacecraft flew through the coma of 81P/Wild 2 on 2 Jan 2004 at a relative velocity of ~6.1 km/sec [1,3]. After recovery of the Sample Return Capsule (SRC)

on 15 Jan 2006, the aerogel collector trays were removed in a clean room at JSC. After documentation of the collection, selected aerogel tiles and aluminum foils were removed and aerogel and cometary samples extracted for study.

**Analytical Techniques:** Members of the Organics PET used a number of analytical techniques to study the abundance and nature of the organics in the returned samples. These included two varieties of two-step laser desorption laser ionization mass spectrometry, called micro-L<sup>2</sup>MS and ultra-L<sup>2</sup>MS, LC-FD/TOF-MS (Liquid Chromatography with UV Fluorescence Detection and Time of Flight Mass Spectrometry, STXM (Scanning Transmission X-ray Microscopy and C, N, and O XANES (X-ray Absorption Near Edge Structure), Infrared and Raman Spectroscopy,

IC (Ion chromatography with conductivity detection), TOF-SIMS (Time-of-Flight Secondary Ion Mass Spectrometry), SIMS (Secondary Ion Mass Spectrometry), TEM (Transmission Electron Microscopy), and EELS (Electron Energy Loss Spectrometry) [4].

*Other PE Subteams:* In addition to efforts made by the Organics PET, the study of the returned organics also benefited from results of other PE subteams, particularly the Spectroscopy [5] and Isotopes [6] Subteams.

*Contamination Control and Assessment:* The Organic PET devoted much effort to establishing the abundance and identity of contaminants present in the samples so they would not be falsely identified as being cometary. This was done by identifying organics on monitoring 'coupons' placed in the SRC but not exposed to the cometary flux, in air and soil samples taken from the landing site, in the SRC ablative heat shields and the SRC canister's air filter, and within the original aerogel tiles themselves. Some of the returned organics are clearly cometary (based on isotopics, intimate association with minerals, etc.) but the provenance of some components of the observed organics remains open.

**Summary of Results:** Organics found in Comet Wild 2 samples show a highly heterogeneous and unequilibrated distribution in abundance and composition. Some are similar, but not identical, to those in interplanetary dust particles (IDPs) and primitive meteorites. A new class of aromatic-poor organic material is also present. These non-aromatic fractions look similar to what is expected from the production of organics by radiation processing of volatile ices. The organics are generally much richer in O and N relative to C than meteoritic organics, but have O/C and N/C ratios that fall in the field populated by IDPs. Aromatic compounds are present, but the samples tend

to be relatively poorer in aromatics than meteorites and IDPs. Most aspects of the organic samples suggest they contain materials that have seen less thermal processing than meteorites and IDPs. D and  $^{15}\text{N}$  excesses in some samples suggest that some of the organics have an interstellar/protostellar heritage [6,7]. While the variable extent of modification of these materials by impact capture is not yet fully constrained, a remarkably diverse suite of organic compounds is present and identifiable within the returned samples. A more detailed discussion of the results of the Organics PET can be found in reference [4] and in a series of papers being submitted to *MAPS*.

**Post PET Examination:** Now that the PE period is over, all STARDUST samples are in the care of the NASA Curatorial Office where they are available for study by the entire scientific community. Samples will now be distributed in a manner similar to that used for allocating other extraterrestrial samples.

**References:** [1] Brownlee D. E., et al. (2004) *Science*, 304, 764-769. [2] Brownlee, D. E., et al., (2006) *Science*, 314, 1711-1716. [3] Tuzzolino A. J. et al. (2004) *Science*, 304, 1776-1780. [4] Sandford, S. A., et al. (2006) *Science*, 314, 1720-1724. [5] Keller, L. P., et al. (2006) *Science*, 314, 1728-1731. [6] McKeegan, K. D., et al. (2006) *Science*, 314, 1724-1728. [7] Sandford S. A., et al. (2001) *MAPS*, 36, 1117-1133.

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