Isotopic compositions of cometary materials returned by the STARDUST mission

K.D. MCKEEGAN[1] AND THE STARDUST PRELIMINARY EXAMINATION TEAM

[1] Dept. of Earth & Space Sciences, University of California, Los Angeles, CA., USA. mckeegan@ess.ucla.edu

First sample return of extraterrestrial rocks since Apollo

The STARDUST spacecraft flew through the coma of comet 81P/Wild2 on Jan. 2, 2004, at a distance of ~236km and a relative velocity of ~6.1 km/s. Dust particles, which were released from the comet hours before the encounter, were captured in silica aerogel and successfully returned to the Earth on Jan. 15, 2006. Cometary debris was also retained in small impact craters on Al-foil strips adjacent to the aerogel collector cells. A prelimary examination team (PET) of ~150 scientists has been engaged in studying the mineralogy/petrology, chemistry, optical properties, organic materials, fluence, and isotopic compositions of a subset of the returned cometary materials. This report will summarize what has been learned regarding isotopic compositions of select elements by the PET during its six month investigation.

Goals of isotope analysis

Isotopic composition can be potentially diagnostic in relating Wild2 materials to other types of primitive extraterrestrial materials, such as carbonaceous chondrites and interplanetary dust particles. A major question is whether, or to what extent, isotopic compositions can be recognized as distinctly extra-solar. Interstellar dust that, at least according to some models, should constitute a major fraction of cometary "refractory" materials might not be very diffierent from average solar system in terms of isotope abundances of major elements, but even in this case one might still expect that such relatively homogenized interstellar dust would be accompanied by a large population of circumstellar (presolar) grains with distinctive nucleosynthetic signatures. Emphasis is given to H, C, N, O, and the more abundant noble gases. Analyses are proceeding by high-spatial resolution (sub-micron) isotopic mapping utlizing several nanoSIMS instruments, large radius SIMS instruments for higher precision "bulk" measurements, and ultra-low-blank gas source mass spectrometry. Both "large" (several micron) individual mineral grains and fine-grained materials are targeted by the SIMS methods, while other analyses examine entire particle 'tracks' carved into the aeorgel collectors. Additional isotope measurements may be made on particle fragments and vapor deposits associated with small craters on the Al-foil used to wrap each aerogel cell.