# First Comet Dust on Earth Reveals Clues to Solar System

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An international team of scientists that examined the first samples brought to Earth from a comet has confirmed that our early solar system was a violent place in which dust and gas underwent considerable mixing while the sun and planets were still in the process of forming.

"The analysis of these cometary dust grains proves that the early solar system was a violent place capable of ejecting dust grains out to distances beyond Neptune," said Gerardo Dominguez, a physicist at the University of California, San Diego, and a member of the research team.

The scientists reported in a series of papers published in the December 15 issue of the journal *Science* that, even though the comet formed in the cold, outer reaches of the solar system, it contains high temperature minerals that formed much closer to the sun, suggesting that these particles were ejected with considerable force.

In addition, because the returned comet samples contained mixtures of high and low temperature materials, the researchers said they were confident that these building blocks of the solar system had been "stored," largely unchanged, since they gathered together to form Comet Wild 2 over 4.5 billion years ago at the birth of the solar system. That makes them especially valuable to those who hope to learn more about the early formation of the solar system.

"We have taken a pinch of comet dust and are learning incredible things," said Stardust principal investigator Donald Brownlee, a professor of astronomy at the University of Washington and the principal author of the overview technical paper, one of seven reports about the mission's initial findings, published in this week's special edition of *Science*.

The researchers discovered that the comet dust contained a wide variety of minerals, as well as organic materials. Some of these minerals and organics look similar to those seen in primitive types of meteorites, they said, but both the minerals and the organics show the presence of some new materials not previously seen in meteorites.

The precious cometary samples were collected from the comet Wild 2 by the Stardust spacecraft and returned to Earth. NASA's Stardust mission traveled 2.88 billion miles during a seven-year round-trip odyssey from Earth to Comet Wild-2, and back again.

On January 2, 2004, the Stardust spacecraft flew by Comet Wild 2 and used a "cometary catcher's mitt," a tennis-racket-shaped particle catcher containing more than 160 square inches of collection area filled with a material called aerogel. Made of pure silicon dioxide, much like "fluffy"glass, aerogel is a thousand times less dense than ordinary glass because it is 99.8 percent empty space. This high-tech material had enough "give" in it to slow and stop particles from their original velocity of around 14,000 miles per hour without altering them radically. After collection, the Stardust spacecraft returned the samples to Earth on January 15, 2006.

UCSD's Dominguez was part of the group examining the aerogel that determined the size distribution of the dust grains released from the comet.

"This distribution was determined by measuring the size distribution of impact craters in the aluminum frame of the spacecraft as well as the size of entry holes in the aerogel collector," he said. "Since the crater size is a function of both the size and velocity, and since the impact velocity was known from relative speed of spacecraft and comet, we were able to estimate the sizes distribution of the dust grains."

The returned samples consisted of extremely small particles, from less than 1 to 300 micrometers (1/1000th of a millimeter) in diameter. The diameter of a human hair, for comparison, is about 50 micrometers. Locked within the cometary particles is unique chemical and physical information that provides a record of the formation of the planets and the materials from which they were made. The scientists used a variety of sophisticated laboratory techniques to study the samples, which revealed a great deal not only about the composition of comets, but provided key insights into the earliest history of our solar system.

The capsule containing the samples entered the Earth's atmosphere at an altitude of 125 kilometers (410,000 feet) over Northern California at a velocity of 46,440 kilometers per hour (28,860 miles per hour), the greatest reentry velocity of any human-made object on record. The capsule landed in the Utah Test and Training Range in northwestern Utah where it was quickly recovered. The return capsule was then transported to NASA Johnson Space Center where the process of removing the samples was begun. Within days, samples were being distributed to scientists on the Preliminary Examination Team for study.

During the preliminary examination of the returned cometary materials, over 200 samples obtained from approximately 35 particle impact tracks were distributed to members of the Preliminary Examination Team around the world. These samples represent only a small fraction of the total collected material returned by the Stardust spacecraft. The samples examined so far were obtained from only 10 of the 132 aerogel tiles in the Stardust collector, and a similar fraction of exposed aluminum foils, that were exposed directly to the comet, leaving the remaining samples for future studies.

Now that the preliminary examination is completed, the samples will be cared for by the NASA Curatorial Office, the same organization that cares for the moon rocks brought back from the moon by the Apollo astronauts. The samples will now be made available for more detailed studies by the world's scientific community.

More information on the Stardust mission is available at: http://stardust.jpl.nasa.gov/home/index.html

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