Yukon meteorite will allow glimpse into origins of life, universe

A meteorite that exploded over a remote area of northwest Canada in January will offer researchers a rare glimpse into the organic materials which "might have seeded life on Earth," said a NASA scientist who has begun analyzing some of the meteorite fragments.

JSC researchers have only begun to do their mineralogical analysis on fragments of the meteorite to determine its context with others that have fallen. "What we have discovered in this regard is that this is a very rare kind of meteorite called a carbonaceous chondrite," said Dr. Michael Zolensky, a cosmic mineralogist at JSC. "The last time one of these fell was in 1969 when two of them fell. So this is a once-in-a-generation type of occurrence to have this meteorite fall and be collected and analyzed.

"This is important because these kinds of meteorites are rich in organics. They contain pre-biotic organic materials such as amino acids and hydrocarbons which might have seeded life on Earth, and they also typically contain star dust including diamonds and silicon carbide that are survivors of the original cloud of dust and gas that made our solar system."

Carbonaceous chondrites, which comprise only about 2 percent of meteorites known to have fallen to Earth, contain many forms of carbon and organics, basic building blocks of life. They are typically difficult to recover because they easily break down during entry into Earth's atmosphere and during weathering on the ground.

JSC researchers received 10 egg-shaped chunks of the meteorite in mid-February. About a dozen additional pieces of the meteorite were delivered in early March. Only one of the initially received samples has been thawed; the rest are being kept frozen. "They have probably been frozen since they formed 4.5 billion years ago," said Zolensky.

The samples are in near-perfect condition. The location and timing of the fireball that streaked over a remote area of the Yukon Territory the morning of January 18, 2000, contributed to the scientific value of the samples. The frozen snow-covered ground of the Yukon provided near-ideal conditions for preservation. The finder, who has requested anonymity, collected the fragments in clean plastic bags and kept them continuously frozen. They were kept frozen until they arrived at JSC. "This is the first time that anybody has received such an uncontaminated meteorite," Zolensky said.

Scientists estimate that the meteoroid was 3 to 10 meters in diameter, making it the largest object ever sampled for laboratory study.

Zolensky now has about a pound of meteorite fragments provided by the Canadian government and the University of Calgary. The finder loaned them to the Geological Survey of Canada's National Meteorite Collection of Natural Resources Canada (NRCan) and the University of Calgary, which then provided the samples, still frozen, to JSC for study and analysis. NASA is working closely with NRCan scientists and is providing results of the analysis to them.

NASA JSC Photo JSC2000-02037

Samples of three carbonaceous chondrite meteorites that fell to Earth. Carbonaceous chondrites contain many of the building blocks of life. Left: Allende meteorite fell on Mexico in 1969. Center: Sample of Yukon meteor that exploded over Yukon Territory, Canada. Right: Murchison meteorite sample, which fell to Earth in Australia in 1969.

Scientific analysis of the fragments has just begun and results are only preliminary. In addition to conducting the mineralogical analysis, researchers have measured the induced radioactivity present in some of the samples.

Tests for induced radioactivity, which are being carried out by Dr. David Lindstrom at JSC, measure the object's exposure to space radiation. This radiation enters the objects and induces some radioactivity, which researchers can detect using gamma-ray counters. Samples from deep within the object in space are shielded from this cosmic ray exposure and are less radioactive, while pieces on outer parts of the object would have been more heavily bombarded and thus are more radioactive.

"By measuring the radiation of the fragments of the meteorite as we get them, we can tell where these pieces were in the object as it was in space," said Zolensky.

The next step in the study of the fragments will be baseline analyses of the organics in the meteorite. This would require the destruction of some samples, and negotiations are under way with the finder of the fragments for permission to do such tests.

To find out more about how the planets and the sun were formed, researchers will look at the composition of the meteorite and the different isotopes for each element that is present. This data will tell researchers about the history of the atoms in the sample, how they came together, how the minerals originally formed, how they have been modified and how the sun has affected it. So the data will give researchers a history of the sun as well.

At JSC's request, and with the concurrence of the Canadian government, NASA's Dryden Flight Research Facility sent an ER-2 aircraft to sample the air in the vicinity of the fireball. Canadian scientists also gathered snow from local frozen lakes in an attempt to sample the dust shed from the fireball. These samples are now being examined at JSC.

NASA JSC Photo JSC2000-02039

Dr. Michael Zolensky, a NASA cosmic mineralogist, with a fragment of the Yukon meteorite. The meteor exploded over the Yukon Territory on January 18, 2000, and a local resident collected several fragments for analysis. Samples of the meteorite are being analyzed at JSC at the request of the Geological Survey of Canada, Natural Resources Canada, which is borrowing them from the finder.

Canadian scientists are analyzing the fireball track to determine what the original orbit of this meteorite was around the sun. U.S.-based satellite detection systems imaged the meteorite as it fell. "So we may actually be able to figure out where this meteorite came from for once, which would be unique for this kind of meteorite," said Zolensky.

Aside from their inherent scientific value, the samples are serving as a testbed of sorts for future sample return missions from Mars or Jupiter's moon Europa, Zolensky said. "One of the concerns in analyzing Martian samples is that we do not want to contaminate any return samples with organics from the Earth, and we want to learn how to prevent that from happening. So here we have a chance to examine an uncontaminated meteorite. We can do some baseline analyses now. We can then do our best to curate it for a few years and then analyze it to see how good a job we did in keeping it clean.
If we find that we didn't do a good job, then we could find how to do a better job. There is enough time to do that now to factor in how we would design a lab to analyze return Martian samples."

In addition to performing elemental, organic, and isotopic analyses on the meteorite, researchers may perform tests on it in the future that are as yet undetermined.

"One of the beauties of having actual samples on the ground to analyze is that you can tuck some of them away for a long time. In the future when new questions or techniques come along, you can pull out some samples and analyze them and learn more," Zolensky said. ■

Continued from Page 1

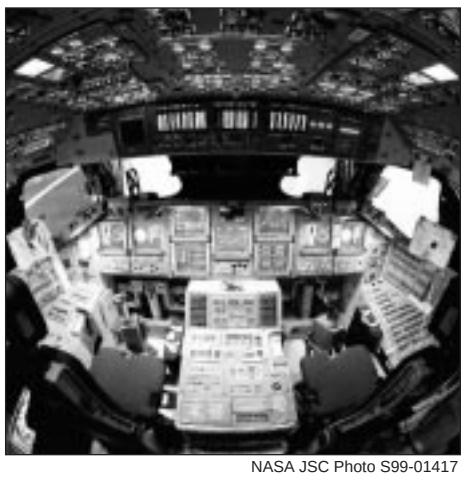
DEVELOPMENT

Usachev, Voss and Helms will return to the ISS next year as the second crew to live and work aboard the station. Permanent occupancy of the ISS is scheduled to begin in the fall by the Expedition One crew, William Shepherd, Yuri Gidzenko and Sergei Krikalev, who will be launched on a Russian Soyuz rocket from the Baikonur Cosmodrome in Kazakhstan.

Williams and Voss are the two space walkers during *Atlantis*' planned 10-day flight. Williams, who has no previous space-walking experience, will carry the designation of EV 1 during the planned excursion outside *Atlantis* and will wear the suit marked with red stripes on the elbows and the knees. Voss will be designated EV 2 and will wear the pure white suit. He conducted a space walk during the STS-69 mission in 1995 lasting almost seven hours.

The STS-101 mission originally was designed to follow the launch of the Zvezda Service Module as the flight to outfit the Russian component as the early living quarters for crews aboard the ISS. When Zvezda's launch was delayed, shuttle and station managers agreed to fly *Atlantis* on two separate flights to the station this year, STS-101 to conduct maintenance and logistics work aboard the ISS in advance of Zvezda's arrival, and STS-106, to unload supplies onto Zvezda from both the shuttle and a Russian Progress resupply vehicle. STS-106 is scheduled for launch in August, about five weeks after Zvezda's planned July launch on a Proton rocket from Baikonur.

"To me, the significance of this flight has been to demonstrate the quick response capability," said Sharon Castle, STS-101 launch package manager. "We officially decided to split this flight in January, and here we are at the end of March and we're pretty well ready to go. I'm happy we were able to demonstrate this so early in the assembly sequence."



NASA JSC Photo S99-01417

All of the space shuttles will be upgraded with the "glass cockpit," left, by 2002.

The crew plans to transfer almost a ton of equipment from a double Spacehab module housed at the rear of *Atlantis*' cargo bay into Zarya and Unity for use by the Expedition One crew later this year. Those logistical items include personal clothing, medical and exercise equipment, computer equipment and printers, hardware for stowage and trash management, and a centerline camera for Unity's common berthing mechanisms to which other ISS components will be mated. Four large bags of water will also be brought from *Atlantis* into the ISS for later use. The station will weigh 2,300 pounds more after all items are delivered and replaced than it did before STS-101.

"The team has been looking forward to this flight for a long time," said Engelauf. "We think we're all ready to go fly, and we're really looking forward to the mission." ■