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MINING COSMIC DUST FROM THE BLUE ICE LAKES OF GREENLAND. M. Maurette¹,
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Each year as the Earth orbits the sun, it collides with 10,000 tons of extraterrestrial material, mostly debris from the disintegration of comets and asteroids. Only a tiny fraction of this material is found on the ground as conventional meteorites. Most of it invisibly settles to Earth's surface as dust particles smaller than a millimeter in size. Particles of 1/10 millimeter size (twice the diameter of a blond human hair) fall at a rate of one per square meter per year. They occur everywhere but are usually nearly impossible to find because they are mixed in with much larger numbers of Earthly dust and dirt. Finding an extraterrestrial dust particle in a bucket of ordinary dirt is literally like searching for a needle in a haystack. In very special environments, however, the particles can be collected with comparative ease. Collection is important because the "cosmic dust" particles that are recovered can potentially provide important information about comets. Comets are the most important source of dust in the solar system and they are probably the major source of extraterrestrial dust that is collectable at the Earth's surface. Comets are mountain-sized bodies of ice and dust that have been preserved at low temperature since the origin of the planets. Comets are believed to be samples of the original building blocks that the outer planets, Uranus, Neptune and Pluto, formed from.

Typical dust particles in the size range from 1/10 to 1 millimeter in diameter melt during high velocity entry into the atmosphere to produce spheres. A few percent of the particles are not so strongly heated and do not melt. The first collection of "cosmic spheres" occurred over a century ago when scientists on the H.M.S. Challenger expedition discovered them in mud recovered from the floor of the Pacific Ocean at a depth of over two miles. Cosmic spheres could be collected from this site because of its isolation from sources of terrestrial particles of similar size and shape. The deep ocean floor is an important collecting site for cosmic spheres, but it has serious shortcomings. The recovery of large amounts of extraterrestrial material is difficult from such great depths and the particles that are collected are chemically altered by weathering processes in the sea floor sediment. We report here a new collection site for cosmic dust which is on land and is in an environment where degradation by weathering is minimal.

We have found that the blue ice lakes on the Greenland ice cap provide an ideal location for collection of extraterrestrial dust particles larger than 1/10 millimeter in size. The lakes occur in pure ice for a short period of time each summer. For the rest of the year they are frozen solid. The lakes are basins where dust released by the melting of billions of tons of ice is concentrated. The lakes are a unique location where cosmic dust is more highly concentrated than another spot on Earth. The extraterrestrial particles in the lakes originally fell onto ultra-pure ice in the interior of Greenland, a remote location that is isolated from significant sources of Earth dust in the millimeter-size range. Particles that fall in the interior are buried and remain embedded in the glacial ice that slowly flows outwards to the coast. Several thousand years after their fall the particles reach the zone along the coastline where ice melts during the summer. Particles from the melting ice are carried by temporary streams and deposited into the blue lakes that form at low

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points in the ice.

We discovered this concentration mechanism last summer when we mounted a French-Danish expedition to Greenland to search for extraterrestrial particles in the blue lakes. Particles were collected by magnets and by suction hoses that were used to vacuum sediment deposits from the lake bottoms. We found that the lakes contain enormous amounts of cosmic dust and that the dust is much better preserved than similar particles recovered from the ocean floor. During the previous decade it was found that unique properties of Antarctica made it the world's best location for finding meteorites. It now is evident that unique properties of Greenland make it the best region on Earth for collecting cosmic dust. On future expeditions it is expected that large numbers of particles will be recovered from the pristine and also beautiful blue ice lakes formed each summer near the southern coastal regions of Greenland. Analyses of these samples will give important new insights into the nature of comets and other primitive solar system materials.