Space Sciences

Earth's largest lunar meteorite announced

A meteorite found seven months ago in Antarctica now appears to rank as the largest piece of the moon yet recovered on Earth. Weighing 663 grams, just under a pound and a half, it and a related sample raise to eight the number of lunar rocks identified among the thousands of meteorites collected and cataloged on Earth.

Before 1982, scientists did not even know whether meteorite impacts could actually knock rock fragments free of the moon's gravity and send them to Earth. However, a tiny chunk weighing little more than an ounce and found in Antarctica late in the previous year by a U.S. team reminded some researchers of samples brought back from the moon by the Apollo astronauts. When various scientists analyzed bits of that meteorite, they agreed nearly unanimously that it indeed had come from the moon. Since then, Japanese researchers, who also go meteorite-hunting at the bottom of the world, have identified five more Antarctic rocks as coming from the moon.

Confirming the existence of lunar meteorites proved of particular interest, in part because some researchers suspect that certain other meteorites found on Earth come from Mars. As yet, no one has confirmed a Martian origin for any of these rocks, and the likelihood of meteorites reaching Earth from Mars remains speculative (see story, p.53).

Scientists with a U.S. team located the latest lunar addition (designated MAC88105) along with about 1,000 other meteorites on an icy expanse of Antarctica's MacAlpine Hills. Among them, says Marilyn M. Lindstrom of NASA's Johnson Space Center in Houston, was a smaller fragment (MAC88104) weighing just over 2 ounces, which is probably a broken-off chip of the record-setting rock. According to Brian Mason of the Smithsonian Institution in Washington, D.C., the evidence that the two finds came from the moon includes their iron-manganese ratio, high aluminum oxide percentage, low amounts of sodium and potassium, and the composition of the glassy matrix that holds the smaller fragments together.

Each chunk is a form of rock called a breccia, consisting of small particles of various rocks and minerals crushed and recombined by impacts on the lunar surface. Most of their outer surfaces are dark gray and pitted, as though bits had been removed by temperature changes and other effects of weathering. A thin gray-green "fusion crust," probably formed by the heat of the meteorites' descent through Earth's atmosphere, covers about 30 percent of their surfaces.

Tar sands on Iapetus

One of the solar system's most unusual-looking moons is Saturn's "two-faced" Iapetus, icy-bright on the side that faces behind as the satellite circles in its orbit, but darkened on the "leading" hemisphere by some unidentified material about 10 times less reflective. Now a researcher says spectral measurements of the dark side resemble those of tar sands on Earth.

Tar sands, according to Edward A. Cloutis of the University of Alberta in Edmonton, consist of clays, bitumen (a complex array of variously polymerized hydrocarbons), quartz grains, water and lesser amounts of a few other minerals. After studying tar-sand samples from northeastern Alberta, consisting of viscous, organic material embedded in sediments, Cloutis reports in the July 14 SCIENCE that the best match for the dark-side spectrum of Iapetus is a mixture of 90 percent clay and 10 percent coal tar representing organic material.

Still, he notes that neither the specific clay-coal tar mixture nor the tar sand in general provides a perfect spectral match for Iapetus' dark stuff. An iron-substituted clay "seems to be a necessary component," he says, and other materials — such as some amount of a highly polymerized hydrocarbon — improve the spectrum. For now, Iapetus remains an enigma.

Technology

Little lenses for little lasers

High-tech lens grinders have made crystalline flakes twice the length and thrice the width of this "s," yet hosting more than 1000 teensy lenses, each about 2 hair-widths, or 130 microns, across. The thousand-eye chips could fill niches in hybrid optical/electronic computers, sensors and communications devices for civilian uses and important components of the Strategic Defense Initiative, according to the scientists who devised them.

Composed of the semiconductor material gallium phosphide, the lenses are transparent to light of visible wavelengths. This makes them well-suited for collimating light beams emitted by solid-state lasers based on gallium arsenide, a related material remarkable for its ability to transform electronic excitations into laser beams and vice versa. Such collimation is important for chip-to-chip communication in forthcoming opto-electronic technologies.

In the July 10 APPLIED PHYSICS LETTERS, four researchers at the Massachusetts Institute of Technology's Lincoln Laboratory in Lexington led by Zong-Long Liau report making the first arrays of gallium phosphide lenslets. Starting with commercially available wafers of ultraflat gallium phosphide, the researchers use photolithographic and chemical etching techniques to pattern the wafer with six-step circular structures, which resemble three-dimensional dart-boards with the bull's-eyes on top and the outer rings sequentially lower. Finally, an 80-hour treatment with a 1,000°C, phosphine-spiked hydrogen wind causes the gallium phosphide in the circular steps to redistribute into smoothly curved lenslets. Phosphorus atoms from the hot phosphine fill pocks that form in the lens during processing.

Don't forget your heat-pipe mittens

Some defense dollars spent on research have a better chance of civilian spinoffs than others. A case in point: Lightweight gloves that keep fingers toasty even at frigid polar temperatures without being so bulky that they render hands mere appendages. Today well-insulated gloves are the predominant and imperfect means of hand protection in cold environments. Electrically heated gloves are a good idea. But sufficiently powerful yet small and long-lasting batteries are not available, and the resistance wires that actually do the warming tend to break, notes mechanical engineer Amir Faghri at Wright State University in Dayton, Ohio.

As a solution, he and his co-workers suggest making gloves with built-in heat pipes that shunt heat from the relatively warmer elbow region to the colder fingertips. "As far as we know this would be the first application of heat pipes to heat transfer problems in humans," the researchers claim in the June MECHANICAL ENGINEERING.

A heat pipe consists of a sealed container holding a liquid such as Freon R12, which evaporates and condenses within the range of temperature for the intended application. Heat applied at one end vaporizes the liquid. Due to its higher pressure, the heat-laden vapor travels to the cooler end of the pipe where it then condenses into liquid while dumping its heat load to the surrounding material. The liquid returns to the evaporation section of the heat pipe along a wick by means of capillary action.

The researchers say the most likely initial designs will retrofit elbow-length insulated gloves already used by the Army with five flexible heat pipes. Starting out packed side-by-side at the inside elbow, the pipes would wrap around to the forearm and travel down to the wrist, where individual pipes then would follow each finger down to the tips. Farghi envisions the low-tech supergloves also cooling active robotic limbs and heating divers' hands underwater.