A Mars-to-earth rock-throwing method

Since the late 1970s, a growing number of scientists have been studying the possibility that a tiny fraction of the 10,000 or so meteorites known on earth may have come from Mars. Colloquially known as "snicks," or SNCs, the intriguing space rocks are named for the acronym of three meteorites — Shergotty, Nakhla and Chassigny. Fragments of those three are different in composition from all other studied meteorites as well as from the earth and moon, and some bear gas-isotope ratios consistent with atmospheric measurements made in 1976 by the Viking landing craft on Mars.

Such data notwithstanding, however, a key question has been how such chunks could have been kicked free of Mars's gravity to get here in the first place. The possibility got a boost in 1983 when more than 20 teams of scientists concluded almost unanimously that a different meteorite had come from earth's moon (SN: 3/26/83, p. 196), but the escape velocity required to leave Mars is about twice as great. Even with geochemical evidence seeming to link Mars and the SNCs, is such a feat "mechanically" possible?

Now a pair of Caltech researchers has concluded that the answer is yes.

Merely hitting the Martian surface with an incoming meteorite sufficiently fast and massive to knock loose some pieces is not good enough. Under many conditions, various researchers have concluded, such an impact would partially melt or even vaporize any escaping fragments, yet two of the three kinds of SNCs seem to have been only lightly to moderately shocked by whatever set them free.

One possible implication of such an inconsistency has always been that perhaps the SNCs did not come from Mars at all, leaving the geochemical findings as an increasingly frustrating coincidence. But according to John D. O'Keefe and Thomas J. Ahrens of the Caltech Seismological Laboratory in Pasadena, there is a less shocking means of escape.

The answer, the authors propose in the Oct. 17 SCIENCE, is an oblique impact by the incoming object, vaporizing enough of *itself* to form high-speed vapor jets or plumes that can carry away, or entrain, surface rocks and accelerate them to speeds faster than Martian escape velocity. The Caltech team combined computer simulations with actual tests in a compressed-gas gun that fired solid plastic projectiles. At impact angles of 25° to 60° from the horizontal, the tests showed vapor plumes moving at speeds of almost 50,000 miles per hour. On Mars, the researchers calculated, incoming projectiles (meteorites) from 0.12 to 1.2 miles in diameter could produce plumes dense enough (0.1 to 1.0 grams per cubic centimeter) to pick up surface rocks and drive them away at speeds sufficient to send them all the way to earth.

In fact, report O'Keefe and Ahrens, "oblique impact-induced jet plume entrainment appears to be the only mechanism that provides the physical mechanism required to explain the acceleration to high speed of lightly shocked planetary samples such as SNC meteorites."

The confirmation of the lunar meteorites (the tentatively identified number is now up to three) was made possible, however, only by the presence of samples from the Apollo program for comparison. Now, about a Mars sample-return mission . . . — *J. Eberhart*

Cells on spheres help sick livers

Although it is still several years down the road, medical researchers are progressing toward an easier, safer and less expensive alternative to liver transplantation for some patients.

When the liver stops performing, as in severe acute liver failure, the prognosis is grim. The liver performs many vital functions, among them carbohydrate and fat metabolism, detoxification of poisons and manufacture of blood proteins. Presently the only treatment is transplantation, which is limited by organ availability, patient suitability and technical complexity. Although 602 transplants were performed last year in the United States, 4,000 to 6,000 patients could have used a substitute liver, according to the Department of Health and Human Services.

Since it is liver *function* and not necessarily the actual liver that many of these patients must have in order to live, liver cells could in principle be sufficient. To test this idea in practice, researchers from the Albert Einstein College of Medicine in the Bronx attached liver cells from healthy rats onto protein-coated microscopic spheres and injected them into four groups of mutant rats with specific inborn liver disorders. The carbohydrate spheres were coated with collagen — a major component of connective tissue — since this provides a lifelike matrix for the attached cells.

The researchers, led by Achilles A. Demetriou, now at Vanderbilt University Medical Center in Nashville, observed that the cell-laden microcarriers injected into the rats' abdominal cavities attached primarily to fatty tissue on the rats' pancreases and, from there, took over the liver functions the rats lacked.

One rat group studied was treated with cyclosporine to suppress its immunological machinery, which otherwise would have "perceived" the injected liver cells as foreign. Cell rejection was not a problem with another mutant group studied because those rats were genetically almost identical to the donor rats. In both of these groups, liver function increased throughout the 28-day-long experiment. In contrast, liver function returned only briefly to the remaining two groups of rats, which were neither genetically similar to the donor rats nor immunosuppressed with cyclosporine. After six days, these rats' liver deficiencies gradually increased until they were as severe as before the cell injection. The researchers report their results in the October PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (Vol. 83, No. 19).

Clinical trials in which humans with liver disorders are treated with microcarrier-attached cells are several years off, Demetriou says. He adds that he anticipates no fundamental barriers that might prevent the treatment from becoming a useful therapy for many, though not all, patients with liver disease.

Paul Russell, chief of transplantation at Massachusetts General Hospital in Boston, says he considers this selective transplantation of cells "a very reasonable possibility" for some patients who need whole-organ transplants. However, he adds, transplantation will remain the treatment of choice in cases where the liver is so diseased that it needs to be totally replaced. — *I. Amato*

El Salvador earthquake

An earthquake with a surface-wave magnitude of 5.4 rocked El Salvador Oct. 10, killing at least 800. According to researchers at the U.S. Geological Survey (USGS), the quake's destructiveness suggests that it was centered under San Salvador and was too shallow to have been caused by the Cocos oceanic plate plunging beneath Central America. The Mexican quake that killed thousands of people last year (SN: 9/28/85, p.196) was such a subduction earthquake.

David H. Harlow and Randall A. White at USGS in Menlo Park, Calif., say they suspect that the quake occurred on one of a series of surface faults that run through San Salvador, along a northwest-trending chain of volcanoes. They think the Cocos plate is pushing a sliver of crust, bounded on one side by these faults, toward the northwest, causing the faults to slip and making quakes.

The researchers have studied 31 shallow quakes of magnitude 6 or greater that have occurred since 1900 along the Central American volcanic chain. Of potential concern, they say, is the finding that two-thirds were paired, with one large quake following another within 30 days' time. — *S. Weisburd*