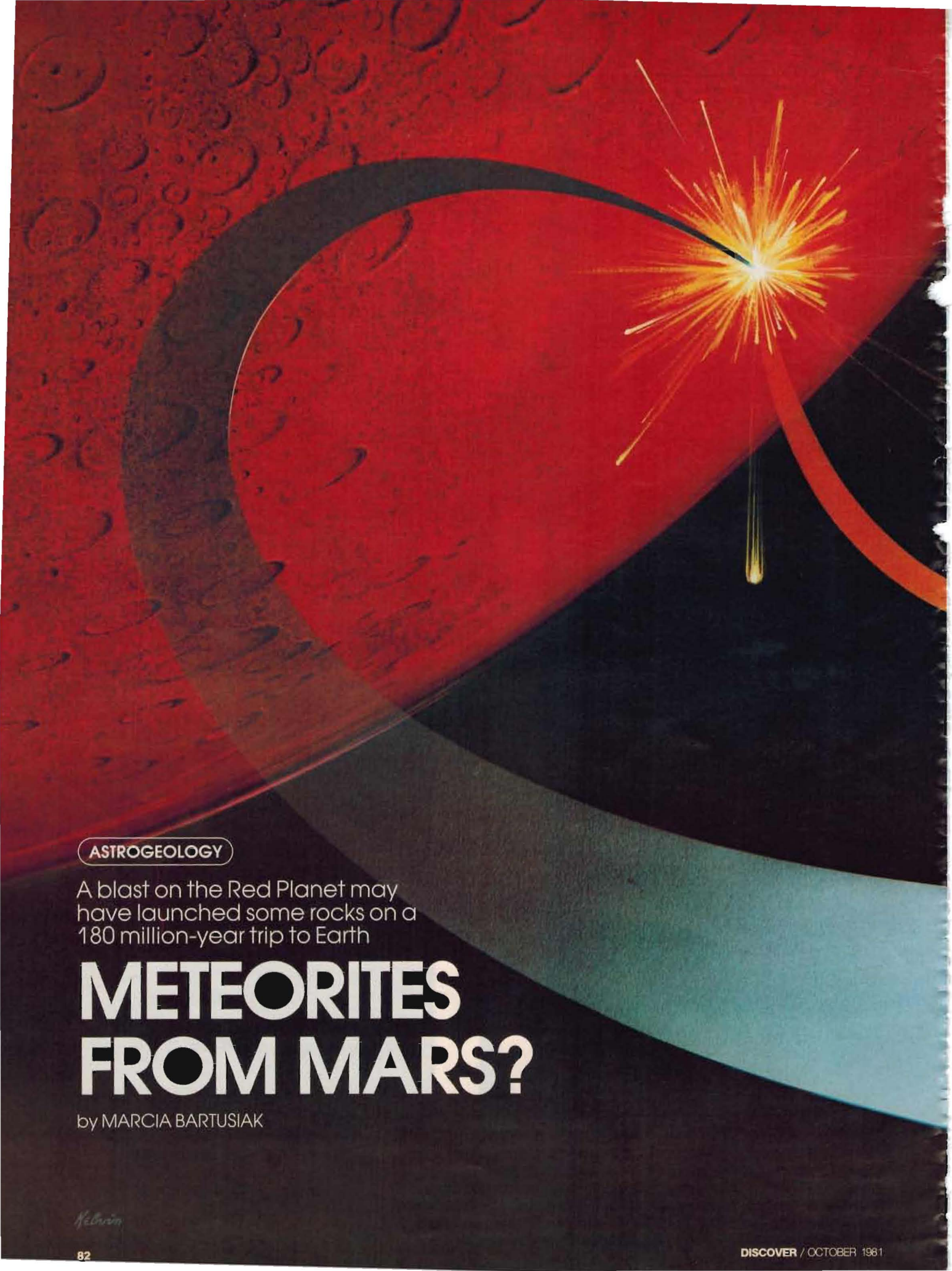
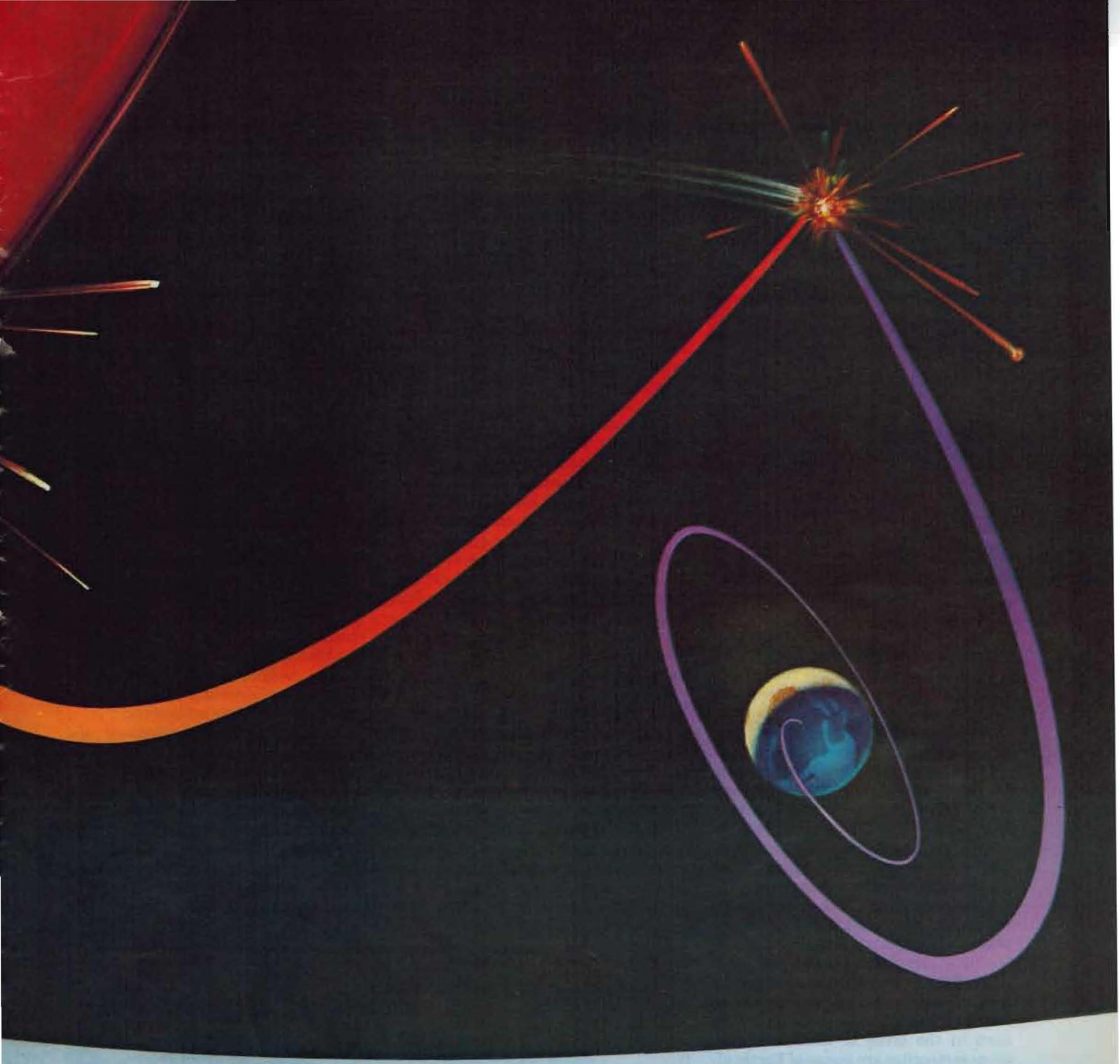


ASTROGEOLOGY

A blast on the Red Planet may have launched some rocks on a 180 million-year trip to Earth

METEORITES FROM MARS?

by MARCIA BARTUSIAK



Some 180 million years ago, an immense meteor or a comet streaked through the thin air of Mars and plunged with the force of many hydrogen bombs into the surface of the Red Planet. Driven by the stupendous energy released by that blast, billion-year-old chunks of volcanic rock several yards in diameter were hurled into space. There, they wandered for millions of years, at times colliding with other solar system debris. Eventually, by chance, some crashed into Earth, where they are now baffling scientists and prompting disputes.

This scenario broadly outlines a theory that some scientists are coming to regard as a likely explanation for some of the strangest of all meteorites—the shergottites, nakhlites, and chassignites. What makes these meteorites so unusual is their apparent age; they seem to be much younger than any meteorite should be. Most meteorites are thought to be chunks of rock and scraps of iron and nickel left over from the birth of the solar system more than 4.5 billion years ago.

While thousands of these older meteorites have been collected throughout the world, the young meteorites have been discovered in only nine places. One fell in 1865 near Shergotty in northeastern India, and was named for the town. Nearly a century later, a similar meteorite was found near Zagami, Nigeria; others have turned up in France, Australia, Brazil, Antarctica, and the state of Indiana. What they seem to share is a

ILLUSTRATION BY GEORGE V. KELVIN

GEORGE V. KLEIN

Young meteorites: where and when they fell to Earth

genesis from molten lava a mere 1.3 billion years ago—remarkably recently, in astronomical terms. This corresponds to a time when lava was still solidifying into rock on the Martian surface. Some of the meteorites also carry evidence of a cataclysmic event 180 million years ago. By the time these peculiar rocks were formed, the commoner kind—thought to have come from the asteroid belt between Jupiter and Mars—had been wandering for a few billion years. What could account for the newcomers?

George Wetherill, of the Carnegie Institution of Washington, one of the scientists who has studied the Martian meteorite theory, recalls that a few years ago a French colleague was struck by the similarity of these young meteorites to the ordinary basalt rocks that were born in the lavas of Earth. "Maybe these meteorites are pieces of Earth, after all," the Frenchman said.

Wetherill knew this was impossible. For one thing, some of the specimens had actually been seen near the end of their long voyages, blazing through the sky as shooting stars before striking the earth. Unable to explain the Earth-like nature of rocks from the sky, Wetherill quipped, "They might as well have come from Mars"—an idea that had already occurred to others.

Spurred on, Wetherill and several like-minded scientists began a serious examination of the notion that the odd meteorites had come from a large planet on which volcanoes were still active. Knowing that Mars was spewing molten rock from its volcanoes about a billion years ago, the scientists started honing their ideas. A review of the evidence, to be published this winter in *Proceedings of the 12th Lunar and Planetary Science Conference*, observes that "Mars is the only plausible parent body" for these young rocks.

The authors of the review, planetary geologist Charles Wood of NASA's Johnson Space Center and geochemist Lewis Ashwal of the Lunar and Planetary Institute, both in Houston, write that the stones "differ chemically, petrologically, physically, and magnetically from other meteorite types," and in such a way as to suggest Mars as the source. Wetherill had earlier published a possible explanation of how a rock could have reached Earth from Mars. If a large meteorite or comet hit Mars hard enough, he said, it might have vaporized large amounts of underground ice, forming steam jets. Combined with the energy released by the impact of the meteorite, the propulsive force of the expanding gas might have been great enough to launch the Martian rocks on interplanetary journeys.

Some scientists argue that the physics of ballistics seems to weigh against such a theory. In the absence of detailed calculations demonstrating that a rock could be shot from Mars to Earth by such a mechanism, they say, the case for the Mars theory remains dubious.

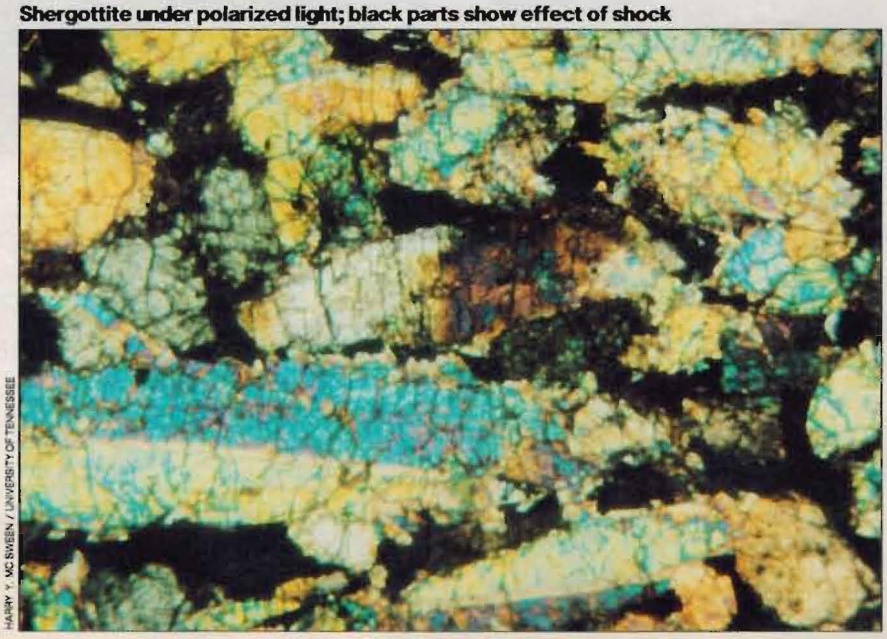
Yet one of the classes of young meteorites under study, the shergottites, did, in fact, undergo a substantial shock at one time. One of the crystalline minerals from which shergottites were formed, plagioclase, was transformed by some impact into a glassy substance called maskelynite. The transformation, scientists calculate, would have required a sudden burst of pressure equal to 4.5 million pounds per square inch.

By measuring the decay of the radioactive substances in the meteorites, Laurence Nyquist, Donald Bogard, and others at the Johnson Space Center estimated the time of that shock to be about 180 million years ago. Says Nyquist, "That could be the signature of the impact on Mars," the time when the volcano-born rock was finally blasted away. Another hint of Martian origin comes from the composition of the young meteorites. Edward Stolper, now with the California Institute of Technology, reported in his 1979 doctoral thesis that the chemical composition of shergottites bears a striking similarity to that of Martian soil scooped up by the Viking lander.

The case for Mars is further strengthened by the difficulty in arguing for other planets and moons of the solar system as possible points of origin. The bodies considered—and discounted—as cradles of the young meteorites:

- Venus. Its dense atmosphere and strong gravitational field would make escape of any material very difficult.
- The Moon. Its gravity is weak and relatively easy to escape, but the moon was not producing new volcanic rock a billion years ago. Even if it had been, such rocks would have reached Earth quickly because it is so close and has a strong gravitational pull. But judging by the

Shergottite under polarized light; black parts show effect of shock



HARRY Y. MC SWEEN / UNIVERSITY OF TENNESSEE

wear and tear on the meteorite surfaces caused by cosmic ray bombardment, scientists are fairly sure that the chunks of rock drifted in space for millions of years.

- Earth. Harry McSween, of the University of Tennessee, points out that it is unlikely that a rock, if it could be kicked off the earth, would remain in orbit for millions of years before plunging back to the surface. Also, in the meteorites, the ratio of iron to manganese and of two rare forms of oxygen to the plentiful variety is quite different from the proportions of those on Earth. Another objection is that virtually no magnetic field was present when the meteorites were formed. This implies, Wood and Ashwal reason, that the puzzling meteorites could not have cooled from liquid rock on or near the earth, which has a relatively strong magnetic field.
- Io. A Voyager space probe found that this moon of Jupiter was volcanically active, but its mineral composition does not match that of the meteorites. In any case, no one can imagine how any fragments from Io could escape the immense pull of Jupiter.

Still, the fact that other bodies in the solar system seem not to qualify as sources of the young meteorites does not settle the argument in favor of Mars. Says Bogard, "It's sheer speculation at this point, but it's healthy speculation." Adds Nyquist, "If they aren't from Mars, the real origin is likely to be just as bizarre."

A major stumbling block to the Mars hypothesis is dynamics. Says Friedrich Hörz, a NASA expert on cratering, "It's not impossible for a chunk of Mars to fly out into space after an impact, but it's pretty hard to make it happen." Hörz calculates that the shock experienced by the shergottites would have accelerated them to a speed of about six-tenths of a mile per second, only a fifth the velocity needed to escape from Mars. Says he: "It's difficult to quickly eject something at full escape velocity without vaporizing it. An added boost from volatile material converted to gas might change the picture, but we just don't know yet."

In fact, some of the meteorites in question do not even appear to have been subjected to shock. Among them are a hail of meteorites that fell at Nakhla, Egypt (hence the name nakhlites), in 1911 and killed a dog (tempting Wood to entitle his talks on the subject "Martian Missile Maims Mutt"). But how could anything be blasted from Mars and come through unscathed? One possible answer, Wood says, is that each of the young meteorite types came from different depths, and thus the shergottites were exposed to greater shocks than were the nakhlites and chassignites.

JOHN GROSSMAN

Ashwal and Wood examining a young meteorite at Johnson Space Center

Another, indirect objection to the Martian theory is that no meteorites from the moon have ever turned up on Earth, despite the fact that the moon, too, has been exposed to a bombardment by very large meteorites, and is much closer than Mars.

Such difficulties have led to alternative theories to account for the young meteorites, including the possibility that they were somehow formed late in the solar system's history in the interior of a large asteroid. But these theories also have troublesome weaknesses, and, as Wetherill, who is still undecided, says, "A violent collision in the asteroid belt might prove to be the best explanation."

But Wood stands firm with the Martian theory. "In a sense," he says, "we've settled on the least preposterous idea. To quote Sherlock Holmes, 'When you have excluded the impossible, whatever remains, however improbable, must be the truth.' " ▣