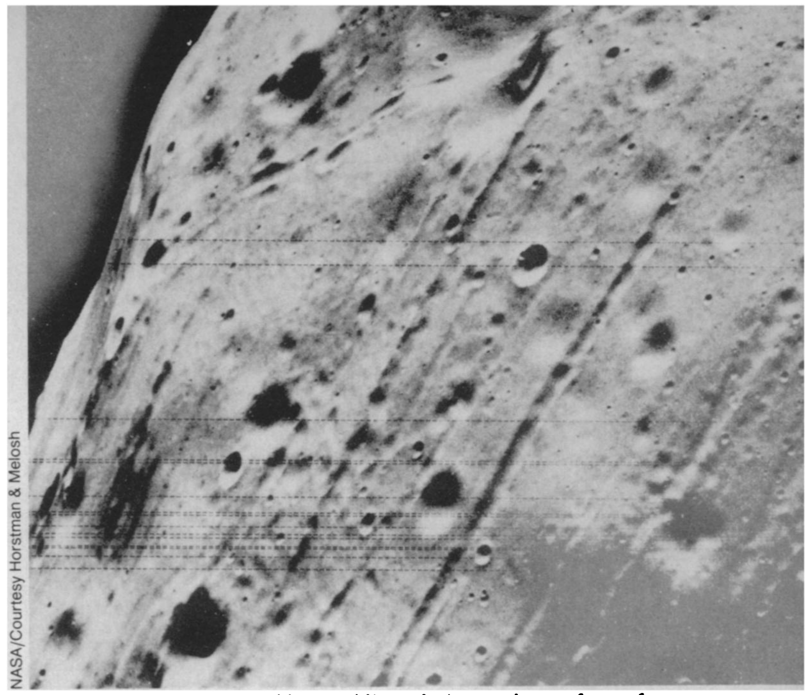
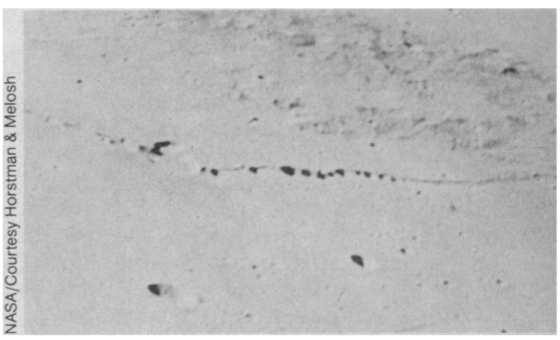
Phobos: Moonlet of the Pits

By JONATHAN EBERHART



NASA/Courtesy Horstman & Melosh

Above: Aligned pits on the surface of Phobos give the appearance of grooves. Below: Rima Hyginus, one of the few rows of pits on Earth's moon, may be due to surface materials draining into a fracture rather than to ejecta from a meteorite impact.



NASA/Courtesy Horstman & Melosh

One of the conspicuously odd features on the surface of Phobos, the larger of the two moons of Mars, is a complex pattern of grooves with strangely regular ripples along their floors and walls. Some researchers regard the grooves as cracks caused when a meteorite smashed into Phobos and created a crater now known as Stickney, almost half as wide as the satellite itself. On the other hand, many of the grooves resemble rows of little, tightly spaced craters or pits strung together like beads on a necklace.

The two Mars-orbiting Viking spacecraft first photographed the grooves in 1976, and an early idea for the cause of the pit-rows was that they were formed by "secondary ejecta" – debris tossed out by the impact that made Stickney. Now, however, two scientists have tried reproducing the pits in a laboratory and conclude the explanation may be very different.

At the University of Arizona's Lunar and Planetary Laboratory in Tucson, Kevin C. Horstman and H. Jay Melosh simulated the surface of Phobos with a pair of narrow, rigid glass plates, placed edge to edge and topped with a layer of tiny, granular particles representing the satellite's loose, rocky surface, or regolith. The researchers report in the Sept. 10 Journal of Geophysical Research that they tried out numerous different materials for their model Phobos, including expanded vermiculite (Kitty Litter in this case, Melosh says), silica sand and small glass spheres. The scientists chose their materials to study the effects of the particles' size, "rounding" or lack of sharp corners, and angle of repose – the maximum steepness slopes can maintain without support. The vermiculite particles were the craggiest, the spheres the roundest, and the sand grains, says Melosh, were somewhere in between.

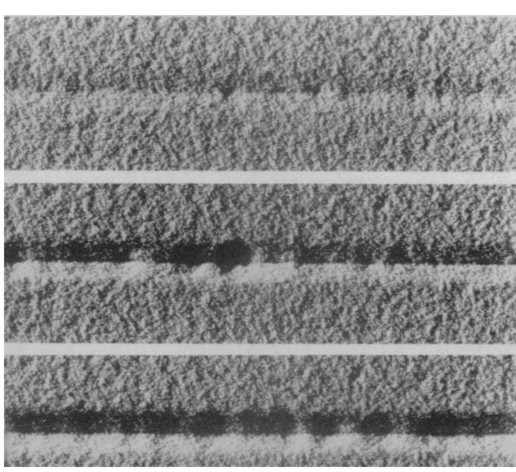
The researchers began each test by moving the plates 1 millimeter apart, to mimic what might happen during the formation of a fracture. "First, a subtle trough develops as a result of the initial material loss through the fissure," Horstman and Melosh report. As the fissure widens, some parts of it deepen more than others, in part because individual grains elsewhere along the crack's length sometimes bridge the gap and hold up other grains. "These deep areas are the sites of the earliest pits to form. The pits typically have steep, nearly conical cross sections. Pits become progressively better developed, and newer pits form as drainage continues." As the fissure widens further, the individual pits become essentially continuous, "the beginning of groove formation."

One striking effect of this process, the authors note, is that if one developing pit intersects another, the minimum distance between their centers turns out to be nearly equal to the thickness of the regolith in which they form.

The laboratory studies, says Melosh, suggest that the spacing of such close-together pits on actual planetary surfaces may thus provide a valuable clue to the thickness of the local regolith. There have been estimates of the thickness of the regolith on Earth's moon, but most were based either on photos showing where flat crater floors meet the adjacent walls, or on seismic studies carried out during the Apollo lunar missions. (Before such information was available, Thomas Gold of Cornell University in Ithaca, N.Y., suggested that the lunar regolith might be so thick and porous that craft such as NASA's then-to-be-launched series of unmanned Surveyors or even the astronaut-carrying Apollo lunar modules might simply sink out of sight. Fortunately, none of those vehicles met such a fate.)

However, Melosh says, there are only a few pit-rows on either Mars or Earth's moon that look as though they formed Phobos-style – with the regolith draining out through cracks – and none identified yet on other solar-system bodies. As for Phobos itself, the scientists report their method suggests a regolith about 300 meters thick – quite a blanket for a potato-shaped satellite whose largest dimension is barely 25 kilometers. □

Pits become more pronounced as a test crack widens from 1.0 to 1.5 to 2.0 mm beneath a 1.5-cm layer of silica sand.



Horstman & Melosh