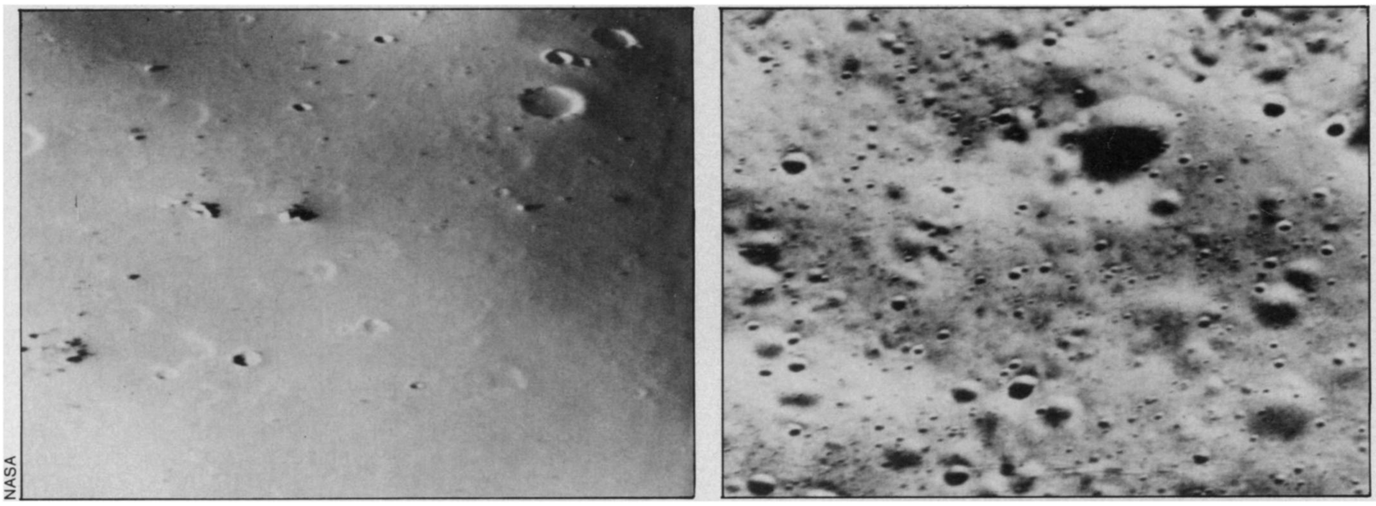
Phobos and Deimos: Similar and yet . . .



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T. Duxbury/NASA

Closest photos ever taken of the Martian moons show smooth regolith of Deimos (at 50 km, left), crater-covered Phobos (120 km).

Even the names have a similarly trochaic ring: Phobos and Deimos—a miniature poem of the moons of Mars. Like identical human twins, they are almost always thought of as a pair, one name echoing the other. It has been thus ever since their common discovery exactly a century ago. Both are tiny, both are dark, both are strikingly deformed from stereotyped sphericity. A growing body of scientific data has served only to tie them more closely together—until now. Among the latest researches, some of which were described last week in Boston at the annual meeting of the American Astronomical Society's Division for Planetary Sciences, there are signs of potentially significant differences. The implications reach back to the very origins of the Martian moons.

Easily the most striking finding about either body in recent years has been the Viking 1 orbiter's discovery last fall of mysterious, parallel grooves across the face of Phobos (SN: 10/2/76, p. 212). Several kilometers long, the grooves are from about 100 to 200 m in width and from 20 to as many as 90 m deep. Startled scientists have proffered hypotheses—not always with conviction—ranging from cracks caused by an equally hypothetical breakup of a larger protomoon into Phobos and Deimos, to the symptoms of tidal stresses caused by Phobos's proximity to Mars. Phobos is already closer to its host planet than the supposed breakup distance known as the Roche limit, says Thomas C. Duxbury of Jet Propulsion Laboratory (though he is not advocating the tidal-stress idea). In fact, he predicts, "Phobos will be the next ring plane in the solar system." An analysis of concentrations of craters within the grooves, however, "seems to rule out the tidal theory," according to Joseph Veverka and Peter Thomas of Cornell University. The crater-counting indicates that the grooves are at least 1 billion years old and, the researchers say, probably more than 3 billion. Since Phobos is still being tidally stressed, they aver, there should be some "fresh" grooves visible if the stress is the primary groove-forming mechanism.

A more likely possibility, says the Cornell team, is that the grooves were produced directly during the impact that formed Stickney, the largest crater on Phobos. Indeed, a map shown by Thomas at the DPS meeting displayed the grooves in a cluster around Stickney, but conspicuously absent elsewhere. A key factor, however, was to confirm that no such grooves existed on Deimos, thus weighing heavily against mechanisms affecting both moons.

On Oct. 15, the Viking 2 orbiter passed closer to Deimos than any other spacecraft (not landing or taking off) has come to any other planetary body. The encounter produced a photo taken from only 50 km away, revealing details as small as 3 m across, but no grooves.

Further pinning down the possible source of the grooves on Phobos is the fact that very few of them appear to be merely chains of close-together craterlets, such as could be dug by low-flying material ejected during an impact. Also, says Veverka, some of the striations appear to have raised edges, suggesting that they could be fractures (whether internally or externally triggered) that were subsequently modified by outgassing.

But the record-setting Deimos close-up shows much more than a lack of grooves. In contrast with the saturation-bombed surface of Phobos, the smaller moon reveals an apparently much smoother surface, with barely visible craters peeking through an obscuring blanket of tiny rock particles, or regolith.

Although the Deimos close-up is less than a month old, with hypotheses just being developed, Veverka suggests that a reasonable explanation could be Phobos's being inside the Roche limit. When a new impact generates a fresh crop of ejected material, he says, the planet attracts the ejecta more strongly than can the little moon, so that craters on Phobos remain exposed to view. Although the weak gravity of still-smaller Deimos (which is *outside* the Roche limit) may let the ejecta escape from the surface, much of the material will remain in the moonlet's orbit, to be recaptured when Deimos comes around again and sweeps it up.

Both moons are considerably darker than Mars itself, dark enough (with albedos, or reflectivities, as low as 5 percent) to resemble carbonaceous chondritic material, a carbon-and-water-rich substance believed to have formed much farther out in the solar system. But if they were later captured by the gravitational pull of Mars, says Duxbury, they then "went their separate ways," so that Phobos is spiralling in toward the planet while Deimos is spiralling out.

But there may be a still more fundamental, if subtle, difference. Linda French of Cornell says that the two moons—essentially gray to the eye—are slightly different in ultraviolet photometric studies: Deimos, it seems, may be brighter in UV than Phobos by a ratio of about 1.15 to 1, and thus, according to French and Veverka, "need not be made of exactly the same material." Kevin Pang of the Planetary Science Institute in California goes one step further in his speculations. While Phobos appears to be a type 1 carbonaceous chondrite, he says, the spectral difference implies that Deimos could be as different as a water-poor type 3 or 4. A clearer idea of the material difference between Phobos and Deimos may emerge in a few weeks, when analyses of gravitational perturbations in Viking's path past Deimos yield a density measurement that may or may not match Phobos's density of 2 grams per cubic centimeter.

These ideas of breaking up the "twins," however, are among the newest in the study of the Martian moons. The real answer could take years. □