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Editorial

Why Study Phobos and Deimos? An Introduction to the Special Issue

In 1877, Asaph Hall, an astronomer at the United States Naval Observatory, discovered that Mars is accompanied by two small satellites, Phobos and Deimos. The two moons have experienced much interest by astronomers and explorers ever since, with their origin being uncertain to the present day. They may have co-accreted with the parent planet, or formed from Martian basin ejecta. Alternatively, they may represent captured primitive asteroids or comets. Space mission planners have identified Phobos and Deimos as targets, from where the recovery of extraterrestrial samples may be comparably straightforward. Also, Phobos has been suggested as a "water-stop" for manned missions to Mars.

Phobos is moving deep in the gravity field of Mars, hence, its orbit is a sensitive indicator of various dynamic parameters in the Martian satellite system, which include the Martian gravity field, its temporal variations, as well as shape-, interior structure-, and rotation parameters of Phobos itself. Ultimately, Deimos is expected to escape from its orbit, while Phobos will disrupt from tidal stresses and disintegrate in the Martian atmosphere within time scales of tens of millions years.

The mass of Phobos has been determined from radio science data obtained during spacecraft flybys, as well as by modeling of its secular motion. More information on the body's interior may be derived from tracking of its rotation and forced librations. Current interior structure modeling suggests that Phobos may be highly porous and to a large extent homogeneous. However, small inhomogeneities, perhaps involving a low-density regolith layer, or mass anomalies associated with the large crater Stickney, cannot be ruled out.

Phobos and Deimos are subjected to an intense meteoroid bombardment. Indeed, the surfaces of the satellites are covered by numerous impact craters, which represent indicators for the source of the meteoroid population and the ages of the satellites' surfaces. It is most puzzling that Phobos appears rather old, in stark contrast to its short remaining lifetime. The meteoroid impacts are known to produce escaping dust, which is predicted to form dust rings within the orbits of Phobos and Deimos. However, no such rings have been detected to the present day.

The heavily cratered terrain of Phobos is a unique geologic laboratory. It is cut by systems of grooves, the origins of which are still uncertain more than three decades after their discovery. They may represent chains of secondary craters from Stickney, faulting introduced by tidal stresses and non-synchronous rotation, or impact ejecta from Mars.

With Mars Express currently being the only Mars spacecraft to carry out Phobos flybys on a regular basis, a wealth of geoscientific data is accumulating. Geodetic control point networks, shape models, and maps for Phobos are continuously improving, which are essential planning tools for remote sensing and landing site selection of future Phobos missions.

Over the past years, astronomers, geophysicists, geologists, cartographers, and planetary explorers from East and West have engaged in several workshops to review our present state of knowledge on the Martian satellites, and to discuss measurements and observations that are required to further our understanding of the satellite pair. Any progress in our knowledge on the origin, evolution, and characteristics of Phobos and Deimos requires the joint analysis and discussion of all available data. Ultimately, however, new missions to Phobos and Deimos, including sample returns may be needed. This special issue summarizes the workshop contributions and discussions of the team.

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