The Thermophysical Properties of Phobos from TES and THEMIS Observations

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Over the past decades a suite of datasets have been acquired of the martian moon Phobos. These include compositional, morphological, and thermophysical data and have been leveraged in a variety of studies (e.g. *1, 2-4*) to address outstanding formation hypotheses and the evolutionary history of Phobos. In the 1970s, thermal infrared observations of Phobos were made by the Viking Infrared Thermal Mapper.

(IRTM) and used to derive a thermal inertia (*4*). In the late 1990s, the Thermal Emission Spectrometer (TES) observed Phobos during its aerobraking phase and acquired numerous, resolved (as opposed to disk integrated), thermal infrared spectra (*2, 3, 5*); however, until recently these data have been largely underutilized. In the 2000s, visible-near infrared and shortwave infrared measurements have been made of Phobos and they typically exhibit a spectral slope with few diagnostic absorption features (*1*).

Recently, the Thermal Emission Imaging System (THEMIS) onboard NASA's 2001 Mars.

Odyssey spacecraft has begun a systematic set of thermal infrared observations of Phobos. THEMIS is a 10-band microbolometer-based, thermal infrared imager paired with a visible framing camera. Two observations have been acquired to date, resulting in ~270 m/pixel sampling at nadir and ~175 pixels that cover pre-dawn to late morning local times across the Mars-facing surface of Phobos (*6*). These diskresolved data are able to address a wide range of questions related to the thermal inertia, surface roughness, and block abundance. In general, TES and THEMIS data (*3, 6*), much like early Viking data (*4*), indicate that the surface has a relatively uniform, low thermal inertia (~20-80 J K^{-1} m^{-2} $s^{-1/2}$), though the higher-resolution THEMIS data may reveal further roughness/block abundance effects as additional data are acquired. THEMIS daytime observations show a clear correlation of spectral slope (indicating anisothermality) with solar incidence angle indicating significant surface roughness, while THEMIS nighttime observations show spectral slopes consistent with a small fraction of blocks (~5%) present on the surface. The afternoon cooling trends place a strong constraint on the derived TI and values from both TES and THEMIS data are consistent with those previously reported (~40 J K^{-1} m^{-2} $s^{-1/2}$).

Here, we present the current status of TES and THEMIS observations related to Phobos, future plans for observing Phobos with THEMIS, and detail the constraints these measurements can make to help understand the origins and evolutions of this enigmatic martian moon. In the coming months, the THEMIS instrument will make additional observations of Phobos. The early results presented here indicate that numerous outstanding questions related to the Phobos regolith will be able to be addressed with this new dataset.

References:

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