SURFACE PROPERTIES OF ASCRAEUS MONS OBTAINED FROM IRTM DATA

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Ascraeus Mons is the northernmost large shield volcano of the Tharsis Montes on Mars (1). Thermal measurements by the Viking Infrared Thermal Mappers (IRTMs) indicated that the shield volcanoes have extremely low thermal inertia (fine-grained or porous) surfaces (2,3,4). High resolution IRTM data, with spatial resolutions almost two orders of magnitude better than previous global surveys, and photogeologic mapping allow spatial variations in the surface properties of Ascraeus Mons to be examined.

Viking images show a sharp contact between the shield material and the surrounding plains, particularly along the NW and SE margins. High resolution images of the summit caldera (401B17-23) show relatively featureless caldera floors surrounded by complexly faulted walls, with numerous fresh-appearing channeled lava flows around the summit rim. Near the base of the shield (401B01-10) the lava flows are subdued and >1 km diameter craters are much less abundant than near the summit.

Four high resolution IRTM sequences cross Ascraeus Mons following the global dust storms and at local times suitable for thermal measurements (Fig. 1). Most of these data were collected during the night but one daytime sequence (4 in Fig. 1) provided albedo values of 0.25 ± 0.02 for the shield. Spatial resolution is $\geqslant 15$ km^2 (equivalent to a rectangle 2 by 7.5 km with the long dimension oriented along the groundtrack). Figure 2 (curve A) shows the average thermal inertias for one sequence. Thermal inertia (10^{-3} cal cm^{-2} sec$^{-1/2}$ K^{-1}) can be related to an effective particle diameter by equating the thermal properties to that of a uniform ideal surface composed of only one particle size; I=4 corresponds to ~90 μm and I<3 corresponds to <50 μm (2).

Jakosky (5) discussed atmospheric effects on the measured apparent thermal inertia; atmospheric thermal conductivity and radiation effects have been removed from the data (Fig. 2, curve B; see ref. 6). Elevations used for the corrections were obtained by shifting photogrammetrically determined contours (7) by -2.83 km to match the most recent Earth-based radar elevations (8). Use of the published contours would increase the corrected thermal inertias on the shield by ~10%.

The sharp contrast between the shield material and the plains corresponds to large thermal inertia changes and a break in slope. The thermal inertia decreases upward from these contacts. Flank terraces correlate with some thermal inertia fluctuations (e.g. ~103°W). The caldera rims have the lowest thermal inertias while the caldera walls display locally enhanced thermal inertia peaks, consistent with increased blockiness that would be expected there. Temperature differences between the 11 and 20 μm bands suggest that <5% of the shield materials contain large blocks exposed at the surface while the surrounding plains have >5% exposed blocks. The shield-plains distinctions make it unlikely that the immense low thermal inertia area around the Tharsis region (2,3) had its origin at the volcanoes. Theoretical considerations of martian volcanic eruptions indicate that ash deposits may have resulted from explosive volcanism (9). Late-stage activity would be expected to modify the shield flows but the fresh morphology of the summit area makes large ash deposits there quite unlikely (10) and the thermal data show no evidence of localized ash deposits. Aeolian processes, such as wind streaks associated with the summit dark collar, represent the most recent modification of the shield materials. The symmetrical distribution of decreasing thermal inertias toward the summit may reflect increasing difficulty in remobilizing storm-deposited dust as atmospheric pressure decreases with elevation.

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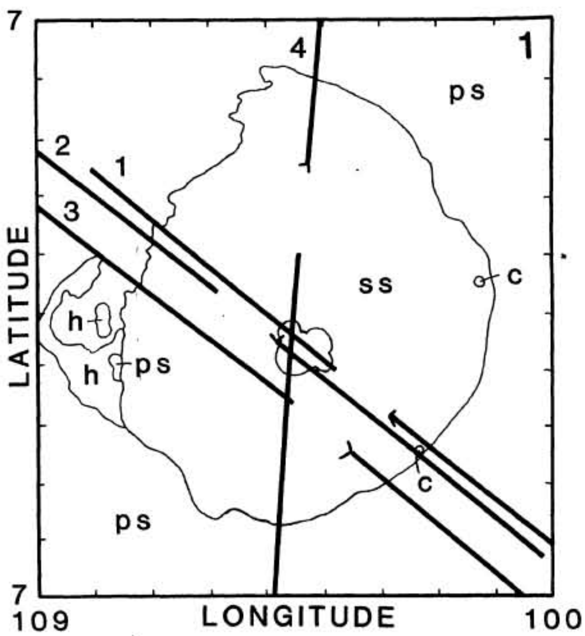

Fig. 1. Geologic map of Ascraeus Mons, from Carr (1), with IRTM sequence locations. Units: c - fresh crater material, ss - sparsely cratered shield material, ps - sparsely cratered plains material, h - hilly material (outer rim of summit caldera complex also included). Heavy lines represent IRTM groundtracks: 1-A465, 2-A543, 3-A659, 4-B484 (gaps are the result of in-flight calibration). Chevron orientation is included for each sequence.

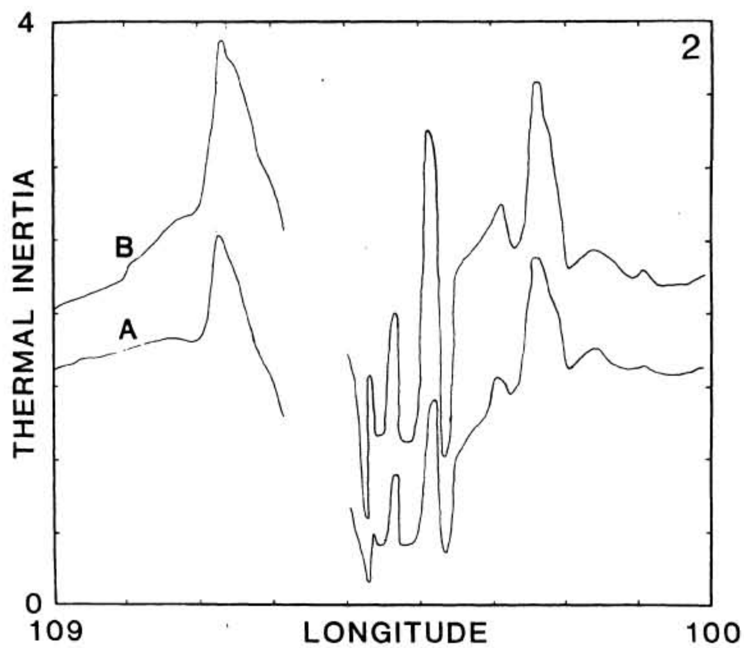

Fig. 2. Thermal inertias for IRTM sequence A543 (see Fig. 1). A) Observed thermal inertias. B) Thermal inertias corrected for atmospheric thermal conductivity and thermal radiation variations with elevation.