The abundance of rocks exposed on the surface provides an important constraint on the physical processes which occur on Mars. At the present time, individual rocks can only be observed from the Viking 1 and 2 landers for two very small portions of the surface. A global estimate of the distribution of surface rocks can, however, be obtained from thermal data returned by the Infrared Thermal Mapper (IRTM) experiments on-board the Viking orbiters using a model which predicts surface rock abundance using differences in brightness temperature between each of the four IRTM surface-sensing thermal bands, i.e., T7, T9, T11, and T20 (Christensen, 1982). This model also takes into account the contributions to these spectral differences produced by non-unit thermal emissivity and atmospheric dust. In previous work the model predictions were fit in a least-squares sense to the observed diurnal variations in spectral differences, collected for each of six study areas (Christensen, 1982). Results from this study revealed that the thermal emissivity of the surface is very closely related to the surface albedo and that the effects due to non-unit emissivity and atmospheric dust are minimized at night.

The purpose of this report is to present the application of this model to a global study. To accomplish this an iterative numerical model was developed which incorporates the first and second derivatives of each spectral difference with rock abundance and thermal emissivity, all computed as a function of surface temperature. Using this model, the effect of non-unit thermal emissivity can be calculated and removed from the observed spectral differences. The remaining differences are assumed to be due to rocks on the surface and their abundance determined. The effects of atmospheric dust were minimized by using only nighttime data during the clearest periods. Preliminary rock abundance maps were produced for the region between -40°S and 60°N using each of the spectral differences T7-T20, T9-T20, and T11-T20 with and without the emissivity correction. The rock values determined for each IRTM measurement were then binned into 2° by 2° bins in latitude and longitude. An example of one of these six maps, computed from T11-T20 with the emissivity correction made, is presented in Figure 1. Missing areas are due to the lack of coverage in the series of 13 IRTM observations used, and to the presence of ice on the surface in the southern hemisphere.

Comparison of the rock abundances found here to the six areas studied previously shows good agreement. The generally low rock abundances in the northern hemisphere are also confirmed. Figure 1 indicates that the southern hemisphere is rockier than the north, a finding consistent with proposed models of aeolian erosion in the south and deposition in the north (Pollack et al., 1979; Christensen, 1982). The Arabia region (-10 to 40°N, 300 to 350°W) has very low rock abundances, particularly north of 30°N, with abundances increasing southward. This distribution is consistent with earlier proposals that Arabia is a site of current dust deposition which has buried coarser material (Christensen, 1982, 1983). The deposit may be thickest between 20° and 40°, with the mantling becoming less complete away from that region.

A region within Syrtis Major (10 to 15°N, 275 to 300°W) has very low block abundances. This region was also observed by Earth-based radar to be very smooth (Simpson et al., 1982) indicating that there is a correlation between radar-determined roughness and rock abundance. Other regions within Syrtis Major have much more rock cover.

The Tharsis volcanic province (80 to 170°W, -20 to 40°N) has a moderate rock abundance, despite having a very low thermal inertia (fine particulate) surface (Palluconi and Kieffer, 1982). Portions of this region appear rough at radar wavelengths and are interpreted to be relatively recent flow surfaces covered by a veneer of fine particles (Schaber, 1980). The rock abundances suggest that this mantle may not be complete, leaving portions of the flow surface exposed.

These preliminary results indicate that the global rock distribution is consistent with other remotely determined surface properties such as thermal inertia and radar roughness. Together,
In summary it does appear that there are general consistencies between the thermal and radar properties, with low inertia surfaces being relatively smooth and having low reflectivities. The roughest surfaces (radar) also have relatively high inertia. These results can be explained by a model in which low inertia surfaces are mantled to varying thickness by a low dielectric material, while high inertia surfaces are less mantled and therefore rougher.

REFERENCES