Progress Report

for

National Aeronautics and Space Administration
Grant NAGW-263

entitled

MARTIAN SURFACE PROPERTIES

covering the period through December 1983

(NASA-CR-173197) MARTIAN SURFACE PROPERTIES Progress Report for period ending Dec. 1983 (Arizona State Univ.) 4 p HC A02/MF A01 CSCL 03B

N84-17091

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G3/91 00596

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Scope of Investigation

One of the primary goals in the study of Mars is to understand the physical processes which have acted on the surface. These include volcanic, aeolian, fluvial, glacial, periglacial, and cratering processes, all of which can result in both depositional and erosional features. However, as these processes cannot be observed in situ over geologic time, it is necessary to infer them by assessing the resultant surfaces through remote sensing. Much of the effort toward this goal has involved the use of spacecraft images to evaluate the morphology of the surface. The images have limited resolution however, and do not provide direct information on small (sub-meter) surface structures; however, in order to understand certain physical processes, small scale features often are the most diagnostic. For example, a well-sorted aeolian deposit could be distinguished from poorly-sorted deposits of other origin (glacial, fluvial, etc.) if data on particle sizes were known.

The Viking Infrared Thermal Mapper (IRTM) provides information on the scale of individual particles. This instrument obtained data in five thermal channels centered on 7, 9, 11, 15 and 20 μm and in one solar channel centered at 1.7 μm. Extensive processing and analyses are required before these data can be used to interpret the surface. Early work in the IRTM project involved understanding the properties of the instruments, converting the measured energy flux into brightness temperatures, and comparing the derived data to a first-order thermal model based on Mariner 9 IRR results (Kieffer, 1976; Kieffer et al., 1976a,b,c; Chase et al., 1978) Results showed that a simple model of the surface is insufficient to explain the characteristics of the observations. The atmosphere was found to contribute to the measured thermal flux, an effect that had to be modeled and removed in order to isolate surface characteristics (Kieffer et al., 1977; Martin et al., 1979; Jakosky, 1979;

Hunt, 1979, 1980). Other deviations from a simple thermal model include blocks on the surface, slopes, CO_2 condensation, and a layered surface structure (Jakosky, 1979; Christensen and Kieffer, 1980; Christensen, 1982).

The next stage of analysis considered the spatial distribution of the IRTM results. Two measured parameters, the predawn temperature residuals between the 20 μm temperature (T_{20}) and the Viking thermal model (Kieffer et al., 1977; Zimbelman and Kieffer, 1979) and the Lambert albedo (Kieffer et al., 1977; Pleskot and Miner, 1980) have been mapped globally. In addition, data from the 20 μm thermal band and the albedo channel have been combined to derive and map the basic thermal parameter, the thermal inertia, $I = (k\rho c)^{1/2}$, where k is the thermal conductivity, ρ is th: density and c is the specific heat (Kieffer et al., 1977; Christensen and Kieffer, 1979; Palluconi and Kieffer, 1980). This parameter varies primarily with the average grain size of the material in the top few centimeters of the surface.

Using these measured and derived thermal properties, some work has been directed toward determining the processes involved in the formation of the surface materials. These studies include the investigation of dust storm development (Peterfreund and Kieffer, 1980), wind streak formation (Peterfreund, 1980), channel formation (Christensen and Kieffer, 1979), volcanic flow characteristics (Schaber, 1980) and polar cap processes (Kieffer et al., 1976b; Kieffer, 1979), and characteristics of the cratered terrain (Zimbelman and Greeley, 1982).

Although the determination of the thermal inertia represents a significant advancement in the understanding of the surface, it does not provide a unique solution to the size distribution of surface materials. A surface with a given inertia can be composed of any combination of material sizes which average to the grain size implied by the derived thermal inertia. This ambiguity was resolved in Phase I of this project by studying the variation of temperature and albedo with viewing geometry (Christensen, 1981, 1982, Appendix 2). These data provided information on the regolith block population, fine component (e.g. sand) thermal inertia, and surface emissivity.

The surface properties derived from the IRTM data will be integrated with the surface properties derived from photogeology, Earth-based radar (Schaber, 1980; Jakosky and Muhleman, 1980) and from Earth-based spectral studies (Singer et al., 1979, 1982). Information on the surface from these data sets will be correlated to derive interpretations of the surface geology on Mars.

Progress

Attached are published reports giving the results of this investigation through this report period.