Thermal infrared imaging for mapping lava flows

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The thermophysical and spectral emission characteristics of lava flow surfaces allow distinguishing units of differing texture, composition and/or modification state using thermal spectral infrared imaging. These techniques have been demonstrated on terrestrial lava flows (e.g., Kahle et al, 1988; Realmuto et al, 1992), and are now being applied to Mars using data from the Thermal Emission Imaging System (THEMIS) aboard the 2001 Mars Odyssey orbiter. THEMIS acquires 9 wavelengths of thermal infrared imaging data between 6.6 and 15.0 microns at a resolution of 100 m/pixel. This spectral region contains absorption features characteristic of many rock-forming minerals, and thus can be used for mineralogic mapping. Temperature maps, acquired in late afternoon and pre-dawn, show variations in the thermal response of surface materials to the diurnal cycle (Christensen et al., 2002). THEMIS data of a lava flow field of Hesperian age in the Tharsis region of Solis Planum (25° S, 265° E) show a remarkably well-preserved diversity of diurnal temperature signatures. This variability indicates a minimal mantle of dust on these surfaces. Mapping of these flows on the basis of thermophysical properties may allow discrimination of the age, surface texture or bulk density of the units. Preliminary examination of the spectral variations of the flows suggests that significant compositional differences are present, which may be due to the primary composition, or to post-emplacement weathering, coatings or dust accumulation. Thermophysical properties derived from thermal infrared imaging can be combined with wavelength-scale roughness signatures from SAR radar imaging to characterize the properties and processes affecting geologic surfaces (Plaut and Rivard, 1992). Data from a future Mars SAR mission will be amenable to such combined analyses.

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