Early Results from the Odyssey THEMIS Investigation. Philip R. Christensen[1], Joshua L. Bandfield[1], James F. Bell, III[2], Victoria E. Hamilton[3], Anton Ivanov[4], Bruce M. Jakosky[5], Hugh H. Kieffer[6], Melissa D. Lane[7], Michael C. Malin[8], Timothy McConnochie[2], Alfred S. McEwen[9], Harry Y. McSween[10], Jr., Jeffery E. Moersch[10], Kenneth H. Nealson[11], James W. Rice, Jr.[1], Mark I. Richardson[12], Steven W. Ruff[4], Michael D. Smith[13], Timothy N. Titus[6], [1]Dept. of Geological Sciences, Arizona State University; phil.Christensen@asu.edu, [2]Cornell University, [3]University of Hawaii, [4]Jet Propulsion Laboratory, [5]University of Colorado, [6]USGS Flagstaff, [7]Planetary Science Institute, [8]Malin Space Science Systems, [9]University of Arizona, [10]University of Tennessee, [11]University of Southern California, [12]California Institute of Technology, [13]Goddard Space Flight Center.

Introduction: The Thermal Emission Imaging System (THEMIS) began studying the surface and atmosphere of Mars in February, 2002 using thermal infrared (IR) multi-spectral imaging between 6.5 and 15 μm, and visible/near-IR images from 450 to 850 nm [1, 2]. The infrared observations continue a long series of spacecraft observations of Mars, including the Mariner 6/7 Infrared Spectrometer [3], the Mariner 9 Infrared Interferometer Spectrometer (IRIS) [4, 5], the Viking Infrared Thermal Mapper (IRTM) investigations [6], the Phobos Termoscan [7], and the Mars Global Surveyor Thermal Emission Spectrometer (MGS TES) [8-12]. The THEMIS investigation's specific objectives are to: (1) determine the mineralogy of localized deposits associated with hydrothermal or sub-aqueous environments, and to identify future landing sites likely to represent these environments; (2) search for thermal anomalies associated with active sub-surface hydrothermal systems; (3) study small-scale geologic processes and landing site characteristics using morphologic and thermophysical properties; (4) investigate polar cap processes at all seasons; and (5) provide a high spatial resolution link to the global hyperspectral mineral mapping from the TES investigation. THEMIS provides substantially higher spatial resolution IR multi-spectral images to complement TES hyperspectral (143-band) global mapping [8, 13-15], and regional visible imaging at scales intermediate between the Viking and MGS [16] cameras.

Results: THEMIS data collected to date have been used to investigate the nature of geologic units and layers, the distribution of rocks and bedrock, the mobile surface sand and dust, 100-m scale compositional variations, polar processes, and visible color and morphology [2]. Regional-scale infrared mapping shows that Mars has both regional and local geologic units delineated by their thermophysical properties. In Meridiani Planum these units imply a complex history involving changes in the nature of volcanic units, the environment of deposition of sedimentary units, and/or the degree of lithification or cementation of initially unconsolidated units. Mars has km-scale exposures of bedrock, and rocky surfaces are commonly observed on slopes and scarps, demonstrating that the production or exposure rate of rock locally exceeds the rate of rock burial or breakdown. Thermally distinct ejecta deposits with a wide range of thermophysical properties are observed around craters of varying sizes. Most crater ejecta, however, are indistinguishable from the surrounding terrain. This variation in the preservation of the infrared signature of crater ejecta may be associated with crater age.

Where large fields of sand dune occur, the dunes are typically coarser-grained than the interdune surfaces, suggesting that finer-grained material is accumulating where active sand motion may be limited. Surfaces known to be mantled by air-fall dust, such as in the Tharsis and Arabia provinces, also appear completely mantled at THEMIS 100-m per pixel resolution.

THEMIS mult-ispectral infrared observations show significant potential for compositional mapping at 100-m scales, as demonstrated by the identification of olivine-rich basaltic units on the floor of Ganges Chasma.

Polar observations have confirmed the presence of CO_2 slab ice and the presence of H_2O exposed at the surface of the south polar summer cap.

The visible imager also has obtained information on the color properties of the surface and of atmospheric aerosols at the highest spatial resolution yet obtained from Mars orbit. As of Jan. 1, 2003, ~1.5% of the surface had been imaged in two to (usually) five colors.

A major goal of the THEMIS investigation is to search for evidence of recent geothermal activity. To date no endogenic heat sources have been identified. The discovery of recent gullies in the walls of mid-latitude and sub-polar southern hemisphere craters [17] has been argued to suggest the existence of near-surface liquid water aquifers [16-18]. To date, however, no unusual thermal signatures have been associated with recent gullied terrains.

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