The Composition of Martian Surface Materials: Mars Global Surveyor Thermal Emission Spectrometer Observations

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Thermal infrared spectral measurements have been made of the surface composition of Mars from the Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) instrument. These data have been obtained during the aerobraking phase of the MGS mission. The spectra observed from orbit are a complex combination of surface and atmospheric emitted and transmitted energy. The TES spectra exhibit the signatures of surface minerals, atmospheric dust, water-ice clouds, CO_2, and water vapor in varying abundances. Separation of these components is complex and requires detailed knowledge of the composition, particle size, and temperature of the atmospheric constituents. To date several surface components have been tentatively identified using atmospheric-corrected spectra. The most common surface component is the indication of basaltic materials in low albedo surfaces. These spectra are best fit by a combination of pyroxene, plagioclase, ±olivine. challenges

The most striking surface component is the definitive identification of crystalline hematite within a localized zone approximately 300 km in diameter centered near the equator at ~5° W. The TES results indicate that the hematite occurs within a localized region with sharp boundaries. Crystalline hematite has been previously reported using Earthbased telescopic visible/near-IR observations, and nanophase hematite is widely thought to be an important component of the materials that give Mars its red color (e.g. *Singer*, 1982; *Morris et al.*, 1989; *Morris and Lauer*, 1990; *Bell et al.*, 1990). The TES observations are remarkable in that the hematite-rich materials are highly localized and have significantly higher hematite abundances than observed elsewhere on Mars. The crystalline hematite discovered by the TES most likely did not form by weathering processes, but may have formed by crystal growth from hot, iron-rich fluids. The highly localized occurrence of hematite in this region provides additional evidence that a unique process has occurred, in contrast to the widespread weathering of iron-rich minerals at the surface that has produced fine-grained, red hematite. A different, and much less common process, such as hydrothermal alteration or precipitation, possibly followed by sedimentary transport, may have created the concentration of hematite observed by the TES.

It is important to note that the low albedo materials observed to date appear to be relatively free of weathering products. These observations suggest that the low albedo materials on Mars are relatively pristine samples of the original igneous mineralogies, and should provide a detailed view of the composition of Martian rocks.

The TES is a Michelson interferometer spectrometer covers the wavelength range from 6 to 50 μm (~1600 to 200 cm^{-1}) with nominal 5 and 10 cm^{-1} spectral resolution (*Christensen et al.*, 1992). A solar reflectance band extends from 0.3 to 2.7 μm and a broadband radiance channel extends from 5.5 to 100 μm. The fields of view for each sensor are 3 km resolution at the nadir.

References

Bell, J.F.I., T.B. McCord, and P.D. Owensby, Observational evidence of crystalline iron oxides on Mars, *J. Geophys. Res.*, *95*, 14447-14461, 1990.

Christensen, P.R., D.L. Anderson, S.C. Chase, R.N. Clark, H.H. Kieffer, M.C. Malin, J.C. Pearl, J. Carpenter, N. Bandeira, F.G. Brown, and S. Silverman, Thermal Emission Spectrometer experiment: The Mars Observer Mission, *J. Geophys. Res.*, *97*, 7719-7734, 1992.

Morris, R.V., D.G. Agresti, H.V. Lauer, J.A. Newcomb, T.D. Shelfer, and A.V. Murali, Evidence for pigmentary hematite on Mars based on optical, magnetic, and Mossbauer studies of super paramagnetic (nanocrystalline) hematite, *J. Geophys. Res.*, *94*, 2760-2778, 1989.

Morris, R.V., and H.V.J. Lauer, Matrix effects for reflectivity spectra of dispersed nanophase (superparamagnetic) hematite with implications for Martian spectral data, *Lunar Planet. Sci,, XIX*, 811-812, 1990.

Singer, R.B., Spectral evidence for the mineralogy of high-albedo soils and dust on Mars, *J. Geophys. Res.*, *87*, 10,159-10,168, 1982.