**THE DISTRIBUTION OF CRYSTALLINE HEMATITE ON MARS FROM THE THERMAL EMISSION SPECTROMETER: EVIDENCE FOR LIQUID WATER.** P.R.Christensen[1], M. Malin[3], D. Morris[5], J. Bandfield[1], M. Lane[1], K. Edgett[3] [1]Dept. of Geology, Campus Box 871404, Arizona State University, Tempe, AZ 85287-1404, [2]U.S.Geological Survey, Denver, CO; [3]Malin Space Science Systems, CA; [4]U. S. Geological Survey, Flagstaff, AZ, [5]Johnson Space Center, TX; [6]Ames Research Center, Moffet Field, CA, [7]Goddard Space Flight Center, MD.

One of the primary objectives of the Thermal Emission Spectrometer (TES) instrument on the Mars Global Surveyor (MGS) spacecraft is to determine and map the mineralogic composition of the Martian surface. Of particular interest is the search for minerals formed through interaction with water, either by low-temperature precipitation or weathering, or by hydrothermal mineralization.

Over 50 x$10^6$ spectra have been observed to date from the MGS mapping orbit. These spectra observed from orbit are a complex combination of surface and atmospheric emitted and transmitted energy. The spectral features resulting from atmospheric $CO_2$, dust, and water ice have been removed using a radiative transfer model [1, 2].

Using these atmospherically-corrected spectra we have identified two major accumulations of crystalline hematite ($\alpha$-$Fe_2O_3$) [3]. Crystalline hematite is uniquely identified by the presence of fundamental vibrational absorption features centered near 300, 450, and >525 $cm^{-1}$, and by the absence of silicate fundamentals in the 1000 $cm^{-1}$ region. The depth and shape of the hematite fundamental bands show that the hematite is crystalline and relatively coarse grained (>5-10 µm). Diameters up to and greater than 100s of micrometers are permitted within the instrumental noise and natural variability of hematite spectra. The spectrally-derived areal abundance of hematite varies with particle size from ~10% (>30 µm diameter) to 40-60% (10 µm diameter). Crystalline hematite has been previously reported using visible/near-IR observations [4], and nanophase hematite is widely thought to be an important component of the materials that give Mars its red color [5-8]. The hematite in Sinus Meridiani is distinct, however, from the fine-grained (diameter <5-10 µm), red, crystalline hematite considered, on the basis of visible, near-IR data, to be a minor spectral component in Martian bright regions.

Crystalline hematite has been mapped over an area in Sinus Meridiani approximately 500 km in longitude extending approximately 200 km in latitude [3]. The extent of this deposit very closely matches the geomorphic boundary of a smooth, layered, friable unit that is interpreted to be sedimentary in origin [3, 9]. This material may be the uppermost surface in the region, indicating that it might be a later-stage sedimentary unit, or alternatively a layered portion of the heavily cratered plains units.

A second accumulation of hematite approximately 60 x 60 km in size is observed in Aram Chaos (2° N, 21° W). This site is also associated with layered materials and a water-rich environment.

We consider five possible mechanisms for the formation of coarse-grained, crystalline hematite. These processes fall into two classes depending on whether they require a significant amount of near-surface water: (1) chemical precipitation that includes origin by (a) precipitation from standing, oxygenated, Fe-rich water (oxide iron formations), (b) precipitation from Fe-rich hydrothermal fluids, (c) low temperature dissolution and precipitation through mobile ground water leaching, and (d) formation of surface coatings; and (2) thermal oxidation of magnetite-rich lavas [3]. We favor chemical precipitation models involving precipitation from Fe-rich water based on the probable association with sedimentary materials, large geographic size, distance from regional heat sources, and lack of evidence for extensive groundwater processes elsewhere on Mars.

The TES results provide mineralogic evidence for probable large-scale water interactions. The Sinus Meridiani region may be an ideal candidate for future landed missions searching for biotic and pre-biotic environments, and the physical characteristics of this site satisfy the engineering requirements for the missions currently being considered.

References

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