Construction of a Self-Consistent Model for Surface Materials in Meridiani Planum using CRISM, CTX, HiRISE, and Opportunity Data

Ray Arvidson and Sandra Wiseman
CRISM Workshop
LPSC
With input from Wendy Calvin, James Wray, Eldar Noe Dobrea, Ron Li, Jue Wang
3/13/09
Overview

• Coordinated CRISM FRT, CTX, HiRISE observations acquired while Opportunity conducted traverses in Meridiani Planum, inventorying surface and near surface material textures, compositions, and mineralogy
• Use the orbital and rover-based data jointly to develop a self-consistent model for surface material distribution and properties
• Gain insight into ability to separate atmospheric and surface radiative streams for CRISM and use of surface spectra for textural and mineralogical retrievals
• Look ahead to exploration of Endeavor Crater
Units & Symbols

- C: Crater
- Ce: Crater ejecta
- Cs: Crater, subdued
- Ph: Hematite-bearing Plains
- V: Valley
- Hct: Cratered Highlands
- Mct: Mantled Terrain

Legend:

- 20 km

Map showing a region with labels such as Ph, Cs, and Hct, and a scale bar indicating 20 km.

Ridgeline trace
Opportunity has traversed 14,834 m as of sol 1816 (3/4/09)

Traverses have been aligned roughly along MRO ground track, providing a “calibration alley” for comparison of orbital and surface observations.
Opportunity observations are consistent with basaltic sands, hematitic concretions, nanophase iron oxide aeolian cover over altered “dirty evaporite” sulfate-rich bedrock

OMEGA and CRISM observations of sulfate-dominated bedrock consistent with nanophase iron oxides and ferrous silicates (i.e., electronic transition features)

OH and H$_2$O vibrations hidden by alteration rind or coating of dehydrated and SO$_3$ poor materials
Sol 36 McKittrick Pancam Image

• APXS data show systematic changes from undisturbed, brushed, and ratted surfaces

• Mini-TES sees 6 µm $\text{H}_2\text{O}$ bending vibration only for ratted surfaces

• Surface is coated or altered, hiding $\text{H}_2\text{O}$ and OH vibrational modes
Mini-TES Data

6 μm H$_2$O bend
Retrieving Surface Reflectance From CRISM FRT Data

• Volcano-scan method uses gas transmission spectrum derived from observations over volcanoes

• DISORT uses radiative transfer computations to solve for surface Lambert Albedo
  – Use historical observations and Pancam and Mini-TES data to constrain optical depth and temperatures and lighting and viewing conditions for FRT 28A1
28A1 CRISM DISORT Models for Gray Lambert Albedos

Spectral I/F and Lambert Albedo

Wavelength, micrometers

0.00 0.05 0.10 0.15 0.20 0.25
0.5 1.0 1.5 2.0 2.5
• DISORT removes aerosol radiative contributions, lowering spectral amplitude
Spectra Consistent with Presence of Nanophase Iron Oxides and Ferrous Silicates
FRT 8541 Endeavor False Color Image

- Portion of frame showing interior layered deposits and rim
  - Blue=1.1521 micrometers
  - Green=1.7172
  - Red=2.3509

Meridani Plains

Sulfate Spectrum

Interior Layered Deposits

Rim
Interior Layered Deposits in Endeavor Crater

- Sulfate spectrum
- Down turn
- H2O combination band
- Increasing reflectance

Relative Reflectance vs. Wavelength, micrometers
Summary

• Used CRISM and Opportunity observations jointly to develop self-consistent model for surface materials examined by rover-based instrumentation
• Rover-based atmospheric and surface measurements used to test radiative transfer methods for retrieval of surface reflectance and comparison to Volcano Scan corrections
• Although coating or rind has obscured OH and H$_2$O signatures in bedrock, Opportunity is on its way to Endeavor where hydrated sulfates are exposed without obscuration
References

