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Surface units of Mars analyzed with spectral, color and stereo images. I: Meridiani

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Introduction:

We are focusing on utilizing and improving the High Resolution Stereo Camera (HRSC, [1]) spectrophotometric data from the Mars Express mission in order to determine and interpret the compositional properties of the Martian surface and address several key Mars science issues. Specifically, we study the Meridiani Planum and the Gusev Crater and [2] sites explored by the Mars Exploration Rovers (MERs) Opportunity and Spirit in order to extend the findings of the rovers to a broader regional context and to improve the calibration and understanding of HRSC data. The present work is focused on 1) further check the HRSC calibration, 2) determine the effects of the atmosphere and ground photometric function on HRSC multi-angle observations of the surface, and 3) use HRSC data to extend local findings at high spatial resolution and narrow aerial coverage to a regional context. We are including OMEGA and CRISM, in our comparison and general treatment, as appropriate.

The surface of Mars at Meridiani

Sedimentary outcrops

The Mars Exploration Rover B Opportunity landed in a low-cratered unit righ in hematite-bearing materials [3, 4, 5]. Bright units with sharps contours as seen on HRSC images correspond to numerous outcrops of sedimentary rocks rich in sulfates. Attempts for spectral identification of sulfates in Valles Marineris have not been successful with HRSC [6], despite their bright albedo is well-contrasted compared to the surrounding environment, and despite their shap contours are a good help for visual interpretation. Overall, the terrain is relatively free of rocks, which is expected to result in low proportions of shade as seen from HRSC images.

Sand dunes

During its traverse, between Endurance and Victoria craters, the rover Opportunity encountered dune fields that have moderate slopes compared to blocks. As a consequence, the surface in not expected to appear very rough from HRSC images

Materials and methods: Processing of HRSC color data

Color images and geometry of the High Resolution Stereo Camera

HRSC has five color filters in the visible and near-infrared up to 1 micron wavelength that are designed for visual interpretation and the mapping of various surface units [1]. Thus, oxide-rich red dust and basalts (pyroxenes) can be mapped, as well as very bright components like water ice [7, 8]. All channels are acquired by separated cameras oriented at varying angles from the normal to the surface of Mars. This implies that a given spectrum is the result of different proportions of shade at each wavelength that must be modeled by spectral analysis.

Method: Spectral Mixing Analysis

Remote sensing spectra are a mixture of spectral components within the field of view. We perform Spectral Mixing Analysis (SMA, e.g. [9, 10]) of HRSC data by using the Multiple-Endmember Linear Spectral Unmixing Model (MELSUM) [11, 12]. This model has been developed to account for those mixtures and to map aerial proportions of materials. The algorithm guarantees mixing coefficients to be strictly positive, and the sum of the fractions to equal unity. The main objective is the mapping of relative abundances of surface materials. Spectral shape of shade is calculated and included in the SMA. Results for shade and residuals are related to topography (at all scales

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and including surface roughness), aerosol scattering, the geometry of illumination/ observation, and instrument noise [13, 13].

Conclusion and perspectives

HRSC color data are used to map the two major surface materials and their relative abundances. The image fraction of shade provides some information about the surface roughness. The present abstract is a work in progress. We are planning to combine other datasets a high-spatial and high-spectral resolution in order to extend spatially the findings of the rover Opportunity.

References

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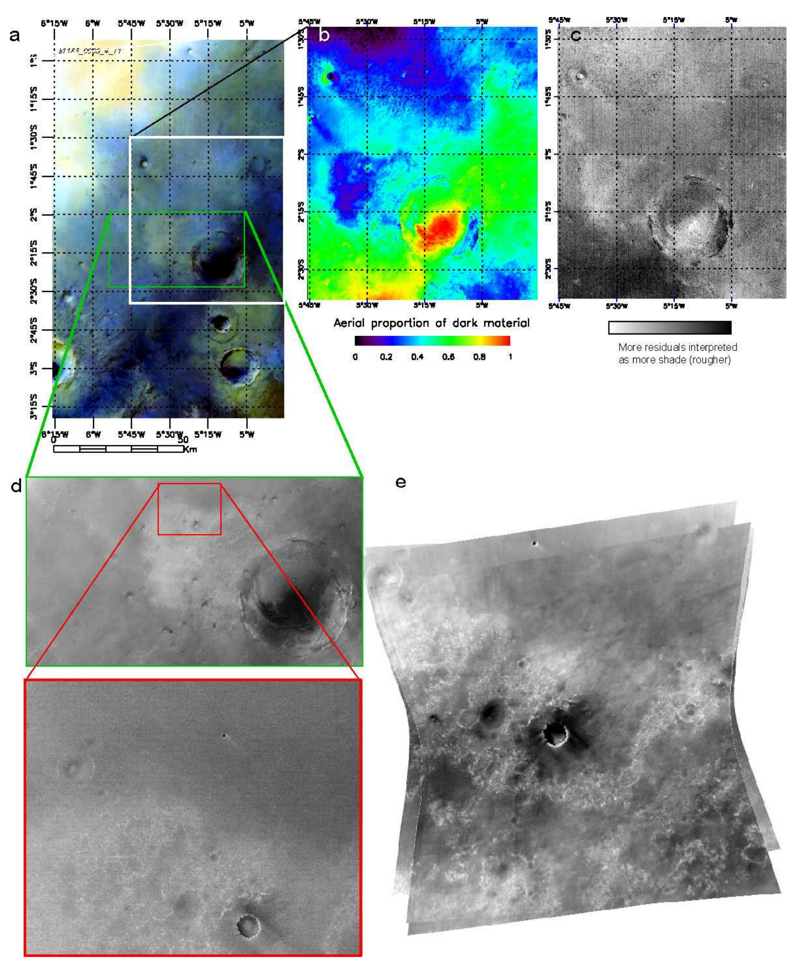

Figure 1: The surface of Mars at Meridiani as seen from orbit. a – HRSC color composite at 750, 530 and 440 nm from image h1183_0000_4_11. b – Image fraction of dark basalt-rich material. c – Image fraction of shade that shows sensitivity to surface roughness. d – HRSC nadir image at full resolution centered on the Columbia Hills. d – Mosaic of 4 targeted CRISM dataset at 1330 nm centered on Victoria crater.

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