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CRISM mapping of surface photometric parameters at MER landing sites

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Abstract

CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) on-board MRO (Mars Reconnaissance Orbiter) acquires observations under varied geometry conditions in visible/near infrared which can provide constraints on the surface physical properties. The study consists on the estimation of the surface photometric parameters by inverting Hapke's photometric model in a Bayesian framework at Mars Exploration Rover (MER) landing sites (Gusev Crater and Meridiani Planum). We present here one of the 6 photometric parameter map, the single scattering albedo ω, which is related to the composition and the particle size. The map of the parameter ω is estimated at 750 nm with a spatial resolution of 180m/pxl.

1. Introduction

Photometric parameters were related to chemical properties such as composition and physical properties of surface materials such as particle size, particle shape (from round to angular), particle internal heterogeneity and their organization such as compaction state and macroscopic roughness. These parameters are very useful to characterize geological terrains and to have information on the geological context of the surface materials such as the history of their formation, transportation, deposit and modification. A previous study had been conducted by Jehl et al. [1] from High Resolution Stereo Camera observations at Gusev Crater.

2. Methodology

Taking into account the capability of CRISM on-board MRO to provide multi-angle images [2], we estimate the surface bidirectional reflectance after aerosols correction using the Multi-angle Approach for Retrieval of Surface Reflectance from CRISM observations technique (MARS-ReCO) [3] and the surface photometric parameters given the possibility to provide these information for regional areas on Mars [3]. Fernando et al. [4,5] proposed an approach to estimated the photometric parameters of the surface materials in terms of structural information by inverting Hapke's photometric model [6] in a Bayesian framework [4,5] that include: the single scattering albedo ω, macroscopic roughness θ-*bar*, particle phase function which is described by a 2-term Henyey-Greenstein function that includes the asymmetric parameter b and the backscattering fraction c, and opposition effect described by its width h and magnitude B_0. Our objective is to derive the surface photometric maps at 750 nm with a spatial resolution of 180m/pxl., applied at MER landing sites at Gusev Crater and Meridiani Planum. They can be compared to the in situ and orbital observations which provide complementary information on surface composition and texture permitting us to validation and to go further in the geological interpretations. In this abstract, we only focuse on the single scattering albedo parameter ω as an example which is related to the composition and the particle size distribution.

3. Results

Gusev Crater (Fig. 1 top): Local variations of the parameter ω are visible (cf. Fig. 1c). The region with high ω values correspond to the region where the nanophase ferric oxides index are less than 1 but higher than 0.95 (cf. Fig. 1b), compatible with the presence of an intermediate quantity of dust-size particles compared to the region with low ω values which seems to be cleaned of dust-size particles. The CRISM RGB image show a dark streak feature in the unit 1 and dark linear tracks in the unit 2 (cf. Fig. 1a). These features seem to be the result of a wind transportation by suspension of dust-size particles revealing the lower-albedo surface (regional winds in the unit 1 or local winds such as dust devils in the unit 2). The in situ observations by the Microscopic Imager (MI) validates this scenario [7].
Meridiani Planum (Fig. 1 bottom): Local variations of the parameter ω are visible (cf. Fig. 1c). The Meridiani plain seems to be cleaned of fine dust

(npOx index <1) (cf. Fig 1b). Compared to the Gusev plain, the variations of the parameter ω values are more compatible with the variation of the composition. In fact, the brightest areas (unit 2, cf. fig. 1a) observed in the CRISM RGB image is related to the presence of sulfate outcrops, corresponding to a bright composition and compatible with the highest ω values (0.67) [8]. The darkest areas (units 1 and 3, cf. fig. 1a) is related to the presence of hematite spherules corresponding to a dark composition compatible with lowest ω values (<0.65) [8].

4. Conclusion

First, variations of the single scattering albedo parameter can be observed at both MER landing sites which means that geological processes modeled the surface and they were recorded by the composition and the texture. Second, at Gusev Crater the variations of the ω values are related to the difference of particle size distribution showing the removal by suspension of the dust-size particles by wind transportation (aeolian process) revealing the the under-layer of sand-size grains. At Meridiani Planum, the variations of the ω values are related to the difference of composition (chemical processes). The results are compatible with the in situ observationss and the presented maps can provide complementary information on the regional geological contexts useful to constrain the geological history.

References

[1] A. Jehl et al., «Gusev photometric variability as seen from orbit by HRSC/Mars-express, Icarus, 197, 2008, [2] S. Murchie et al., «Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) on Mars Reconnaissance Orbiter (MRO)», *J. Geophys. Res.*, vol. 112, E05S03, 2007, [3] X. Ceamanos et al. «Surface reflectance of Mars observed by CRISM/MRO: 1. Multi-angle approach for retrieval of surface reflectance from CRISM observations (MARS-ReCO), *J. Geophys. Res.,* vol. 118, 2013, [4] Fernando et al., «Surface reflectance of Mars observed by CRISM/MRO: 2. Estimation of surface photometric properties in Gusev Crater and Meridiani Planum», *J. Geophys. Res.,* vol. 118, 2013, [5] Fernando et al., «Estimation of surface photometric parameters: Bayesian inversion on Hapke's model», *EPSC* 2013, [6] B. Hapke, 1993, «Theory of reflectance and Emittance Spectroscopy», Cambridge University Press, 1993, [7] R. Greeley et al., «Martian variable features: new insight from the Mars Express Orbiter and the Mars Exploration Rover Spirit», *J. Geophys. Res.*, vol. 110, E06002, 2005, [8] S. Squyres et al., «The Opportunity Rover's Athena Science Investigation at Meridiani Planum, Mars», *Science*, 306, 1698, 2004

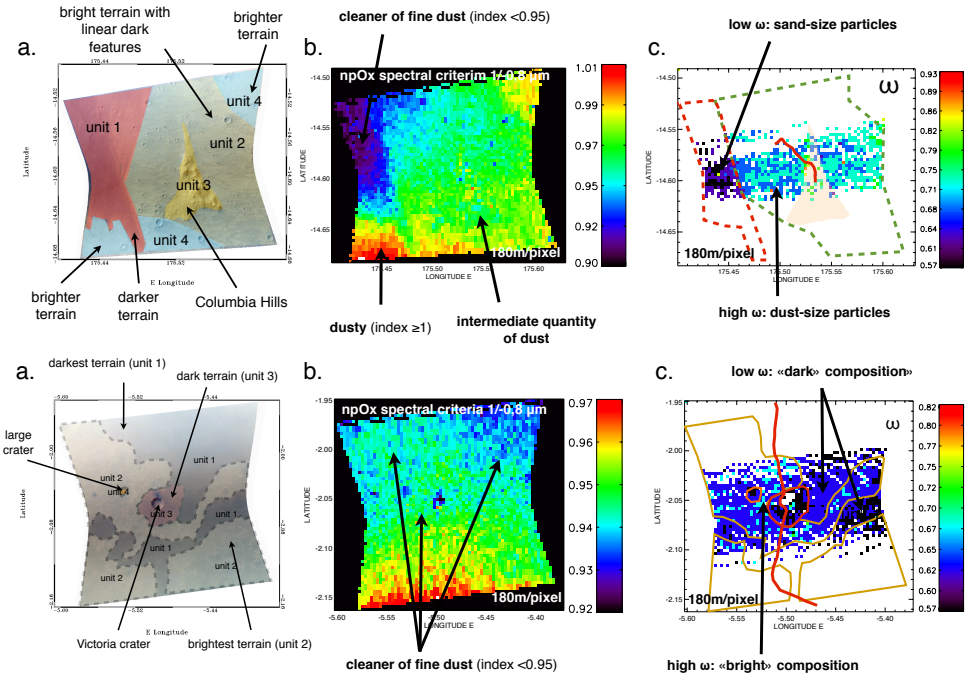

Figure 1: Results at Gusev Crater (top) and Meridiani Planum (bottom) (a) CRISM red, green, blue images at 180 m/pxl superposed with the context map of principal features. (b) nanophase oxide or 1/0.8 µm slope related to the presence of dust (ratio- ≥1). (c) map of the parameter ω estimated from CRISM observations (Gusev: FRTC9FB, Meridiani: FRTB6B5) at 750 nm at 180m/px.