EPSC Abstracts
Vol. 10, EPSC2015-338, 2015
European Planetary Science Congress 2015
© Author(s) 2015

Martian surface microtexture from orbital observations

Fernando, J. (1,2,3), Schmidt, F. (1,2) and S. Douté (4)
(1) Univ. Paris-Sud, GEOPS, UMR 8148, 91405 Orsay, France (jennifer.fernando@u-psud.fr), (2) CNRS, 91405 Orsay, France, (3) Laboratoire de Géologie de Lyon, Terre, Planètes, Environnement (Université de Lyon-Université Claude Bernard Lyon 1-CNRS-ENS Lyon, ERC eMars Team, 69622 Villeurbanne Cedex, France, (4) Univ. Joseph Fourier/CNRS, IPAG, Grenoble, France.

Abstract

The information about the surface microtexture is useful to constrain the geological processes (e.g., transportation, deposition, weathering).

In this study, the grain microtexture is derived from the orbital CRISM/MRO multi-angular observations allowing to characterize the surface scattering behavior. The Hapke radiative transfer model is inverted to derive the photometric parameters which have physical meanings (e.g., grain size, roughness, shape, internal structure).

Eight sites having various geological contexts are selected. The results show a high diversity of grain microtexture. This result put forward that Mars have experimented various geological processes. The link between information about the grain microtexture and the geological processes will be presented at the conference.

1. Introduction

The Martian primary basaltic surface have been highly modified by exogenous (e.g., cosmic bombardments) and by interactions between the atmosphere, cryosphere, hydrosphere and surface (e.g., erosion, transportation, deposition, weathering).

The information about the surface microtexture (e.g., grain size, shape, roughness, internal structure) is helpful to identify and characterize the geological processes. For instance, information about the grain internal structures of volcanic materials can give constraints on the volatile content in the magma or on the cooling rate. The grain size and morphology can give on the grain transportation, erosion and deposition.

Direct in situ imagery can be used to characterize the grain microtexture and give constraints on the local geology but is limited to the rover landing site and along the rover path. Microtexture can also be indirectly estimated from remote photometric measurements by studying the manner in which the solar light is scattered by the surface materials). It has been experimented from in situ measurements from Panoramic Camera measurements on-board Mars Exploration Rover [1,2] and from orbital measurements from High Resolution Stereo Camera on-board Mars Express [3] and from Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) on-board Mars Reconnaissance Orbiter [4,5,6].

2. Methodology

Taking into account the capability of CRISM on-board MRO to provide multi-angle images (eleven images with varied emission angles from 0-70°) [7], 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) [8].

Fernando et al. [5,6] proposed an approach to estimate the photometric parameters of the surface materials in terms of structural information by using the Hapke photometric model [9] in a Bayesian framework that considers: the single scattering albedo ω which depends on the grain size and the composition, the macroscopic roughness θ-*bar* which depends on the roughness from the particle to several centimeters and the particle phase function with a 2-term Henyey-Greenstein function that includes the asymmetry parameter b and the backscattering fraction c which qualitatively depends ont the grain morphology and its internal structures.. Maps of the surface photometric parameters are created and are estimated at 750 nm with a spatial resolution of ~200m/pixel.

3. Site selection and main results

The photometric parameters are estimated for eight sites (Figure 1) having various geological contexts, with favorable geometric and atmospheric conditions, avoiding the dust area [10] and with various mineralogy (alteration phases like phyllosilicates precipitation phases like sulfates and salts [e.g., 11, 12, 13, 14], and basaltic materials [e.g. 15]).

The phase function parameters are qualitatively related to the grain microtexture such as the grain shape, surface roughness and internal structure [16,17]. The results show a high diversity of surface photometric properties (e.g., forward and backward scattering behaviors) revealing a high diversity of grain microtexture, not observed on another planetary surface except the Earth. This diversity puts forward that Mars have experimented various geological processes which is still preserved. The results also showed that the processes are rather local than regional or global. The link between information about the grain microtexture and the geological processes will be presented in more details during the conference.

Part of the selected sites are landing site candidates for the next Exomars (ESA) and Mars2020 (Nasa) rover missions. Those results provide new constraints for the site selection procedure.

Acknowledgements

CNES and PNP support for this work. We thank Michael Wolff for making his aerosol optical thickness values available for this study and the CRISM team for providing the data. J. Fernando has received funding through the European Research Council under the European Union's Seventh Framework Program (FP7/2007-2013)/ERC Grant Agreement No. 280168.

References

[1] J. Johnson et al., J. Geophys. Res., 111, E02S14 (2006). [2] J. Johnson *et al.*, *J. Geoph. Res.* 111, E12S16 (2006). [3] A. Jehl *et al.*, *Icarus* 197, 403 (2008). [4] A. Shaw *al.*, *J. Geoph. Res.* 118 (2013). [5] J. Fernando *et al.*, *J. Geophys. Res.* 118, 514 (2013). [6] J. Fernando *et al.*, *Icarus* 253, 271 (2015). [7] S. Murchie *et al.*, *J. Geoph. Res.* 112, E05S03 (2007). [8] X. Ceamanos et al., *J. Geoph. Res.* 118, 540 (2013). [9] B. Hapke, *Cambridge Univ. Press.* (1993). [10] A. Ody *et al.*, *J. Geoph. Res.* 117, E00J14 (2012). [11] J.-P. Bibring *et al.*, *Science* 312, 400 (2006). [12] S. Murchie et al., *J. Geophys. Res.* 114, E00D06 (2009). [13] J. Carter *et al.*, *J. Geophys. Res.* 118, 831 (2013). [14] B. Ehlmann and C. Edwards, *Ann. Rev. Earth Planet Sci.* 42, 291 (2014). [15] A. Ody, *J. Geophys. Res.* 118, 234 (2013). [16] A. McGuire and B. Hapke, *Icarus* 113, 134. [17] A. Souchon *et al.*, *Icarus* 215, 313 (2011).

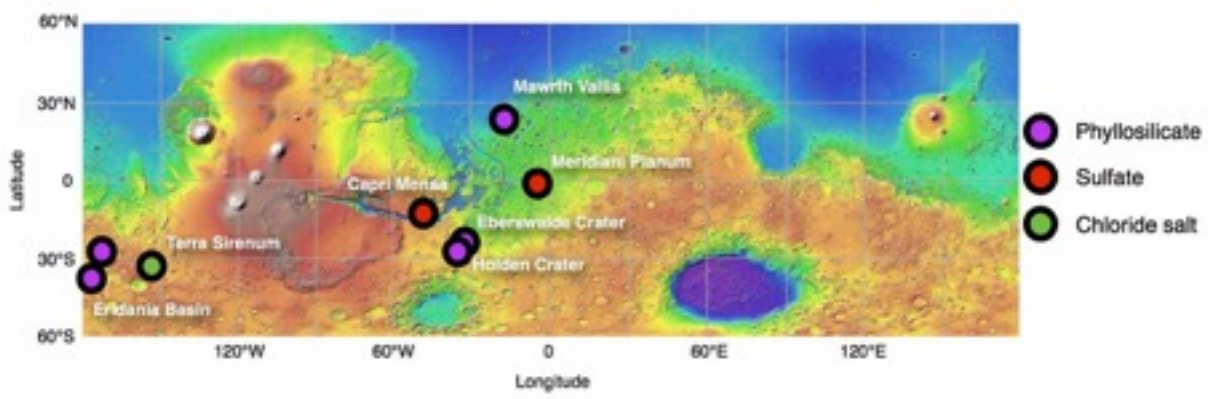

Figure 1: Site locations where hydrated silicates and salts have been detected by previous works [e.g., 11, 12, 13, 14] overlapped on the Mars Orbiter Laser Altimeter topographic map. The color of the filled circle indicates the dominant mineralogy.