MARS EXPRESS / HRSC IMAGING PHOTOMETRY AND MER SPIRIT / PANCAM IN SITU SPECTROPHOTOMETRY WITHIN GUSEV

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Introduction and context: One of the new orbital investigations that can be addressed with the multi-angular HRSC dataset generated with the nadir-looking, stereo and photometric channels, is to derive the photometric characteristics for mapping the variation of the soil/bedrock physical properties of Mars, and to relate them to the spectroscopic and thermal observations produced by OMEGA, TES and THEMIS instruments [e.g., 1]. So far, in situ reflectance measurements of selected rocks and soils over a wide range of illumination geometries have been obtained by the Viking Lander, Mars Pathfinder and MER multispectral imaging facilities and provide constraints on the interpretations of the physical and mineralogical nature of the Martian surface materials.

Given the wealth of in situ information acquired within Gusev crater [*e.g.,* 2, 3], with the very successful landing of *Spirit* and its fruitful traverse, we have drawn [4] a special attention to the observations made respectively on January, 16th and February, 1st ,2004 during the overlapping *MEx* orbits 24 and 72 which flew over Gusev, with different observation geometries. It has been shown that the information gained from 8 different phase angles ranging from 30 to 52 degrees was useful .for documenting at first order the phase function variability associated with the martian surface properties. For this purpose, an inverse method optimizing the determination of the global set of Hapke parameters, developed and tested on experimental data was implemented on the HRSC orbital dataset [5] and maps of photometric quantities were produced, namely for parameters *b, c,* describing the material properties through the particle phase function approximated by the double Henyey-Greenstein function (*b*: phase function form and *c*: forward / backward scattering behavior*)*, the surface roughness θ parameter and the single scattering albedo *w.* As a result, a first regional survey of the photometric properties was carried out across Gusev crater floor, with a resolution cell of 1.6x1.6 km^2 [4]. However, it was recognized that the results were not fully constrained as the phase angle coverage was rather limited [6, 7] and the local variations of incidence and emission angles induced by the topographic variations were not taken into account.

Advanced data analysis and results: In order to alleviate these effects and limitations, a follow-on study has been conducted. It relies on map-projected, ortho-rectified Level 4 HRSC imagery products insuring precise spatial co-registration [e.g., 8, 9]. Both Digital Terrain Models derived from the stereo capabilities of HRSC camera and at local scale from the MOC data processing (MER team) are used to model the incidence and emission angles according to a close approximation of the local topographic slope. In order to enrich the photometric phase function with large phase angle observations, orbits 637 and 648 obtained on July, 20th and 23rd, 2004, have been added, resulting in a phase domain ranging from 25 to 95°. However, due to the very oblique morning illumination conditions for these orbits (i ~ 80°*)*, some areas are in the shadow of the local relief such as next to the Columbia Hills and their photometric characteristics are not retrieved (cf. Figs. 1a, 1f and 2a). The improved global photometric mapping for Gusev is addressed in a companion abstract [10]; we focus here on the local scale study in the vicinity of Columbia Hills (cf. Figs. 1a and 2a) in order to complement at 100m/pixel the in situ observations produced by Pancam on Spirit [11]. As shown hereafter, a sharp photometric contrast is observed between the Gusev Plains and the Columbia Hills, and a high consistency is found between both in situ and orbital photometric surveys [11], and earlier studies of surface textures [e.g., 1, 3, 4].

References:

[1].Martinez-Alonso S. et al. (2005), *JGR, E1,* E002327. [2] Arvidson R.E. et al. (2004), *Science, 305,* 821. [3] Greeley R. et al.(2005), *JGR 110*, E002403.[4] Pinet et al.(2005), *LPSC XXXVI*, # 1721. [5] Cord A.M. et al. (2003), *Icarus , 165*, 414. [6] Kaydash V. et al., *this volume.* [7] Baratoux D. et al*., this volume.* [8] Gwinner K. et al. (2005) *Mars-Express meeting* , ESTEC;

Scholten F. et al. (2005), *in Photogram. Engineer. & Rem. Sens,* 71 (10). [9] Albertz et al. (2004), *Int. Arch. Photog. Rem. Sens.,*35, B4, 869 [10] Jehl et al., *this volume* [11] Johnson J. et al. , *JGR-Planets,* in press.

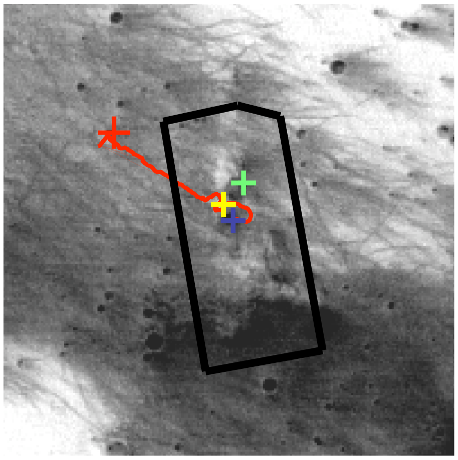

Fig. 1a. 10kmx10km HRSC image with location of MOC DTM frame in black (cf. fig. 1f), Spirit route in red. Cross in red: Bonneville crater, in green: dark patch, in yellow: Columbia top, in blue: El Dorado.

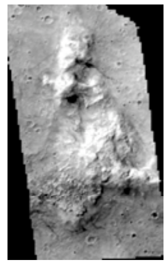

Fig. 1f. MOC DTM Image in black frame (cf. figure 1a).

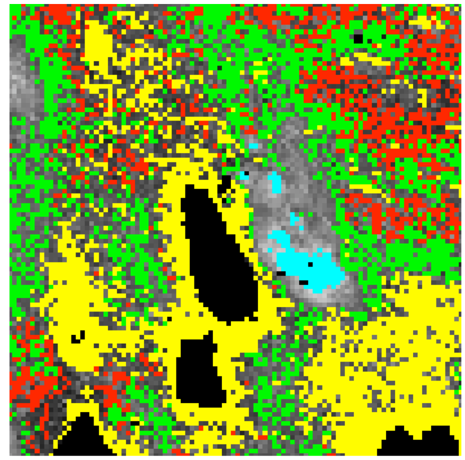

Fig. 2a. PCA classification of Columbia Hills surroundings based on photometric types displayed below. In black: areas shadowed by the relief.

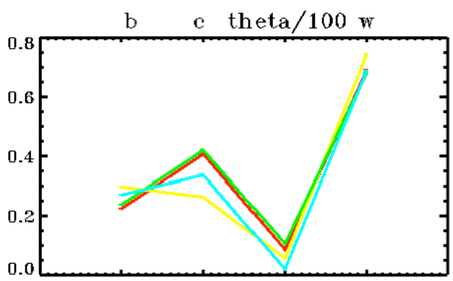

Fig. 1b. Photometric parameters for the 4 spots selected above. Dark patch is photometrically identical to Bonneville sands; Eldorado is one of the smoothest areas in the image (see also Fig. 1d).

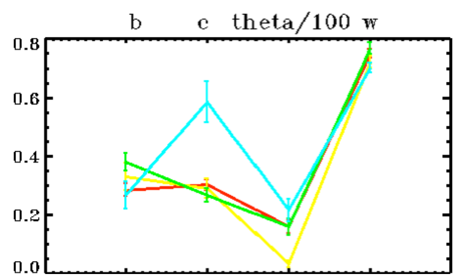

Fig. 2b. In blue: most backscattering behavior generally associated with hill tops; in yellow: smoothest areas associated with Gusev Plains / Dark Streaks (PL) ; in red and green: rougher terrains (WR:Wrinkled type)

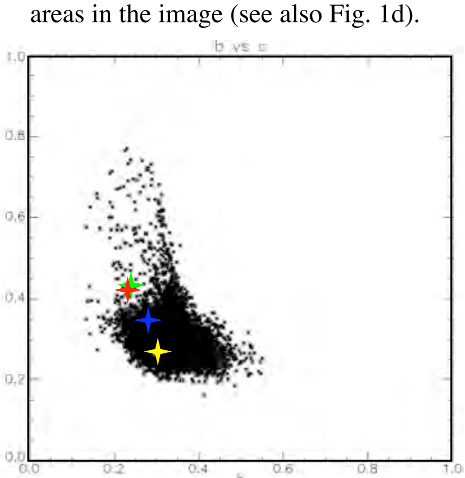

Fig. 1c (Left). c = f (b) graph for HRSC image. Crosses for the 4 selected spots.

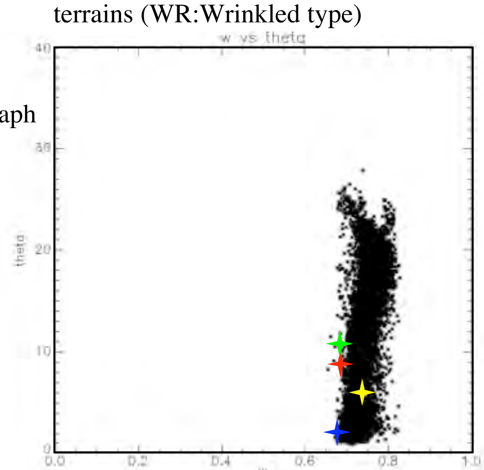

Fig. 1d (Right). θ = f(w) graph for HRSC image. Crosses for the same 4 spots.