

VNIR SPECTRAL DIFFERENCES ON NATURAL AND BRUSHED/WIND-ABRADED SURFACES ON HOME PLATE, GUSEV CRATER, MARS: SPIRIT PANCAM AND HIRISE COLOR OBSERVATIONS.

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Introduction: Since approximately sol 746 of its mission, the Mars Exploration Rover Spirit has been at, on, or near the Home Plate feature in Gusev Crater. Home Plate was first recognized in MOC narrow angle imagery of the Columbia Hills as a distinct albedo feature- a bright circular halo south of Husband Hill. Home Plate has been viewed from near the top of Husband Hill with the multispectral Pancam instrument and it has also been observed with the orbital HiRISE sensor on MRO. These remote observations provide a very different perspective on the nature of rock surfaces at Home Plate than those which were obtained by Spirit as it made up-close observations of Rock Abrasion Tool (RAT) brushed surfaces and surfaces swept clean by eolian action. Here we report on these different sets of observations and relate what connection the small spatial scale VNIR observations have to chemical observations reported on elsewhere [e.g., 1].

Pancam and HiRISE Data: Pancam consists of two capable of multispectral imaging in the 400 to 1000 nm VNIR spectral range. Operational multispectral observations typically consist of observations in 13 filters with spectral overlap between the eyes near 435 and 750 nm [2]. Pancam data are calibrated to absolute radiance using pre-flight radiance coefficients derived from integrating sphere observations and corrected for detector and electronic temperature variations. The data are calibrated to radiance factor (I/F) by reference to measurements of a calibration target mounted on the deck of the rover. An empirical correction for dust accumulation on the calibration target has been applied to the data [3]. By dividing by the solar incidence angle at the time of data acquisition, the data are converted to relative reflectance (R*).

HiRISE acquires broad band red channel (centered at 694 nm) data in a full cross-track swath and blue-green (536 nm) and near-infrared (874 nm) data across the central 20% of the swath [4]. HiRISE collected image data of Home Plate and its surroundings in late 2007. The PSP_005456_1650 observation captured only the blue-green and red HiRISE channels over Home Plate.

Remote Observations from the Summit of Husband Hill: In Fig. 1a, a Pancam L257 false color composite (RGB=753, 535, 432 nm) from the sol 595, P2282 image sequence shows Home Plate. Even in this

simple color composite it can be seen that the north-western rim (on the right side of Home Plate in this image) appears more red than the eastern rim (on the left side in this image). This difference is accentuated in Fig. 1b in a composite where red is the 436 to 754 nm slope, green is the 436 nm R* value, and blue is the 754 to 1009 nm slope.

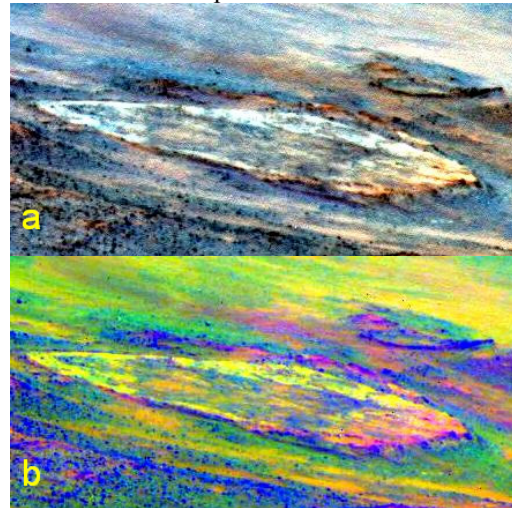


Fig. 1. a. Sol 595, P2282 false color (RGB=753, 535, 432 nm) view of Home Plate taken from the summit of Husband Hill. **b.** Composite of blue-red slope, 436 nm R*, and 754 to 1009 nm slope.

Orbital HiRISE Color Observations: As noted, the HiRISE PSP_005456_1650 observation only has two color data over Home Plate; however, the two channel data can be viewed in a false color RGB mode (using an average of the two as a synthetic third channel) and the two channels can be used to perform a two endmember spectral mixture analysis (SMA) [5] over Home Plate. Fig. 2a shows the false color RGB view of Home Plate and Fig. 2b shows a composite of fraction images of orange-red (nominally bright drift material) surfaces in red, blue (nominally rock surface with less dust cover or coatings) surfaces in green and Root Mean Square (RMS) error in blue.

Differences between the east and west rims stand out in Fig. 2b. The endmember mapped out in red in Fig. 2b was modeled on a set of pixels from the northwest rim from pixels that look orange-red in Fig. 2a. The endmember mapped out in green was modeled on a set of pixels from the northeast rim from pixels that look light blue in Fig. 2a.

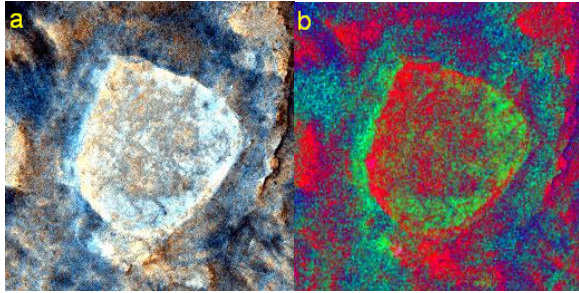


Fig. 2. a. HiRISE color image of Home Plate. **b.** Composite of “orange-red”, “blue-white” fraction images and RMS error as red, green, and blue.

Observations of RAT Brush Spots and Wind-Abraded Surfaces: A different perspective is obtained of rock surfaces when viewed in finer spatial detail. These near-field observations have been made of spots brushed clean by the rover’s RAT and also of surfaces subject to eolian abrasion. **Fig. 3** shows a HiRISE image of Home Plate with sol numbers superimposed indicating where measurements from Pancam 13 filter observations used here were collected. In [6] a set of spectral parameters was used to distinguish between different rock spectral classes. Here, in **Fig. 4**, we plot the 535 nm band depth and 601 nm band depth parameters for the observations noted in **Fig. 3**. There is a distinction in this plot between observations made on the western and southern portions of Home Plate from those on the eastern to northeastern rim. However, these differences do not perfectly match the color differences from the Pancam Husband Hill and HiRISE observations. The sol 1332 “Texas Chili” observation is solidly within the green fraction image portion in **Fig. 2b** that would indicate more of an affinity for the eastern rim materials; however, it plots instead with the western rim observations. The higher 535 nm band depths obtained from these RAT brush spots and wind abraded surfaces on the western and southern portions of Home Plate is suggestive of a higher level of oxidation. In [6] a positive correlation was shown between Pancam derived 535 nm band depth and Mössbauer spectrometer (MB) derived Fe^{3+}/Fe_{Total} . The 601 nm “band depth” (more properly, the degree of convexity in the shoulder at 600 nm) can also be related to the oxidation of surface materials. The edge of the 660 nm band that develops in hematite and goethite contributes to the 601 nm “band depth”. The separation of measurements into two groups in **Fig. 4** correlates with MB measurements of magnetite-bearing and nano-phase ferric oxide (np-Ox)-bearing materials at these locations [7]. There is more np-Ox in western and southern rim measurements than in eastern rim measurements [7] indicating a higher degree of oxidation than to the east.

Implications for Relating Orbital to Ground

Measurements: The remote Pancam Husband Hill and orbital HiRISE observations indicated a spectral difference between the western and eastern rims of Home Plate, with the west being redder and, by inference, more oxidized than the east. These remote inferences are validated by near-field Pancam and *in-situ* MB spectroscopic observations. However, the fact that the sol 1332 Texas Chili observation lies within a region that the remote measurements indicate might be less oxidized, while it actually groups with more oxidized materials based on MB and near-field Pancam indicates an imperfect correlation between remote and near-field observations. Among the possible explanations is that the east/west dichotomy observed remotely could be a consequence of eolian dust cover or a residual coating instead of the brushed rock compositional information observed by the MB and by the Pancam near-field observations.

References:[1] Schmidt M. et al. (2008) *LPS XXXIX*, submitted. [2] Bell J, et al. (2003) *JGR,108*, 2003JE002070. [3] Bell J. et al. (2006) *JGR,111*, 2005JE002444. [4] McEwen, A. et al. (2007) *JGR, 112*, 2005JE002605. [5] Adams, J. et al. (1986) *JGR, 91*, 8098. [6] Farrand, W.H. et al. (2006) *JGR, 111*, 2005JE002495. [7] Schroeder, C. et al (2008) *LPS XXXIX*, submitted.

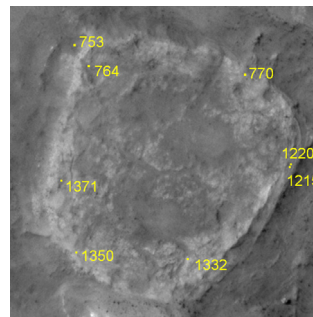


Fig. 3. HiRISE image showing sol number locations for Pancam 13 filter observations used here.

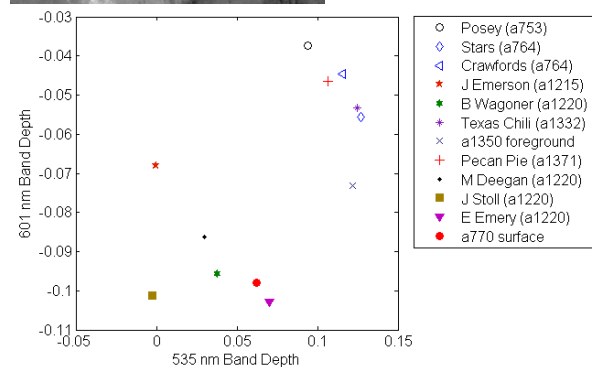


Fig. 4. Plot of 535 nm vs. 601 nm band depth for observation sites noted in **Fig. 3**.