# Insights Into the Mineralogic Diversity of Lower Mount Sharp Units From Mars Science Laboratory Mastcam Multispectral Observations

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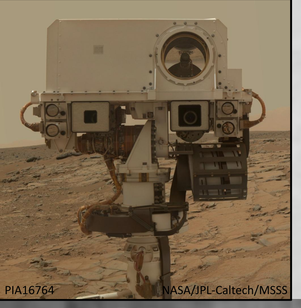
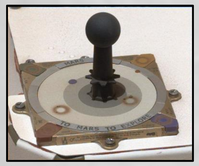



## 1. Instrument & Calibration

- The Mastcam instruments are a pair of 1600x1200-pixel CCD cameras each with a rotating filter wheel for multispectral imaging [1,2].
  - The filter set wavelength band centers span from 445 – 1013 nm, and were selected to capture visible/near-infrared absorption features of certain (commonly iron-bearing) minerals [2].
  - Frequent images acquired of the calibration target (left) located on the rover deck allow observations to be accurately calibrated to relative reflectance.



*Above: The Mastcam calibration target on sol 66*

**Fig. 1:** Reflectance Spectra: Rock/Outcrop Surfaces

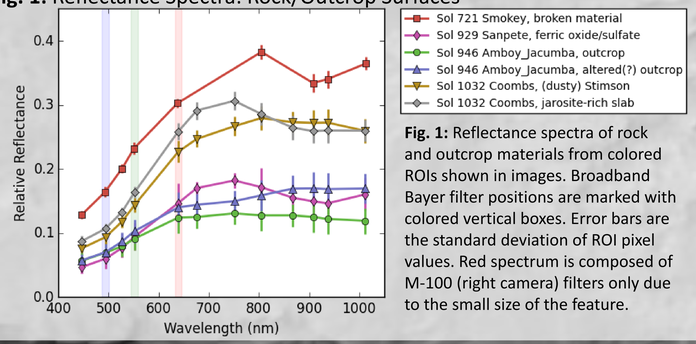
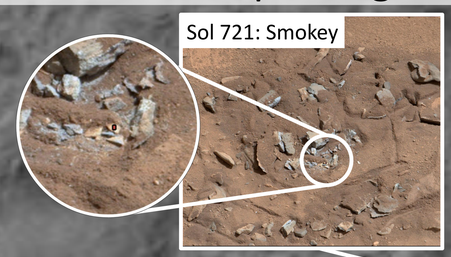
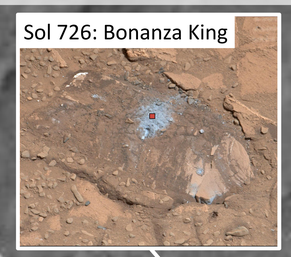


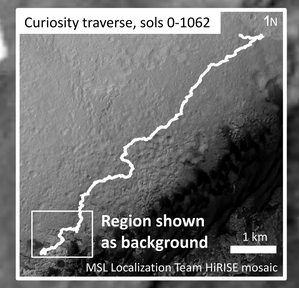

**Fig. 1:** Reflectance spectra of rock and outcrop materials from colored ROIs shown in images. Broadband Bayer filter positions are marked with colored vertical boxes. Error bars are the standard deviation of ROI pixel values. Red spectrum is composed of M-100 (right camera) filters only due to the small size of the feature.

## 2. Hidden Valley

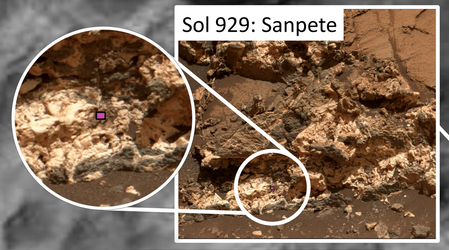
- A partial drill attempt in Hidden Valley on the target "Bonanza King" produced relatively dust-free material for Mastcam multispectral analysis.
- The tailings (sol 726 obs.) are spectrally flat across the Mastcam filter wavelengths (Fig. 2 , red), which may reflect a breakdown/leaching of primary iron-bearing basaltic minerals.
- Small portions of nearby rocks (sol 721) broken by the rover wheels show a strong near-infrared absorption (Fig. 1, red) consistent with indications of a ferric sulfate identified in adjacent fragments by ChemCam passive [3].

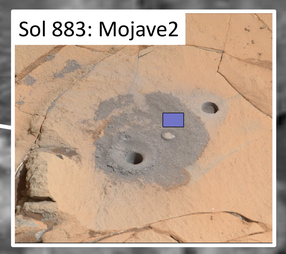


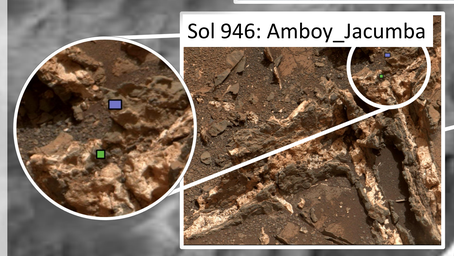



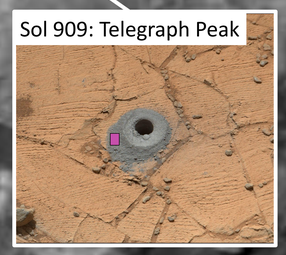








Hidden Valley
Pahrump Hills
Garden City
Marias Pass

## 3. Pahrump Hills

- Curiosity drilled three full-depth holes in the lower Murray Formation at Pahrump Hills. Multispectral observations were acquired on sols 763, 883, and 909.
- In esp. the Confidence Hills (Fig 2, green) and Mojave 2 (Fig. 2, blue) drill tailings, Mastcam spectra show a strong absorption at shorter wavelengths (~450-550 nm) consistent with hematite, although the lack of a band near 867 nm indicates that the particle size is small and/or such a band is masked by other phases.
- The Telegraph Peak drill tailings (Fig. 2, magenta) have a lower reflectance and less spectral contrast, consistent with an enrichment of strongly absorbing minerals such as magnetite.

**Fig. 2:** Reflectance Spectra: Drill Tailings

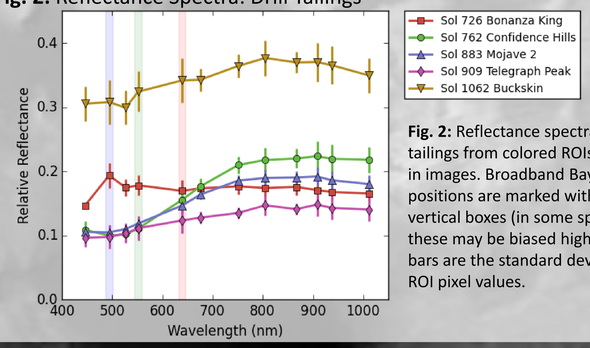
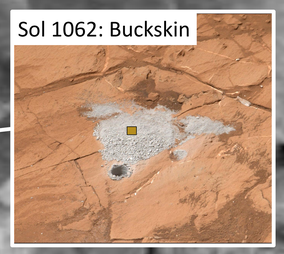



**Fig. 2:** Reflectance spectra of drill tailings from colored ROIs shown in images. Broadband Bayer filter positions are marked with colored vertical boxes (in some spectra these may be biased high). Error bars are the standard deviation of ROI pixel values.

## 4. Garden City

- Multiple multispectral sequences were acquired at a vein-rich outcrop dubbed "Garden City", including two on sols 929 and 946.
- The dark matrix of the outcrop exhibits two different spectral shapes, one more consistent with a basaltic mineralogy (Fig. 1, green) and one which may reflect alteration by the fluids flowing through the veins (Fig. 1, blue).
- On small (mm) spatial scales another spectrally distinct material can be found on/near the veins (Fig. 1, magenta), and possesses a strong NIR absorption consistent with a ferric mineral such as jarosite.


## 5. Marias Pass

- Curiosity conducted a detailed investigation of the contact between the Murray and Stimson units at Marias Pass.
- Mastcam multispectral (sol 1032; Fig. 1, gray) and ChemCam LIBS observations of a spectrally distinct (compare to Fig. 1, brown) slab of material in the Stimson are both consistent with the ferric sulfate jarosite.
- Multispectral imaging of the Buckskin drill tailings (Fig. 2, brown) on sol 1062 quantifies the overall high reflectance observed in normal RGB imaging, consistent with measured high Si [4]. The spectral peak near 800 nm may be a consequence of minor amounts of Fe-bearing phases.

## 6. Summary

- Mastcam reflectance spectra of basal Mt. Sharp units show a spectrally diverse set of materials with large variations in spectral shape and overall reflectance (see Figs. 1 & 2).
- Specific spectral features may be attributed to absorptions by iron oxide and iron sulfate minerals (in particular, hematite and jarosite). High concentrations of jarosite may occur over small spatial scales, perhaps as a coating. Specific outcrops within the Murray Formation possess some of the highest non-vein reflectances, consistent with elevated silica content.
- Reflectance spectra of these materials are distinct from obsevations acquired earlier in the mission and are consistent with a shift from a circumneutral to an acidic alteration environment.

## References

[1] Malin et al. (2010) *41st LPSC,* 1123.
[2] Bell et al. (2012) *43rd LPSC,* 2541. [3] Johnson et al. (2015) *46th LPSC*, 1433 [4] See #2119, this session