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Mastcam multispectral database from the Curiosity rover’s traverse in Gale crater, Mars (sols 0-2302)

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Data Processing

We used calibrated Mastcam observations to radiance using pre-flight calibration coefficients from radiance products available via the NASA Planetary Data System (PDS) (Bell et al., 2017). We compiled a comprehensive database of Mastcam spectra that sample the diversity observed across Curiosity's traverse, from a total of 624 observations between sols 0-2302 (through the exploration of Vera Rubin ridge). This tally excludes 38 multispectral observations acquired during this period because of extensive shadowing, failed image execution, incomplete downlink, and/or complicated mosaic acquisition (which pose challenges to our multispectral analysis tools and have been deferred to future analyses).

For each Mastcam multispectral observation, we characterized the spectral variability in the scene by manually identifying color end members through a visual inspection of the images. We produced decorrelation stretch (DCS; Gillespie et al., 1986) composites from combinations of Mastcam filter images that produced the largest color contrasts for each observation (typically R1/R2/R6 and L1/L2/L6). We identified end members as groupings of pixels that exhibit distinct colors in the DCS products and also represent geologically-distinct surfaces. We took care to identify color end members corresponding to different geologic materials, and to distinguish these from color variations that may result from small differences in local viewing geometry (e.g., the multiple facets of a homogenous rock). In instances of variable dust cover on an otherwise homogenous surface, we selected end members on both the most- and least-dusty regions.

We extracted a representative spectrum of each end member by manually selecting pixels from regions of interest (ROIs) in the right and left camera images separately. We flagged pixels with 11-bit data number (DN) values greater than 2000 in raw images as "saturated" and excluded them from ROI averages on a per-filter basis. In the spectra shown, we represent "error bars" in R* as the standard deviation among the selected ROI pixels; this is a measure of the homogeneity of the pixel values within the ROI, and is generally much larger than the instrumental error (Bell et al., 2017).

File Formats
CSV, JPEG

Dataset Description: ROI_DCS_context_images.zip

Context images for Regions of Interest (ROIs) for each Mastcam multispectral observation in the database (MastcamSpectra_withClasses.csv). ROIs are shown as polygons overlain on decorrelation stretch (DCS) color composite images for Mastcam-left and/or Mastcam-right frames. The ROI color in each image corresponds to a unique spectrum in the database. Filenames are given as “solXXXX_mcamYYYY_MZZZ_do_MN.jpg,” where XXXX is the sol number, YYYY is the sequence identifier number, M is the camera (L or R), ZZZ is the 3-filter combination used to create the DCS, and N is the pointing number (when applicable). (“do” in the filenames is shorthand for “DCS overlay.”)

Dataset Description: MastcamSpectra_withClasses.csv

NAME	Target name associated with the Mastcam sequence
SOL	Martian day of Curiosity’s mission
LTST	Local True Solar Time when the sequence began on Mars, in units of seconds past midnight
SEQ_ID	Mastcam sequence identifier number
ROVER_ELEVATION	Elevation of the rover in meters
TAU	Atmospheric optical depth (from Lemmon et al., 2019)
FOCAL_DISTANCE	Mastcam camera focal distance in meters
INCIDENCE_ANGLE	Incidence angle for the center of the image when the sequence began on Mars, calculated from the Solar Elevation field in the Mastcam image header
EMISSION_ANGLE	Emission angle for the center of the image when the sequence began on Mars, calculated from the Instrument Elevation field in the Mastcam image header
PHASE_ANGLE	Phase angle for the center of the image when the sequence began on Mars, calculated from the Solar Elevation, Instrument Elevation, Instrument Azimuth and Solar Azimuth fields in the Mastcam image header
LAT	Rover latitude
LON	Rover longitude
ODOMETRY	Rover distance traveled in meters
ROI_COLOR	Color assigned to the Region of Interest from which pixels were averaged to extract the Mastcam spectrum; colors correspond to those shown in the ROI_DCS context images
FEATURE TYPE	Geological category of feature (rock or soil)
FEATURE SUBTYPE	Geological subcategory of feature (undisturbed soil; disturbed soil; dump pile; drill tailings; DRT target; broken rock; dusty rock; or vein)
ROCK CLASS	Mastcam spectral class for rock features
SOIL CLASS	Mastcam spectral class for soil features
GROUP	Lithology information from the stratigraphic column of Edgar et al. (2020)
FORMATION	Lithology information from the stratigraphic column of Edgar et al. (2020)

MEMBER	Lithology information from the stratigraphic column of Edgar et al. (2020)
FLOAT	Designation of rocks as “in-place” or “float” (not attached to outcrop)
UNITS	Reflectance units used; IOF is the “radiance factor,” which can converted to “reflectance factor” (*R**) by dividing by the cosine of the solar incidence angle
L2	Reflectance at 445 nm
R2	Reflectance at 447 nm
L0B	Reflectance at 481 nm
R0B	Reflectance at 483 nm
L1	Reflectance at 527 nm
R1	Reflectance at 527 nm
R0G	Reflectance at 551 nm
L0G	Reflectance at 554 nm
R0R	Reflectance at 638 nm
L0R	Reflectance at 640 nm
L4	Reflectance at 676 nm
L3	Reflectance at 751 nm
R3	Reflectance at 805 nm
L5	Reflectance at 867 nm
R4	Reflectance at 908 nm
R5	Reflectance at 937 nm
L6	Reflectance at 1012 nm
R6	Reflectance at 1013 nm
L2_ERR	Standard deviation at 445 nm
R2_ERR	Standard deviation at 447 nm
L0B_ERR	Standard deviation at 481 nm
R0B_ERR	Standard deviation at 483 nm
L1_ERR	Standard deviation at 527 nm
R1_ERR	Standard deviation at 527 nm
R0G_ERR	Standard deviation at 551 nm
L0G_ERR	Standard deviation at 554 nm
R0R_ERR	Standard deviation at 638 nm
L0R_ERR	Standard deviation at 640 nm
L4_ERR	Standard deviation at 676 nm
L3_ERR	Standard deviation at 751 nm
R3_ERR	Standard deviation at 805 nm
L5_ERR	Standard deviation at 867 nm
R4_ERR	Standard deviation at 908 nm
R5_ERR	Standard deviation at 937 nm
L6_ERR	Standard deviation at 1012 nm
R6_ERR	Standard deviation at 1013 nm
FILTER_AVG	Average reflectance of all filters
ERR_AVG	Average of the standard deviations for all filters

References

Bell, J.F., III, Godber, A., McNair, S., Caplinger, M. A., Maki, J. N., Lemmon, M. T. et al. (2017), The Mars Science Laboratory Curiosity rover Mastcam instruments: Preflight and in-flight calibration, validation, and data archiving, *Earth and Space Science, 4(7),* 396-452, https://doi.org/10.1002/2016EA000219.

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