CRISM HYPERSPECTRAL TARGETED OBSERVATION LOCAL AREA MOSAICS. F. P. Seelos, K. D. Seelos, C. E. Viviano, F. Morgan, D. C. Humm, and S. L. Murchie, Space Department, JHU/APL, 11100 Johns Hopkins Road, Laurel, MD 20723 (frank.seelos@jhuapl.edu).

Introduction: The Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) has acquired nearly 23,000 hyperspectral targeted observations with a ~400 - 3920 nm wavelength range and 6.55 nm sampling. Full Resolution Targeted (FRT) observations have a ~10x10 km footprint @ ~20 m/pxl and Half Resolution Long/Short (HRL/S) observations have a ~10x20 km or ~10x10 km footprint @ ~40 m/pxl. The CRISM data set includes numerous spatially overlapping targeted observations covering sites of high scientific interest (e.g. Figure 1). We report on the development and demonstration of a CRISM hyperspectral targeted observation mosaicking procedure that supports the generation of scientifically compelling local area mosaics (e.g. Figure 2, Figure 3).

Prerequisites: The mosaicking procedure is dependent upon the Map-projected Targeted Reduced Data Record (MTRDR) data processing pipeline [1]. The MTRDR pipeline includes a rigorous data validation process that ensures the quality and completeness of the mosaic constituent observations. The MTRDR data processing addresses CRISM-specific targeted observation characteristics and normalizes the data to a series of empirically determined references. The primary MTRDR data product is a full spectral range, co-registered, map projected hyperspectral image cube that has been corrected for illumination geometry and atmospheric gas absorptions, normalized to the nearest-nadir sampled geometry to correct atmospheric aerosol and path length effects, with minor radiometric residuals mitigated and known bad data bands removed (Figure 1). The MTRDR mosaicking procedure subsequently makes use of spatial overlap statistics to transform a set of spatially interconnected MTRDR data products to a common radiometric reference.

MTRDR Mosaicking Procedure: The mosaicking procedure can be conducted using a spatially interconnected set of either MTRDR I/F [2] or derivative spectral summary parameter [3] data products.

Overlap area identification: The MTRDR pipeline generates a map-projected CRISM Derived Data Record (DDR) that incudes pixel-specific geospatial information. This is used to identify all binary footprint intersections in the mosaic observation set and generate sampling masks indicating which pixels participate in a given intersection.

Data sampling and initialization: The sampling masks are used to isolate paired sample sets that correspond to the image intersections. The figure of merit for a given image overlap is calculated from the cumulative distribution functions (CDFs) of the sampled data distributions where the score for a given intersection is proportional to the area between the CDFs. The figure of merit for the overall mosaic system is the weighted total of the individual intersection scores, with the weighting set by the area of each intersection.

System optimization: Optimization of the mosaic system is conducted with the IDL MPFIT implementation of the Levenberg-Marquardt non-linear least squares optimization method [4]. I/F data is constrained on the interval [0,1] which allows spectral bands to be varied according to a gamma-gain-offset function X' = P[0] + P[1] * X^P[2] where P is the parameter vector for the observation from which the data X were drawn. Spectral summary parameters are generally not constrained over the same interval and so are instead restricted to a gain-offset correction. The objective of the system optimization is to identify the parameter set P for each constituent observation that minimizes the overall overlap area discrepancy throughout the mosaic. A high quality (ideally relatively low atmospheric optical depth, S/C roll, incidence angle, and IR detector temperature) well-connected reference image is selected and held constant during the optimization process to maintain the radiometric stability of the optimized mosaic result. The CDF-based intersection residual calculation allows the full shape of the underlying distribution to inform the optimization process.

Mosaic product assembly: The final state configuration yields the optimization parameters for each observation that, when applied to the source MTRDR data, minimize the figure of merit for the mosaic system. These parameters are applied to the source data and the optimized bands are assembled into a mosaic product. The mosaic stacking order is governed by observation quality metrics, optimization performance metrics, or configured manually (Figure 2, Figure 3).

MTRDR Mosaic Applications: The resultant optimized MTRDR mosaic data products allow for the consistent evaluation of spectral characteristics over areas in excess of a single targeted observation footprint and across observation boundaries. A pertinent application for such spectral mosaic products will be supporting the landing site selection and certification process for future Mars landed missions. Many of the reference sites considered by the MEPAG MSR E2E-iSAG [5] have existing high quality CRISM hyperspectral targeted observation coverage – mosaic products for selected reference sites will be presented.

References: [1] F. P. Seelos, et al. (2012) *Planetary Data: A Workshop for Users and Software Developers*. [2] F. Seelos, et al. (2012) *MRO/CRISM Data User's Workshop*, http://crism.jhuapl.edu/CRISM_workshop_2012/. [3] S. M. Pelkey, et al. (2007) *JGR*, 112, E08S14. [4] C. B. Markwardt (2009) *Astronomical Data Analysis Software and Systems XVIII*, 411, p. 251. [5] MEPAG (2011) Planning for Mars Returned Sample Science: Final report of the MSR End-to-End International Science Analysis Group.

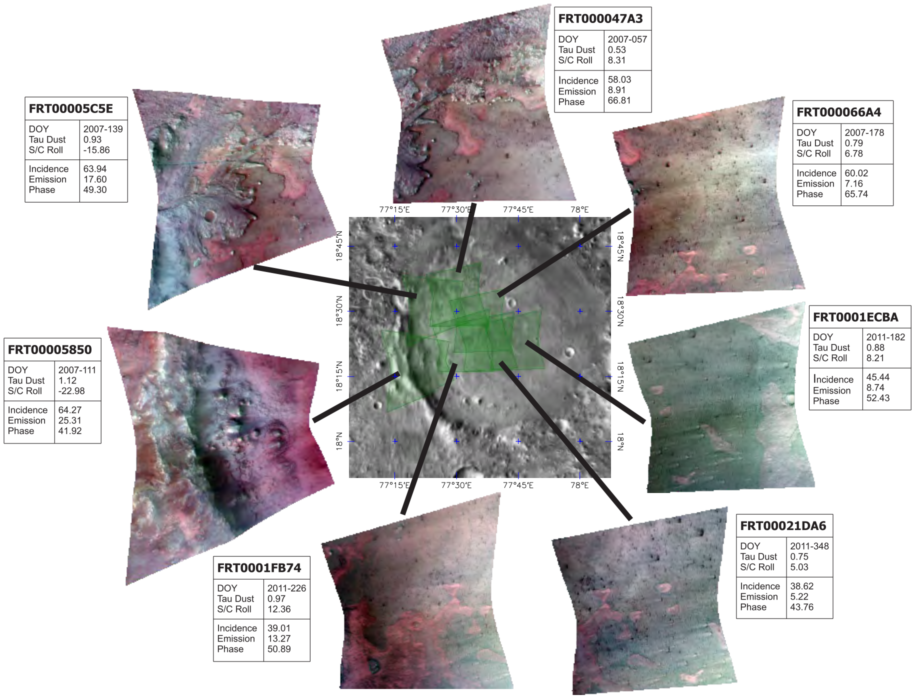

Figure 1. Jezero Crater MTRDR mosaic configuration. (Center) Footprint layout of the local area mosaic over THEMIS daytime IR. (Radial) Each constituent MTRDR data product is shown as an RGB false color tandem (TAN) composite (R:2529 nm; G:1330 nm; B:770 nm) with a 0.5% linear stretch on each spectral band. Individual observation characteristics are provided in the accompanying tables. FRT000047A3 was used as the optimization reference.

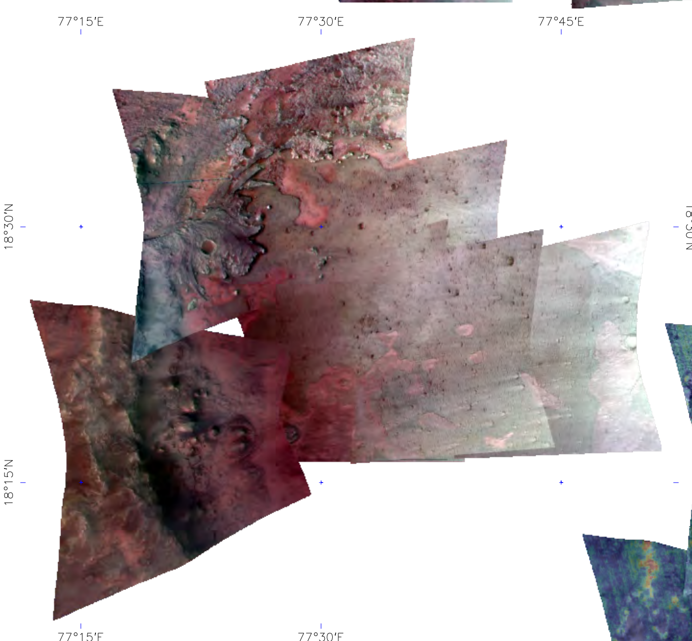

Figure 2. (Left) Jezero Crater optimized MTRDR TAN local area mosaic. The tandem (TAN) RGB false color composite (R:2529 nm; G:1330 nm; B:770 nm) is shown with a 0.5% linear stretch on each spectral band. The resulting mosaic product is shown without any additional processing to address residual image seams (e.g. blending, feathering).

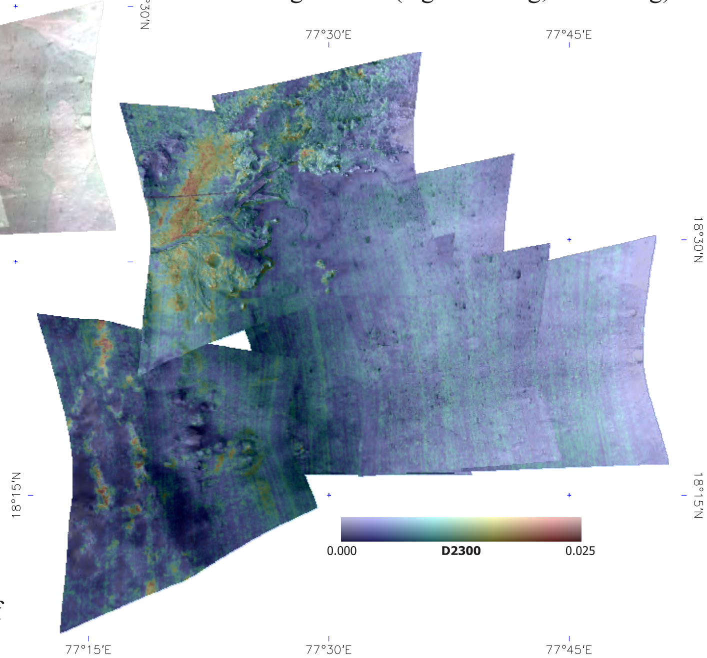

Figure 3. (Right) Jezero Crater optimized MTRDR D2300 local area mosaic. The 2300 nm drop off (D2300) spectral summary parameter is shown in color at 25% opacity over the 1330 nm IR albedo (IRA) image mosaic with a 0.5% linear stretch. The D2300 parameter can be indicative of Fe-Mg phyllosilicates or Mg carbonate.