RELEASE OF THE GLOBAL CTX MOSAIC OF MARS: AN EXPERIMENT IN INFORMATION-PRESERVING IMAGE DATA PROCESSING.

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Introduction: The Context Camera (CTX) [1] onboard the Mars Reconnaissance Orbiter (MRO) has achieved near-global coverage of the surface of Mars at high-resolution (~5.0-6.0 m/px) with broadly consistent illumination conditions. These data provide the necessary input for a global, seam-corrected image mosaic at unprecedented scale (> 8 trillion pixels).

Image mosaics of planetary surfaces are essential for both engineering and scientific tasks. A community focus has been aimed at maximizing the engineering value of mosaics, including adoption of the term "foundational" to describe the role mosaics play as datasets upon which other products can be reliably placed [2]. Less work has been done to increase the intrinsic scientific value of image mosaics themselves, of particular importance for CTX, which provides the highest-resolution coverage of > 90% of the surface of Mars.

Ideally, image mosaics should be held to the same scientific standards of traceability as the science that they facilitate [3]. All derived data should be traceable back to their source, all methods for the construction of the mosaic should be reported and known artifacts and other limitations of the product should be communicated. These standards have long been applied to the instruments that collect the data [1], and the science derived from image mosaics, but not to mosaic products themselves.

Since conventional geospatial raster processing pipelines are typically destructive [4] (ancillary information is lost as data proceed through the pipeline) we treated the global CTX mosaic (Fig. 1) as an experiment in non-destructive image processing, which is reversible and information-preserving and allows for direct traceability from each mosaic pixel to the raw product from which it was derived (Fig. 2). We report here on the result of this experiment: the first semi-controlled seamless global CTX mosaic of Mars.

Pipeline: Mars was divided into 3,960 4°x4° tiles from 88°S to 88°N and each tile was initially mosaicked separately. Within each tile, individual images were registered to each other using a linear shift with residuals recorded for each tie point [5]. Images with data transmission gaps (labeled "ERROR" in their "DATA_QUALITY_DESC" tag) were segmented into separate images and registered to overlapping data, each segment independently of others. Each image was tone-shifted and uniformly contrast curved to decrease

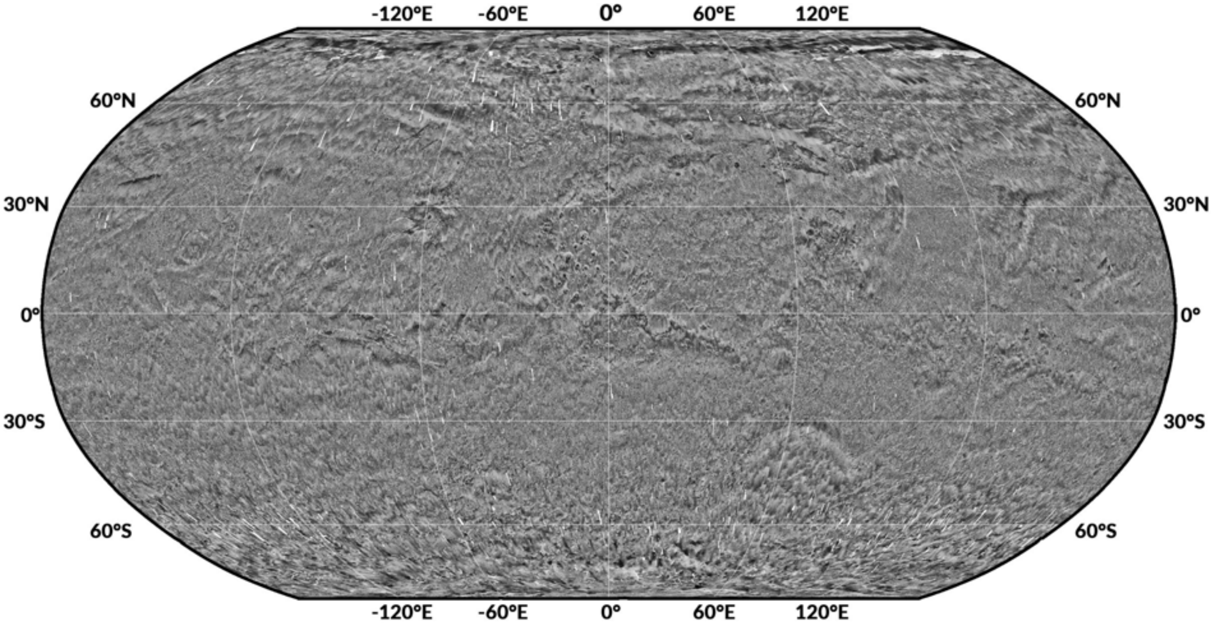

Figure 1. The fully blended, semi-controlled, seam-corrected and seam-mapped global CTX mosaic of Mars. Gaps in the mosaic, which make up less than 0.5% of the composition, are shown in white.

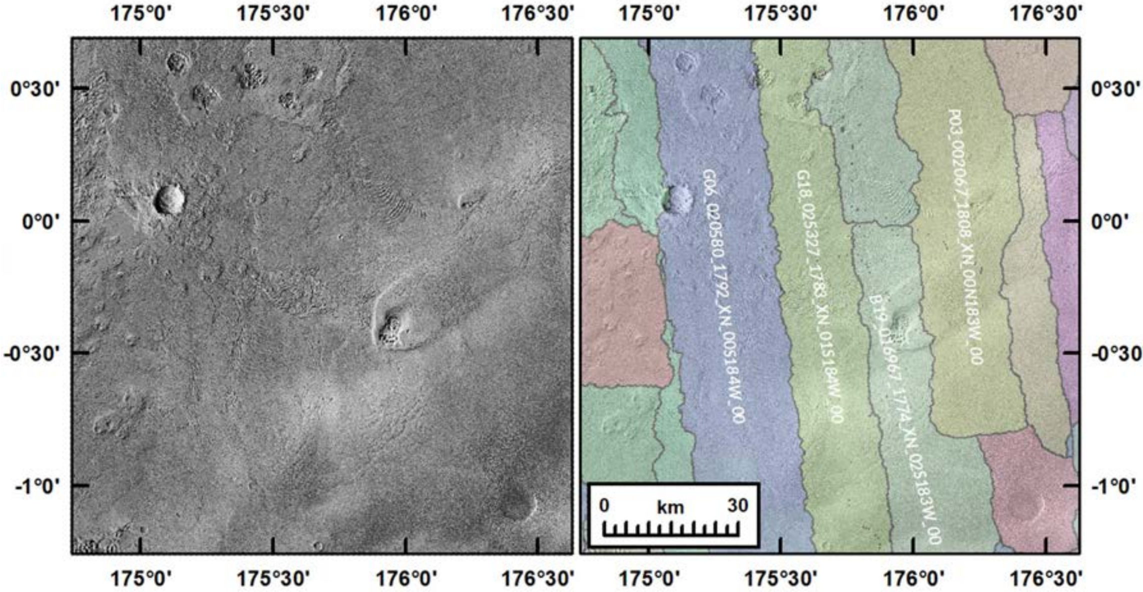

Figure 2. Sample of the global CTX mosaic of Mars from the Medusae Fossae Formation. This example contains the nexus of four separate tiles (176°E, 0°N) to show the result of our tile-blending algorithm. The sample of the mosaic is unstretched. All features mapped on the right inherit the ancillary data from the original, pre-blended orbit.

brightness disparities among overlapping data. Images were blended non-destructively by calculating the path-of-least-contrast between orbits, then these paths were preserved to generate polygonal seam maps that inherited all ancillary data for each pixel (Fig. 2) [4].

Alternating blended tiles were then registered to either the THEMIS-controlled IR mosaic within 60° of the equator [6] or the MOLA dataset poleward of 60° [7]. Remaining tiles were then registered to their four neighboring tiles and a first-order affine adjustment was applied. Tiles were then blended together using a similar non-destructive technique that was used for individual orbits (Fig. 2). Individual tile seam maps were then clipped using the masks created during the tile-blending process.

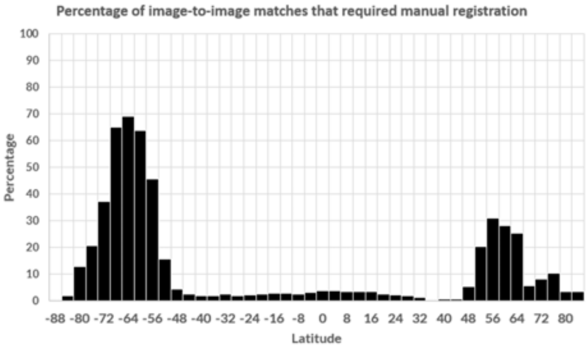

Figure 3. Results of our feature-matching procedure. More variable atmospheric activity in the southern hemisphere strongly inhibited automated image-to-image registration.

Results: The final CTX mosaic covers > 99.5% of the surface of Mars between 88°S and 88°N. It is comprised of 86,571 separate images co-registered by 3,147,169 control points. Our automated image-to-image registration worked well on most of the planet but struggled in the mid-latitudes, particularly the southern mid-latitudes where increased clouds hampered feature-matching (Fig. 3).

The seam-correction algorithm successfully generated 4,969,287 separate polygonal features within the mosaic, with each feature hosting all metadata for the original orbit and links to raw and non-blended versions of the data underlying (Fig. 2). This permits direct comparison of the mosaic to its source to verify observations.

The mosaic and seam maps will be available via the PDS imaging node and the Murray Lab website (http://murray-lab.caltech.edu/CTX/) with plans for streaming versions of the entire product in its native state. A manuscript of the process is being prepared for submission as [8]. A separate effort on a mosaic that is fully-controlled version is underway [9].

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