CONSTRUCTION OF THE CRISM GLOBAL MULTISPECTRAL MAP OF MARS. E. Malaret[1], C. Hash[1], S. Murchie[2], F. Seelos[2], P. McGuire[3], R. Arvidson[3], M. Wolff [4], M. Smith[5], J. Mustard[6], S. Pelkey[7], T. Martin[8], A. McGovern[2], T. Choo[2], D. Humm[2], W.-J. Shyong[2], and the CRISM Team, [1]Applied Coherent Technology, Inc., Herndon, VA (malaret@actgate.com); [2]Applied Physics Laboratory, Laurel, MD; [3]Washington University, St. Louis, MO; [4]Space Science Institute, Boulder, CO; [5]NASA/Goddard Space Flight Center, Greenbelt, MD; [6]GeoEye, Inc., Thornton, CO; [7]Brown University, Providence, RI; [8]Jet Propulsion Laboratory, Pasadena, CA.

Summary: A major part of the MRO/CRISM science investigation is acquisition of a near-global, ~200 m/pixel, 72-wavelength map of Mars (the "multispectral survey"). This map is designed to provide a uniform, global VISIR data set that resolves <1 km features. It allows searching for kilometer-scale exposures of aqueous minerals unresolved in OMEGA data, and provides context for MRO's high-resolution observations. As of January 2008 nearly 60% coverage of Mars has been acquired. Onground, the data are map-projected and processed to three parallel versions: I/F, "Lambert albedo" corrected for photometric and atmospheric effects, and "summary products" which are indices showing spatial variations in spectral properties of the surface and atmosphere. The first parts of the map were publicly released in December 2007.

Data Acquisition: The multispectral survey is acquired with CRISM pointed at nadir, using separate visible/near-infrared (0.4-1.0 µm, VNIR) and infrared (1.0-3.9 µm) detectors. Onboard, data are 10x-binned spatially, and 72 out of the 544 total wavelengths are retained [1]. This wavelength set was chosen using OMEGA data to measure absorptions due to Fe minerals, sulfates, phyllosilicates, and atmospheric gases, and to search for additional phases such as carbonates [2]. Data are taken in 10-km width, 3-minute duration (550-km length) segments separated by internal background calibrations. Measurements of the internal radiometric reference (a small integrating sphere) are taken several times daily. During the first 6 months of MRO's Primary Science Phase, every second orbit was nadir-pointed to provide day-side coverage with minimal gores; subsequent coverage has occurred primarily by filling gaps in the schedule between high-resolution targeted observations [1].

Calibration and Map Projection: Raw data are processed to radiance by subtracting interleaved instrumental background measurements and scaling to the internal integrating sphere [1]. Radiance is converted to I/F using the solar spectrum of Kurucz et al. [3] resampled to the instrument bandpasses. Map projection and photometric corrections are facilitated by a set of backplanes for each calibrated image. Latitude and longitude are calculated using SPICE [4] kernels to determine the intercept of every spatial pixel with the MOLA shape model of Mars; photometric angles are evaluated relative to the areoid. For post-processing corrections, MOLA elevation and TES thermal inertia and bolometric albedo are retrieved at those locations from publicly available map-projected data.

The calibrated data (Targeted Reduced Data Records, or TRDRs) and backplanes (Derived Data Records, or DDRs) are retained as separate multiband images for PDS archival.

Correction for Atmospheric Properties: I/F data are further processed to estimate and remove attenuation of surface radiance by atmospheric gases, and the component of radiance from atmospheric aerosols. The procedure is described in detail by McGuire *et al*. [5]. Briefly, given an input I/F at some wavelength, a hyperdimensional lookup table is used to estimate a correction based on the elevation and the aerosol contribution expected for that latitude, longitude, and solar longitude based on TES climatology. The output, "Lambert albedo," is an estimate of the surface I/F for hypothetical normal illumination and viewing geometry in the absence of an atmosphere.

Calculation of Summary Products: Summary products are described in [6]. Out of 45 total, 2 are albedos at reference wavelengths. Thirty-two, which are calculated from Lambert albedo, represent spectral ratios or band depths possibly indicative of H_2O and CO_2 ices, Fe minerals, sulfates, phyllosilicates, or additional phases such as carbonates. Eleven more, calculated from I/F without additional corrections, are indicative of atmospheric aerosols or trace gases. Most of the summary products are based on variations that occupy a few percent or less of the dynamic range at their respectively wavelengths, so noise-reduction filtering is applied to lessen the effects of systematic instrument artifacts that escape correction during calibration.

Construction of Map Tiles: Multispectral coverage through the end of December 2007 consisted of over 50,500 pairs of VNIR and IR TRDRs with varying illumination conditions (Fig. 1). To create a more user-friendly, systematic product, the data are organized into 1,964 separate tiles (Multispectral Reduced Data Records, or MRDRs) each approximately 5°x5° in size. This scale provides a convenient approach to managing the extremely large data volume (2.6 TB) of the whole map. The full map consists of three parallel versions: I/F, Lambert albedo, and summary products. Both the I/F and Lambert albedo versions are accompanied by backplanes that provide traceability to source observations (observation number, line and sample in the source product) and their conditions (e.g., photometric geometries and solar longitude). Images are map-projected using nearest-neighbor resampling to preserve values in the original data. The order of stacking is with minimum incidence angle on top, to maximize the area covered at favorable illumination and with a minimum of frost or ice cover. To exclude images obscured by the global dust event of 2007, only observations acquired prior to 25 June 2007 and after 29 September 2007 are used to build MRDRs.

Release Status: Instrument calibration is sufficiently mature that the I/F version of the map is being built and released. The first 209 tiles were released in

December 2007, covering key regions such as Valles Marineris, Terra Meridiani, Nili Fossae, Tyrrhena Terra, and plains surrounding the *Phoenix* landing site. The Lambert albedo and summary product versions of the map are in development, with the current focus on improving correction for aerosol effects at <1 µm.

Example: Figures 2 and 3 provide an example of the types of information conveyed in the three parallel versions of the map. Correction from I/F to Lambert albedo (Fig. 2) removes most systematic variations between mapping strips; however residuals remain due to aerosol phenomena not included in the climatological model. Summary products (Fig. 3) highlight mineralogically significant spectral variations that are small in magnitude or restricted in wavelength. Note for example that, in the area shown, spectral signatures of olivine are concentrated in smooth inter-crater plains (mapped as Hesperian in age) and on crater floors, whereas pyroxene is more prevalent in higher-standing Noachian cratered terrain. Phyllosilicate is concentrated in crater rims, walls, and ejecta implying excavation from depth.

References: [1] Murchie, S. *et al.*, *J. Geophys. Res., 112*, doi:10.1029/2006JE002682, 2007. [2] Pelkey, S. *et al.*, *J. Geophys. Res.*, *112*, E08S14, doi:10.1029/2006JE002831, 2007. [3] Kurucz, R., unpublished report at http://kurucz.harvard.edu/sun.html, 1997. [4] Acton, C., The Navigation and Ancillary Information Facility, http://naif.jpl.nasa.gov/naif/. [5] McGuire, P. *et al*., submitted to *Trans. Geoscience and Remote Sensing*, 2008. [6] Murchie, S., et al., CRISM Data Product Software Interface Specification, http://wwwpds.wustl.edu/missions/mro/index.htm, 2006.

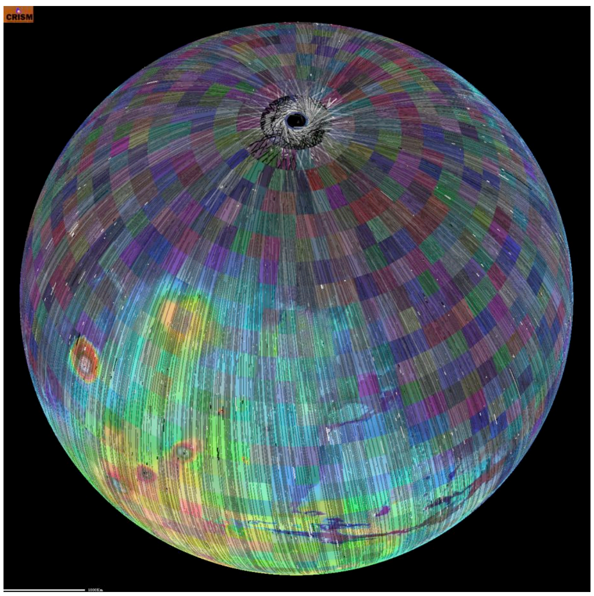

Fig. 1 (left). Orthographic view of Mars showing coverage by the multispectral survey through late 2007. 1.3-µm albedo in CRISM multispectral survey strips is shown in gray. Colored blocks represent the limits of the 1,964 constituent tiles in the map, and they are overlain on a false-color map of MOLA elevation.

Fig. 2 (below, left) Map projected Lambert albedo for tile 750 in Tyrrhena Terra. Values at 2.53, 1.51, and 1.08 microns are shown in the red, green, and blue image planes. The slightly bluish color of some regions is residual effects of aerosols not included in the climatological model. The data are overlain on a THEMIS daytime IR mosaic.

Fig. 3 (below, right) Composite of three summary products. OLINDEX (a measure of the spectral signature of olivine) is shown in the red image plane, D2300 (a measure of the 2.3-µm absorption due to Fe- or Mg-phyllosilicates) is shown in the green image plane, and HCPINDEX (a measure of the spectral signature of high-Ca pyroxene) is shown in the blue image plane.