POST-VIKING ORBITER GLOBAL GEOLOGIC MAPPING OF MARS: INITIAL STEPS.
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Introduction: We have initiated a five-year (2007 to 2011) Mars global geologic mapping project supported by NASA's Planetary Geology and Geophysics Program that will result in a 1:20,000,000-scale printed map in orthographic projection, along with downloadable digital files served through USGS websites. This map will supersede the 1:15,000,000-scale map, which was based primarily on Viking Orbiter image and topographic data sets [1]. Here we describe data used, approaches that will guide the mapping process, and the initial steps the mapping team has taken since project inception in 2007.

Data: Due to the global nature of the mapping project, two key datasets are the most useful for our primarily morphologically based mapping approach. First is the Mars Global Surveyor (MGS) Mars Orbiter Laser Altimeter (MOLA) digital elevation model (DEM) at 463 m/pixel resolution globally and 231 and 115 m/pixel at higher latitudes where data are densest. The MOLA DEM permits us to construct views of the surface of Mars that portray pure morphology and topography without the complex mixing of albedo with slope-shading effects inherent to image data.

The second dataset on which we rely for mapping is the Mars Odyssey (ODY) Thermal Emission Imaging System (THEMIS) infrared (IR) global image mosaics, especially for daytime images. The mosaic is currently 231 m/pixel, and a full-resolution, 100 m/pixel version is in production by the THEMIS Team. These data have fairly consistent illumination direction (south-southwest) and are of higher resolution and quality in many regions relative to Viking images. Perhaps most importantly for our purposes is that the images depict thermophysical characteristics of local surfaces that were not observed in Viking data sets, providing a fundamentally different criteria upon which to delineate and describe geologic units. Additionally, the THEMIS IR data are closely registered spatially with the MOLA DEM, which has the most accurate locations for surface features on Mars.

Additional datasets are being consulted where available and are proving useful for addressing mapping issues, particularly for geologic contact characterizations and unit descriptions and comparisons. These include: (1) moderately high-resolution images (mostly 18- to 50-m/pixel) from the Mars Express (MEX) High Resolution Stereo Camera (HRSC) and the THEMIS visible-range (VIS) camera; (2) very high-resolution (decimeter- to meter-range) images from the MGS MOC narrow-angle (NA) camera, the Mars Reconnaissance Orbiter (MRO) Context Camera (CTX), and the MRO High Resolution Imaging Science Experiment (HiRISE); and (3) multi-spectral, mapping-resolution (100 m/pixel) images that detect water ice and minerals from the MRO-borne Compact Reconnaissance Imaging Spectrometer for Mars (CRISM). We are able to readily access these data either in geospatially defined versions or through footprint shapefiles (web-linked for THEMIS VIS and MOC NA) in a Geographical Information Systems (GIS) project. Data formatted this way, along with available tools, permit us to efficiently and digitally compile geologic unit contacts and surface features that are spatially registered and contained within a digital framework [2].

Mapping approach: We are applying most of the photogeologic and stratigraphic approaches described in detail in the recently completed geologic map of the northern plains of Mars at 1:15,000,000 scale, which relied largely on the MOLA DEM and scattered THEMIS IR and VIS and MOC NA images [2]. Similar to that map, our 1:20M-scale mapping effort relies on delineating geologic units mainly by morphologic character and relative age. Special attention is given to contact relations such as onlapping, gradational, and laterally-variable or inferred expressions. Various other features are being mapped, including tectonic structures (e.g., grabens and wrinkle ridges), large impact craters (and morphologic variants thereof), and valley systems (along with trunk and tributary designations). We are incorporating post-Viking mapping results from other mapping projects, including the northern plains map [2] as well as other maps in progress by various colleagues that focus on cratered highland, lowland, highland-lowland transitional, impact-basin, and volcanotectonic surfaces.

The planet has been divided into four regions that will each be the principal responsibility of one mapper (Fig. 1). The project lead (PI Tanaka) will ensure consistency in mapping among the regions, so that the entire map will be harmonious. Valleys (Co-I Miyamoto) and collapse structures (Co-I Rodriguez) are being mapped by others.

Initial steps: We have assembled and organized information on a list of tentative map units for each of the map regions. The information includes unit symbol, name, regional grouping, primary and secondary characteristics, type locality, adjacent units and their contact and superposition relations, relative age, origin, and previous unit identifications [1, 2].

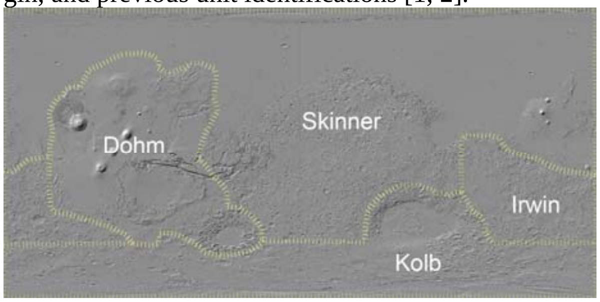

Fig. 1. *Mapping regions and their principal mappers.*

In turn, the gathered information by each individual mapper is providing a solid basis for evaluating whether or not the map unit can be retained or requires modification in how it is defined. Because of our approach, many of the units used previously in Viking-based mapping [e.g., 1] require renaming, redefinition, or other modification. Many such units have been used in larger-scale regional and local geologic maps from 1:500,000 to 1:5,000,000 scales. As such, we anticipate that our geologic and stratigraphic improvements will have considerable impact on future mapping efforts. For example, we will not define, name, or map units based on presumed secondary characteristics such as tectonic, erosional, or impact features. In some cases, this will mean that units formerly differentiated as varieties of smooth, ridged, and dissected will now either be re-designated based on observed characteristics deemed to be primary in their formation or grouped together. Through this tactic, we anticipate a general reduction in the number of globally-identified geologic units (compared to [1]). On the other hand, similar-appearing outcrops may be differentiated into multiple units by their geographical and geological context, which may contribute to unique origins for the outcrops. Smooth plains materials, for example may be related to sedimentation from local valley or outflow channel sources, aeolian deposition, or lava or ash. Detailed and consistent mapping of tectonic, erosional, and other secondary features will be used to reconstruct their histories as well.

Each mapper has already selected and mapped a test area within their region. This exercise was useful in helping us to see how to (1) effectively map the units using available data and software tools; (2) compile graphical and textual notebooks on map units and mapping relations; and (3) communicate effectively via telecons, emails, and web resources (wikispaces). Next steps will include actual mapping of the relatively youngest map units in each region, which tend to be best preserved and have the clearest contact relations.

Community Input: We plan to compile our mapping every 6 months for presentation and community input at annual LPSC (March) and Planetary Geologic Mappers meetings (June). We will utilize various GIS web services and publish these preliminary maps on-line. This will allow the team to review the progress using globe viewers like NASA's WorldWind or within Google Earth. At times, these preliminary maps will be made available for community input using these same on-line viewers. Through these venues, we hope to achieve a more effective, applicable, scientifically-complete geologic map. In addition, the mapping will yield updates and insights to the global stratigraphy and geologic development of Mars. Key results will appear in journal articles.

References: [1] Scott D. H. et al. (1986-87) *USGS Misc. Invest. Ser. Maps I-1802A-C.* [2] Tanaka K. L. et al. (2005) *USGS Sci. Invest. Map SIM-2888*.