PROGRESS IN GLOBAL GEOLOGIC MAPPING OF MARS. K.L. Tanaka[1], J.M. Dohm[2], R. Irwin[3], E.J. Kolb[4], J.A. Skinner, Jr.[1], and T.M. Hare[1]. [1]U.S. Geological Survey, Flagstaff, AZ, ktanaka@usgs.gov, [2]U. Arizona, Tucson, AZ, [3]Smithsonian Inst., Washington, DC, [4]Google, Inc., CA.

Introduction: We have completed the second year of a five-year effort to map the geology of Mars at 1:20,000,000 scale using mainly Mars Global Surveyor, Mars Express, Mars Odyssey, and Mars Reconnaissance orbiter imaging and altimetry datasets. Previously, we have reported on initial aspects of project management, mapping datasets (local and regional), initial and anticipated mapping approaches, tactics of map unit delineation and description, and preliminary mapping results, focusing on Amazonian units and fault mapping [1–3]. Here, we describe new and updated aspects of our team effort, use of data sets, mapping approaches and progress, current issues, and future work.

Nature of team effort: Team meetings and telecons held several times a year provide opportunity for discussion of tactical and strategic issues in our mapping project, as well as how to assemble and view data sets. These discussions promote effective approaches and techniques and their consistent application among team members. Also, we are able to review among ourselves preliminary mapping results. In cases where multiple solutions may exist, the PI makes final decisions.

Mapping of the planet is being accomplished regionally by different team members, according to their familiarity to Mars from previous work (Fig. 1). Collation of the map into a consistent and coherent product is the responsibility of the project PI (Tanaka).

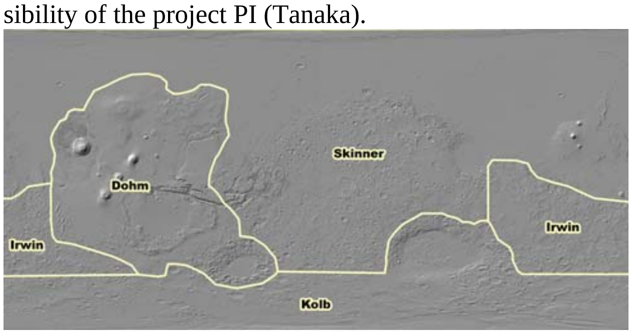

Figure 1: Mapping regions for the global geologic map of Mars, according to principal mapper. Dohm is responsible for Tharsis and Argyre, Irwin for the highlands between Hellas and Argyre, Kolb for Hellas and the southernmost highlands, and Skinner for the northern plains, Elysium, and Arabia Terra.

Accessing data sets: Our standard global mapping data sets include mosaics of Thermal Emission Imaging System (THEMIS) day and night IR, Viking images, and digital elevation models (especially hillshade, color-scaled elevation, and slope) of Mars Orbiter Laser Altimeter (MOLA) altimetry data, all georegistered to adequate precision at mapping scale. In addition, a new global HRSC topography mosaic provides improved resolution of topography for large regions of the planet. Oblique views that merge imagery and topography can now be viewed handily using the new Google Mars engine (about to be released at the time of this writing).

THEMIS VIS, Context (CTX), Mars Orbiter Camera (MOC), and High-Resolution Imaging Science Experiment (HiRISE) images are generally too high of resolution, too dispersed in coverage, and not always adequately georegistered to use as mapping base data at the global scale. However, they and other thematic maps (such as those derived from spectral data sets) are useful in documenting unit characteristics, contact relations, and secondary modifications including deformation, erosion, and mantling by surficial materials. These data sets are accessed as raster images that can be imported into GIS projects or viewed as web downloads.

Mapping scale: The mapping project was anticipated to provide a print map at 1:20,000,000 scale, sufficient to fit upon one map sheet. Digital datasets and mapping methods, however, provide the opportunity to map at much larger scales. Balancing these efforts is of critical importance, particularly for a global mapping project. As such, we established a set of rules that provide a framework for determining geologic linework as well as allowing some flexibility for the mapper.

We are nominally mapping at 1:5,000,000 scale, using digital streaming with lines defined by points (vertices) spaced at 5 to 10 km. We are allowing local increases in map scale, with the caveat that these local lines may be preserved as ancillary and supportive layers in the final GIS-based geologic map. However, to conform to the proposed map scale, we will systematically generalize higher-resolution lines to produce vertex spacings at 10 km. This allows us to convey sufficient global detail while minimizing the digital size and usability of the map product. ArcMap editing tools can be used to homogenize vertex spacing and smooth linework to achieve an accurate and precise map at scale but also at a minimum file size.

Tabulated unit descriptions: As we identify units, we are compiling preliminary and tentative unit information including unit names, symbols, group category, occurrence, primary characteristics, stratigraphic relations, stratigraphic age, interpretation, and other information. In many cases, we start with map units previously mapped at 1:15,000,000 scale based on Viking [4] and Mars Global Surveyor [5] data. We also will incorporate simplified versions of up-to-date, larger-scale unit and topical feature mapping supplied to us by colleagues. The spreadsheet helps us to use consistent criteria in identifying, classifying, describing, and interpreting map units. We also see the need at present to distinguish geologic and geomorphic (or terrain) units, which has been a common circumstance in photogeologic mapping. Map unit group headings thus far indentified include widespread units (occurring globally), highlands, lowlands, Tharsis, Elysium, and geomorphic terrains. At present, about 90 units have been identified, comparable to the total number from the previous global, Viking-based mapping [4]. However, many of these units need further scrutiny, and much of the planet remains to be mapped.

Visual unit descriptions: In addition to tabulated observations, we are also compiling visual unit descriptions in the form of PPT presentations. This allows a comprehensive and ongoing gathering of stratigraphic characteristics, type localities, and comparisons of previously defined units. Our approach of tabulated and visual unit descriptions is intended to document observations over the life of the project as well as to make final unit descriptions easier.

Mapping progress: Thus far, we have completed preliminary unit mapping of most Amazonian and some Hesperian materials, particularly in the northern plains, along the highland/lowland dichotomy boundary, and much of Tharsis. Also, parts of Tharsis structure have been mapped as well, in much greater detail than was shown in Viking-based mapping [4].

Current issues: We continue to address what constitutes a geologic map unit at our global scale. Questions needing further assessment include: (1) What should a unit's minimum spatial extent and thickness be?, (2) what types of contact relations are valid for delineation of units, and how extensively do they need to be expressed?, (3) what kinds of terrains, if any, should be mapped as geomorphic units?, (4) what information can and should be mapped, not as map units, but as other kinds of features?, and (5) in this age of digital mapping, how do we appropriately balance the respective utilities of a print vs. a digital map? We desire to achieve as much consistency as possible in these areas, which requires extensive communication and decision-making among team members. To help make this happen, we intend to map key test areas individually in the coming year from which we develop common mapping techniques and strategies.

Prospects: In spite of the issues that we have yet to resolve, we are confident that the new map will represent significant progress over previous global-scale mapping [4-5] in (1) the accuracy of its drafting, (2) the application of multiple, largely spatially registered image and topographic data sets at various resolutions, (3) its rigorous style of unit definition and documentation, (4) its detail and accuracy of mapped secondary features, including faults and valleys, (5) its capability to address global geologic questions, and (6) its dissemination as a digital product for spatial analysis with other data sets and research results. In addition, documentation of our rationale and methods to meet current challenges will assist the planetary mapping community at large in the proposing, managing, and finalizing of future map projects.

References: [1] Tanaka K.L. et al. (2007) *7th Intl. Conf. Mars* Abs. #3143. [2] Tanaka K.L. et al. (2008) *LPSC XXXIX*, Abs. #2130. [3] Tanaka K.L. et al. (2008) in L. F. Bleamaster III et al. (eds.), Abs. Ann. Mtg. Planet. Geol. Mappers, Flagstaff, AZ, 2008, *NASA CP-2008-215469.* [4] Scott D.H. et al. (1986-87) *USGS Maps I-1802-A, B, C.* [5] Tanaka K.L. et al. (2005) *USGS Map SIM-2888.*