

GEOLOGY OF LIBYA MONTES AND THE INTERBASIN PLAINS OF NORTHERN TYRRHENA TERRA, MARS: FIRST YEAR RESULTS AND SECOND YEAR WORK PLAN. J.A. Skinner, Jr.¹, A.D. Rogers², and K.D. Seelos³, ¹Astrogeology Science Center, U.S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001 (jskinner@usgs.gov); ²Stony Brook University, 255 Earth and Space Science Building, Stony Brook, NY 11794; ³Johns Hopkins Applied Physics Laboratory, MP3-E140, 11100 Johns Hopkins Road, Laurel, MD 20723.

Introduction: The Libya Montes-Tyrrhena Terra highland-lowland transitional zone of Mars is a complex tectonic and erosional region that contains some of the oldest exposed materials on the Martian surface [1-3] as well as aqueous mineral signatures that may be potential chemical artifacts of early highland formational processes [4-5]. Our 1:1M scale mapping project includes the geologic materials and landforms contained within MTMs 00282, -05282, -10282, 00277, -05277, and -10277, which cover the highland portion of the transitional zone. The map region extends from the Libya Montes southward into Tyrrhena Terra and to the northern rim of Hellas basin and includes volcanic rocks of Syrtis Major Planum and a broad low-lying plain (palus) that forms a topographic divide between Isidis and Hellas basins. The objective of this project is to describe the geologic history of regional massif and plains materials by combining geomorphological and compositional mapping observations. This abstract summarizes the technical approaches and interim scientific results of Year 1 efforts and the expected work plan for Year 2 efforts.

Data Sets and Methods: We are following the mapping recommendations outlined in the 2009 Geologic Mappers Handbook [6] as well as approaches used in recent and ongoing geologic maps [7-9] to iteratively produce and refine the geologic map using primary and supplemental data sets. The primary geomorphologic base map is a THEMIS daytime IR mosaic (100 m/px). Compositional information is critical to the objectives of this project and regional THEMIS DCS images (100 m/px) and CRISM summary parameters (231 m/px) are considered primary products wherein geologic units are being delineated and defined. Supplemental data sets include MOLA topography (and derivative products) as well as the full range of THEMIS VIS, CTX, MOC, and HiRISE images via web-linked image footprints. Compositional characterizations will be supplemented by local TES and CRISM hyperspectral observations.

Year 1 Results: The Year 1 work plan consisted of managerial aspects, geologic mapping, feature mapping (including impact craters), nomenclature reviews, and exploratory mapping for Year 2.

Project management. Year 1 efforts included managerial steps that addressed technical/scientific and organizational/financial aspects. We established guiding parameters in order to produce geologic linework of

consistent fidelity (*e.g.*, vertex spacing and digital map scale), identified the role of specific data (*e.g.*, primary

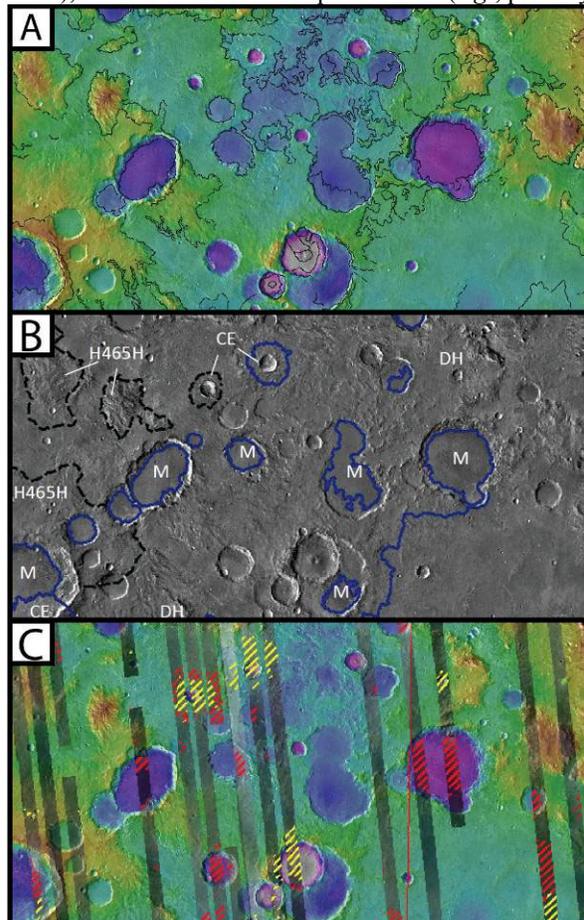


Figure 1. Excerpts from center two quads showing Year 1 geomorphologic and compositional map results. (A) Massif, intermediate, and low-lying geomorphologic and stratigraphic units. (B) THEMIS IR-based mafic plains (“M”), pyroxene-depleted impact materials (“CE”), high-silica highlands (“H465H”), and undivided highlands (“DH”). (C) CRISM-based summary parameters showing olivine- and phyllosilicate-bearing units (red and yellow, respectively). Panels are approximately 400 kilometers wide.

versus supplemental), and produced and packaged the necessary data sets within a dedicated GIS. A project GIS DVD containing primary base maps and relevant supplemental data sets was compiled and distributed to team members in March 2009. CTX images, THEMIS DCS mosaics, and CRISM summary parameters were subsequently added to the project GIS and will be up-

dated as necessary. In addition, we acquired the requisite agreements for conveyance of funds to cooperating institutions (Stony Brook and JHU-APL).

Geologic mapping. In order to identify the pervasively occurring geologic surfaces, onlap relationships, landforms, and units, we focused Year 1 geomorphologic and compositional mapping efforts on materials and landforms that occur within the center two quadrangles (**Fig. 1**). These quads were selected because they contain the three geologically, stratigraphically, and topographically distinct surfaces within the study region: high-standing massifs, intermediate elevation dissected plains, and low-lying plains.

Geomorphologic mapping resulted in the preliminary identification of six highland units, including a single “massif” unit, a single “intermediate plains” unit, three “low plains” units, and a channel unit (**Fig. 1A**). Of particular note, the currently identified “low plains” sequence appears to contain traceable topographic benches, which show some evidence of confinement to broad topographic warps as well as lateral thinning against older materials. Further mapping efforts and supportive topical research will investigate evidence for syntectonic deposition within the intermediate and low-lying plains. We also began mapping seven impact crater facies, in similar fashion to [8].

Compositional mapping resulted in the identification of multiple unique surfaces using both thermal and visible range spectral data sets. TES surface emissivity provided first-order spectral variability in the region, which was refined using morphology, thermophysical properties, and THEMIS DCS mosaics. These assessments led to the identification of five surface units: younger degraded plains, older degraded highlands, flat-floored craters with high thermal inertia fill, crater ejecta, and high-silica degraded highlands (**Fig. 1B**). CRISM-based summary parameters led to the identification of two pervasive surface units: an olivine-bearing unit (generally located in crater floors and low-lying plains) and a phyllosilicate-bearing unit (generally located in crater rims and ejecta deposits) (**Fig. 1C**). Generalized compositional mapping will segue into targeted spectral deconvolutions of “type surfaces” to provide key information for the delineation, description, and interpretation of geologic units.

Feature mapping. Feature mapping, including topographic features and tectonic structures, intentionally lags the identification of preliminary geologic units so as not to unnaturally bias unit delineation. The THEMIS daytime IR base map is particularly well suited to identifying geologic features at digital mapping scale (1:250,000). We began cursory examination of mappable features during unit mapping phases and noted those features that are likely to be delineated during Year 2 and 3 and incorporated into the final

map. In addition to the pervasively applied channel, ridge, and trough features, we are likely to map narrow grooves (associated with massifs), small tholi (located in low-lying plains), “albedo” boundaries (where not associated with geologic contacts), and secondary crater clusters (with parent crater, if identifiable [10]). We digitized impact craters ≥ 1 km in diameter using the USGS Crater Helper Tool, which will be used to compile crater-based relative age information and supplement map-based cross-cutting observations.

Nomenclature. The use of approved nomenclature is critical for geologic mapping because it allows succinct identification and description of units and features. Though we identified several surface features that may require a formal name (including the palus features located between large massifs), we did not submit any formal nomenclature requests during Year 1.

Exploratory mapping. We began preliminary geomorphologic mapping of the northern two quadrangles, extending the units delineated in the center two quads where possible. Where the units were sufficiently varied between quads, we noted the key variations and subdivided geologic units. Later stages of mapping are likely to result in the grouping of similar units, particularly where stratigraphic evidence is sparse. Key differences in single units will be identified in the description of map units.

Year 2 Work Plan: The second year of the project is underway and closely follows Year 1 scientific mapping tasks. The Year 2 efforts include the following:

- Collating geomorphologic and compositional line-work into a master project GIS for re-distribution
- Continuing geologic unit mapping efforts, including TES and CRISM/OMEGA spectral deconvolutions for unit type localities
- Tabulating preliminary description of map units, to include primary and supplemental characteristics as well as unit type locality figures
- Mapping of geologic features located within all six quadrangles and begin compiling feature descriptions and type locality figures
- Refining the crater data set and begin first-order crater statistics for preliminary units, as necessary
- Drafting a letter-sized manuscript describing the key units and their geomorphologic and compositional characteristics as well as their implied evolution

References: [1] Greeley and Guest (1987), *USGS I-1802-B*, 1:15M scale. [2] Crumpler and Tanaka (2003), *JGR*, 98. [3] Tanaka et al. (2005), *USGS SIM 2888*, 1:15M scale. [4] Bibring et al. (2005), *Science*, 307. [5] Bishop et al. (2007), *7th Int. Conf. Mars*, #3294. [6] Tanaka et al. (2009), *Plan. Geo. Map. Handbook, PGM 2009 abstract volume*. [7] Skinner and Herkenhoff (2010), *this volume*. [8] Skinner and Tanaka (2010), *this volume*. [9] Tanaka et al. (2010), *this volume*. [10] Nava et al. (2010), *40th LPSC*, abstract #2530.