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

**Introduction:** The highland-lowland boundary (HLB) of Mars is interpreted to be a complex tectonic and erosional transition that may hold evidence for past geologic processes and environments [1-3]. The HLB-abutting margin of the Libya Montes and the interbasin plains of northern Tyrrhena Terra display an exceptional view of the earliest to middle history of Mars that has yet to be fully characterized [4]. This region contains some of the oldest exposed materials on the Martian surface [4-5] as well as aqueous mineral signatures that may be potential chemical artifacts of early highland formational processes [6-7]. However, a full understanding of the region's geologic and stratigraphic evolution is remarkably lacking. Some outstanding questions regarding the geologic evolution of Libya Montes and northern Tyrrhena Terra include:

- Does combining geomorphology and composition advance our understanding of the region's evolution?
- Can highland materials be subdivided into stratigraphically discrete rock and sediment sequences?
- What do major physiographic transitions imply about the balanced tectonism, climate change, and erosion?
- Where is the erosional origin and what is the post-depositional history of channel and plains units?
- When and in what types of environments did aqueous mineral signatures arise?

This abstract introduces the geologic setting, science rationale, and first year work plan of a recently-funded 4-year geologic mapping proposal (project year = calendar year). The objective is to delineate the geologic evolution of Libya Montes and northern Tyrrhena Terra at 1:1M scale using both "classical" geomorphological and compositional mapping techniques. The funded quadrangles are MTMs 00282, -05282, -10282, 00277, -05277, and -10277 (**Fig. 1**).

**Regional Setting.** Physiographically, the map region extends from the Libya Montes southward into Tyrrhena Terra and to the northern rim of Hellas basin (**Fig.1**). The western Libya Montes are obscured by materials of southeastern Syrtis Major Planum, which locally forms a gentle (<1º), east-facing slope dominated by arcuate wrinkle ridges. The >1000-m-high Oenotria Scopulus extends >1500 km from Tyrrhena Terra to Syrtis Major Planum and may be an impact ring. A low-lying plain (*palus*) forms a topographic and drainage divide between Isidis and Hellas basins.

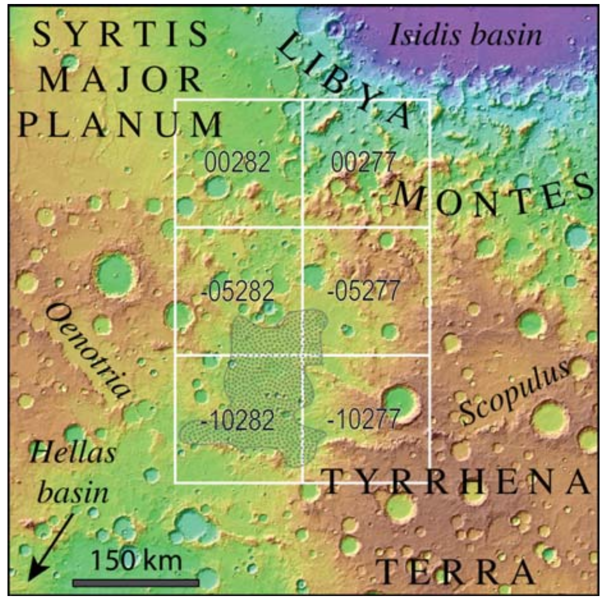


**Figure 1.** MOLA color shaded relief image showing the map region, which extends from 75 to 85ºE, -12.5 to 2.5ºN. Isidis is located to the NE and Hellas is located to the SW. Oenotria Scopulus bounds a topographic divide and unnamed *palus* (low-lying plain, delineated by stipple).

Geologically, the map region can be reduced into three geologically, stratigraphically, and topographically distinct surfaces, based on geologic contacts identified in *Viking Orbiter* images [4-5]. In stratigraphic order these are: (1) high-standing massifs (units Nm and Nplh), which constitute 28% of the proposed map area, (2) intermediate-elevation dissected plains (units Npld and Nple), which constitute 50% of the proposed map area, and (3) low-lying plains (units Hpl3, Hr, and Hs), which constitute 22% of the map area. These geologic terrains collectively represent very ancient, uplifted and eroded crustal blocks related to the Isidis and (perhaps) Hellas impacts, dissected intercrater plateaus likely composed of intercalated colluvium volcanic sequences, and depositional sedimentary plains [4-5].

**Datasets and methods.** The primary geomorphologic base map is a THEMIS daytime IR mosaic (100 m/px). Compositional base maps include regional THEMIS DCS images (100 m/px) and CRISM summary parameters (231 m/px), which will be supplemented by local TES and CRISM hyperspectral observations. Supportive datasets include hotlinked THEMIS VIS images, MOLA topography and derivatives layers, and CTX images. Higher-resolution images (including MOC NA and HiRISE) will be used intermittently to provide localized views of unit surfaces, geologic contacts, and type localities.

Mapping layers are co-registered in GIS, which serves as the digital mapping environment. Past mapping experience indicates that 1:250,000 scale is optimal for digital mapping using the THEMIS daytime IR base map. Linework is streamed using a digital map tablet or mouse with an anticipated vertex spacing of 250 meters (1 vertex/mm at mapping scale). Line attributes are assigned on-the-fly and unit polygons will be constructed and attributed periodically to allow progressive revision.

**Task Summary.** Our approach to detailing and reconstructing the geologic evolution of Libya Montes and northern Tyrrhena Terra is divided into four overlapping tasks: (1) geologic mapping, (2) compositional assessments, (3) integration and analyses, and (4) deliverable production.

*Task 1:* This task consists of 1:1M scale geomorphologic, structural, and stratigraphic characterizations within the map region. These efforts include delineation of tectonic fabrics, erosional patterns, impact crater populations (≥ 1 km), geomorphic type localities, and major cross-cutting relationships.

*Task 2:* Task 2 consists of 1:1M scale compositional characterizations using visible, near IR, and thermal IR spectral data. This task is two-fold in approach using first regional and then local observations. These efforts include delineation of compositionally-unique regional units using THEMIS multispectral and CRISM summary parameters and determining mineralogical type localities.

*Task 3:* The geologic character of the transitions between and within the Libya Montes and northern Tyrrhena Terra (including contrasts between type localities, relative ages, tectonic signatures, and compositional landforms) provide the basis for "reconstructing" the regional geologic evolution. Task 3 consists of integrating Task 1 and 2 results in order to describe type surfaces, analyze the geologic character of physiographic transitions, and place the results into a global context.

*Task 4:* The specific separation of deliverable products from other tasks helps clarify and benchmark the progress of mapping over the life of the project. Task 4, in chronological order, consists of conference presentations, a letter-size interim results publication, a paper-size type-locality and evolutionary scenario publication, a USGS Scientific Investigations Map, a paper-size HLB comparison publication, and a non-technical, popular interest USGS Circular.

**Year 1 Work Plan.** The project contains a detailed work plan that describes major milestones and personnel obligations. These plans provide a framework for benchmarking progress and will be adapted as necessary over the life of the project. Year 1 consists of managerial components, GIS and dataset construction, and preliminary mapping efforts.

*Management:* This project benefits from the inclusion of researchers from diverse backgrounds, including "classical" geomorphologic mapping (PI J. Skinner and Co-I K. Tanaka) as well as THEMIS- and CRISM-based compositional mapping (Co-I D. Rogers and Co-I K. Seelos, respectively). This project also benefits from the diverse skill sets of collaborators, including T. Hare, L. Crumpler, L. Bleamaster, and D. Crown. Year 1 management obligations have been dominated to date by project set-up responsibilities. For example, we recently secured the requisite agreements for conveyance of funds to cooperating institutions (Stony Brook and JHU-APL). Also, we held a "kick-off" meeting at the 40$^{th}$ LPSC as a means to introduce the region and Year 1 tasks, which was attended by all team members.

*Dataset Collation:* One of the first components of a geologic mapping project is the accumulation of datasets. As stipulated by PGG, the USGS Astrogeology cartography group produced a THEMIS daytime IR mosaic and MOLA DEM excerpts in the publication projection (Mars Transverse Mercator). These were included in a GIS mapping template and distributed to team members in March, 2009. In addition, CTX images, THEMIS DCS mosaics, and CRISM summary parameters are being processed and included in the GIS project. The GIS project will serve as the basis for all digitized linework and will be updated and re-distributed to the team, as necessary.

*Preliminary Mapping:* Geomorphologic and compositional mapping recently began, with initial focus on the center two quadrangles in order to identify unique surfaces. Mapping tactics, as proposed, will proceed separately as a means to maintain objectivity with approaches and datasets. Collation of results will occur at the end of Year 1 and vector information will be distributed to the team. In addition, we will digitally catalog all impact craters ≥1 km in diameter located within the quadrangle boundaries using tabulation software built by T. Hare. Finally, nomenclature updates and requests will be submitted at the end of Year 1 and each subsequent year, as necessary.

**References.** [1] Nimmo, F., and Tanaka, K.L. (2005), *Annu. Rev. Earth. Planet. Sci. 33*. [2] Tanaka et al., (2005) *USGS SIM 2888*, 1:15M scale. [3] Skinner, J.A. Jr. et al., (2007) *Icarus*, *186*, 41-59. [4] Crumpler, L.S. and Tanaka, K.L. (2003), *JGR, 98.* [5] Greeley, R. and Guest, J.E., (1987) *USGS I-1802-B*, 1:15M scale. [6] Bibring et al. (2005), *Science, 307.* [7] Bishop et al. (2007), *7$^{th}$ Int. Conf. Mars.*, abs. #3294.