GEOLOGIC MAPPING OF LOCATIONS FORMERLY KNOWN AS MSL LANDING SITES: NILI FOSSAE AND MAWRTH VALLIS, MARS. L.F. Bleamaster, III[1,2], F.C. Chuang[1], and D.A. Crown[1], [1]Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson AZ, 85719; [2]Trinity University Geosciences Department, One Trinity Place #45, San Antonio TX, 78212; lbleamas@psi.edu

Introduction. Geologic mapping at 1:1 million-scale of Nili Fossae and Mawrth Vallis is being used to assess geologic materials and processes that shape the highlands along the Arabia Terra dichotomy boundary. Placing these landscapes, their material units, structural features, and unique compositional outcrops into broad spatial and temporal context along the dichotomy (red dashed line = topographic dichotomy) and with other highland-lowland transitions (like the Hellas basin rim) (***Fig. 1***) may help to: a) constrain paleo-environments and climate conditions through time, b) assess fluvial-nival modification processes related to past and present volatile distribution and their putative reservoirs (aquifers, lakes and oceans, surface and ground ice) and c) address the influences of nearby volcanic and tectonic features on hydrologic systems and processes, including possible hydrothermal alteration, across the region and d) further evaluate the origin and subsequent modification of the Martian crustal dichotomy. The identification of broad geologic/ geomorphic units (12 map units for Mawrth Vallis and 27 for Nili Fossae; ***Figs. 2 & 3***) at scales significantly higher than previously available [1] constrain the distribution, stratigraphic position, and crater model age of units across these areas providing regional and temporal context for larger-scale and more focused studies looking at mineralogic signatures from orbit.

Data and Methods. Datasets for geologic mapping include Viking and THEMIS day & night IR basemaps, MOLA topographic data (128 pixel/deg; ~462 m/pixel), and HRSC and CTX images. Mineralogy maps are derived from CRISM and OMEGA data and have been extracted from multiple literature sources [2, 3, and references therein]. These mineralogy maps, show outcrops and deposits of olivine, pyroxene, hydrated silicate, phyllosilicates, carbonate and sulfate detections. Using GIS and digital methods, manual geo-rectification of published mineralogy is compared with the newly generated geologic maps, and crater counts provide temporal context.

Nili Fossae (MTM quadrangles 20287, 20282, 25287, 25282, 30287, 30282; ***Fig. 2***) is located west of Isidis basin and north of Syrtis Major volcano. Nili Fossae contains several regional plateau and plains sequences from the Noachian to late Hesperian as constrained by crater counts (***Fig. 2***) and several localized occurrences of landslides, alluvial fans, dunes, and dust mantles from the Amazonian. Nili Fossae itself and a series of other small curved

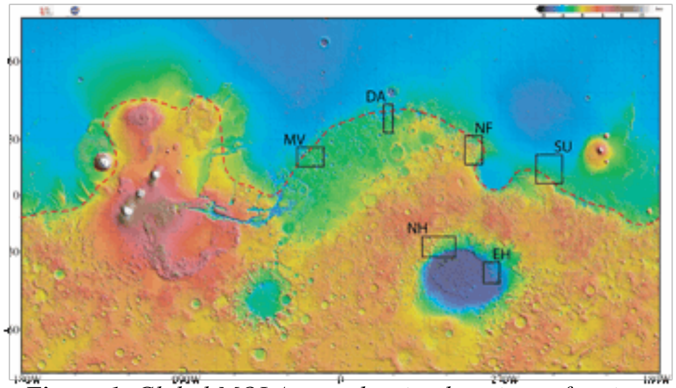

Figure 1. *Global MOLA map showing locations of various highland-lowland mapping efforts: MV=Mawrth Vallis, NF=Nili Fossae, DA=Deuteronilus/Arabia [12], EH=Eastern Hellas [13], SU=Southern Utopia [14], NH=Northwest Hellas [15].*

depressions related to the Isidis basin cut both the plateau and plains sequences revealing a window into the local stratigraphy provided they have not been completely filled with eolian deposits (particularly in the northeast portion of the trough), which mask the underlying bedrock. Minerals identified in the Nili Fossae region include: smectites, chlorite, prehnite, serpentine, kaolinite, potassium mica, high and low-FE olivine, high and low-Ca pyroxene, and traces of dunite [2]. Outcrops of phyllosilicate-bearing materials (likely Noachian in age) have been discovered by both the OMEGA and CRISM instruments; these lie mostly within the plateau sequences of the highlands, but mostly in exposures along trough walls. The presence of these phyllosilicates provides evidence for the stable presence of water for extended periods of time in Mars' ancient history. In contrast, low calcium pyroxene outcrops are also observed in the plateau sequences (brown and green units) and make up the majority of the Isidis plains unit (blue unit). These mineral signatures, if broadly correlated with morphology and geologic units may reveal a break in aqueous alteration. Lastly, many of the Amazonian surface deposits also contain phyllosilicate materials; these likely represent redistribution of previously altered and weathered rock.

Mawrth Vallis, (MTM quadrangles 20022, 20017, 20012, 25022, 25017, and 25012; ***Fig. 3***) is one of the oldest preserved outflow channels on the surface of Mars. This sinuous channel cuts across the western surface of the Arabia Terra plateau and is a possible manifestation of past catastrophic outflow of a subterranean aquifer or persistent groundwater sapping. Few bed forms are preserved indicating the channel has undergone significant modification since its formation. There are three primary units along and within Mawrth Vallis: the Noachian cratered terrain, Hesperian channel floor materials, and Amazonian deposits near the northwest boundary of the channel.

Three principal clay types are present: Fe, Mg, and Al-rich smectites. The Al-rich phyllosilicates, in the form of montmorillonite clays, are located in eroded light-toned outcrops along the flanks of Mawrth Vallis [4]. The Al-rich unit is minimally hundreds of meters thick [4, 5, 6], layered down to the meter-scale [4-8] with moderate thermal inertia signatures [5, 6], and eroded into knobby and flat mesa-like cliff forms [7, 8], typical of the dark blue map unit. In some locations along the walls of Mawrth Vallis, the Al-rich unit appears to lie stratigraphically between Fe or Mg-bearing smectite units (e.g., nontronite) [8, 9]. A transitional unit with spectral signatures of both Al-bearing and Fe/Mg clays is also observed. The Al-bearing unit has meter-scale polygonally fractured surfaces while the darker-toned Fe/Mg-bearing clay units have larger polygonal surfaces that are tens of meters wide [5, 10]. These surfaces may have formed as a result of thermal and/or desiccation contraction [5, 10]. Other dark-toned materials present throughout the region are identified as pyroxene-rich materials (i.e., basaltic sand and dust) that mantle the surface (and clay-bearing units) [6, 8, 9]. The presence of clays in Mawrth Vallis is important as they imply a past aqueous environment in this region of Mars. It is argued that the clay-bearing units were formed early in the history of Mars (also prior to the formation of Mawrth Vallis) as aqueous deposits of sedimentary or pyroclastic materials, or a combination of both [4-11].

References: [1] Greeley and Guest (1987) USGS Geo. Inv. Ser. Map 1802-B. [2] Ehlmann et al., (2009) JGR 114, doi:10.1029/2009JE003339 [3] Noe Dobrea et al., (2010) JGR 115, doi:10.1029/2009JE003351 [4] Poulet et al. (2005) Nature 438, 623-627; [5] Loizeau et al. (2007) JGR 112, doi:10.1029/ 2006JE002877; [6] Michalski and Fergason (2009) Icarus 199, 25-48; [7] Bibring et al. (2006) Science 312, 400-404; [8] Michalski and Noe Dobrea (2007) Geology 35, 951-954; [9] Bishop et al. (2008) Science 321, 830-833; [10] Wray et al. (2008) GRL 35, doi:10.1029/ 2008GL034385; [11] Howard and Moore (2007) LPSC 38, abstract #1339; [12] Chuang and Crown (2009) USGS SIM #3079; [13] Bleamaster and Crown (2010) USGS SIM #3096; [14] Skinner and Tanaka (2010) Ann. Meet. Plan. Geo. Mappers, abstract p. 42; [15] Crown et al., (2010) Ann. Meet. Plan. Geo. Mappers, abstract p. 26.

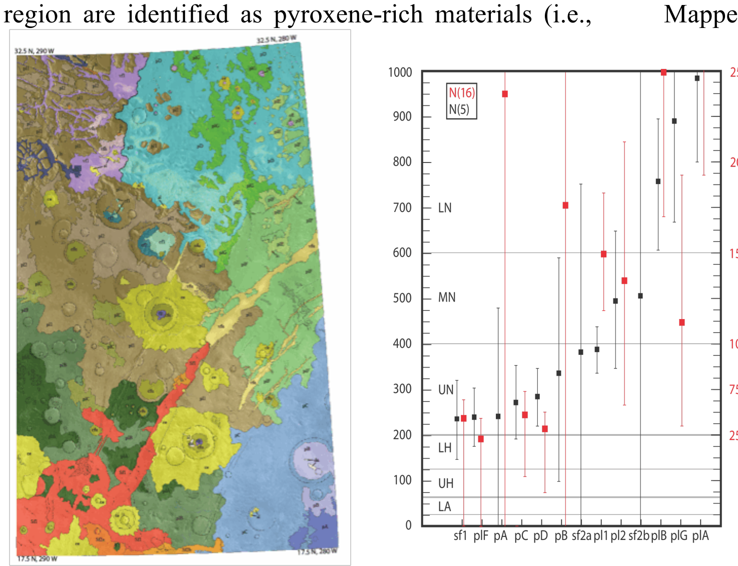

Figure 2. Nili Fossae (left). Current mapping and cumulative crater count (N5 and N16) of spatially significant map unit

Figure 3. Mawrth Vallis (below) Current mapping and cumulative crater count (N5 and N16) of spatially significant map units.