EVIDENCE FOR AN ANCIENT BURIED LANDSCAPE ON THE NW RIM OF HELLAS BASIN, MARS.

David A. Crown[1], Leslie F. Bleamaster III[1], Scott C. Mest[1], John F. Mustard[2], and Mathieu Vincendon[2], [1]Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719; crown@psi.edu, [2]Dept. of Geological Sciences, Brown University, Providence, RI 02912.

Introduction: Hellas basin is the largest (2000+ km across) well-preserved impact structure on Mars and its deepest depositional sink [e.g., 1]. The Hellas rim and adjacent highlands are of special interest given the possibility of paleolakes on the basin floor [2-4], recent studies of potential localized fluvial/lacustrine systems [2, 5-17], and evidence for phyllosilicates around and within impact craters north of the basin [18-26].

We are producing a 1:1.5M-scale geologic map of eight MTM quadrangles (-25312, -25307, -25302, -25297, -30312, -30307, -30302, -30297) along Hellas' NW rim. The map region (22.5-32.5°S, 45-65°E) includes a transect across the cratered highlands of Terra Sabaea, the degraded NW rim of Hellas, and basin interior deposits of NW Hellas Planitia. No previous mapping studies have focused on this region, although it has been included in earlier global and regional maps [27-29].

Geologic Mapping of NW Hellas: Mapping of the NW Hellas rim initially involved production of geologic maps of two subregions of the larger map area in order to establish a scheme for delineation of geologic units. Research related to the geologic mapping investigation [30-34] has included general terrain characterization, evaluation of geomorphology and stratigraphic relationships, exploration of compositional signatures using CRISM, and investigation of impact crater distribution, morphometry, and interior deposits. These analyses are providing new constraints on the magnitudes, extents, and history of volatile-driven processes as well as a geologic context for mineralogic identifications.

Mapping Results: NE Subregion. Geologic mapping of the NE subregion (22.5-29°S, 57.6-65°E) characterizes the Terra Sabaea plains zone, interpreted to be a depositional shelf formed subsequent to degradation of rugged highland terrain adjacent to the basin rim [30-34]. Terra Sabaea plains are found at elevations intermediate (-1800m – 500m) to those of the highlands of Terra Sabaea proper and the steeper basin rim zone. Eastern Hellas exhibits evidence for widespread deposition at similar elevations, potentially associated with flooding from Reull Vallis, large paleolakes within Hellas, and/or accumulation of atmospheric volatiles due to circulation patterns off of the south pole [e.g., 2, 4, 35-36].

Surface materials in the NE subregion can be divided into the following types: highlands, smooth plains, crater materials, and crater floor deposits. Subunits within both the highlands and plains may be defined as mapping continues; the plains in particular display significant brightness variations in THEMIS IR images. Small valleys dissect plains surfaces and are concentrated on sloping plains deposits at the margins of highland outcrops. Detailed mapping of this sub-region has resulted in identification of more irregular depressions than were found initially [30]. In some cases, the scarps defining these depressions reveal finely layered outcrops. The occurrence of the irregular depressions and layered outcrops in both crater floor deposits and within the plains may indicate emplacement of sedimentary units on a regional scale. Mapping shows an eroded and extensively buried ancient highland landscape, with partial exhumation indicated by etched surfaces and retreat of plains around eroded massifs and crater rims [32-33].

Mapping Results: NW Subregion. Geologic mapping of the NW subregion (22.5°-30°S, 45-50°E) characterizes the highlands of Terra Sabaea, which typically are found at elevations above 500m and exhibit numerous impact craters with various sizes and degradation states. Irregular depressions exposing layered deposits have been identified in crater interiors [30-34]. This region is located at higher elevations and contains generally larger impact craters with extensive ejecta deposits relative to the NE subregion, and, in general, resembles a typical highland terrain. However, closer inspection during detailed mapping reveals that the units defined for the NE subregion also characterize the surface geology of the NW subregion. MRO Context Camera (CTX; ~5 m/pixel) images show evidence for burial and partial exhumation of what appear to be relatively well-preserved crater rim and ejecta materials (e.g., 24.9°S, 46.1°E) in lower resolution images. CTX images also show that variations in brightness of plains materials seen in THEMIS IR images can be attributed to differential removal of layered sequences. These geologic characteristics are consistent with burial of ancient cratered terrain extending to the higher elevations of Terra Sabaea.

Correlation of CRISM Mineralogy to Geologic Mapping. We are analyzing CRISM multispectral data for the NW Hellas map area for phyllosilicates and Fe-bearing silicates, including smectite, chlorite/prehenite, pyroxene, and olivine. Mineralogic signatures typically consist of 10s to 100s of pixels grouped together in a localized area. We are examining the distribution of specific compositional signatures to search for correlations with geologic map unit, physiographic setting, elevation, local topography, local geomorphic setting, and the presence of dark deposits.

Fe/Mg smectites are identified in CRISM data by the presence overtones and combinations tones of vibrational absorptions due to water, OH, and coordinating cations near 1.9 and 2.3 µm. Pyroxene and olivine are identified by the presence of ferrous crystal field absorptions between 1 and 2.5 µm and a lack of vibrational overtone bands. We use spectral parameters [26] calculated from the CRISM multispectral mosaics to identify locations of mineral-bearing outcrops. Each occurrence is then validated by examining representative spectra of the occurrences and comparing to library spectra. Spectral ratios are generated to better isolate the mineral absorption features.

From examining the locations of smectite and chlorite/prehenite across the entire map region and for olivine within the NW mapping subregion, we observe that mineral signatures are most abundant in the Terra Sabaea plains zone (-1800m – 500m), common in the Terra Sabaea highlands (above 500m), rare below elevations of -3100 m in the Hellas rim zone, and absent from the floor of Hellas basin. Chlorite/prehenite identifications are much less frequent than the other mineral signatures and are strongly associated with remnants of the highlands found in the Terra Sabaea plains zone. Pyroxene exposures are more numerous and larger in size at the higher elevations of the Terra Sabaea highlands zone than in the Terra Sabaea plains, where they are also found in significant numbers. In comparison, olivine is more evenly distributed across the plains and highlands. There are no obvious correlations between mineralogic signature and geologic map unit, although there are typical settings in which mineralogic signatures most commonly occur. In addition, there are a series of locations within the map area that exhibit exposures of smectite, olivine, and pyroxene. These typically occur in deposits associated with degraded crater rims.

Conclusions: Geologic mapping and investigations of impact craters on the NW Hellas rim [30-34] show evidence for crater infilling and regional resurfacing along with widespread occurrences of phyllosilicates and Fe-bearing silicates in association with highland remnants, including depressions formed by retreat/erosion of plains. The NW Hellas region preserves the record of an extensively buried landscape with sedimentary deposition that extended beyond the topographic margin of Hellas basin and well into the surrounding highlands.

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