GEOMORPHOLOGIC MAPPING AND MINERALOGY OF PITS IN INTERCRATER PLAINS, NORTHWEST CIRCUM-HELLAS REGION, MARS. F. C. Chuang, E. Z. Noe Dobrea, S. C. Mest, and D. A. Crown, Planetary Science Institute, 1700 E. Ft. Lowell Road, Suite 106, Tucson, AZ 85719 USA (chuang@psi.edu).

Introduction: The circum-Hellas region has received much attention due to the area's potential for past habitable conditions on Mars. In particular, there is evidence for both marine/lacustrine [1-3] and hydrothermal systems [4] around Hellas sometime after its formation. Regional spectroscopic studies of Hellas [5,6] support the interpretation for aqueous activity by providing evidence for phyllosilicates and sulfates associated with geological features on and near the rim of Hellas [7-9]. Evidence has also been found for hydrothermally-altered products on plains near Hellas [8] and in the circum-Hellas region [9].

Although recent studies have surveyed regions for aqueously-altered minerals near Hellas, the abundance of high-resolution data from the Mars Reconnaissance Orbiter mission now permits detailed studies to link mineralogy with specific geomorphic units in a stratigraphic context. Tracing the stratigraphic relationships of units across the region is important in constraining the sequence of past aqueous processes over time. This type of analysis may potentially reveal the geologic setting, timing, pH level, and chemistry of aqueous processes during a period or periods in Martian history when conditions were favorable to the development of life.

NW Circum-Hellas Landforms: The circum-Hellas region has experienced significant modification by a host of processes, producing a diverse range of geological environments and landforms [10-15] since basin formation ~3.9 Ga [16]. Among the various landforms, three are particularly distinct: hills and massifs, intracrater layered deposits, and pitted intercrater plains. These landforms also characterize several major geologic units defined in zones around NW Hellas including Terra Sabaea highlands, Terra Sabaea plains, and Hellas rim and floor materials [3,8].

The formation of Hellas produced an arcuate zone of hills and massifs beyond the basin floor to the NW that may include remnants of ejecta from the impact, and uplifted and tilted blocks of Martian crust. These features also exhibit zones of hydrothermal alteration [9]. Many craters in the circum-Hellas region (e.g. Niesten, Terby, and Millochau) have thick (hundreds of meters) layered deposits that are exposed within the walls of large depressions or along plateau slopes [1,17]. In Terby crater, layered deposits appear to be composed of hydrated materials including Fe/Mg phyllosilicates and possible sulfates [7, 18-20].

The circum-Hellas region also exhibits abundant evidence for erosion and removal of materials in the intercrater plains [8]. These occur in pits, or irregular depressions by [3]. A total of 39 irregular depressions, 17 within intracrater deposits and 22 within intercrater plains were identified in an area between 45°-65° E and 22.5°-32.5° S [3]. The pits provide windows into the history of the upper crust and(or) the depositional processes of the materials that infilled the plains. Here we present detailed mapping of geomorphologic units within one of these pits along the NW circum-Hellas rim.

Data and Methods: Geomorphologic mapping was performed digitally using ArcGIS 10.2.2 software. All mapped geomorphologic units were stored as mapped polygons. A host of raster data was used in this study, including 100 m/pixel Thermal Infrared Emission Imaging System (THEMIS) day IR global base mosaic, 5-6 m/pixel Context Camera (CTX) images, 0.25-1 m/pixel High Resolution Imaging Science Experiment (HiRISE) images, and 36 m/pixel Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) images. CTX, HiRISE, and CRISM data products were manually geo-registered to the THEMIS base mosaic prior to mapping.

Mapping Site and Results: Our mapping is focused on a pit (54.3° E, 26° S) within an area defined as the Terra Sabaea plains zone (500 m to -1800 m elevation) [11]. Impact craters in this zone have a range of preservation states: partially to completely buried, preserved to exhumed ejecta blankets, and heavily modified rims that are in some cases, completely eroded [21]. These observations, along with fluvial dissection by valleys and high THEMIS day IR values (indication of coarse-grained material) [11] suggests that sedimentary deposition was a significant process in this region.

Geomorphologic Units. We have mapped eight units using morphology and superposition relationships observed in CTX images (Figure 1). Three units are interpreted to be flow deposits (*flow1, flow2, flow3*) with the sediment source coming from a large braided channel that ends at the southwestern edge of the pit. A fourth possible flow deposit (*flow*) with an unknown source, lies on the west corner of the pit. Two pit units are observed with one possibly being exhumed pit floor materials (*pit*) and the other a possible combination of unconsolidated debris shed from adjacent higher-standing flow units and(or) fill units. Two fill units are present throughout the pit (*fill1, fill2*) and are likely to be the original accumulated sedimentary material that has filled the crater and the pit in NW circum-Hellas.

The youngest flow unit, *flow3*, appears relatively smooth with a small fan-like terminus and was deposited on top of the larger, smoother *flow2* unit that also appears to have a fan-like terminus. The *flow3* deposit may have been once connected to the channel, but the section closest to the pit edge later collapsed into the pit. Towards the eastern half of the pit, the *flow2* unit has either been eroded and removed, only partially covered the pit floor when deposited, or a combination of both (see Fig. 1). In HiRISE images, exposures of light-toned layers occur in places along the edge of the *flow2* unit. Below the *flow2* unit, in descending order, is *flow1* and exposed *pit* materials. A field of ripples are observed on the *flow2* unit down to the flow1 unit, and further onto the pit unit, indicating gentle topography between these three units. Both *flow3* and *flow2* units are likely late-stage fluvial deposits that occurred after widespread NW circum-Hellas sediment deposition and exhumation of the pit.

Of the two fill units, *fill2* forms a cap on *fill1* and its surface texture appears rough and cratered, similar to the plains outside the pit. CRISM detections of interpreted chlorite-smectite mixed-layers correlate well with light-toned materials on *fill1* slopes and outcrops. *Fill1* units also have patches of cracked, light-toned polygonally-shaped surfaces, but most of these do not have as strong chlorite-smectite signatures. In general, the correlation of CRISM spectral signatures and light-toned exposures is spotty, likely due to noise and coarseness of CRISM data relative to HiRISE/CTX-scale features.

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Figure 1. Map of geomorphologic units in intercrater plains pit. Large braided channel from the west provides a sediment source for two depositional flow units (flow3 and flow2). Two fill units (fill1, fill2) are present in the pit with fill2 forming a cap on fill1 materials. 10 km wide impact crater along the southern edge of the pit is filled with material similar to the surrounding plains. Background composed of 5-6 m/pixel CTX images.