PROGRESS ON GEOLOGIC MAPPING IN THE SOUTHERN UTOPIA BASIN. H. C. Buban and C. H. Okubo, Astrogeology Science Center, U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001, (hbuban@usgs.gov).

Introduction: The southern Utopia basin of Mars is home to landforms that are commonly referred to as pitted cones, and whose origin is currently unknown. Geologic mapping is ongoing in this area to try and understand the formation and complex geologic history of these cones. Here, we present the status of the map components and initial findings based on the map.

Background: Pitted cones occur in large numbers in the Utopia basin and northern lowlands but are also found in other sedimentary basins and chaotic terrains across Mars. Previous investigations have found these pitted cones to be either pingoes [1], pyroclastic cones [e.g., 2,3], or mud volcanoes [e.g., 3,4]. These cones are thought to provide insight to the complex Martian geologic history when they are believed to have formed in Late Hesperian to Early Amazonian. Regional geologic mapping in this study could lead to more certain time constraints and better understanding of the conditions on the Martian surface when these cones were created.

The study area for this mapping project is the southern Utopia basin, approximately 3,000 km east of Olympus Mons. In 2016, Okubo et al. [5] identified an area of interest where multiple types of pitted cones and rifting appeared to form concurrently with the surrounding Vastitas Borealis Formation (VBF), and interpreted that the cones in this area were formed by sedimentary processes, not igneous or periglacial as has been interpreted in the past.

Data & Methods: A 1:150,000 scale geologic map is in progress. Contacts have been traced on a controlled CTX basemap with MOLA DEM and hillshade, THEMIS day/night IR, and HiRISE supplemental images. A digitizing scale of 1:30,000 with a vertex spacing of 30 m was used to create geologic contacts.

Over 500 cones with a diameter greater than 500 km have been mapped in the study area. Cones that have a diameter of 100-499 m will be mapped as point features.

Following mapping guidance from the USGS Planetary Geologic Mapping (PGM) group [6], craters have been delineated at the rim (d=450-750 m) or circled and included in the surface features (d>700 m). The largest crater in the mapping area has a diameter of 2.11 km and has some ejecta present and a small central peak- like structure. Two old and highly modified circular features are found in the map area and are probably rims and/or ring structures from ancient craters.

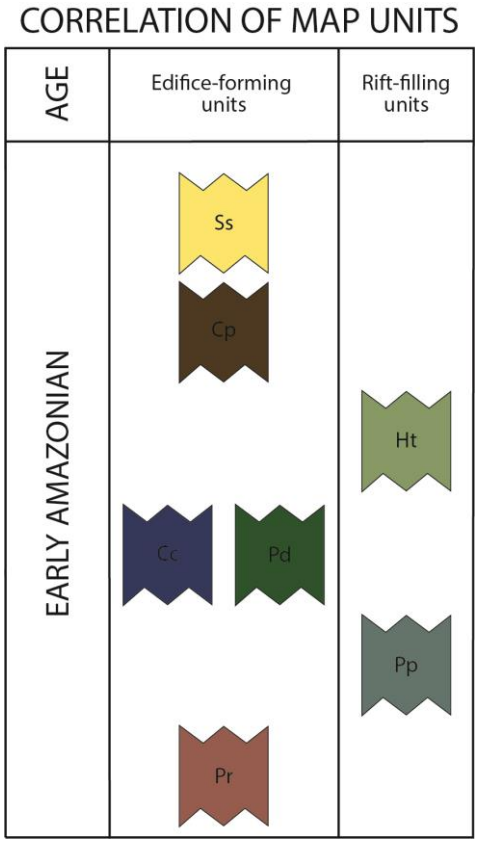

Figure 1- Current version of the correlation of map units (COMU) for the study area.

Results: Seven geologic units have been identified in the area (Figure 1). The units vary in type from positive relief features like promontories (unit Pr), cones (Cc), and domes (Pd), to a gently undulating and lobate unit with narrow arcuate ridges (Ss). The latter is the largest unit identified in this study, covering 82% of the mapping area.

Three types of cones have been identified in the mapping area: cratered cones, pitted domes, and cratered pancakes (Figure 2). Most of these cones occur within the rift filling units, although some cratered coned and pitted domes can be seen showing through the thinner margins of the Ss lobes.

The geologic history of this area is not yet finalized, but our preliminary assessment includes the following: 1) formation of mesas along highland/lowland boundary (Pr) accompanied by extension and spreading, 2) formation of sedimentary unit Pp through subsurface sediment mobilization, 3) eruption of fluid-rich sediments through cones (Cc) and domes (Pd), 4)

spreading and rifting of Pp unit through extension, Pp unit broken apart and surrounded by fluid-rich sediment (Ht) that contains low-lying cones (Cp), 5) eruption of large amounts of fluid-rich sediment, possibly through vents and fissures, covering many areas of older units.

The map, seen in Figure 3, is currently undergoing minor edits before the final version is ready for submission to the USGS Planetary Geologic Mapping group. The current COMU is shown in Figure 1. Based on the observations from mapping, we propose that the cones and rifts are intrinsic properties of the VBF and were not caused by post-depositional, exogenic processes. This further establishes the interpretation that subsurface sediment slurries were a driving factor in the evolution of the Martian landscape during the Late Hesperian to Early Amazonian.

Summary: Mapping in this area of the Utopia basin continues to support the interpretation put forth by Okubo et al. [5] that pitted cones and rifting of materials occurred during the formation of the VBF and are not caused by external, post deposition processes. This finding can help further constrain the time of formation for similar features found in other basins across the surface of Mars.

Next Steps: The next steps for this project are as follows:

- continue to make edits to the 1:150,000-scale geologic map
- finalize DOMU, COMU, and geologic history
- work on map text
- conduct crater counting to better constrain age of units

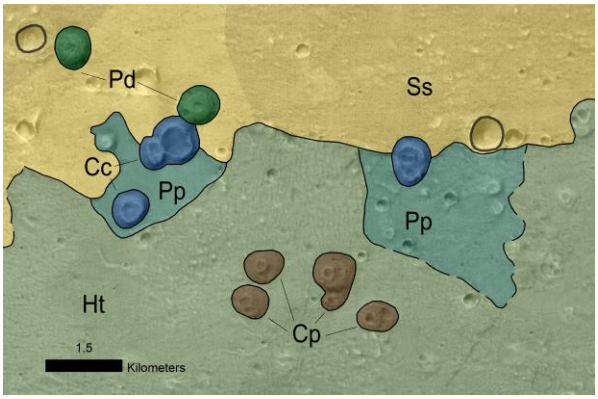

Figure 2- Example of the three types of cones found in mapping area: pitted domes (Pd), cratered cones (Cc), and cratered pancakes (Cp). Approx. 95.5’ E 30.8’ N.

References: [1] de Pablo M. and Komatsu G. (2009) *Icarus*, 199, 49–74. [2] Brož P. and Hauber E. (2013) *JGR*, 118, 1656–1675. [3] Brož P. et al. (2015) *JGR*, 120, 1512–1527. [4] Komatsu G. et al. (2016) *Icarus*, 268, 56-75. [5] Okubo C. H. et al. (2016) *LPS XLVII* Abstract #1334. [6] Huff A. E. et al. (2020) *PGMM* Abstract #7046.

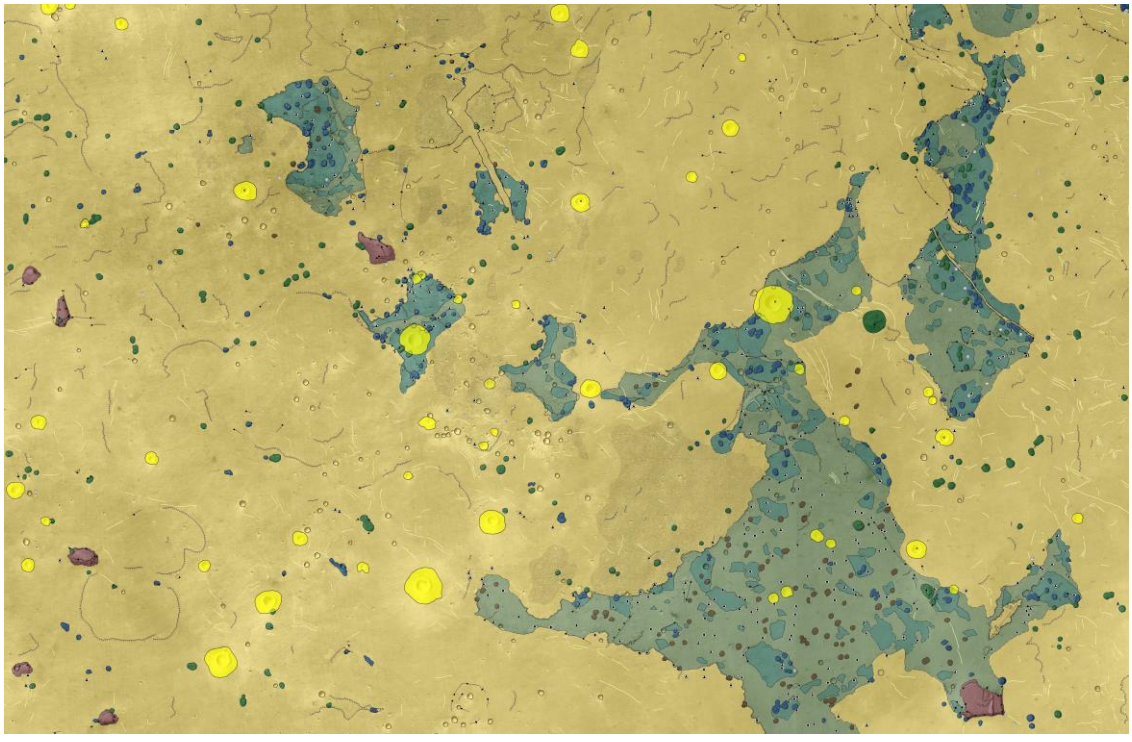

Figure 3- Current version of the geologic map. All units, contacts, linear features, surface features, and location features are shown. Approx. 94.1 to 96.8’ E, 30.5 to 32’ N.