STRATIGRAPHIC SECTIONS OF CENTRAL HADRIACUS CAVI, MARS. M. L. Barton[1,2], J. A. Skinner, Jr.[2], and C. M. Fortezzo[2]. [1]School of Earth Sciences and Environmental Sustainability, Northern Arizona University, Flagstaff, AZ, 86011. [2]Astrogeology Science Center, U. S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ, 86001 (mbarton@usgs.gov).

Introduction: Hadriacus Palus and Cavi are located along the northeast rim of the Hellas basin in the Martian cratered highlands. The cavi are a series of irregularly-shaped depressions that expose a sequence of alternating light- and dark-toned layers. These strata provide a glimpse into very ancient geologic processes that filled basins located between potentially Hellas-uplifted topographic promontories during the Middle Noachian [1-3]. The geologic and stratigraphic architecture of Hadriacus Cavi is being mapped at 1:24,000 scale using standard photogeologic mapping techniques as well as local stratigraphic sections [4]. Current geologic mapping identifies four major rock groups in the study area: (1) a stratigraphically lower, mostly massive, dark-toned "basal" group (80-180 m thick), (2) a stratigraphically intermediate, mostly stratified, light- and dark-toned "cavi" group (60 to 80 m thick), (3) a stratigraphically higher, mostly massive, light-toned "mons" group (120 to 150 m thick), and (4) a superposing (and possible interfingering) massive to stratified, light- and dark-toned "palus" group (80 to 140 m thick). Herein, we summarize the approach used to construct map-supportive stratigraphic sections as well as the complications involved in their representation, analysis, and correlation. This abstract focuses exclusively on sections located within the "cavi" group, which are the most laterally continuous and consistently stratified rocks in the study area. Details of other mapped groups and their history is provided by [4].

Data and Methods: The stratigraphic relationships in central Hadriacus Cavi were documented using one stereo-derived 1.5 m/post HiRISE DTM (centered at lat -27.31°N, long 78.03°E) and the accompanying 0.5 m/pixel ortho-rectified image. Lines representing the sections were drawn and measured using Esri's ArcGIS software package. The 3-D Analyst tool was used to create an interpolated line, and from that, a profile graph was created to get a better topographic view of the sections. Locations were chosen based on the exposure of strata. Though uniform spacing between sections along the cavi wall was preferred, this was not possible due to the occurrence of thick mantles. The lat/long and elevation of both the top and bottom of the sections were recorded and, from that, an overall thickness of the section was defined. This same method was applied to each of the subunits within each section, which were characterized by tone (light and dark), texture (mantled, pockmarked, cratered, polygonal, brecciated, and fractured), and the presence of unique geologic features (columnar joints, conjugate joints, and channel-form features). Differentiation of subunits is complicated by apparent gradation from one tone or texture to another, the occurrence of multiple geologic features within one presumed subunit, and obscuration of definable characteristics due to surficial mantling. Tones and textures were placed within the sections, while triangles that indicate the top and bottom of scarps, and geologic features such as columnar joints, channel forms, and weak sub-meter layering are placed in the margins. We developed a schematic approach to assigning and representing subunits in section (**Fig. 1**) using trial-and-error tests that focused not only on the dominance of particular characteristics (mostly tone) but also reproducibility.

Results: We documented the characteristics of a 60- to 80-m-thick section of "cavi" group strata in 25 locations throughout the study area. All sections compiled thus far depict details of "cavi" group subunits from "layer zero" (an informal reference surface that occurs throughout Hadriacus Cavi and is located directly beneath the "mons" group) down to the cavi floor (defined as the top of the "basal" group), or until obscured by dark-toned mantles (*i.e.*, colluvium, dunes, or non-duneform sand sheets). We note that our section construction methods do not yet account for the 2-6° NNW dip that is recorded for the "cavi" group [4]. Though there are variations in thickness and stratigraphic location, the subunits exposed within the "cavi" group are predominately arranged as described below, from top to bottom (**Fig. 1**).

Layer zero subunit. Pockmarked and/or undulating horizontal surface that forms a notable scarp along the cavi margins. Mostly comprised of dark-toned layers weak stratification, and mottled outcrop surface. Subunit erosion supplies dark-toned material that mantles subjacent, often light-toned surfaces.

Alternating light and dark subunit. Light- and dark-stratified subunit that commonly outcrops beneath layer zero subunit and bounds the channel-form subunit. Smooth, slope-forming, and mantled outcrop surface. Stratification strong to weak with variable thickness.

Channel-form subunit. Light-toned, mostly massive, often mantled subunit that contains asymmetrical lenses with flat tops (13 to 183 m wide) and parabolic bottoms (2 to 10 m deep) [5].

Polygonal subunit. Light-toned with interlocking meters-wide polygons that are generally similar in size and hexagonal shape. Forms slopes and scarps.

Columnar jointed subunit. Typically light- and dark-toned subunit that occurs near the bottom of most sections within the "cavi" group. Smooth and undulating, slope- and scarp-forming outcrop surface. Scarps display columns between 5 and 10 m in length.

Brecciated/jointed subunit. Light-toned subunit that consists of meter- to decameter-scale angular (not hexagonal), non-interlocking blocks separated by dark-toned material. Often obscured by dark-toned mantle.

Discussion: Stratigraphic sections of Hadriacus Cavi are proving critical for providing important vertical and horizontal details that cannot be depicted in our 1:24,000-scale geologic map. The sequence of subunits exposed in the "cavi" group, which makes up the bulk of the cavi walls in the study area, have broadly consistent characteristics at local scale. Yet, we observe subtle vertical and horizontal variations that likely document changing depositional environments. The "cavi" group is characterized by both mostly massive and mostly stratified subunits. Massive units are predominantly composed of light-toned subunits. In general, the dark-toned units consist of friable slope-forming material that is easily eroded and typically found mantling lighter-toned, subjacent subunits. The light-toned units appear to be more resistant to erosion and constitute a greater portion of the cavi stratigraphy.

Despite their critically informative nature, there are many complications associated with constructing local stratigraphic sections using high resolution, gray-scale images and DTMs alone. Lighting and shadow make it difficult to distinguish actual versus apparent tone of the various subunits. Tone is the primary property used to separate units, but mantling can obscure lighter-toned units making them appear slightly darker. We found that applying a simplified set of schematic units was not only more succinct and reproducible but also more beneficial for the overall correlation of sections. As such, we avoided use of "intermediate tone" and relied instead on light tone and dark tone subunit characteristics. Aside from tone, texture and geologic features also proved challenging to distinguish from one another and represent in section as these often overlap. Some subunits contain tight interlocking, multi-sided polygons while others contain non-interlocked polygons separated by dark-toned interstitial material. Though both characteristics commonly occur in bright-toned subunits, distinct differences between polygon size, shape, and interconnectedness led us to separate these using differing section symbols. A simplified classification process proved to be the best method when separating the units based on these characteristics, but required interpretation, and thorough annotations to assist with reproducibility.

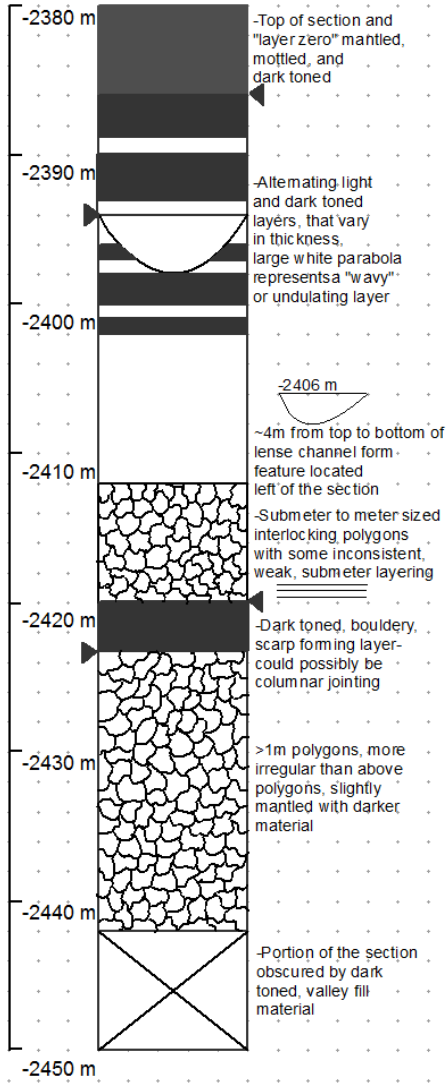

Figure 1. Example of a schematic stratigraphic section for the "cavi" group located on a SW-facing cavi wall between -2444 and -2385 m elevation. Interior symbols are defined and restricted based on dominant tone or texture. Marginal comments and symbols provide additional detail, particularly where characteristics overlap.

References: [1] Tanaka, K. L. et al. (2014) *USGS SIM 3292*, 1:20M scale. [2] Skinner, J. A., Jr. et al. (2015) *LPS XLVII*, Abstract #2806. [3] Skinner, J. A., Jr. et al. (2016) *Annual PGM Meeting*, Abstract #7041. [4] Skinner, J. A., Jr., et al. (this volume). [5] Barton, M. L. et al. (2015) *LPS XLVII*, Abstract #2833.

Acknowledgements: This work was supported by NASA's PG&G Program award No. NNH1AU831.