HIGH-RESOLUTION GEOLOGIC MAPPING IN EAST CANDOR CHASMA: 2016 STATUS REPORT. C. H. Okubo, US Geological Survey, 1541 E. University Blvd., Tucson, AZ 85721, cokubo@usgs.gov.

Introduction: This abstract summarizes current results and planned activities from an ongoing initiative to construct a series of high-resolution structural and geologic maps in the east Candor Chasma region of Valles Marineris, Mars.

The goal of this work is to advance current understanding of the coupled structural evolution of east Candor Chasma and the sedimentary deposits within it through a campaign of geologic unit and structural mapping at spatial resolutions that are at least an order of magnitude finer than has been achieved by previous studies in this part of Valles Marineris. This will be accomplished by characterizing the structure of the sedimentary deposits using digital elevation models (DEMs) derived from publicly released, stereo image pairs acquired by the High Resolution Imaging Science Experiment (HiRISE) camera.

As originally proposed, mapping in east Candor Chasma would focus on three separate areas (Fig. 1). Work on the original north Nia Mensa map area is now complete, and mapping in the southeast Nia Mensa map area has begun. For reasons explained below, work on the south Juventae Mensa map area has been canceled in order to support mapping in an expanded north Nia Mensa map area.

Current results from the north Nia Mensa map: Completed mapping in this area was based on two HiRISE stereo pairs (ESP_014154_1730/ ESP_014431_1730 and ESP_031916_1730/ ESP_031982_1730), which were used to create one merged digital elevation model (DEM) and to orthorectify the associated HiRISE images. This map area encompasses the contact between the massive sedimentary rocks that comprise most of Nia Mensa and the stratified sedimentary and mass-wasting deposits exposed between Nia Mensa and the north wall of east Candor Chasma (Figs. 1 & 2). The area also contains a stratified fan-like deposit that appears to be sourced from, and post-date the sediments that constitute, Nia Mensa.

Here are key findings from the mapping:

1) The strata within the fan-like deposit are found to dip outward at $< \sim 10°$, away from its morphologic apex, consistent with an origin as a depositional fan (rather than being carved into a fan shape by erosion). Whether this fan has a subaerial or submarine origin has not yet been determined.

2) The map area shows evidence of soft-sediment deformation in the form of clastic dikes and contorted bedding. These findings indicate that these deformed sediments were poorly consolidated and water saturated at the time of deformation.

3) The strata hosting the soft-sediment deformation shows evidence of kilometer-scale doming and uplift. Further, the northern section of the map area encompasses part of a fractured rise, and deposits interpreted as mud flows mantle the top of this rise. Inferred flow directions of these mud flows suggest that the mud erupted out of these fractures.

Taken together, the kilometer-scale doming and uplift, the fractured rise, mud flows and clastic dikes are consistent with past sediment mobilization processes within the subsurface. On Earth, water-saturated, poorly consolidated strata at depth became mobile through processes such as liquefaction driven by seismicity, tectonic compression, gravity-driven compaction, hy-

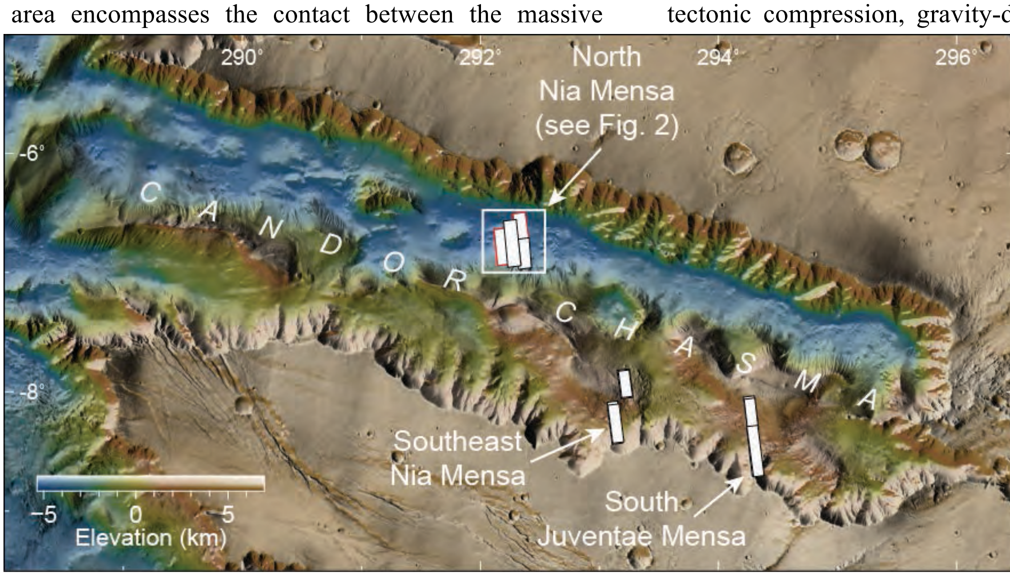

Figure 1. *Locations of the maps discussed in this abstract. Background is a colorized MOLA DEM merged with a THEMIS daytime infrared mosaic.*

drocarbon generation, dehydration of clay minerals, hydrothermal activity and sediment diapirism [e.g. 3]. Similar processes, with the likely exception of hydrocarbon generation, may have contributed to the mobilization of subsurface sediments in the map area. In this way, the kilometer-scale doming and uplift and the fractured rise may be evidence of the diapiric rise of mobilized subsurface sediments [c.f. 1], and the mud flows may record the eruption of these sediments onto the ground surface.

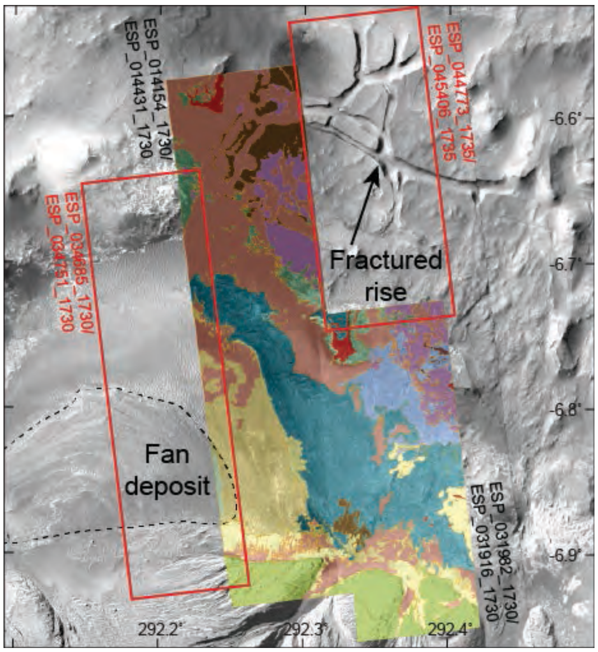

Figure 2. *The north Nia Mensa map area showing the area mapping where mapping is complete (colored) and new areas to be added later this year (red boxes).*

These findings place needed constraints on the depositional environment of the sediments that comprise the local stratified bedrock. The inferred fan deposit indicates that lateral transport was a component in the depositional history of these sediments. Therefore the sediments did not form entirely as a mantling deposit, such as air fall ash or sediments settled out of a water column. The soft-sediment deformation and subsurface mobilized sediments indicate that groundwater was present in the area after deposition of the sedimentary bedrock, but before its lithification.

Further, evidence for subsurface sediment mobilization has significant astrobiologic implications. In terrestrial sedimentary basins, the mobilization of subsurface sediments is recognized as a common and significant process that acts to enhance, impede or otherwise alter local patterns of fluid migration and storage within the subsurface. The patterns of fluid flow established by mobile subsurface sediments can be areally extensive and persist for millions of years and therefore have a substantive impact on hydrologic, geologic and biologic processes within the surrounding environment. Due to their sustained flux of fluids, centers of mud flow eruption on Earth (a.k.a. "mud volcanoes") are oases for bacterial and archaeal communities [e.g. 3]. Therefore, mud volcanoes and their subsurface feeder systems of mobilized sediments are important sites for investigating the geologic processes that could have supported past habitable environments on Mars and for seeking evidence of past life in the form of fossils and other preserved biomarkers.

An important scientific obstacle encountered during mapping was that evidence supporting key interpretations of the area's geologic history is not contained within the originally-proposed map area. Most notably, this includes evidence in support of the idea that the fractured rise in the northern part of the map area formed due to subsurface sediment mobilization, as well as facies that could be used to distinguish between a subaerial and submarine origin for the depositional fan in the southwest part of the map area. Fortunately this supporting evidence appears to be present within existing, publicly available HiRISE stereo images that are adjacent to the current map area.

Accordingly, the north Nia Mensa map area will be expanded to encompass these key adjacent outcrops through the production of additional DEMs and orthoimages from two adjacent HiRISE stereo pairs (Fig. 1). This increase in work effort for this map area will be achieved within the project's original budget by cancelling work on the proposed south Juventae Mensa map area. Essentially, the work proposed for two separate maps will be combined to produce one map that is twice as large in areal extent and more comprehensive. Thus completion of the north Nia Mensa map is currently on hold pending production of the two additional HiRISE DEMs and orthoimages (tentatively scheduled for September or October 2016).

Current results from the southeast Nia Mensa map: DEMs were produced from the HiRISE stereo observations PSP_004344_1715/PSP_005623_1715 and ESP_039749_1720/ESP_039604_1720. These data were then incorporated into an ArcGIS project. As shown on Figure 2, these stereo images do not overlap, thus the final map product will comprise two separate map sheets. Work is currently focused on measuring layer orientations using Layer Tools [2] and mapping unconformities within this map area.

References: [1] Skinner, J. A. and Tanaka, K. L. (2007) *Icarus, 186*, 41–59. [2] Kneissl, T. et al. (2010) *LPS XXXXI*, Abstract #1640. [3] Huuse, M. et al. (2010) *Basin Res. 22*, 342–360 [4] Wrede, C. et al (2012) *Sediment. Geol. 263-264*, 210–219.