LARGE-SCALE GEOLOGIC MAPPING THROUGH THE CENTRAL CANDOR COLLES, WEST CANDOR CHASMA, MARS. C. H. Okubo, U.S. Geological Survey, Flagstaff, AZ 86001, cokubo@usgs.gov.

Introduction: Candor Colles is a population of low, conical hills along the southeast flank of Ceti Mensa, in west Candor Chasma (Fig. 1). Previous geologic maps of the area utilized the relatively low-resolution Viking Orbiter photomosaics (20-150 m/pixel). Geologic maps covering west Candor Chasma were created at scales of 1:15,000,000 for the western equatorial region of Mars [1], 1: 2,000,000 for the Valles Marineris region [2], and 1:500,000 for the far eastern part of west Candor Chasma [3]. Meter-scale imagery and stereo observations from the High Resolution Imaging Science Experiment (HiRISE) camera enable a reevaluation of previous mapping efforts and provides fresh insight into the depositional and structural histories of these deposits.

Results of the first 1:20,000-scale geologic map of this area are presented here. This mapping effort employs high-resolution structural measurements in order to 1) refine the previous unit boundaries in this area established by [2], 2) revise the local stratigraphy where necessary, 3) characterize bedforms to help constrain depositional processes, and 4) determine the styles and extent of deformation to better inform reconstructions of the local post-depositional geologic history. This work has yielded significant new insight into the origin of the local layered deposits and the regional geologic history.

Methods: The primary dataset is a pair of stereo HiRISE observations, PSP_001641_1735 and PSP_002063_1735 (Fig. 1). A digital terrain model (DTM) with 1-m post spacings is extracted from these two observations. Both images are in turn orthorectified to the DTM. The DTM production and image orthorectification follows the methodology outlined by [4]. Mapping was conducted exclusively within the areal extent of the DTM, thus the region of stereo overlap in the HiRISE stereopair effectively defines the map area. Interpretations of local stratigraphic relationships and structure within the map area were checked for consistency with other outcrops in the Candor

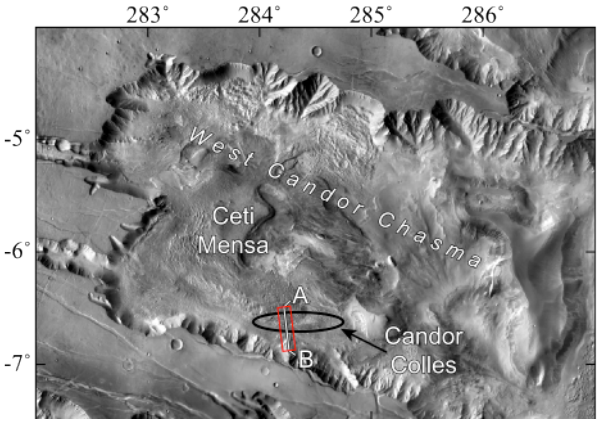

Fig. 1. Location of the map area, outlined in red.

Colles/south Ceti Mensa region using adjacent HiRISE and Context Imager (CTX) non-stereo and stereo observations. The classic Viking-based units and relative ages in this area were set aside until additional large-scale mapping is done and a more comprehensive understanding of these relationships is established on a regional scale.

Results: The oldest material exposed in the map area is the volcanic rock that constitutes the south wall of west Candor Chasma and the Ceti Labes unit (CeL) (Fig. 2). Unit CeL consists of landslide deposits derived from the wallrock. Accordingly, this and all subsequent units within the map area were deposited after west Candor Chasma had formed.

The Candor Colles unit (CaC) buries Ceti Labes. Accumulation of unit CaC occurred within a depositional environment that was at a sufficiently low energy that the primary landslide textures of the Ceti Labes landslide were preserved. No facies change between the initial sediments of unit CaC and later sediments within this unit is apparent at HiRISE resolution. Deposition was accompanied by occasional erosional events and the formation of numerous local unconformities, but this erosion did not cause extensive

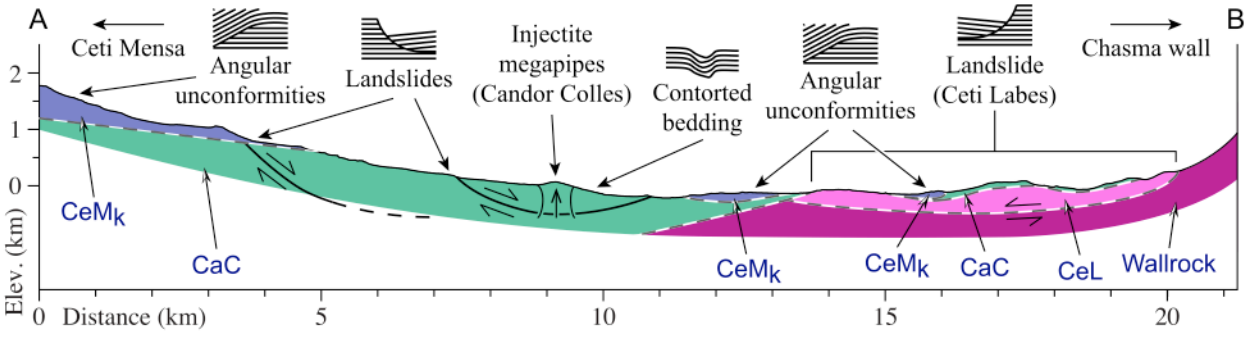

Fig. 2. Synoptic cross-section through the map area.

modification of unit CeL. The unit CaC materials were deposited in layers that show onlap and offlap relationships with preexisting topography. Away from unconformities, faults and other deformation, the layers generally dip toward the south at ~10° or less. Diagnostic fluvial and eolian bedforms at scales of one meter or more are not observed in these layers. These findings are consistent with the mechanism of formation recently advocated by [5], in which these sediments accumulated and underwent diagenesis in a sabkha environment, similar to some of the layered deposits exposed in Meridiani Planum (c.f., [6]).

Once accumulated, unit CaC experienced soft-sediment deformation, leading to formation of contorted bedding and injectite megapipes (i.e., the Candor Colles) [7]. The lack of breccia incorporated into this soft-sediment deformation indicates that unit CaC was poorly lithified at the time of deformation. On Earth, soft-sediment deformation is typically the result of seismic shaking of water-saturated sediments.

Unit CaC experienced brittle deformation along major fault zones. Crosscutting relationships indicate that slip along these major fault zones was contemporaneous with the formation of Candor Colles landforms. Thus, these fault zones are the most likely source of the seismicity that drove the soft sediment deformation within unit CaC. The geometries and senses of offset along these major fault zones are most consistent with an origin through landsliding within unit CaC. These fault zones are interpreted as the failure surfaces of a landslide complex that displaced material of unit CaC down toward the south.

The sense of landlide movement indicates that the paleo-slope of unit CaC dipped toward the south at the time of landsliding. Therefore a 'paleo-moat' between the layered deposits and the south wall of west Candor Chasma, analogous to the present-day moat, existed here when the landslides were active. Similar southward-directed landslides of the layered deposits have also been mapped adjacent to this area [8,9].

Deposition of unit CaC eventually ceased, and erosion of this unit ensued, resulting in the development of a bounding unconformity. Some of the landslide fault surfaces were exhumed at this time, based on onlap relationships with the overlying Ceti Mensa knobby unit (CeM_k). Unit CeL appears to have been re-exposed at this time as well, because the Ceti Mensa knobby unit also unconformably overlies it. The primary ~2–3-m-scale landslide textures of unit CeL were preserved throughout this erosional episode. Evidence of either fluvial erosion or marine regression is not apparent along this unconformity.

Unit CeM_k was then deposited on top of the regional unconformity at the upper boundary of units CaC and CeL. The onset of deposition occurred in an environment where the sediments accumulated in layers that lap onto preexisting topography. As with CeL, this depositional environment was at a sufficiently low energy that the primary landslide textures of Ceti Labes were preserved. Units CeM_k and CaC exhibit similar facies characteristics, suggesting that both units were deposited in comparable sabkha environments.

The eolian-dominated environment within which CaC and CeM_k are inferred to have accumulated is consistent with the other inferred geologic processes in the area. Topographically forced wind circulation and eolian erosion is proposed to be the cause of the moats surrounding the mounds of layered deposits in impact craters elsewhere on Mars [10]. Thus an analogous process of eolian erosion within the basin of west Candor Chasma is a plausible mechanism for widespread erosion of these units and development of the current and paleo-moat. Further, eolian excavation of this moat into unit CaC is a credible process by which regionally extensive, over-steepened slopes could have developed and resulted in the observed landslides.

The transition from deposition of unit CaC to development of the paleo-moat, subsequent landsliding, and regional erosion can be ascribed to either, or a combination of, a change in wind regime, a decrease in sediment supply, or diminished sediment trapping due to lowering of the water table. This was then reversed allowing the deposition of CeM_k. Unlike the Candor Colles unit, major fault zones and soft sediment deformation are not observed within unit CeM_k, possibly because this unit did not accumulate as quickly or erosion was not appropriate for creating landslides.

Deposition of unit CeM_k eventually ceased, and a predominantly erosional environment reemerged. Similar to the erosional event following deposition of the unit CaC, this event was widespread, with no evidence of a fluvial or marine component, and was at a sufficiently low energy to preserve the primary landslide textures of Ceti Labes. Again, eolian erosion is most plausible. This environment presumably persisted into the present-day given the apparent lack of subsequent layered deposits in the area.

Future work: Large-scale mapping is underway in three other locales in west Candor Chasma, in the areas of the following HiRISE images: ESP_011372_1730, PSP_003896_1740, and ESP_024822_1755.

References: [1] Scott D. H. and Tanaka K. L. (1986), *U.S. Geol. Surv. map 1802A*, [2] Witbeck N. E. et al. (1991) *U.S. Geol. Surv. map 2010*, [3] Lucchitta, B. K. (1999) *U.S. Geol. Surv. map 2586*, [4] Kirk R. L. et al. (2008) *JGR, 113,* E00A24. [5] Murchie, S. L. et al. (2009) *JGR, 114*, E00D05. [6] Arvidson, R. E. et al. (2011) *JGR, 115*, E06002, [7] Wheatley, D. et al. (2013) *44th LPSC (this volume),* [8] Okubo, C. H. et al. (2008) *JGR, 113*, E12002, [9] Okubo, C. H. (2010) *Icarus, 207*, 210-225, [10] Bennett, K. A. and Schmeeckle M. W. (2012) *AGU Fall 2012*, Abs. P21D-1875.