HIGH-RESOLUTION GEOLOGIC AND STRATGRAPHIC MAPPING IN OLYMPIA CAVI, PLANUM BOREUM, MARS.
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Introduction: The north polar plateau of Mars, Planum Boreum (PB), ~1000 km in diameter and ~2.5 km in maximum thickness, has been a focus of attention by spacecraft missions for four decades. However, many aspects regarding the form, structure, composition, and age of these deposits are not well documented, and much of the Mars Reconnaissance Orbiter (MRO) data has yet to be used address these issues.

We are documenting the stratigraphy and reconstructing the geologic evolution of diverse, yet understudied, polar sequences that are exposed along a complex series of troughs and scarps known as Olympia Cavi and Rupēs (Fig. 1). The Olympia Cavi (OC) region, which is located between 180 and 250 °E longitude, is well-suited for detailed geologic mapping because it displays the full suite of polar layered deposits (PLD), basal materials, and lags (e.g., Tanaka and Fortezzo, 2012; Skinner and Herkenhoff, 2012). This investigation focuses on mapping unconformity-bounded units, identifying stratigraphic packages, and measuring and correlating strata using high-resolution images and stereo-derived topography. We selected three noncontiguous sites, west, central and east (Fig. 1) OC, in order to characterize the continuity and variability of polar layered deposits and establish their three-dimensional architecture.

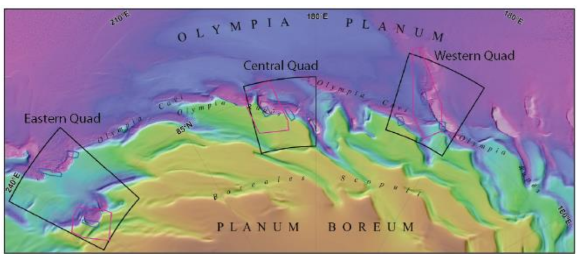


Figure 1. MOLA shaded relief of a portion of PB and OC. Three map areas outlined in black, CTX DEMs in red, HiRISE DEMs in blue.

Datasets: The Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) mosaic provides 100% coverage over the map areas at 6 m/pix. We have generated one CTX stereo digital elevation model (DEM, 20 m/pix) per map area. We also utilize MRO HiRISE images (≥25 cm/pix) in three locations per map area, with derived stereo digital elevation models (DEM, 1.5 m/pix). These DEMs cover the layered deposits in different areas, with at least one overlapping CTX and HiRISE DEM per site. The stereo pairs used per area are listed in Table 1.

Methodology: We are in the process of producing geologic maps at 1:100,000-scale using geographic information systems (GIS) with CTX image mosaics as base maps. To this end, we are mapping at a digital scale of ~1:25,000. We are using CTX and HiRISE DEMs to document a range of detailed observations, for constructing measured stratigraphic sections within each map area. We are mapping the stratigraphic packages and other geologic units at 1:10,000-scale (mapping at 1:2,500-scale) for publication. We will construct stratigraphic columns and fence diagrams at key locations using a combination of GIS and RockWare. We plan to synthesize our results in a three-part geologic map, which will include stratigraphic sections that are regionally connected by fence diagrams and detailed inset maps.

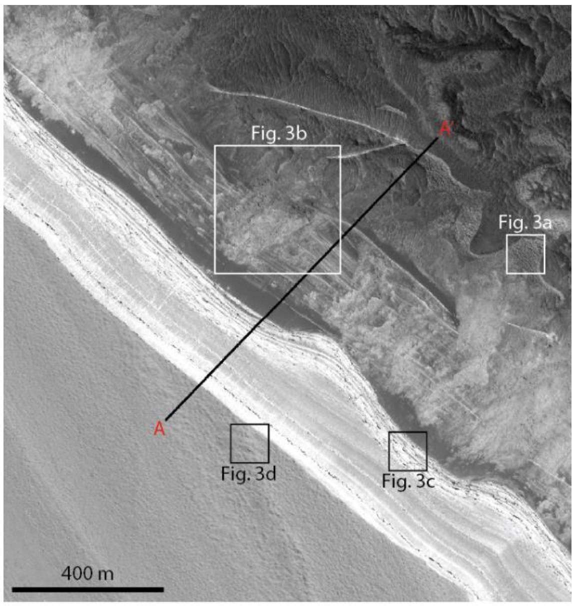
Table 1. Stereo Pairs used for this study.

Region	HiRISE Stereo Pair	CTX Stereo Pair
Central	PSP_009634_2655 PSP_009793_2655	
	ESP_018943_2655 ESP_019181_2655	G02_018852_2651 G02_019115_2655
	ESP_018852_2655 ESP_019115_2655	
East	ESP_018863_2650 ESP_019548_2650	
	ESP_018190_2640 ESP_018941_2640	G02_018863_2651 G03_019548_2651
	ESP_019298_2640 ESP_019047_2640	
West	PSP_009134_2645 PSP_009687_2645	
	ESP_018957_2655 ESP_019222_2650	P21_009279_2646 P22_009687_2646
	ESP_018905_2650 ESP_019222_2650	

Initial observations: The scarps exposing the PLD within each of the three map areas are broadly similar in appearance with three core stratigraphic units. The scarps have reliefs ranging from ~500 m to ~1.6 km, and have elevations from ~-4800 m to ~-3200 m within the map areas (Fig 2).

The lower stratigraphic unit is characterized by broad, irregularly outcropping benches near the bottom, and becoming more regular and thinly bedded as the slope steepens. A thin lag and mantle deposits of dark materials, sometimes shaped through eolian process, are present on benches and low slopes. Where exposed, the tops of the benches often present a polygonal pattern (Fig. 3a) along or near the edge of the bench sometimes with spalled blocks near the base of the bench. Toward the top of this lower unit, higher albedo, thin lobes to irregular patches of material with blocks and fines mantle the layered outcrop, and stretch up to 1 km down slope (Fig. 3b). The lower unit shows indication of cross bedding both large and small scale.

The middle stratigraphic unit has a unique character and is consistently present throughout each of the map areas. This unit is typically ~200 m thick, and forms the steepest slopes within the scarps of OC. This change in slope defines the transition from the lower and middle units of the OC. This unit is characterized by thinly-layered beds of moderate albedo materials with vertical cracks, blocks, and an irregular surface texture of smooth and rough areas (Fig. 3C). No internal bedding structures have been observed at HiRISE resolutions, although some areas appeared to show crossbedding. Using thickness measurements from the DEMs, we determined that these were artifacts of local changes in slope and erosion exposing multiple layers that are not visible in the adjacent steeper slopes.



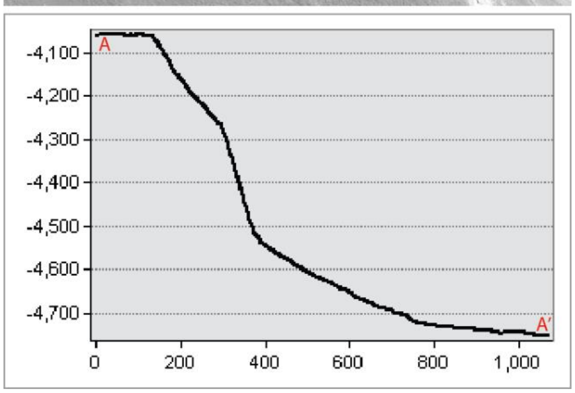


Figure 2. A portion of HiRISE image ESP_018905_2650 (25 cm/pix) showing the location a topographic cross section (A-A') from a stereo-derived DEM and plotted at bottom. Also shown are the locations of Figure 3.

The upper stratigraphic unit has an average thickness of ~700 m and a gentler slope than the middle unit. This member consists of hundreds of moderate to high relative albedo layers with a softened, hummocky surface texture. These thin layers are grouped into thick packages of broader albedo bands. There are thin packages of layers that have a similar morphology, yet less dense fracturing, to the middle unit. The upper unit layers appear contiguous throughout the length of their HiRISE images, with no discernable unconformities, but disconformities may be present.

Approaching the top of the scarp, the layers thin and/or become less distinct from each other. Beyond the scarp crest, on the very gently sloping top of Planum Boreum, the layers are expressed as thin, broad benches forming a much shallower slope. The surface of Planum Boreum has a fine-scale ridge texture overprinting a smooth surface with random small pits (Fig. 3d).

Progress and future work: Contacts have been sketched for the 3 full map areas using CTX images, 6 of the 9 HiRISE DEM locations (east and central) have contacts and some surficial units mapped, and none of the CTX DEM locations have been mapped.

The stratigraphy in the HiRISE areas will be cataloged, described and compared to each other to examine changes across OC over the next year. The 3 CTX DEM locations will be mapped based on the HiRISE results. The CTX locations each expand on at least one HiRISE area and will provide good tests to see if the HiRISE stratigraphy holds true within a larger context.

References: [1] Tanaka, K. L. and Fortezzo, C. F. (2012) *USGS Map SIM-3177*, [2] Skinner Jr., J. A. and K. E. Herkenhoff (2012), *USGS Map SIM-3197*

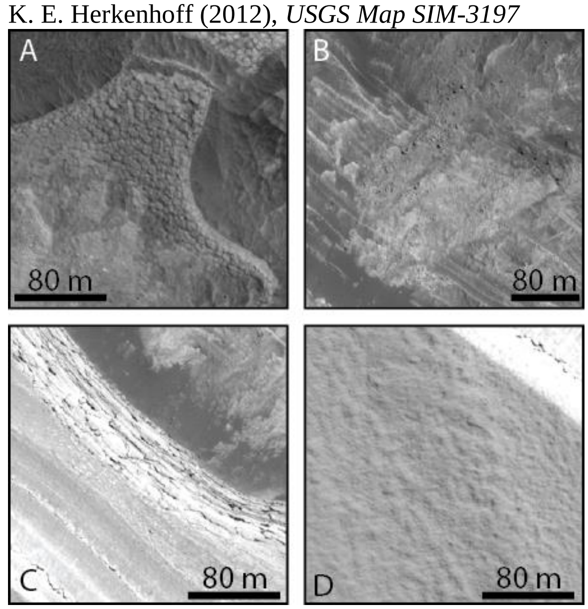


Figure 3. Portions of HiRISE image ESP_018905_2650 (A) showing polygonal texture at margins of lower layer deposit outcrops, (B) showing mass wasting deposits over lower layer deposits, (C) showing blocky middle layer deposits and upper layered deposits, and (D) showing typical mottled texture at the top of Planum Boreum.