GEOLOGIC SETTING OF THE OLYMPUS MACULAE, MARS. K. D. Seelos1, C. E. Detelich1,2, K. D. Runyon3, S. L. Murchie1, J. L. Bishop2, A. D. Rogers4, and K. E. Craft1. 1Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723 (Kim.Seelos@jhuapl.edu); 2Univ. of Alaska, Anchorage, AK; 3 SETI Institute, Mountain View, CA; 4Stony Brook University, Stony Brook, NY.

Introduction: The Olympus Maculae are an arcuate series of ten, ~20 km-diameter semicircular albedo anomalies located in Lycus Sulci, the aureole terrains northwest of Olympus Mons (Figure 1). These features have no topographic expression and superpose other late Amazonian units [1, 2], including the aureole terrains (unit Aa in [2]), Medusa Fossae Formation materials (unit AHtu), and lava flows (unit Ave) (Figure 1). While this region is an area of net dust accumulation, detailed characterization [3,4] has shown that the maculae are conspicuous because of their relative lack of dust, and that the process of preferential dust removal is modern and active [5]. Current thinking is that the anomalies are likely supported by thermally-driven atmospheric turbulence [3, 5]; however, it remains unclear exactly how the maculae were initiated.

In this work, we map the local geology of the Olympus Maculae in order to provide spatial and stratigraphic context for these features and clues as to the underlying mechanism(s) responsible for their origin.

Datasets and Methodology: Units were defined on the basis of morphologic expression and albedo differences (in the case of the maculae) at the scale of approximately 1:50000. To do this we utilized multiple global and local datasets including topography from the Mars Orbiter Laser Altimeter (MOLA), 100 m/pix controlled mosaics from the THERMAL EMission Imaging System (THEMIS; daytime IR, nighttime IR, and derived qualitative thermal inertia), and 6 m/pix visible imagery acquired by the Context Camera (CTX). All data were supplied by the Planetary Data System (PDS); CTX data were calibrated and processed by the USGS Projection on the Web (POW) tool.

Descriptions and Stratigraphic Relationships:

Seven units were delineated and are shown in Figure 2:

Ridged Terrain I and II. Two lobes of aureole terrains overlap within in our study area. Thought to have formed as a result of massive underwater landslides [6,7], these highly fractured landforms have a corrugated appearance with long, high relief linear ridges extending roughly perpendicular to the extensional direction. In our map area, the ridges of the older of the two lobes are oriented primarily N-S and mapped as Ridged Terrain I. Ridged Terrain II corresponds to the younger lobe toward the north and consists of both the ridged terrain as well as long runout landslides originating at the lobe’s marginal scarps.

Aeolian Terrain. Superposed on the Ridged Terrain units is a mantle of layered material consistent with other regional occurrences of the Medusa Fossae Formation (MFF), most likely comprised of ash fall deposits and ignibrites sourced to Apollinaris Patera and perhaps other Tharsis volcanoes [8]. These materials were deposited after emplacement of Ridged Terrain II as well, although the marginal landslides may have formed later.

The MFF materials are highly susceptible to aeolian modification, resulting in extensive fields of both linear and U-shaped yardangs [3]. Within the dust-free maculae themselves, dark sand ripples as well as cross-bedded layering is evident, indicating multiple cycles of aeolian erosion and redeposition [3]. In a few areas, deflation of a previously more elevated surface is evidenced by pedestal craters and highstanding U-shaped features that were likely former yardang troughs.

Volcanic Terrain. An extensive lava flow field encroaches upon the eastern map area. The morphologic texture of flow surfaces varies from smooth to crenulated with well-defined individual flow margins. The flows clearly embay both Ridged Terrain I and II (Figure 2). Volcanic Terrain tends to also superpose the Aeolian Terrain unit, although there are a few instances where this relationship is ambiguous and concurrent deposition may be a possibility.

Figure 1. Regional context showing the study area located west of Olympus Mons on Lycus Sulci (the aureole terrains). (Top) Viking color MDIM over MOLA shaded relief. (Bottom) Amazonian global geologic units identified by [2] over MOLA shaded relief.
Macula: As previously mentioned, the maculae are defined based on their albedo and other anomalous characteristics, e.g., enhanced relative thermal inertia, lack of topographic expression or any perceived spatial relationship to other landforms. Emplacement post-dates that of both aureole Ridged Terrains and the Aeolian Terrain, with ongoing dust-clearing activity as observed since the MY34 (2018) global dust event [5].

Crater and Crater Ejecta: There are very few craters in the study area with none observed over 1 km in diameter. This may be a result of late Amazonian surface age but the apparent friable nature of the Aeolian Terrain materials as well as infilling by dust likely contribute to obliteration. Similarly, a vast majority of craters exhibit no ejecta at all, although as few display pedestal morphology. The Volcanic Terrain and Ridged Terrains retain craters to a greater extent than other mapped units.

Discussion: The Olympus Maculae represent an intriguing series of very young features on the flank of Olympus Mons. Their presence appears largely independent from local geologic features (i.e., yardangs, ridges, or volcanic flows), and yet, the maculae may be fairly unique on Mars. This suggests that the provenance of the maculae may be sourced to subsurface activities and/or conditions, like structural controls or hydrothermal circulation.

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