DISTRIBUTION OF SCALLOPED DEPRESSIONS IN WESTERN UTOPIA PLANITIA, MARS AND IMPLICATIONS FOR THEIR FORMATION. T. N. Harrison[1] and C. M. Stuurman[2], [1]School of Earth and Space Exploration, Arizona State University (tanya.harrison@asu.edu), [2]European Space Research and Technology Centre, European Space Agency.

Introduction: Western Utopia Planitia has long been an area of intrigue based on the presence of potential glacial and periglacial features suggestive of active and past cryospheric processes. One such feature is scalloped depressions, which occur in high concentration in the region relative to the rest of Mars. Scalloped depressions are rimless and exhibit flat floors typically with steep pole-facing walls and gently graded, equator-facing terraced walls that sometimes expose internal layering [i.e., 1]. They are typically meters to tens of meters deep and ~100–3000 meters wide, and in many cases, adjacent scalloped depressions appear to have coalesced [i.e., 1, 2].

Some authors have suggested that scalloped depressions formed via subsurface ice melting [3–6], while others propose ice sublimation [1, 7–9]. It has also been suggested that the terrain hosting the scalloped depressions is a distinct, unique geologic unit [e.g., 10]. The presence of large near-surface deposits of excess ice in Western Utopia [11] is supported by data from the Mars Reconnaissance Orbiter (MRO) Shallow Radar (SHARAD) instrument. Here we map the extent of scalloped depressions in Western Utopia to look at their formation and implications for the Late Amazonian history of Mars.

Mapping: The terrain bearing scalloped depressions was mapped using MRO Context Camera (CTX) images in the Java Mission-planning and Analysis for Remote Sensing (JMARS) software package [15]. CTX has near-complete coverage of the region at 6 m/pixel resolution.

Results: The scalloped depression bearing terrain (SDBT) extends from ~38–54°N and 70–128°E (Figure x). We observe occurrences of scalloped depressions within craters out to ~60°N and ~150°E. Poleward of 50°N, some craters exhibit what we interpret to be scalloped depressions in very early stages of formation. The SDBT gradually becomes discontinuous near the margins of the possible "Periglacial Unit" ABp mapped by Kerrigan [10] at its southern boundary. Near its southern extent, the SBT is typically darker toned than the surrounding terrain. Along the northern boundary, the tone of the SDBT is comparable to that of the surrounding terrain. Within the ABp boundaries mapped by Kerrigan [10], the tone of the SDBT is highly variable. However, the tonal differences between the SDBT and the underlying/surrounding units do not appear to be a primary feature of the unit: The mottled tonal differences across the SDBT appear to arise from differences in dust cover based on observations in areas of concentrated dust devil tracks, revealing darker-toned material amidst lighter-toned (interpreted as dusty) areas. The occurrence of scallops gradually tapers off with increasing latitude, consistent with the observations of Morgenstern et al. [7]. The SDBT drapes the underlying terrain, superposing CCF and crater ejecta but appearing to be contiguous with crater wall mantling ("pasted on" [16]) deposits.

A reflector coinciding with the base of the layered scarps of the SDBT has been detected using SHARAD with dielectric properties consistent with porous, slightly dirty H_2O ice (50–85% ice by volume) ranging in thickness from ~80–170 m [11]. A large ice component in the SDBT is also supported by the lack of talus along scarp edges within the unit.

Interpretations: If the SDBT is composed of ice-cemented fine-grained sediments (e.g., dust) or volcanic ash [17], then any dust left behind upon sublimation of the ice would be easily transported by wind and thereby largely removed over time. This could explain both the lack of debris along scallop/scarp slopes, as well as the dark tone of the SDBT relative to the terrain to the south. In this region of Utopia under current martian conditions, west-to-east storm activity is common during autumn, winter, and spring [e.g., 18]. This storm activity is predominantly driven by a combination of topography and temperature differentials between the seasonal north polar cap and the adjacent frost-free ground [19]. Therefore, it is expected that this pattern would hold during past climate conditions that are similar to the present, and these winds could mobilize dust off the surface of the SDBT. This creates a positive feedback cycle for erosion of the SDBT; that is, removal of the protective surface lag exposes more near-surface ice to sublimation, resulting in desiccation and a new non-cohesive surface lag of dust, which is then removed by aeolian activity over time, with the process repeating itself with the cyclic variations in martian obliquity.

The contiguous appearance of the SDBT relative to the "pasted on" mantle suggest they are a single depositional unit. If the "pasted on" mantle and the latitude dependent mantle [20] (LDM) are related as suggested by Levy et al. [21], the occurrence of scallops may be at least partially controlled by LDM thickness and/or ice content. SHARAD reflectors are only observed in thick SDBT areas, likely due to the ~10-15 m vertical

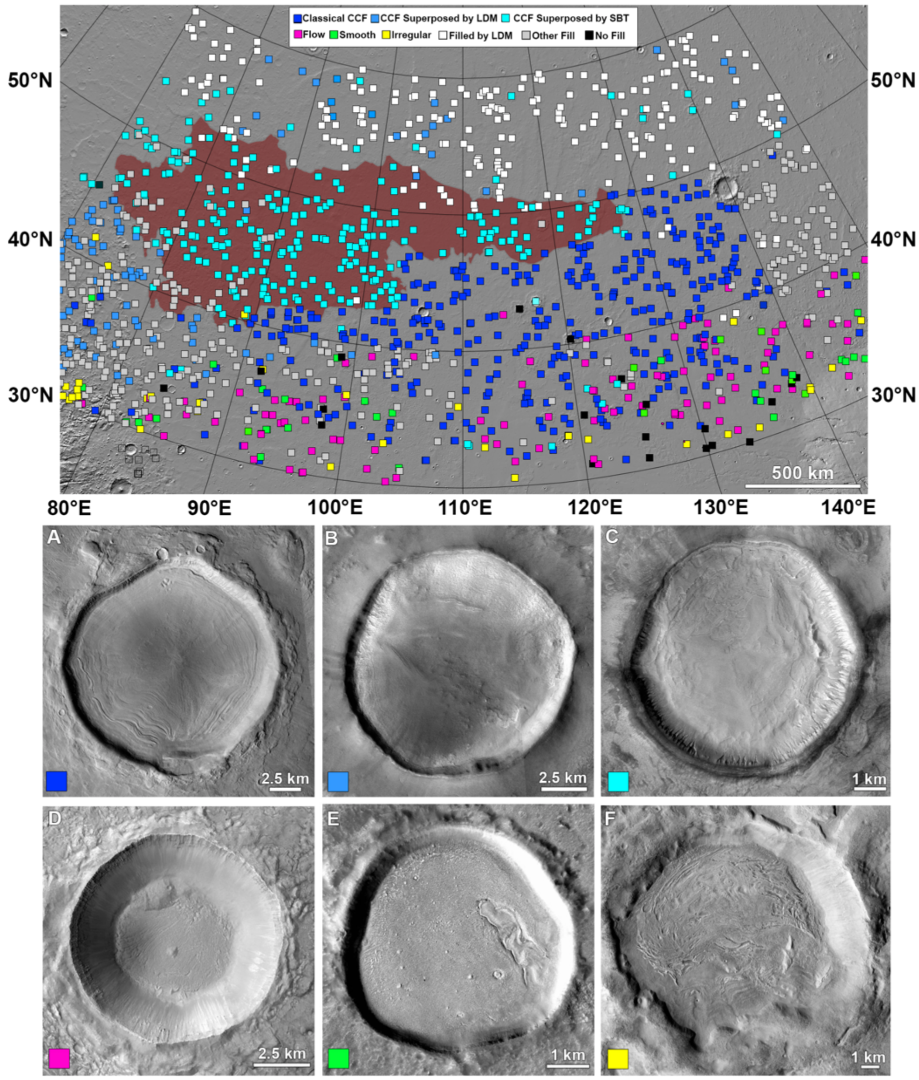

Figure 1. Top: Classes of crater fill from Harrison [22]. Teal dots denote SDBT-draped craters. Red polygon denotes "ABp" unit as mapped by Kerrigan [10]. Bottom: Crater fill class examples. See Harrison [22] for details.

resolution limitation. Both the LDM and SDBT exhibit internal layering, supporting the interpretation that they may be a single depositional unit.

Along the crater wall contact, evidence for retreat of the SDBT is sometimes visible. The SDBT is thin enough within some craters that underlying CCF patterns are visible, but thick enough in other craters that even when highly eroded, the surface patterns of the underlying CCF are not visible. All of these observations suggest that the SDBT was once more areally extensive. Based on the morphology, internal layering, stratigraphic relationships, and SHARAD results of Stuurman et al. [11], we interpret the SDBT to be ice-rich layered deposits emplaced at periods of high obliquity [i.e., 7, 8]—i.e., thick, preserved deposits of the latitude dependent mantle.

The typical lack of mass movement features along scalloped depression walls, despite slopes up to ~80°, combined with the relative lack of impact craters preserved on the SDBT surface supports the hypothesis that the SDBT is rapidly degrading [11] and/or geologically youthful.

Continuing Work: The next step of our mapping effort is to analyze scallop density and growth direction in relation to local topography to look for any controls at that scale on scallop formation.

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