ORIGIN OF THE PITTED CAPPING UNIT IN NILI FOSSAE, MARS. Carol B. Hundal[1], John F. Mustard[1], and Christopher H. Kremer[1]. [1]Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI, 02906. (carol_hundal@brown.edu).

Introduction: A widely distributed, mafic "pitted capping unit" overlies the stratigraphy of the circum-Isidus region of Mars [1,2,3,4,5]. Many areas across Mars are capped by morphologically similar dark-toned, pitted geological units (e.g., Mawrth Vallis and Sinus Meridiani [7]), and significantly, the interior of Jezero Crater, the landing site of the Mars 2020 rover, is filled with a mafic pitted unit, which may be related to the pitted capping unit discussed here.

The pitted capping unit of the circum-Isidis region is generally characterized by a dark-toned, crater preserving surface. It is commonly observed as a resistant cap that tops erosional mesas with steep bounding scarps (see Figure 1B, 1C). Although the pitted capping unit is sufficiently erosionally resistant to form mesas, it is also sufficiently friable to erode into yardangs [6]. Recent work has shown mafic clastic rock units are present elsewhere in the region [5,8], prompting investigation on whether the pitted capping unit is also a clastic rock.

Hypotheses for the origins of the capping unit are diverse, including by volcanic lava flows from Syrtis Major [3,4,9], impact melt [2], or as an air-fall deposit [10,4,11]. We map the pitted capping unit's geographic extent and measure its geometries relative to underlying units to constrain its origin. We find that the pitted capping unit is most likely a clastic deposit of aeolian or air-fall (volcanic/impact-related) origin.

Mapping: The pitted capping unit has been mapped at a 1:50,000 scale in ArcGIS using images from the High Resolution Imaging Science Experiment (HiRISE) [12] and the Context Camera (CTX) [13] aboard the Mars Reconnaissance Orbiter, as well as CTX mosaics [14] (see Figure 1A). Our mapping was guided by (1) geomorphic characteristics of the pitted

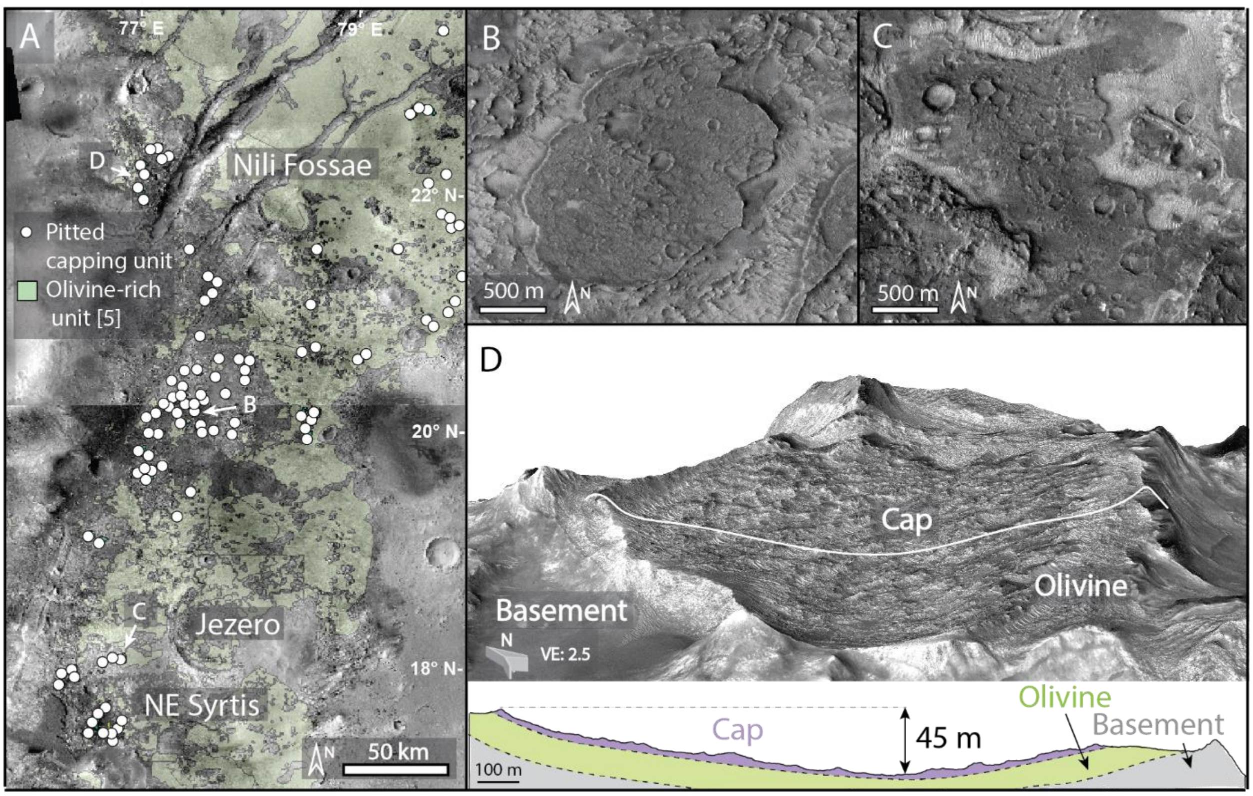

Figure 1: Pitted capping unit in Nili Fossae. (A) Capping unit locations on a CTX basemap [14] indicated by white circles (some circles represent more than one outcrop). Light green is the olivine-rich unit as mapped by [5]. Locations of B, C, and D indicated. (B, C) images of pitted capping unit taken from CTX mosaics. (D) Perspective view of the pitted capping unit draping the olivine-rich unit and basement rock. Interpreted cross-section location indicated by the white line. Vertical exaggeration is 2.5x. HiRISE PSP_002176_2025 draped on DEM created with

capping unit (see above), which are unique within this region, and (2) its stratigraphic relationship above the olivine-rich unit as mapped by [5].

A morphologically similar "pitted caprock" in the Libya Montes region also directly overlies the olivine-rich unit [1,3,9]. Future work will focus on determining whether this caprock is stratigraphically, morphologically, and mineralogically equivalent to the pitted capping unit in Nili Fossae.

Topographic data: High-resolution Digital Elevation Models (DEMs) were created from HiRISE stereo pairs using the Ames Stereo Pipeline [15]. The vertical precision of HiRISE DEMs is on the order of <1 m [12]. We also examined data from the Mars Orbiter Laser Altimeter (MOLA) aboard Mars Global Surveyor [16] to find the range in elevation for the unit as a whole.

Draping geometries: The draping geometries of the pitted capping unit provide insight into the possible mechanisms for its emplacement. We analyzed these geometries by examining the relief of outcrops draping bowl-shaped depressions, using topographic profiles extracted from HiRISE DEMs. The dips of several surfaces of the pitted capping unit were also calculated but are not included here, as erosion has likely modified the unit's surface topography.

Results: Profiles were taken across outcrops to test for concavity. The surface topography of an example outcrop of the pitted capping unit (Fig. 1D) strongly conforms to a bowl-shaped concavity defined by the underlying olivine-rich unit and basement unit, with slopes up to 10^o (see Figure 1D).

In Northeast Syrtis, outcrops of the unit are also concentrated in topographic depressions with relief of ∼35 m, where they potentially drape the underlying topography. The total extent of the unit covers a wide topographic range of ~2000 m from Northern Nili Fossae to Libya Montes [2]. No flow features were observed over ~1000 km^2 of outcrop.

Discussion: Deposition as a melt from Isidis basin is ruled out as the capping unit lies above the post-Isidis olivine-rich unit [4]. We rule out melt deposits from other impacts based on the vast areal extent of the unit (> 1000 km from northern-most to southern-most deposit).

The unit's lack of flow features and extent over 2000 meters of elevation cast doubt on emplacement by lava, though this hypothesis has not been completely ruled out.

The wide topographic range (2000 m) and striking parallelism of the pitted capping unit's surface topography with the surface defined by the underlying rock units are most consistent with aeolian epiclastic or air-fall pyroclastic deposition. Both mechanisms can cover vast ranges in elevation, drape or pile against steeply sloping topography, and form in bowl-shaped depressions. However, the extent of erosion of the unit's surface remains unknown, and so, we do not yet have a definitive interpretation of these draping geometries. Deposition as volcanic ash would be consistent with work by [11], which found spectroscopic evidence for glass in the pitted capping unit.

Implications for Mars 2020 and beyond: Data from the Mars 2020 rover could help differentiate between pyroclastic and aeolian epiclastic origins for the unit, by examining (a) whether the unit exhibits planar versus cross-bedded features and (b) the unit's grain morphology. For example, highly angular grains were used by [19] to show the clastic material comprising olivine-rich rocks in Columbia Hills was deposited by air-fall.

If the pitted capping unit proves to be a volcanic air-fall deposit, a returned sample could provide invaluable information about the timing and the mechanisms of Mars' transition from explosive to effusive volcanism in the Hesperian [20,21].

The presence of mafic capping units globally and possibly in the Mars 2020 landing site gives the pitted capping unit both regional as well as global significance. Future work will focus on refining interpretations of the rock unit's origins and providing data that can relate remote observations to *in situ* investigations.

Acknowledgments: Many thanks to Michael Bramble, Ralph Milliken, and Jim Russell for insightful discussions. We used CTX mosaics produced by the Bruce Murray Laboratory for Planetary Visualization.

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