NEWLY MAPPED EXTENT, MORPHOLOGY AND INTERNAL STRATIGRAPHY OF THE MARTIAN NORTH POLAR CAVI UNIT. S. Nerozzi1 and J. W. Holt1, 1Institute for Geophysics, Jackson School of Geosciences, The University of Texas at Austin (stefano.nerozzi@utexas.edu, holt@utexas.edu)

Introduction: The basal unit (BU) is a sedimentary deposit that underlies the north polar layered deposits (NPLD) in the Planum Boreum (PB) of Mars [1-3]. It is divided into the rupes unit and the cavi unit [2]. The latter records climate conditions and geomorphic processes from ancient times until NPLD accumulation [4]. Cavi unit is easily distinguished from the overlying water ice deposits due to its characteristic aeolian cross strata and low albedo, both readily apparent in high-resolution orbital imagery [4-5]. Therefore, imagery has long been the basis for stratigraphic mapping, but we need the means to correlate the distant, scattered visible exposures. The Shallow Radar (SHARAD) on Mars Reconnaissance Orbiter [6] detects the morphology of the BU underneath the NPLD [3] and reveals its internal structure. In this study, we integrate imagery and radar interpretations to reveal the full extent of the BU, the cavi unit in particular, thus providing the stratigraphic context necessary to correlate distant outcrops. We also find new details of morphology that reveal renewed depositional and erosional activity in cavi unit after the NPLD started to accumulate.

Methods: We tracked radar reflectors (“horizons”) across ~1100 SHARAD profiles in a seismic interpretation environment (Landmark DecisionSpace®). We depth-converted the time delay horizon information assuming a water ice composition for the NPLD ($\varepsilon_r=3.1$, [7]) and a mixture of water ice and sand for the BU ($\varepsilon_r=7.4$, [8]), thus allowing thicknesses to be calculated for each body using ESRI ArcMap®.

Cavi unit extent: Analysis of SHARAD profiles indicates that the cavi unit extends over a larger area than previously thought (Fig. 1). This work revealed the presence of a weak radar reflector located beneath the NPLD and adjacent to the previously mapped cavi unit [3]. This reflector is interpreted as the top of the Vastitas Borealis interior unit (on which Planum Boreum sits, [4]), and delineates the base of a sedimentary body up to 200 m thick (assuming $\varepsilon_r=7.4$, [8]) that appears continuous to cavi unit. In fact, the basal reflector can be traced beneath cavi unit and the two overlying, adjacent units share similar radar scattering signatures. At the presently mapped extent, this lobe extends from the western edge of Gemina Lingula to a visible exposure in the eastern end of Olympia Undae, covering an area of over 80,000 km². HiRISE images taken over the outcrop location reveal flat lying terrains forming terraces and characterized by sinuous forms and cross strata (Fig. 2, 3). Our observations suggest that this lobe is a relatively thin veneer of cavi material that extends farther to the south than previously determined.

Cavi unit morphology and stratigraphy: Our radar-based topographic mapping also reveals a series of elongated depressions along the edge of cavi tens to hundreds of meters deep (Fig. 4). In some cases, the base of these depressions are flat and appear to continue...
as reflectors internal to cavi for hundreds of kilometers. We interpret these reflectors as significant changes in composition within cavi, delineating sequences that exhibit different resistance to erosion, thus forming terraces that are observed in radar profiles, visible imagery and altimetry data. The location of the elongated depressions coincides with the presence and shape of the buried chasma observed by [9], suggesting that cavi was eroded in the same event that shaped the chasma.

Although SHARAD does not generally detect subtleties of the gradation between cavi and the NPLD, perhaps due to the limited vertical extent of the transition and its gradational nature, we did find evidence of a lens of isolated material located between cavi unit and the NPLD. The top of this deposit is a relatively sharp reflector protruding from the underlying cavi unit, followed by a diffuse return and a reflection-free zone. This feature extends over an area of ~4000 km² (Fig.1).

Discussion: Our study, based on integration of radar profiles and orbital imagery, revealed that the BU, its cavi member in particular, is significantly more extensive than previously thought. The area covered by the lobe of cavi material is equivalent to ~13% of the previously mapped BU [3], and adds ~2% to its volume. The new topography maps will be used to provide context to cavi outcrops and reveal potential exposure. One of these, the newly discovered cavi lobe outcrop, likely records climate conditions just prior to NPLD deposition and its flat topography exposes cross strata in plan view, a rare occurrence in cavi outcrops. For this reason, this location should be target for high-resolution imaging in the near future.

We interpret the lens of material located above cavi as a late episode of aeolian sand accumulation on top of cleaner water ice. We have found a potential, yet smaller analog of this feature in the central region of Olympia Cavi, where a scarp exposes a scattered dune field sitting on top of a ~150 m thick NPLD package (Fig. 5). This could be the first detection of such transitional deposits in radar profiles and provides new information on the potential size of these features.

In general, our study revealed new details of cavi morphology that indicate a more complex history than previously thought, characterized by late, renewed deposition and erosional activity. The resulting morphology must have had an impact on subsequent NPLD accumulation and evolution, and we hypothesize that some throughs and depressions visible on the modern surface result from the depressions mapped in this study.

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