MAPPING OF REFLECTORS IN PLANUM BOREUM WITH 3-D SHARAD DATA. A. G. Nair[1] and I. B. Smith[1,2], [1]York University (4700 Keele St, Toronto, ON M3J 1P3, akhila91@yorku.ca), [2]Planetary Science Institute.

Introduction: The north polar layered deposits (NPLD) and Basal Unit (BU) make up the plateau of Planum Boreum, and they record deposition and erosion history in stacks of layers [1]. The layers differ in the fractions of ice, dust, and sand, and those variable properties create dielectric contrast that is observable as radar reflectors [1]. Understanding these layers provides insights into the recent climate processes of Mars [2]. Previous work has found that observed transitions between erosion and accumulation can result in unconformities that are observed at the surface by optical instruments and subsurface by Shallow Radar (SHARAD) [3]. We use a three-dimensional (3D) Shallow Radar data set [4] to understand the stratigraphy of the NPLD.

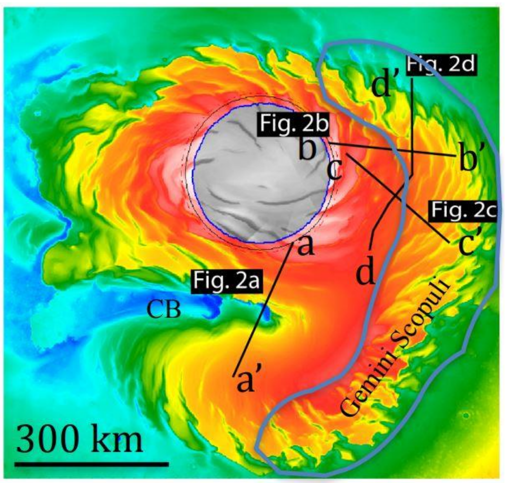

Figure 1: Topographic map of North Polar Layered Deposits showing figure locations

Data and Methods: We mapped two radar reflectors across the NPLD that had previously been named R25 and R29 [2] (Figures 2-4). We use a time-delay version of the 3D data that has high fidelity of reflector position to understand the distribution of R25 and R29 and their historical relationship of interactions with spiral trough migration and other erosive periods. Limitations of using the two-dimensional (2D) data profiles [2] are overcome by the new set of 3D volume datasets [4]. The 2D data volumes experienced interfering reflections, signal losses, and scattering which hampered the complete interpretation of the data. The new data volumes have applied geometric corrections, clutter reduction, and better viewing geometries, making finer interpretation of layers [4, 5].

Findings: We present several 2D cross sections taken from the 3D data in Fig. 4. These reveal the layering details and the large-scale unconformities, along with a buried chasma (BC) that was previously identified [Holt et al. 2010].

Sloping discontinuities that reach down from the spiral troughs are known as trough migration paths (TMPs) and are present in (Fig. 2) [6]. When TMPs interact with reflectors below the surface, it results in discontinuous reflectors (Fig. 3) that identify the former position of the spiral troughs.

In Fig. 4a, near Chasma Boreale (CB), R25 and R29 are observed on the north and south sides, but with different geometries. From both directions, R25 is more discontinuous than R29. On the south side, both reflectors dip downwards, conformable with the current surface, telling of the former extent of Gemini Lingula. TMPs that break up the reflectors on then north side indicate that the spiral troughs were present when R25 and R29 formed.

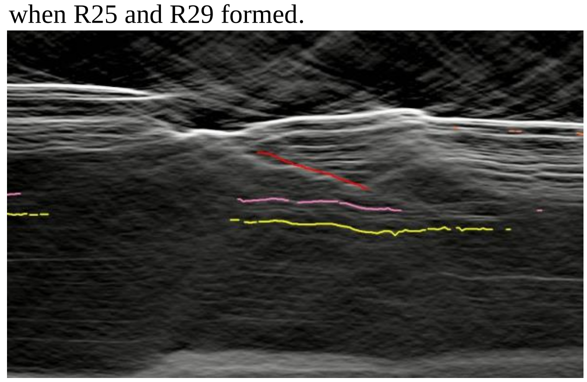

Figure 2: Sloping discontinuity adjacent to low side of a trough. R25 (pink) and R29 (yellow) are discontinuous where the trough migration path (TMP, red) intersects.

In the region of the buried chasma, the two mapped reflectors are more contiguous, with fewer discontinuities (Fig. 3) because of fewer trough interactions. R25 and R29 are buried by a thicker stratigraphic column towards the interior of the NPLD (Fig. 4d and 4c) but approach the surface at the NPLD margins.

Towards the margins of the NPLD (at Gemini Scopuli), unconformities are abundant (Figs. 4b & 4c), even truncating R25 and R29, implying one or more erosive events that removed a significant amount of material from NPLD. Spiral troughs stratigraphic signatures are only observed stratigraphically above these reflectors, meaning that this region of troughs formed after R25 and R29, like the findings of [2]. In many cases, trough stratigraphy in this region arises immediately above the unconformity, providing a timing constraint on trough formation.

Similar to what we see in other regions, R29 is always more continuous than R25. This is because many of the troughs formed sometime between deposition of R29 and R25, meaning that R25 experienced more trough interactions (Fig. 4a). These observations agree with the 2D data findings of [2].

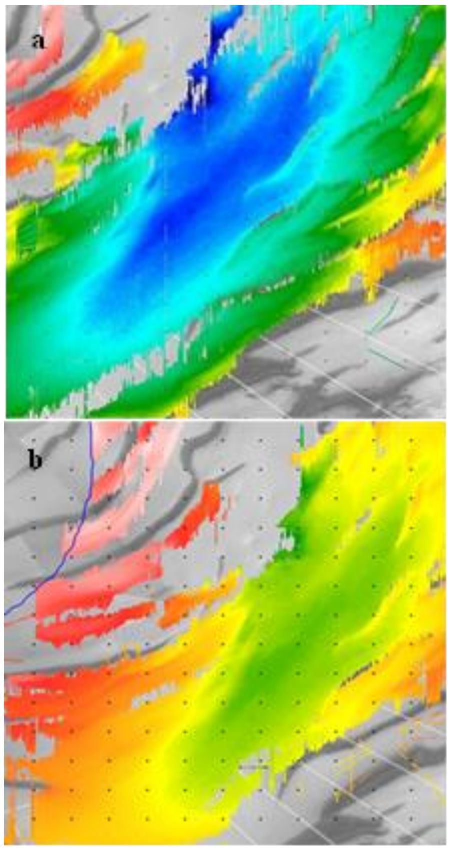

Figure 3: Buried chasma visible during the mapping of (a) R29 as deep blue in shade (b) R25 as green

Conclusions: Radar stratigraphy provides a significant role in understanding the processes of accumulation history in NPLD development. In our study, we map two radar reflectors called R25 and R29 across most of the NPLD. Compared to previous results using 2D data [2], the 3D data volume improved identification and interpretation of buried deep structures of NPLD. The presence of large-scale unconformities associated with the Gemini Scopuli region are likely related to massive erosion events, and the truncation of the R25 and R29 are also noticeable along with their trough interactions. In general 3D interpretations agree with the prior interpretations made in the 2D data volume.

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References: [1] Phillips et al. (2008) Science, 320(5880), 1182. [2] Smith and Holt (2015) JGR Planets 2014- JE004720. [3] Smith et al. (2016) Science 352, 1075–1078. [4] Foss et al. (2017) The Leading Edge 36, 43–57. [5] Putzig et al. (2018) Icarus, 308, 138-147. [6] Laferriere.K. (2022) LPSC LIII, abst 1452. [7] Holt et al. (2010) Nature, 465, 446–449.

Additional Information: The 3D dataset is available for public use at https://sharad.psi.edu/3D.

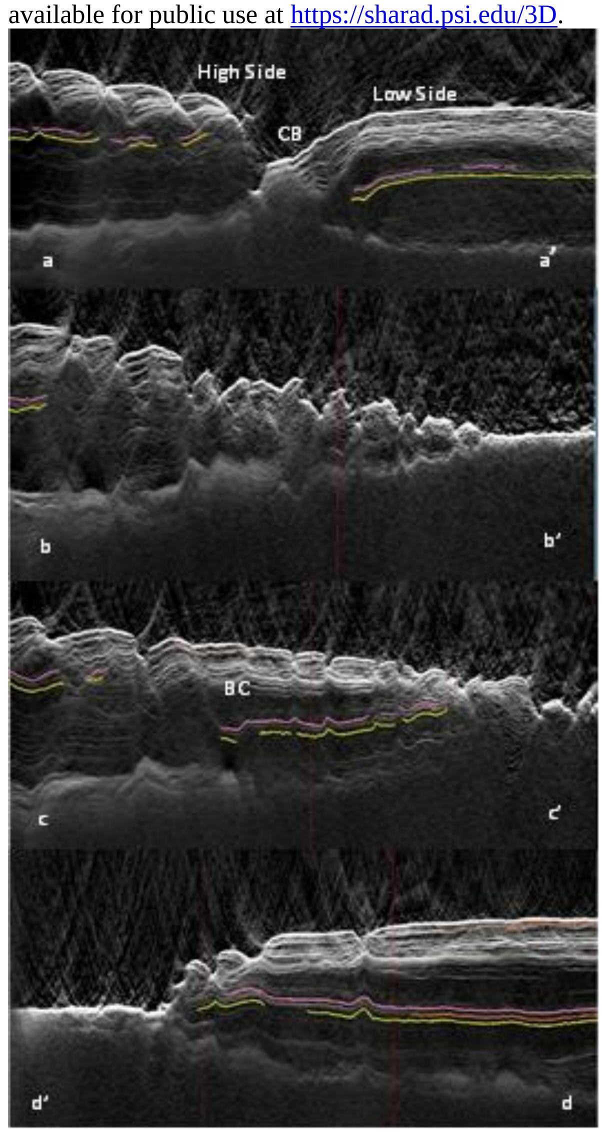

Figure 4: Radar stratigraphy images of the NPLD. Pink lines are R25, and yellow lines are R29. a) Represents the mapped reflector around Chasma Boreale. b) Radar profile indicates the large-scale unconformities towards NPLD margin c+d) Radar profile of R25 and R29 on the buried chasma and truncation towards the edges of NPLD.