RENEWED ANALYSIS OF BURIED DEEP STRUCTURES IN THE POLAR LAYERED DEPOSITS OF MARS WITH 3-D SHARAD VOLUMES. I. B. Smith, 1 N. E. Putzig, 1 J. W. Holt, 2 1Planetary Science Institute 1546 Cole Blvd #120, Lakewood, Colorado. 2University of Texas Institute for Geophysics, Austin, Texas. Contact: ibsmith@psi.edu.

Introduction: The north and south polar layered deposits (NPLD and SPLD) of Mars contain a record of accumulation through time that is expressed in the layers that comprise the ice caps. Using newly generated three-dimensional (3-D) radar datasets [1], we are able to detail several events that played roles in development of the PLDs.

Much of the NPLD’s early history is one of near-uniform accumulation with some lateral variability [2-4]. After about half of the NPLD was in place, the spiral troughs developed [5,6], modifying the accumulation pattern from near-uniform to highly localized, dependent on position relative to the troughs. Trough onset was only one of several major events in NPLD history. The development and burial of a large chasma, equal in size to Chasma Boreale, predated the troughs [7], and several erosional events are preserved in the layers [6-8]. A large-scale unconformity associated with Gemini Scopuli (Fig. 1) and likely related to massive erosion from climate forcing is also of interest.

In the south, we focus on new orientations to view the thick CO₂ units that reside at high latitudes and are buried beneath the south polar residual cap (SPRC) [9]. These units behave as glaciers [10] and represent periods of atmospheric collapse [11].

Data and Methods: We interpret two- and three-dimensional data from the Shallow Radar (SHARAD) instrument [12] on Mars Reconnaissance Orbiter. Thousands of 2-D (single-orbit) observations were processed to create two 3-D volumes of radar data [1]. This volumes provide more utility than the 2-D dataset because of the geometric corrections applied, reduction of clutter, and viewing geometries that are not dictated by the ground tracks of the spacecraft [13]. This utility makes is possible to demonstrate in one image something that is impossible to visualize in the 2-D data. These and other factors reduce interpretation time by a factor >10 and increase confidence in interpretations.

Findings: We show 3-D profiles from the NPLD in Figs. 2a and 2b that exhibit major unconformities and the buried chasma (BC) in the north, and the base of the CO₂ deposit in the south. The buried chasma has many similarities to Chasma Boreale (CB, not shown): both locations have dipping reflectors that nearly reach the basal interface, a portion of the Basal Unit is separated from its main lobe at each section (purple arrows), a steep cliff exists for both on the main-lobe side (orange arrows), and an eroded surface towards the interior of the NPLD (dashed red lines). Nerozzi and Holt [4] interpreted the eroded basal unit to be the initiation surface of both chasmas.

The major unconformity in Fig. 2b corresponds to U2 and U3 from [14]. This is the event that created the Gemini Scopula region (Fig. 1), with abundant unconformities, at the margin of the NPLD from −0° E to 180° E. The Gemini Scopuli erosion removed significant quantities of material from the NPLD.

For the CO₂ deposits of the SPLD (Figs. 2c 2D) we are able to observe the base more easily than in 2-D and interpret the full structure of the deposit.

Interpretations: With these 3-D observations we confirm the prior interpretations [e.g., 2-4, 10, 14] that were done based on 2-D analysis.

At one point in time, the initial stages of both CB and BC would have appeared similar and had similar dimensions. Their subsequent accumulation histories drove different evolutions. Chasma Boreale persisted through many hundreds of meters of accumulation, likely widening as it grew taller due to wind scour on the main-lobe side (with equator-facing slope). This maintained the steep cliff present today.

The buried chasma, on the other hand, began to fill in soon after the red reflector was deposited. This cre-
ated an accumulation pattern that affects surface topography even today (Fig. 2c). At present, two topographic lows exist on the surface of the NPLD, remnants of the former deepest section of the basal unit erosion. Immediately below, the layers are conformable to the current surface, leaving a U-shaped deposit (immediately above the ‘B’ in Fig. 2c). A similar pattern likely would have formed had Chasma Boreale also filled in.

The leading hypothesis for the divergence in the history of the two chasmata is that CB was ideally situated so that katabatic winds driven by the Coriolis Force would funnel into the canyon and then outward towards its mouth [14]. The same winds would have funneled headward into the buried chasma and been hindered when they met the saddle region that connects Gemini Lingula [11]. Thus, the icy material or water vapor would have only been transported a short distance and never away from the NPLD.

With new observation geometry, the hypothesis of SPLD CO₂ units as glaciers can better be tested.

**Conclusions:** Structures deep within the PLDs provide information about events that occurred at various stages in development. Significant amounts of mapping in 2 dimensions have been completed, and here we use the 3-D data volume to revisit and reinterpret those features. With few exceptions, 2-D mapping has been very successful in describing different chosen features. However, there are many deep structures that have not been interpreted because of the difficulty to do so with the 2-D dataset. 2-D observation geometries and clutter hindered potentially important discoveries of structures that inform the history of accumulation at both PLDs. We will present these and new observations at the conference, including updated figures from [15] that provide context for the uppermost units of the NPLD.

**Additional Information:** The 3D dataset is available for public use at [https://sharad.psi.edu/3D](https://sharad.psi.edu/3D).

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