

BED STRUCTURES OF POLAR LAYERED DEPOSIT OUTCROPS IN AUSTRALE MENSA: IMPLICATIONS FOR THE FORMATIONAL HISTORY OF PLANUM AUSTRALE, MARS. E. J. Kolb¹ and K. L. Tanaka², ¹Google, Inc. Mountain View, CA; ekolb@google.com, ²USGS, Flagstaff AZ.

Introduction: The thickest stack and thus most complete stratigraphic section of south polar layered deposits (SPLD) is exposed in Australe Mensa, a domal feature centered at 315°E, 87°S. Our previous mapping of SPLD exposures in the Promethei Lingula [1] and Australe Scopuli regions [2] of Planum Australe identified a regional unconformity in canyon walls. Bed orientations indicate the unconformity controls the bedding structures of overlying SPLD and marks the initiation of local chasma and curvilinear canyon formation. We have undertaken mapping of Australe Mensa to address specific formational issues: (1) If unconformities crop out in SPLD exposures of Australe Mensa, do they control overlying SPLD bed structure? (2) If regional unconformities are exposed, can correlations be made with the regional unconformity of Promethei Lingula and Australe Scopuli?

Stratigraphy. Planum Australe units 1 through 4 form Planum Australe [3]. The Planum Australe 1 unit (unit Aa₁) comprises ~3.5 of the ~4.0 km-thick stack of SPLD, including all of the Australe Mensa exposures examined here. The regional unconformity in Promethei Lingula and Australe Mensa sub-divides unit Aa₁ into the lower (unit Aa_{1a}) and upper (unit Aa_{1b}) members.

Methods and Approach. Map-projected THEMIS VIS and HRSC images comprise our map base. We apply the mapping technique we used for subdividing the SPLD of Promethei Lingula and Australe Scopuli into sequences to mapping of the SPLD of Australe Mensa. Specifically, a SPLD layer sequence is bracketed, and thus defined, by an upper and lower marker layer. Marker layers are traceable over most-to-all of the study region and exhibit identifiable bedding and/or outcrop feature(s) such as extensive unconformable bedding, or consistent outcrop expression such as cliff or terrace structures. Where appropriate, local bed azimuth and dips were determined using the 3-point problem-solving technique.

Results: Australe Mensa's basal SPLD sequence crops out in a shallow re-entrant whose headwall is centered at 317.0°E, 82.8°S (not shown), along a 75 km-long marginal scarp centered at 305.4°E, 82.5°S (not shown), and along a 75 km-long interior scarp (Canyon Wall 1 (C1) in Fig. 1) centered at 310.0°E, 82.9°S. In Figure 1, the terrace-forming marker layer marking the top of the basal sequence (Sequence 1 (S1)) crops out in the uppermost wall section of C1 and along the base of the adjacent interior canyon, C2 (centered at 305.9°E, 83.9°S; Fig. 1). S1 has an apparent thickness of ~650m

and exposes several unconformities (not shown), all of which appear to be of local extent. In C2 exposures, the apparent thickness of Sequence 2 (S2) is ~550m. Along several outcrop exposures, the S2-S3 marker layer (Fig. 1 and 2) is unconformable with underlying S2 beds. Along its longest trace in C2 exposures (Fig. 1), the S2-S3 unconformity extends a distance of ~55 km and cuts across S2 layers having an apparent thickness of ~200m. A few local unconformities crop out in S2 beds exposed in the canyon walls of the re-entrant centered at 317.0°E, 82.8°S (not shown). Stacked unconformities occur above nearly all unconformable S2-S3 marker layer outcrop sections (e.g., unconformable S3-S4 and S4-S5 beds in C2 of Fig. 1). As well, the apparent dip and down-cutting extent is greater in each successive marker layer. For example, in C2, S3 thickness is ~200m; the unconformable S3-S4 marker layer downcuts through all of S3 and into S2.

The marker layers delineating the S2 through S5 sequences crop out almost continuously over a trace distance of 350 km. At each outcrop location, similar stratigraphic relationships and bedding structures are seen. For example, along the equator-facing scarp centered at 318.3°E, 83.6°S (Fig. 2) of a north-orientated ridge separating two Australe Mensa canyons, the S2-S3 marker bed unconformably buries S2 layers having an apparent thickness of ~100m; total S2 apparent thickness is ~500m. Moreover, the S3-S4 marker bed unconformably buries all S3 layers and the uppermost layers of S2; total S3 apparent thickness is ~250m. Finally, the S4-S5 marker bed unconformably buries a S4 section having an apparent thickness of ~125m; total S4 and S5 apparent thicknesses are ~150m and >200m, respectively. At the exposure's NW and NE extents, marker beds crop out as a series of stacked unconformities. Similar to C2 exposures, bed dips here commonly steepen in each successive sequence. For example, at the NW extent, the steepest bed dips (4.1°) occur in S4 beds that unconformably bury SPLD of S3 and S2.

Interpretations: The S2-S3 marker layer appears to represent Australe Mensa's earliest regional erosive event, removing >200m of SPLD material from some regions. Unit Aa_{1a} thickness is >1 km in Promethei Lingula, and ~1.2 km in Australe Scopuli [1-2]. The S2-S3 unconformity occurs at an apparent SPLD thickness of ~1.2 km, and is thus likely stratigraphically comparable to the regional unconformity separating unit Aa_{1a} and unit Aa_{1b}. In Promethei Lingula, the paleosurface formed seedling canyons that were progressively

enlarged into the chasmata seen today by the preferential funneling of katabatic winds during later SPLD depositional hiatuses [1]. In Australe Scopuli, the paleosurface formed small canyons that were progressively enlarged into the curvilinear canyons seen today [2]. Similarly, we interpret the outcrops exposing stacked unconformities as regions that have undergone sustained preferential erosion. As in Promethei Lingula and Australe Scopuli, bed tilt associated with the unconformities focuses erosion action onto these dipping paleo-

surfaces. The increasing bed tilt and magnitude of down-cutting commonly seen for each successive unconformable sequence indicates these regions have undergone increasing concentration of erosive action with each successive depositional hiatus.

References: [1] Kolb E. J. and Tanaka K. L. (2005) *Mars*, 2, 1-9. [2] Kolb E. J. and Tanaka K. L. (2006) *Mars 4th Polar Sci. Conf.*, #8085. [3] Tanaka K. L. and Kolb E. J. (2006) *Mars 4th Polar Sci. Conf.*, #8098.

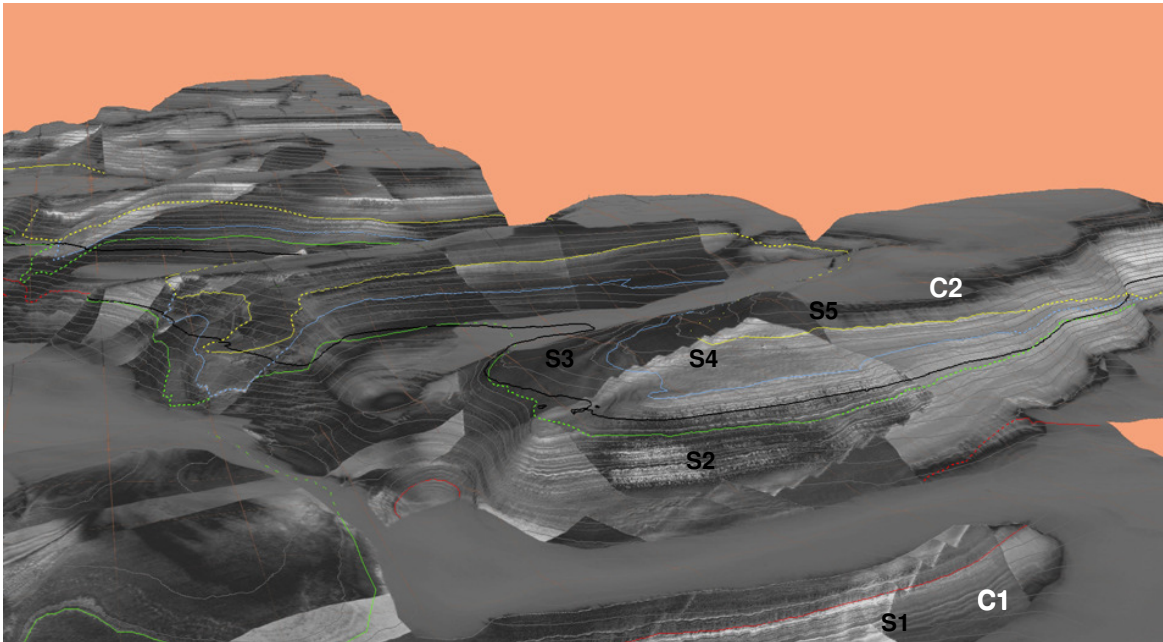


Figure 1. Perspective view of Australe Mensa canyons, Planum Australe, Mars; view is to the south east. See text for description. Image is a THEMIS VIS and HRSC composite mosaic draped over the MOLA DEM. Red line: S1-S2 marker bed; Green line: S2-S3 marker bed; Turquoise line: S3-S4 marker bed; Yellow line: S4-S5 marker bed. Unconformable marker bed sections (dashed line segments) are only drawn where bed truncations are exposed. 50m contour interval; Black contour line: 2400m.

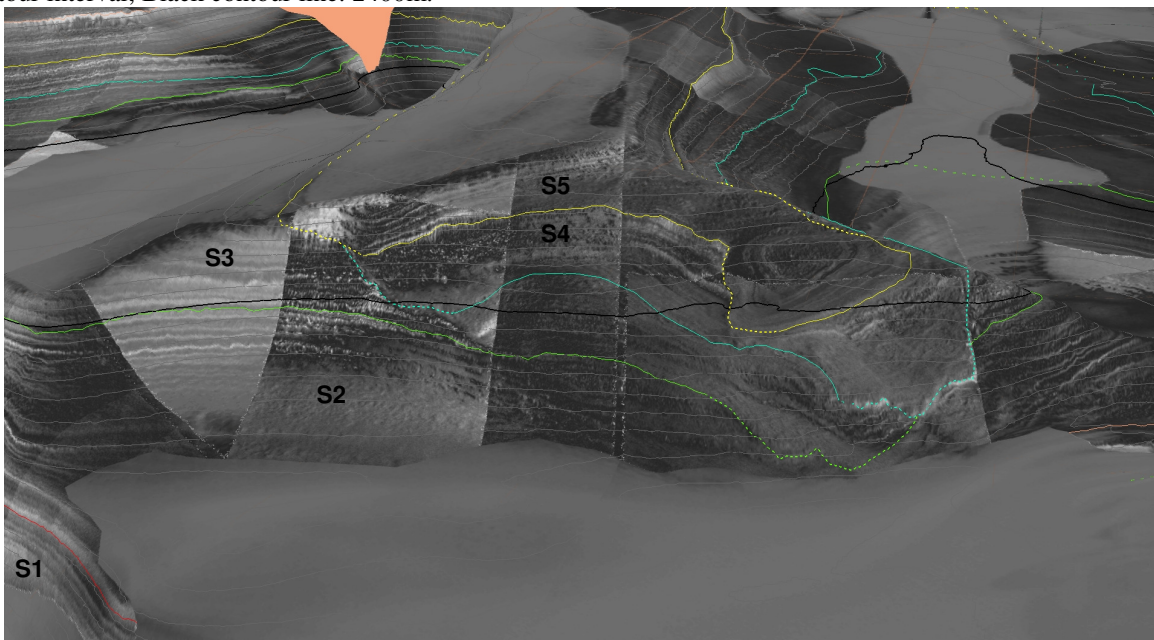


Figure 2. Perspective view showing SPLD outcrops. View is to the south. See text for description.