NEW CONSTRAINTS ON THE FORMATION OF ABALOS MENSA, PLANUM BOREUM FROM RADAR STRATIGRAPHY AND HIGH-RESOLUTION IMAGERY. T. C. Brothers¹ and J. W. Holt²,
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Introduction: Abalos Mensa is a lobate wedge of material located directly south of the Rupes Tenuis scarp on the edge of Planum Boreum (PB) at 285°E. It measures ~180 km across and is separated from PB by a narrow trough on the east and a broader trough containing Abalos Undae dune fields on the west (see fig. 1) [1]. This enigmatic deposit contains information vital to understanding PB accumulation and evolution.

Two dominant hypotheses exist to explain the formation of Abalos Mensa and related landforms. The first hypothesis ascribes these features to interactions of volcanoes or geothermal heat sources with ice [2-5]. It requires melting of icy polar material to fluviually deposit Abalos sediments. This hypothesis has been refuted due to its assumptions relating terrestrial shield volcano morphology to martian cone morphologies [6]. Additionally, the same conical deposits described as volcanic [2,4,5] have been mapped as containing icy rupes tenuis unit outcrops [1,7]. The presence of rupes tenuis unit in these mounds complicates the timing of their proposed volcanic activity. This is because rupes tenuis unit predates all other PB ice deposits [1] yet is still in-place where they hypothesize volcanic activity.

The second dominant hypothesis explaining the formation of Abalos Mensa incorporates the presence of basal unit, a term which combines rupes tenuis and PB cavi units. This hypothesis states the features are aeolian and carved from a more expansive basal unit deposit [1,6]. While several variations of these hypotheses have been presented, the main ideas have not changed.

This work will address the second hypothesis in greater detail. Is Abalos Mensa in fact preserved basal unit material that resisted aeolian erosion? We will present evidence derived from high resolution imagery and radar stratigraphy that does not correlate well with this hypothesis. As a result, we will present an alternative hypothesis for feature formation of Abalos Mensa with implications for the interaction of atmospheric processes with PB paleotopography.

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Methods: Orbital sounding radar data from SHAlow RADar (SHARAD) were used to construct maps of Mars' PB basal unit elevation. SHARAD is an orbital sounding radar with a vertical resolution of ~9 m in water ice [8]. PB radar stratigraphy was interpreted using commercially available seismic data software and then exported to ESRI's ArcGIS where it was gridded using the nearest neighbor algorithm.

While radar sounding provides an overview of regional basal unit topography likely coeval with Abalos Mensa formation and detects younger north polar layered deposit (NPLD) stratigraphy, it does not clearly illuminate bedding within the basal unit. For this reason, a combination of HiRISE and CTX imagery was used to map stratigraphy. Stratigraphic layers for interpolation were chosen based on layer continuity, layer visibility, and distance of exposure. Preference was given to layers with distinct erosional resistance and an albedo contrast with surrounding material, as these features have been attributed to basal unit layering [7,9].

Optical mapping was performed within ESRI's ArcGIS with the images draped over MOLA 512 ppd topography to extract elevation. To calculate stratigraphic attitudes, 3 to 4 individual points were taken.
along each optical horizon and then fit using a linear regression interpolation. The resulting grids were used to analyze relationships between Abalos Mensa and Rupes Tenuis basal unit exposures.

**Results:** Observations of NPLD radar stratigraphy in Abalos Mensa show no indication of widespread erosion or geothermally induced melting. The reflectors drape across a lobate surface, thickest at the center and gradually thinner as they downlap near the edge onto Vastitas Borealis material. There is no warping at the edges, nor do the layers truncate unexpectedly (see fig. 2). These observations support previous Abalos Mensa age estimates placing it older than NPLD [1,6]. Therefore, analysis of Abalos Mensa genesis using modern topography as has been done in volcanic simulations [5] is inappropriate.

Given that Abalos Mensa formation was coeval to basal unit, a useful reference frame is basal unit topography. Basal unit topography shows abrupt truncation at the Rupes Tenuis scarp and there is an isolated patch of basal unit beneath the western half of Abalos Mensa [10]. Rupes Tenuis scarp topography is locally similar to modern topography where winds have been observed actively moving material away from Rupes Tenuis.

Mapping of basal unit layers in optical imagery provided details on bedding attitude. All analyzed basal unit layers on eastern Abalos Mensa have a west facing dip, very near perpendicular to the exposed margins of the landform; therefore, the layers are dipping away from the thickest portion of Abalos Mensa. Analysis of basal unit layering on adjacent Rupes Tenuis revealed layers dipping east, away from their exposed scarp in the direction of the unit’s edge. The dip of rupes tenuis unit exposed in the Rupes Tenuis scarp is very near 180 degrees different from the Abalos Mensa PB cavi unit layers (see fig. 3).

All basal unit bedding analyzed in this study indicates in-place deposition. Similarly, overlying NPLD shows downlapping layers at the edge of the deposit, a relationship consistent with in-place deposition of icy material. The analysis done here indicates that visible, stranded basal unit beneath Abalos Mensa has a bedding geometry inconsistent with nearby rupes tenuis unit and poorly explained by large scale coverage and erosion.

While lack of transport may be expected in the younger cavi unit, SHARAD data do not indicate rupes tenuis unit exists beneath Abalos Mensa. Therefore, it is likely that the entirety of Abalos Mensa formed in situ. Furthermore, SHARAD data clearly illustrate that basal unit material in Abalos Mensa is confined to the western half and is not widespread. Where basal unit exists, radar analysis gives no indication of rupes tenuis unit. The basal unit identified in radar stratigraphy is most easily correlated with exposed PB cavi unit, the only unit present in optical analysis [1]. Radar data do not contain a marked transition to suggest material change from cavi unit to rupes tenuis unit in Abalos Mensa.

**Conclusions:** Our findings further constrain the timing of Abalos Mensa formation and provide additional evidence negating the NPLD-melt hypothesis. An alternative hypothesis that we present is independent accumulation of cavi unit and NPLD adjacent to Rupes Tenuis. This hypothesis still permits widespread initial rupes tenuis unit deposition and erosion [1] but does not necessitate selective preservation. Selective preservation is often attributed to impact cratering, a feature identified primarily by morphology. The lack of basal unit beneath Abalos Mensa’s western half is inconsistent with current impact preservation hypotheses [1]. Additionally, impact hypotheses use rupes tenuis unit material which SHARAD data do not reveal in this region.

A notable implication of our hypothesis is that it requires independent deposition of icy material in the Abalos Mensa region. Material would only be able to accumulate here if atmospheric processes were favorable for deposition separate from the rest of PB. Mesoscale modeling is being conducted to compute the wind conditions here using ancient topography [10] and will provide insight into the likelihood of this hypothesis.

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