ABALOS MENSA, PLANUM BOREUM, MARS: A CONSTRUCTIONAL, AEOLIAN HISTORY DERIVED FROM RADAR AND OPTICAL STRATIGRAPHY, REINFORCED BY ATMOSPHERIC MODELING. T. C. Brothers[1], J. W. Holt[1], A. Spiga[2], [1]University of Texas Institute for Geophysics, Jackson School of Geosciences, University of Texas, Austin, TX 78758 tcbrothers@utexas.edu; jack@ig.utexas.edu. [2]Laboratoire de Météorologie Dynamique, Université Pierre et Marie Curie, France.

Introduction: Abalos Mensa, Mars is a wedge-shaped mound adjacent to the Rupes Tenuis scarp of Planum Boreum (PB) circa 285°E. This feature is ~180 km across and isolated from PB via two channels (Fig. 1). As this deposit has unique morphology, scientists have debated its origin. Efforts to explain Abalos Mensa and its morphology have fallen into two dominant categories: (a) fluid flow and/or geothermal heat flux [1-4], and (b) stranded ancient PB material [5].

The geothermal heating or fluid flow hypotheses require localized heat sources such as shield volcanoes [1,3] to initiate flow by melting polar materials. Morphological evidence has been presented [1,2] in support but the scenario requires a very specific series of events. Furthermore, the interpretation of nearby conic landforms as volcanic has been called into question [6] and indicates a problem inherent to any melt hypothesis, a missing heat source. An additional complication is the presence of ancient rupes unit on the hypothesized volcanic cones [5]. Rupes is the oldest ice rich unit on the north pole of Mars. Post deposition, this unit should not survive a volcanic event.

The stranded-PB hypothesis states that the Abalos Mensa mound is remnant rupes material armored by impact crater shielding. The surrounding rupes was removed, leaving an isolated patch that fostered later Polar Layered Deposit (PLD) deposition [5].

Here we have analyzed SHARAD subsurface data along with optical imagery to test these two hypotheses using internal stratigraphy; in particular, bedding attitudes and the extent of basal unit (BU) materials. We then present an additional hypothesis for Abalos Mensa formation that requires only observed processes instead of undocumented ancient processes.

Methods: Data from four instruments on three spacecraft were used: Shallow Radar (SHARAD) and High Resolution Imaging Science Experiment (HiRISE) on Mars Reconnaissance Orbiter, Mars Orbiter Laser Altimeter (MOLA) on Mars Global Surveyor, and the High Resolution Stereoscopic Camera (HRSC) on Mars Express. To examine internal stratigraphy and BU extent beneath Abalos Mensa, orbital radar sounding data from SHARAD were used. The vertical resolution of SHARAD is ~9 m in water ice [7]. To correctly position the SHARAD data a first return algorithm was used. This algorithm uses a picked surface return and its time delay to calculate the surface location of the dominant signal return; this is especially useful in areas with significant topographic relief.

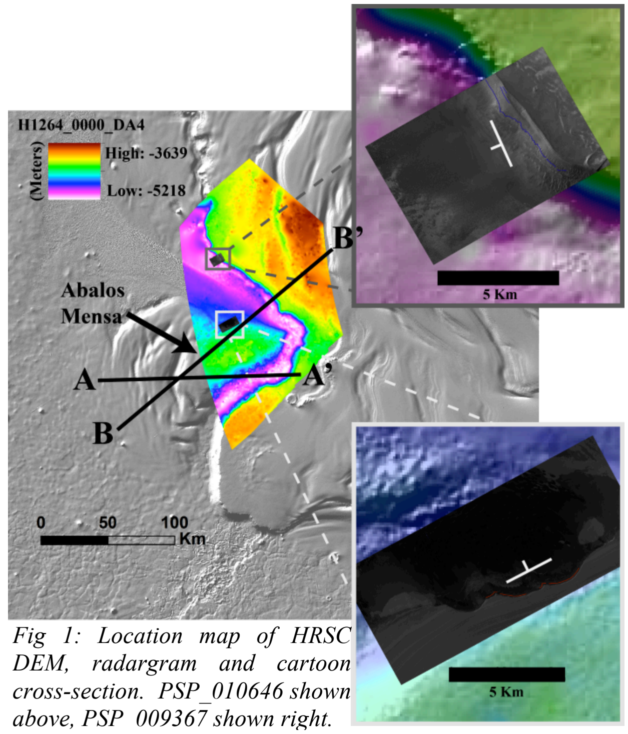

Fig 1: Location map of HRSC DEM, radargram and cartoon cross-section. PSP_010646 shown above, PSP_009367 shown right.

With HiRISE imagery we mapped stratigraphic boundaries on exposed BU both in the Rupes Tenuis scarp and Abalos Mensa. Imagery was used to bolster radar interpretation because meter-scale stratigraphy is not resolved by SHARAD. BU boundaries in the Abalos region were picked on geolocated HiRISE images coregistered with MOLA data and a HRSC digital elevation model (DEM) in ESRI's ArcGIS. Points were extracted from the interpreted boundaries with elevation values corresponding to MOLA and HRSC.

Once the boundaries were picked and elevation data extracted as a series of points, slope maps, aspect

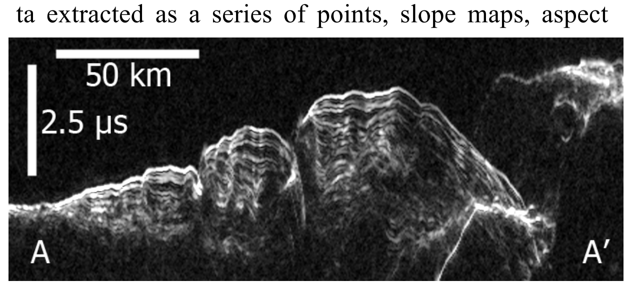

Fig 2: Radargram FPB_1612601000 showing downlapping NPLD reflectors and no evidence for basal unit. 2.5 μs is approximately 420 m in water ice.

maps and trend maps were created to show bedding attitude for each boundary. The maps were then analyzed in correlation with the radar data to evaluate prior hypotheses and formulate a new hypothesis.

Results: Radar stratigraphy in Abalos Mensa shows PLD reflectors forming a lobate deposit. Reflectors are thickest at the center and thin as they downlap onto surrounding Vastitas Borealis material. BU material is only found in the radar stratigraphy as an isolated patch on the western half of Abalos Mensa. This location is the only visible outcrop of BU in Abalos Mensa [8], and all of the exposed material is mapped as PB cavi unit, the younger BU member [5].

Bedding geometry was determined by mapping of images coregistered with DEMs. Two independent DEMs were used, MOLA 512 ppd and HRSC H1264_0000_DA4.IMG. Points extracted along bedding planes produced consistent geometries using the two DEMs. Dip direction of the BU in Abalos Mensa was measured at ~330^o while BU on the Rupes Tenuis scarp dipped towards ~220^o. At both sites calculated dip direction was nearly perpendicular to the BU exposure; i.e., away from the deposit's center (see Table 1).

Using a martian mesoscale atmospheric model [9] modified with BU topography, as derived from [10], we were able to test the likelihood of deposition in the Abalos Mensa region after the erosion of rupes unit and the creation of the Rupes Tenuis scarp. The model results show strong winds flowing down from the scarp face and along the scarp edges. However, the friction velocity of the wind drastically tapers off where the Abalos Mensa deposit is now, making it a region where sediment deposition was more favorable.

HiRISE Image	MOLA Aspect	HRSC Aspect	MOLA Dip	HRSC Dip	Line Length
009367-1	335	347	18.3	5.5	530 m
009367-2	334	330	11.1	11.1	284 m
009367-3	*(330)*	322	2.3	1.9	2,300 m
010646	223	239	14.2	12.3	597 m

Table 1: Boundary layer dip and dip direction measured from HiRISE images PSP_009367 and PSP_010646 using MOLA and HRSC topography.

Discussion: Fluid mobilization as a result of melting from geothermal anomalies should create downwarped layers. Internal radar stratigraphy of Abalos Mensa does not show PLD reflector warping; rather, reflectors are continuous and downlap onto Vastitas Borealis (Fig. 2), consistent with in-place deposition of the PLD. Furthermore, the dip direction of exposed BU bedding surfaces along Rupes Tenuis scarp and Abalos Mensa is consistent with in-place deposition. No disruption of bedding as would be expected from a remobilization event is observed in either radar or imagery. Therefore, all evidence indicates that the cavi unit within Abalos Mensa also formed in place.

BU extent beneath Abalos Mensa is isolated to a small, western portion of the deposit. Additionally, the BU is exposed in HiRISE imagery near its thickest location in radar. Based on imagery, the only present BU is cavi unit. Therefore, it is unlikely that rupes material exists beneath Abalos Mensa as required in the impact shielding hypothesis presented earlier [5]. This places a time constraint on in the formation of Abalos Mensa. Abalos Mensa is younger than rupes yet older than the north polar layered deposits (NPLD), making it likely coeval with cavi deposition.

Given the bedding geometry, BU extent, and BU member composition, our data do not agree with the two dominant Abalos Mensa hypotheses. The deposit is not the result of mobilized icy material nor impact ejecta shielding rupes material. The results from this study indicate that the BU and overlying material in Abalos Mensa are the result of constructional events. This new hypothesis is consistent with our mesoscale modeling results that showed wind frictions compatible with erosion of PB material along the Rupes Tenius scarp accompanied by deposition in the location of Abalos Mensa. This scenario likely led to the gradual construction of Abalos Mensa following widespread rupes erosion. Abalos Mensa is therefore likely to be younger than thought, and formed as the result of processes that are currently operating on Mars.

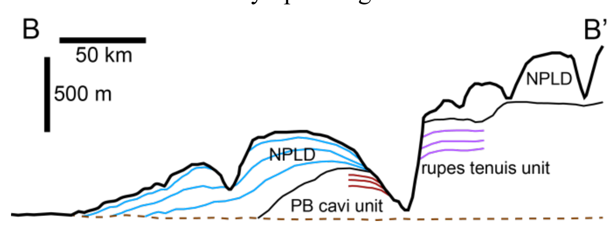

Fig 3: Interpretation of radar and optical stratigraphy crossing Abalos Mensa (see Fig. 2 for location). Note opposing dip direction of rupes tenuis and PB cavi units.

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