UNCONFORMITY ORIENTATIONS IN PLANUM BOREUM, MARS: PRELIMINARY RESULTS AND INTERPRETATION. C. M. Fortezzo[1,2] and K. L. Tanaka[2], [1]Department of Geology, Northern Arizona University, Flagstaff, Arizona, cmf72@nau.edu, [2]U.S. Geological Survey, Flagstaff, AZ 86001, ktanaka@usgs.gov.

Introduction: We have begun measuring the orientations of unconformity surfaces and mapping their locations within the polar layered deposits (PLD) of Planum Boreum, Mars. Our goals are: (1) to better understand the relationship between unconformities and their adjacent layers and troughs in which they lie, and (2) to test and, if need be, to develop possible formational mechanisms.

Methods: Unconformities were mapped using ArcGIS on a basemap of 115 m/pixel resolution MOLA topography data overlain by hundreds of ~19-17 m/pixel THEMIS VIS images and selected <10 m/pixel resolution THEMIS and MOC narrow angle images. The mapped unconformities (Figure 1) represent only a small sample of the total number in the region and correlate to unconformities previously identified in MOC narrow angle images [1].

The ArcView 3.2 three-point problem calculator plug-in program was used to determine the dip magnitudes and directions of the unconformities using 3D location data from the 115-m/pixel MOLA digital elevation model in a polar stereographic projection. The orientation data were then plotted in a rose diagram to resolve the dominant orientations (Figure 2).

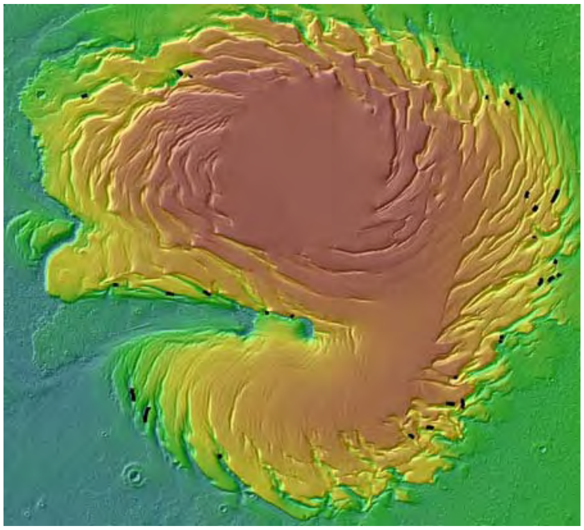

Figure 1: MOLA-based color shaded relief map of Planum Boreum, Mars (warmer colors are higher elevations). The black lines are the mapped unconformities measured in this study.

Results: The map (Figure 1) shows 43 distinct unconformities that we measured distributed throughout Planum Boreum. The surface expressions of the unconformities are randomly orientated with respect to each other but are generally parallel with the troughs in which they lie.

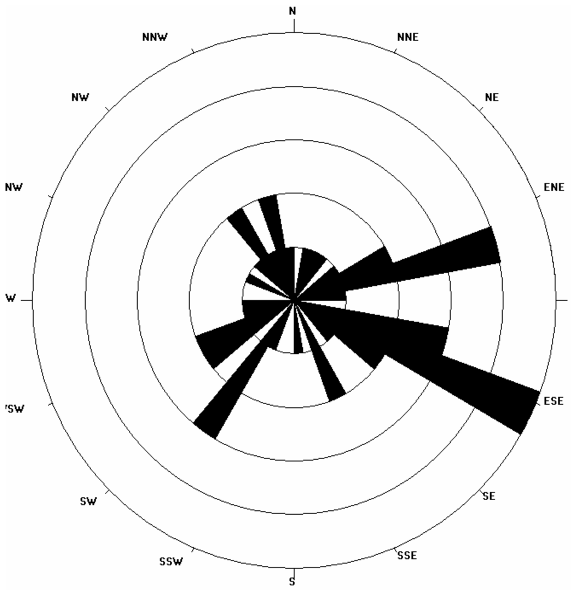

Figure 2: Rose diagram of the dip azimuths for the 43 measured PLD unconformity surfaces in this study. Note the east-southeast dominant orientation. Data is separated into 36 10º bins and the great circle interval is 1 data point.

The three-point problem solutions for the measured unconformities yielded a range of dip-directions (17º - 356.6º) and dips (0.1º - 83.9º). Errors within these measurements were not quantified, but we recognize errors occur because (1) the curvilinear expression and limited extent of the unconformities is not ideal for calculating three-point solutions, (2) an order of magnitude difference in resolution between the images and topography data may cause the inadvertent measurement of the wrong layer and (3) registration errors of images to the MOLA base may cause discrepancies in the resultant data if the pixels are not aligned correctly. We tried to assess the degree of error by taking multiple measurements at different locations along the same unconformity to test whether or not the measurements were reproducible.

The rose diagram (Figure 2) shows that there is an array of orientations within the dataset. Significantly, we find that a dominant, eastward orientation, mean resultant direction being 101º. This trend could be due to the location of many of the unconformities used in the analysis and will be further examined as more unconformities are measured. There is also a less dominant trend to the southwest.

Discussion: One scenario of trough formation involves insolation-induced ablation of equator-facing scarps and redeposition on flats and pole-facing scarps in stepped and troughed topographies as troughs migrate poleward; unconformities resulting from this process are expected to dip parallel to scarp dip trends [2-3]. Measurements of Planum Boreum scarp dip directions demonstrate predominantly a SSW direction [2]; thus this process may account for the less dominant unconformity set of trends directed to the south and southwest. However, this process does not account for the dominant east-trending dips.

The troughs are also perpendicular to katabatic (downslope) winds across Planum Boreum that deflect westward across Planum Boreum, which are consistent with the SW orientation of Chasma Boreale and of dune migration of Hyperborae Undae within the chasma and the SW to W dune migration of Abalos and Olympia Undae on the margins of Planum Boreum. However, these winds are oblique to perpendicular to most trough scarp orientations, thus the troughs cannot be directly attributed to katabatic winds.

An additional observation is that Planum Boreum is marked by gentle undulations that align with trough orientations. These undulations may form as a consequence of preferential dust accumulation where perennial ice exists. If during particular climate episodes the ice is preserved year-round where insolation is relatively low and removed where the insolation is high, differential dust and ice accumulation may occur, ultimately leading to trough formation where scarps develop of sufficient steepness [4]. If this is the dominant mechanism for trough formation, then troughs do not migrate poleward significantly but can enlarge both by deepening and by elongation at their ends.

One additional mechanism for unconformities in PLD suggests that winds crossing topographic saddles between troughs may cause local erosion or non-deposition of PLD [1], which could result in unconformities that dip parallel to the troughs, in either direction.

Our mapping of Planum Boreum unconformities indicates that most occur within the deeper troughs that dissect thicker sections of PLD near the margins of the planum. Also, the unconformities occur low within the PLD stratigraphy. We suggest that the majority of east-dipping unconformities result from major episodes of trough deepening, burial, and exhumation. Most of the eastern to southeastern terminations of the troughs have since been removed by retreat of the margin of Planum Boreum, whereas the western to northwestern terminations are nearly all preserved. This can account for the predominant eastward dip trends of unconformity surfaces. While troughs have continued to develop in higher PLD strata, they apparently have not experienced burial and exhumation that has been preserved in the long-term stratigraphic record. However, the uppermost PLD rest unconformably on the underlying PLD, particularly on poleward-facing trough scarps [1]. The unconformable parts of these uppermost PLD may be deposited and removed cyclically with climatic insolation variations, perhaps in part due to rapid removal of a dust-rich basal layer [5]. Thus the unconformities in the lower PLD may represent more profound climate variations that occurred when early PLD accumulation occurred, perhaps during the abrupt decrease in insolation occurring ~5 million years ago [6] and/or in earlier epochs.

Future work: We will complete the mapping of the unconformities and the measuring of their surface orientations as well as those of the overlying and underlying bedding. In addition, measuring the trends of the curvilinear troughs and undulations and comparing those to the dip directions will enable us to test whether the relationships support particular and perhaps multiple trough formational hypotheses as indicated thus far.

References: [1] Tanaka, K.L. (2005) *Nature 437*, 991. [2] Howard A.D. (1978) *Icarus 34,* 581-599. [3] Howard A.D. et al. (1982) *Icarus 50,* 161. [4] Cutts J.A. et al. (1979) *JGR 84*, 2975-2994. [5] Rodriguez J.A.P. et al. (this volume). [6] Laskar J. et al. (2004) *Icarus 170,* 343-364.