

The Peculiar Stratigraphy of Offset Troughs within the Martian North Polar Layered Deposits – Evidence for Deformation? D. Pais¹, B. C. Murray², A. V. Pathare², S. Byrne³ and R. F. Chomko² ¹Saint Louis University (MSC 2262, 20 N. Grand Blvd., Saint Louis, MO 63103: paids@slu.edu), ²California Institute of Technology, ³Lunar and Planetary Laboratory, University of Arizona.

Introduction: Deciphering the stratigraphy of the Martian North Polar Layered Deposits (NPLD) may provide critical insight into climatic processes on Mars. Detailed layering is exposed within NPLD troughs, the stratigraphy of which can either simply appear straight-lying or manifest in a more complex offset pattern (Fig. 1). Here we examine small-scale variations in the stratigraphy of offset troughs over distances of 20 to 40 km, using digital elevation models from Mars Orbiter Laser Altimeter (MOLA) data and high resolution images from the Mars Orbiter Camera (MOC) and the Thermal Emission Imaging System (THEMIS). We present observations of curvilinear ‘wrinkle’-like layering exposed near the junctions of some offset troughs (e.g., Fig. 1), which may represent evidence of localized ductile deformation within the NPLD.

Observations: Nomanbhoy et al. [1] utilized MOLA observations of the north polar cap to identify numerous offset troughs exhibiting lateral displacement (Fig. 1) across the entire NPLD. However, our examination of all available MOC and THEMIS images corresponding to these offset troughs indicated that the observed ‘wrinkled’ stratigraphy is restricted to the quadrant of the NPLD bounded by the 270°E and 0°E meridians encompassing Chasma Boreale (Fig. 2). Additionally, all wrinkled offset troughs exhibit a poleward-westward sense of deflection, such that the offset trough segment located closer to the pole is always displaced to the west (e.g., Fig. 1).

Mechanisms: The key question is whether the wrinkling is simply due to erosion of a plane-parallel layer stack, or a result of lateral deformation? As shown in Fig. 3, we have conducted extensive layer tracing in order to create detailed three-dimensional reconstructions of layer stratigraphy within wrinkled offset troughs. Our analysis indicates that the wrinkled layers in these offset troughs show distinct deviations from planar fits, especially at the junctions between the troughs (Fig. 3). In contrast, layers in more common ‘wrinkle’-free troughs can be well-approximated with planar fits.

Implications: Therefore, we find that simple surficial erosion of plane-parallel layers cannot account for the observed three-dimensional stratigraphy of wrinkled offset troughs. Instead, we conclude that their most likely formation mechanism is a past episode of subsurface deformation involving differential lateral shear (perhaps associated with Chasma Boreale, given the localization of wrinkling shown in Fig. 2). We will consider the observational implications of this origin for subsurface radar sounders such as MARSIS and SHARAD, which could potentially confirm that wrinkled offset troughs represent evidence of ductile flow processes within the North Polar Layered Deposits.

References: [1] M. Nomanbhoy, B. C. Murray, A. V. Pathare, M. Koutnik, S. Byrne (2004) *LPS XXXV*, Abstract #1694.

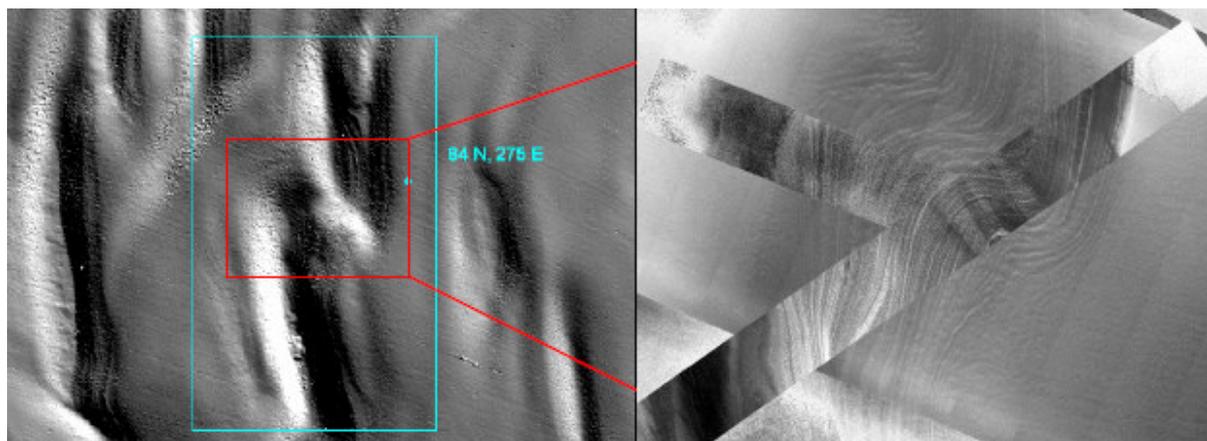


Figure 1: (Left) MOLA topography of offset trough centered at 84°N and 275°E. Red box highlights the wrinkle shown (at Right) in THEMIS and MOC images. North is to the right of both images.

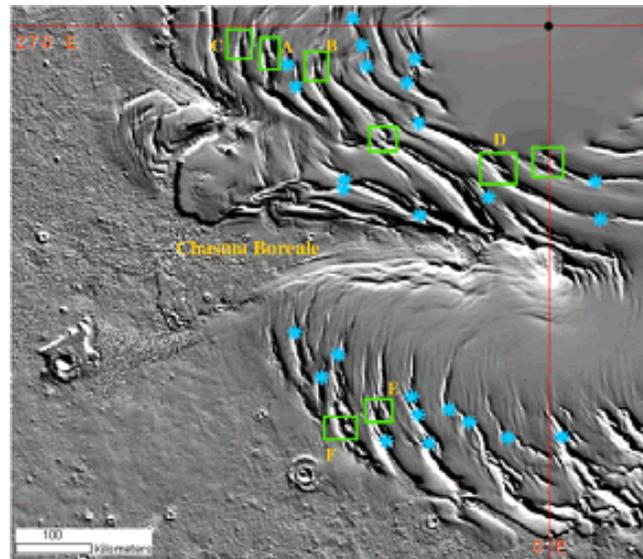


Figure 2: MOLA-identified offset troughs [1] in NPLD quadrant bounded by 270°E and 0°E: green boxes denote presence of wrinkled offsets, while blue stars indicate offset troughs that do not exhibit wrinkling.

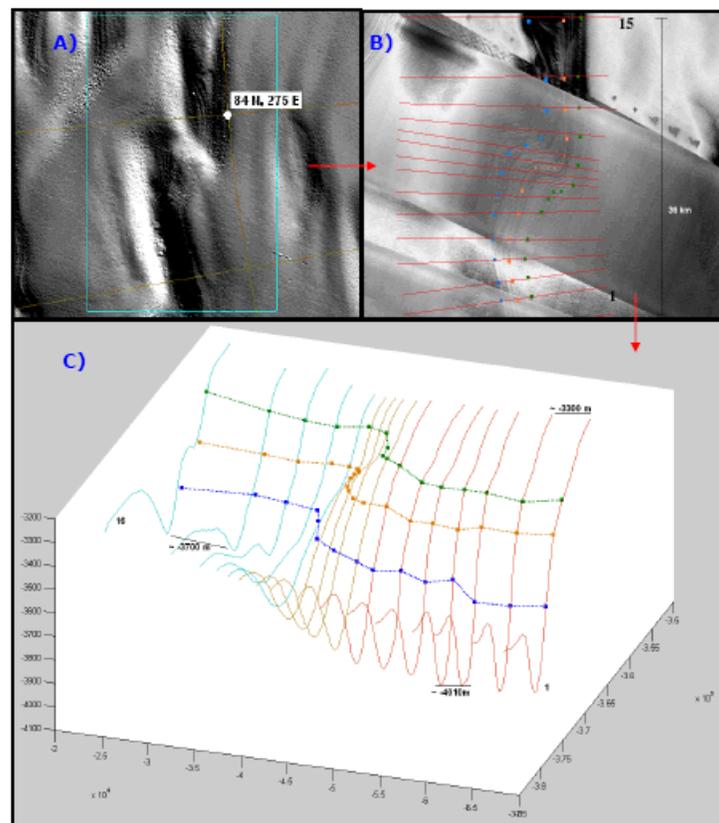


Figure 3: (A) MOLA-DEM of offset trough, (B) THEMIS and MOC images showing layer traces of exposed wrinkled stratigraphy, and (C) Three-dimensional reconstruction of the offset trough: coloring of layers corresponds to that of the layer traces in (B). The two trough segments are distinguished using red and blue profiles in order to better identify the location of the offset.