Morphological Evidence for the Large-Scale Evolution of Martian North Polar Troughs? M. Nomanbhoy[1], B. Murray[1], A. Pathare[1], M. Koutnik[2], and S. Byrne[3] [1]California Institute of Technology (Mail Code 150-21, Pasadena, CA 91125: mariya@gps.caltech.edu), [2]University of Washington, [3]Massachusetts Institute of Technology.

Introduction: The kilometer-scale topography of the North Polar Layered Deposits (PLD) is dominated by arcuate troughs that appear to spiral outward from the pole (Fig. 1). These troughs are typically asymmetric, with equatorward-facing (EWF) walls that are generally steeper than their poleward-facing (PWF) counterparts. Several mechanisms for trough evolution have been proposed, including: preferential sublimation from sun-facing EWF walls (1,2), eolian ablation by katabatic winds (3,4), and differential relaxation due to the slower relaxation rates of colder PWF walls (5).

Morphometry: In order to constrain the present state and evolutionary history of the NPLD, we have employed Mars Orbiter Laser Altimeter (MOLA) data to measure trough configurations and orientations. We have examined almost every trough upon the NPLD (Fig. 1). As seen in Fig. 2, NPLD troughs are characterized by maximum EWF slopes that are roughly 75% steeper than their maximum PWF slopes (2,5). Fig. 2 also shows that EWF trough walls are generally deeper than opposing PWF walls. However, our NPLD-wide measurements indicate that neither trough depth nor maximum slope is correlated with polar distance—i.e., troughs do not get progressively steeper or deeper further from the pole.

Morphology: Much as photographic imagery unveils the stratigraphic variety of NPLD layers, so too does laser altimetry reveal the morphological complexity of North PLD troughs. For instance, the shaded relief map in Fig. 3 shows a typical example of "offset" troughs, which we have identified throughout the NPLD. Do such troughs result from lateral displacement? Another common form is the "branched" trough shown at the bottom right of Fig. 4, in which one parent trough seemingly splits into two. We will present a comprehensive map of where these two trough types are located throughout the NPLD.

Implications: The large-scale evolution of the NPLD is likely governed by one or more of three processes: water ice sublimation and condensation (1), dust erosion/deposition (3), and glacial flow (6). We will use Mars Orbiter Camera (MOC) and Thermal Emission Imaging System (THEMIS) images of complex troughs form in order to test these hypotheses. For example, the sizable NPLD sub-section shown in Fig. 4 (corresponding to most of the upper left quadrant of Fig. 1) exhibits numerous offset and branching troughs that may be consistent with differential regional flow—a theory that we will assess using MOC and THEMIS data.

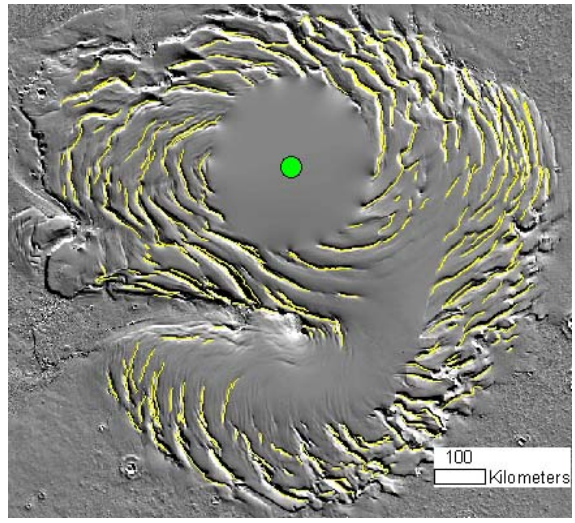

Figure 1: MOLA shaded relief map of NPLD. Yellow lines represent centers of examined trough, as derived from contiguous zero points on a slope map.

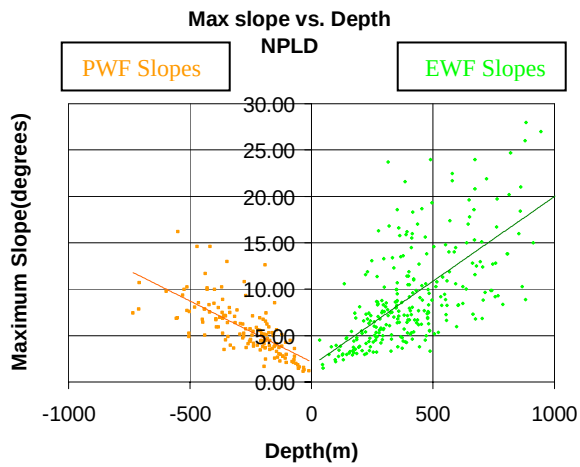

Figure 2: Maximum PWF and EWF slopes vs. total depth for over 300 NPLD trough profiles.

References: (1) Howard A. H. (1978) *Icarus*, *34*, 581-599. (2) Ivanov A B. and Muhleman D. O. (2000) *Icarus*, *144*, 436-448. (3) Howard A. H. (2000) *Icarus*, *144*, 267-288. (4) Ng F. S. L. and Zuber M. T. (2003) 3rd Mars Polar Conf., Abstract # 8061. (5) Pathare A. V. and Paige D. A. (2003) *LPS XXXIII*, Abstract #2051. (6) Fisher D. A. (2000), *Icarus*, *144*, 289-294.

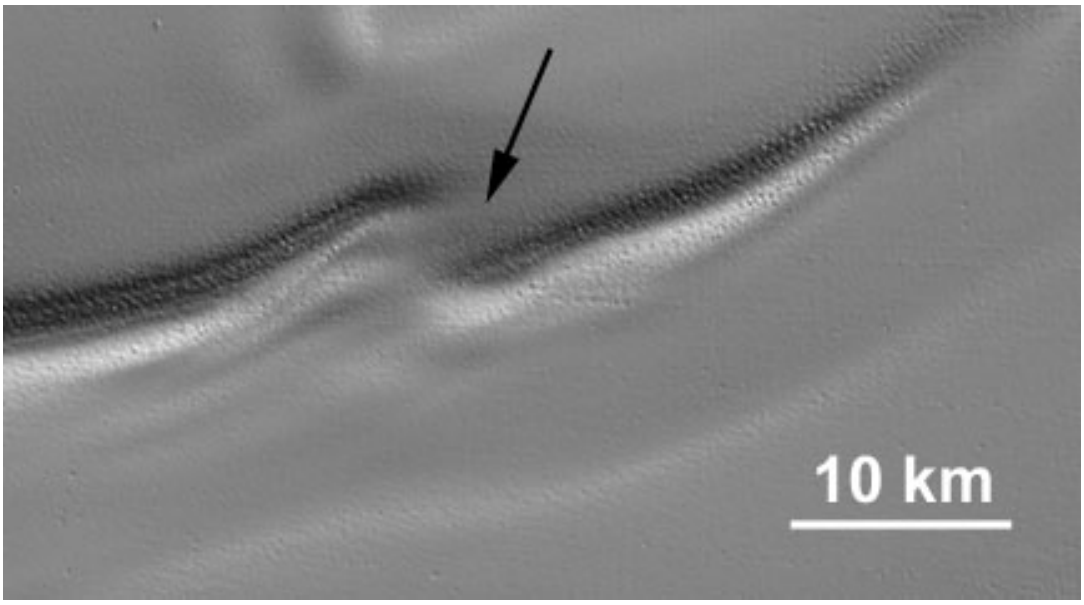

Figure 3: MOLA shaded relied map centered at 86˚N, 240˚W. The arrow indicates the apparent displacement point of an “offset” trough.

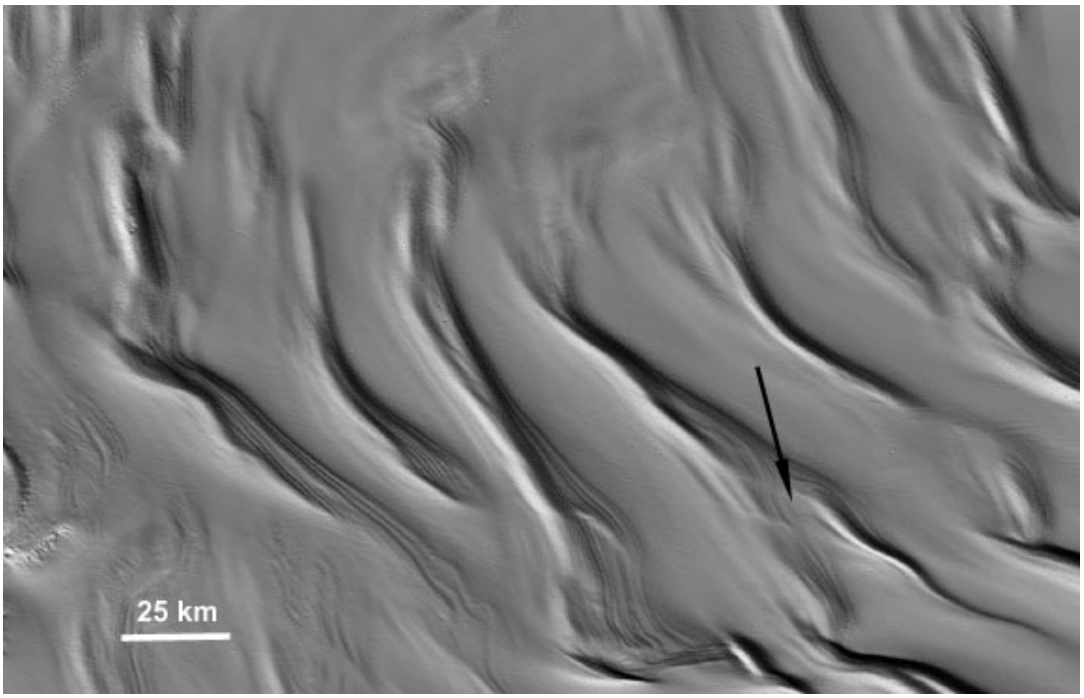

Figure 4: MOLA shaded relied map centered at 86˚N, 240˚W. The arrow indicates the apparent dividing point of a “branching” trough. Note the numerous offset troughs near the top the image, which are possibly indicative of differential flow within this region.