TRANSPRESSION AND MULTIPHASE DEFORMATIONS IDENTIFIED FROM THE DISCONTINUITY PATTERNS IN LUNAE PLANUM, MARS.

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Introduction: The Hesperian ridged plain of Lunae Planum (Mars) comprises km-scale layers of flood basalt, accommodating <0.3% regional strain [1]. Wrinkle ridges originate during thrusting as a part of thin-/thick-skinned tectonics in basaltic as well as sedimentary/layered terrains ([2] and refs. therein). Along with the influences of topography and gravity, the flexural loading stresses and thrust-backthrust combinations play the key role in wrinkle ridge formation [2]. Conversely, strike-slip faults are less pronounced in planets and satellites due to the absence of prominent plate tectonics, and/or undetectable displacements [3]. However, based on geomorphic features, strike-slip faults have been detected on Mars [e.g., 4-6]. Conjugate strike-slip faults and Riedel fractures [7] mark the inception and development of a thrust system and the zig-zag 'wrinkle' geometry of the ridges [8, 9]. A strike-slip component is generally associated with a thrust system experiencing oblique convergence (i.e., transpression), where the non-orthogonal principal compressive stress on the thrust plane results in the simultaneous development of thrusting and strike-slip features [10, 11]. This *ongoing* research focuses on the precursor discontinuities and strike-slip signatures related to the wrinkle ridges in the Lunae Planum. The aim is to understand the variation in local stress patterns, and the contribution of other factors, such as the ~NE tilted topography, material properties [12], pre-existing discontinuities (e.g., buried craters), etc., in the formation and final morphology of the wrinkle ridges.

Methods: The wrinkle ridges and associated discontinuities are identified from visual inspection of the CTX 6 m/pixel and THEMIS Daytime IR 100 m/pixel data. CTX tiles created by the Murray Lab [13] were used for creating a mosaic covering Lunae Planum. Elevation profiles are extracted from the HRSC-MOLA 200 blended DEM [14]. All the work shown here has been carried out in a GIS environment.

Observations and Discussions:

Transpression and local-stress patterns. Based on their orientations, the wrinkle ridges can be grouped into two major categories: the more abundant N-S (± 25°) ridges, and the ~E-W trending cross ridges. In both the cases, the precursor conjugate fractures (Fig. 1a) and/or en-echelon Riedel fracture sets (mostly R fractures, Figs. 1b, c) led to the development of thrust faults (Y fractures, i.e., the wrinkle ridges). The ridges then propagated by connecting the nearby en-echelon segments (Fig. 1d). At the endpoints, a propagating ridge connects with a nearby discontinuity either by rotating towards it (Fig. 1e) or by developing wing-cracks (Fig. 1e). This results in the stepover zones (Figs. 1e, f). R-fractures, systematic en-echelon steps, and stepover zones speak for a strike-slip component preceding the thrusting that produced the wrinkle ridges. Anomalous stress regimes are produced by such a transpressional mechanism [15], reflected in the well-distributed orientation of the ridges and Riedel fractures as well as the twisting of the systematic en-echelon discontinuities (Fig. 1g) as observed here. However, quantifying this anomalous stress pattern and finding a regional pattern (if any) is the key future work.

Multiple phases of deformation. At places, the ~N-S trending wrinkle ridges were found to follow older discontinuities (Fig. 1h). Again, sometimes the younger ~E-W trending ridges (Figs. 1i, j) and grabens (Fig. 1k) show offset along the ~N-S ridges. Hence, although the wrinkle ridge formation is the most prominent deformational phase here, there are signatures of both older and younger phases as well. The future tasks will also focus on the demarcation of multiphase deformation signatures and their influence on younger deformations.

Preliminary Interpretations:

i. There is a strike-slip component associated with the formation of wrinkle ridges.

ii. Signatures of deformational phases older and younger than the ~N-S wrinkle-ridges are observed

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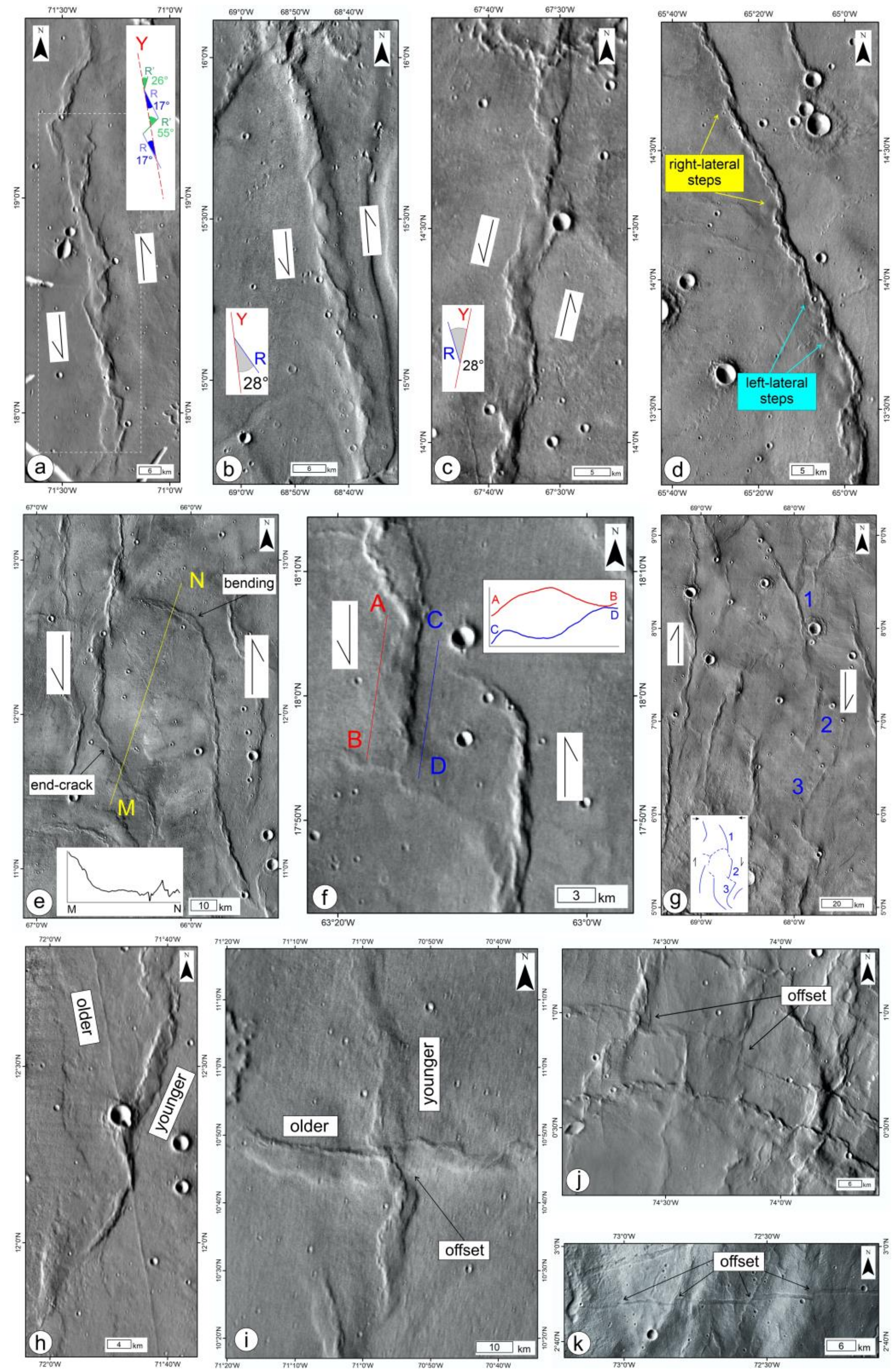

Figure 1: (a) Precursor conjugate fracture sets (R and R' in inset) present with the ridge thrust (Y in inset). **(b, c)** En-echelon Riedel fractures (R) present along the ridge (Y). **(d)** Right- and left-lateral en-echelon steps merged together. **(e)** Bending and end-cracks at the ridge endpoints. **(e, f)** Extensional step-overs. **(g)** Twisting of en-echelon ridges in a 'transpressional flower'-like structure. **(h)** Pathway of a younger ridge influenced by an older discontinuity, probably an extensional crack. The ~ E-W ridges **(i, j)** and grabens **(k)** show offset along ~N-S ridges.