RESULTS OF AXIAL SURFACE MAPPING ON SOLIS PLANUM, MARS: IMPLICATIONS FOR LINKED LOW-RELIEF ARCHES AND WRINKLE RIDGES. A. Vidal[1] and K. Mueller[1], [1]Department of Geological Sciences, University of Colorado, Boulder, CO 80309-0399.

Introduction: Wrinkle ridges in the Tharsis region of Mars form in response to planetary-scale loading and uplift. Wrinkle ridges are the surface expressions of folds that overlie blind thrust faults that collectively accommodate low bulk strains in comparison to terrestrial analogues, such as basement-cored Laramide folds. Models are based on MOLA (Mars Orbiter Laser Altimeter) topographic data and use methods of cross section construction developed for terrestrial analogs based on both kinematic and mechanical techniques. Previous work based on elevation offsets across ridges and their backlimb geometry suggest blind thrusts on Solis Planum penetrate deeply into the Martian crust [1]. Axial surface mapping and forward and inverse modeling of wrinkle ridges on Solis Planum using topographic data from MOLA are used to constrain fault geometry and the depth at which thrust faults flatten.

Wrinkle Ridge Structure: A variety of wrinkle ridge types exist in Solis Planum, as described below. These types have distinct ridge morphology. Tate [1] measured ridge morphology in over 4000 topographic profiles, which were grouped in four end-members: 1) arch with high-relief superposed hill; 2) simple asymmetric ridges without a broad arch; 3) blocky ridges that have no clear asymmetry; and 4) monoclinal ridges [1]. In order to retain continuity and avoid complexity associated with the development of backthrusts [2], this work focused on the simplest type 1 ridges. Changes in backlimb morphology on these ridges can thus be attributed to changes in subsurface fault dip without complexities produced by backthrusts.

Methodology: Axial surface mapping was undertaken to examine scaling relationships for wrinkle ridges on Mars and to unambiguously identify changes in fold geometry produced above bends or curves in underlying thrusts. Terrestrial models have utilized axial surface mapping in defining the structural character of fault-bend folds [3].

Axial surface mapping consists of finding first and second derivative values from MOLA data oriented perpendicular to the fold axes of wrinkle ridge structures. Two regional profiles were constructed across the Solis Planum region (Fig. 1). These topographic profiles were linearly detrended with respect to the regional slope of Solis Planum, which dips gently to the east (Fig. 2). Fifty kilometer wide swaths of first and second derivative maps were created along the profile to ascertain changes in wrinkle ridge morphology. More specifically, the second derivative values aided in identifying the axial surfaces on the edges of the forelimb and backlimb of the fold. Using estimates for crustal thickness and the profiles, themselves, forward and inverse models can be constructed in order to determine the depth to detachment of the fault and fault curvature at Solis Planum.

Fourier analysis was conducted using Mars Global Surveyor data. A filter was constructed to highlight all features sharing the general trend and wavelength of the wrinkle ridges, in order to look for more broad, subtle features associated with wrinkle ridge formation.

Results: First and second derivative slope maps (Figs. 3,4,5) reveal gently curved and wide (10’s of kilometers) backlimbs. Forelimbs show a pronounced change in elevation across Solis Planum. Backlimbs show little evidence of kink-bands. Thus, backlimb width and total relief suggest underlying thrusts are listric in nature. We assumed these listric faults flattened to near horizontal features at, or near, the brittle-ductile transition.

Forward mechanical modeling was undertaken using the listric fault modeling software developed by Johnson and Johnson [4]. Models assumed a depth of eight to twelve kilometers of basalt, with five layers. Values for layer were varied, but all models allowed for flexural slip. The models produced features that were too broad to be compatible with the Martian topography observed at Solis. More robust solutions are currently being developed using greater numbers of freely slipping layers.

Fourier filtering highlighted broad arch features sharing the general trend of the wrinkle ridges, but lacked definitive wrinkle ridge morphology. However, several of these features mimicked changes in wrinkle ridge trend. We argue that adjacent arches and ridges are thus produced by slip above a single fault for these examples.

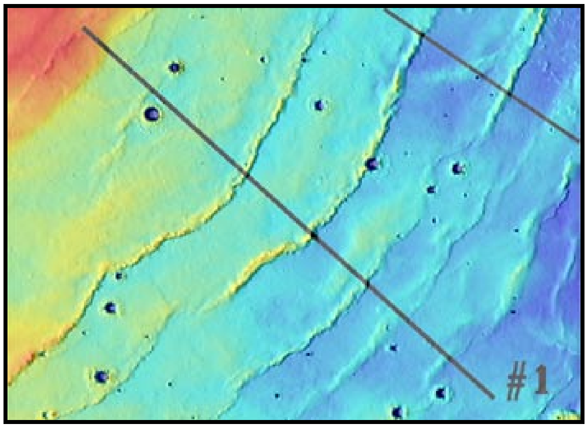

Figure 1. Shaded relief image of Solis Planum area, on Mars. The line of the topographic profile is shown.

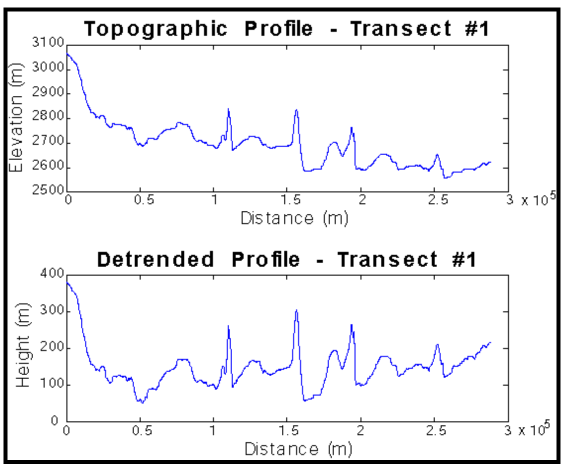

Figure 2. Topographic profile taken across Solis Planum, subsequently detrended for regional slope.

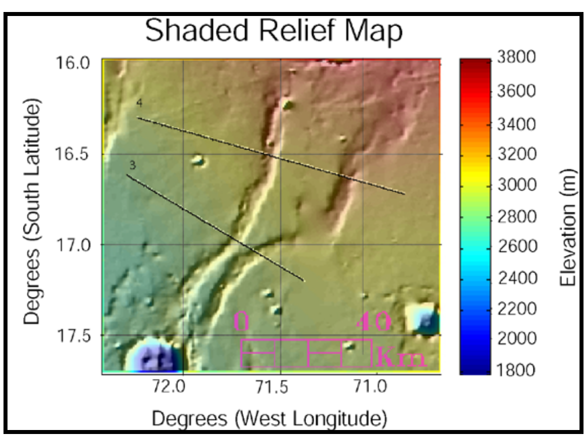

Figure 3. Shaded relief map of two wrinkle ridges on Solis Planum.

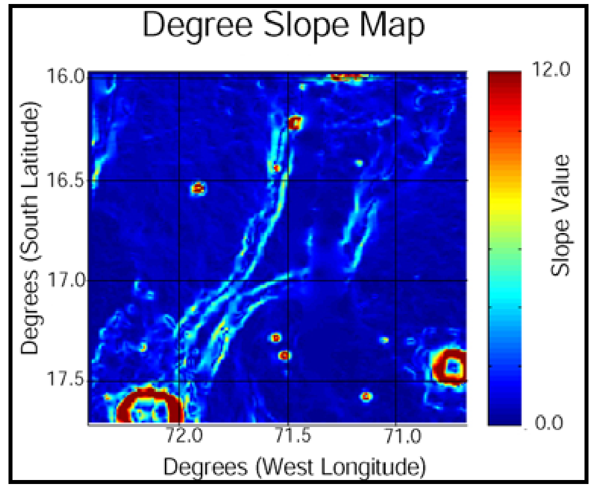

Figure 4. First derivative (slope) map of the same area.

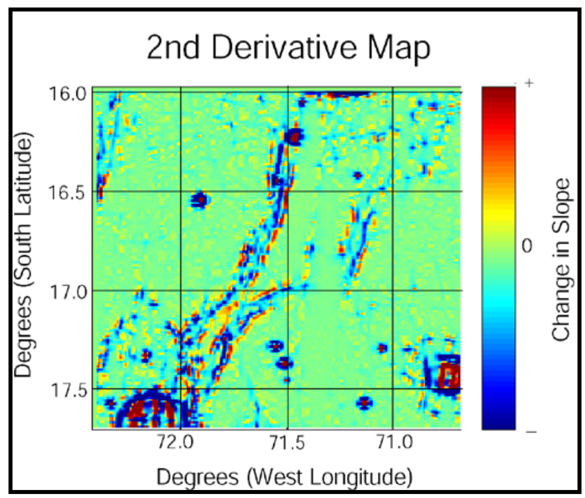

Figure 5. Second derivative map of the same area.

References:

[1] Tate, A. (2001) *Masters Thesis, University of Colorado,* 172p. [2] Schultz, R.A., (2000) *JGR*, *E5 105*, 12,035-12052. [3] J. Shaw et. al., (1994) *AAPG Bull.* 78, 700-721. [4] Johnson, K.M., and Johnson, A.M. (2002) *Journal Struct. Geol.*, *24,* 277-287.