DEFLECTION OF LAVA FLOW DIRECTIONS RELATIVE TO MODERN TOPOGRAPHIC SLOPES IN THE THARSIS REGION OF MARS: INDICATIONS OF POST-FLOW SUBSIDENCE. D. J. Chadwick[1], [1]Department of Geography and Earth Sciences, University of North Carolina at Charlotte, Charlotte, N.C., 28223.

Introduction: The Tharisis Province of Mars is the dominant tectonic and volcanic province on the planet, with a long and complex geologic history [e.g. 1, 2, 3]. High-resolution topographic data from the Mars Orbiter Laser Altimeter (MOLA) and imagery from the Thermal Emission Imaging System (THEMIS) and Mars Orbiter Camera (MOC) are used in this study to compare the flow directions of linear lava flows to current topographic slopes in the Tharsis region. In areas where angular deviations are identified between these two calculated directions, the magnitude and mechanisms of post-flow local and/or regional deformation that has modified the topography can be assessed. A similar approach was used to identify possible post-flow tectonic subsidence on the Snake River Plain in Idaho [4].

Method: This study has been conducted in areas where regional topographic slopes are relatively consistent over a broad area (e.g. south of Olymous Mons; Figure 1) and long, linear lava flows with regionally consistent flow directions are present. Slope and aspect data were generated from MOLA digital elevation models, and regionally smoothed (1 km^2 average) slope direction vectors were generated. Flow directions of individual lava flows were digitaized primarily in geolocated THEMIS imagery and supplemented by MOC imagery. These two data sets were then used to identify areas with a consistent regional divergence of the two vectors.

Results: In many areas, lava flows closely adhered to local topographic contours and show no evidence of post-emplacement deformation. Small-scale local aberrations from the apparent downhill direction that affected only part of a lava flow were considered to be the result of local topographic undulations that are not apparent in the elevation data, and not to significant tectonic deformation.

In a few of the areas, such as south of Olympus Mons (Figures 1-3), there is a clear indication of significant regional divergence of lava flow directions from the modern topography. In the area shown in Figure 1, the topographic slopes consistently deviate approximately 21-31 degrees in a clockwise direction from the lava flows. This is an indication that the topography has been deflected due to regional tectonic deformation following flow emplacement. Other regions of possible large-scale deformation include Daedalia Planum, Syria Planum, and near Ascraeus Mons.

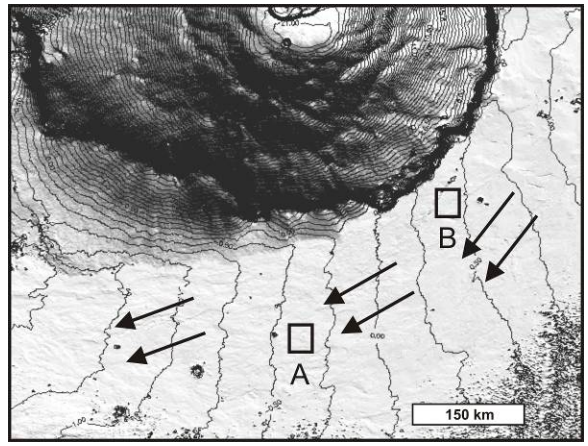


Figure 1. MOLA-derived topographic data for the region to the south of Olympus Mons. Arrows show generalized lava flow directions relative to regional slopes indicated by topographic contours.

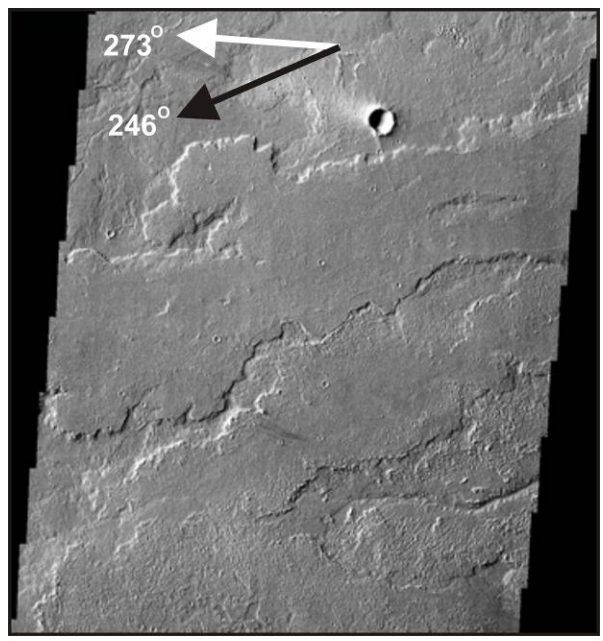


Figure 2. Inset area "A" in Figure 1; THEMIS visible-light image showing the average direction of the calculated regional slope (white arrow) and average direction of digitized linear lava flows in the area, showing a 27 degree difference and a clockwise rotation of the topographic vector relative to the flows. In this area to the south of Olympus Mons, the angular difference averages 24 degrees.

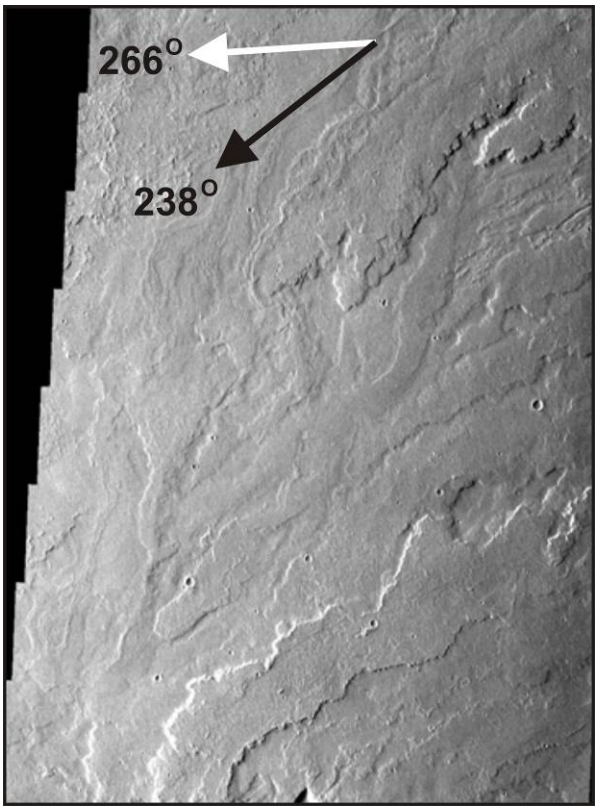
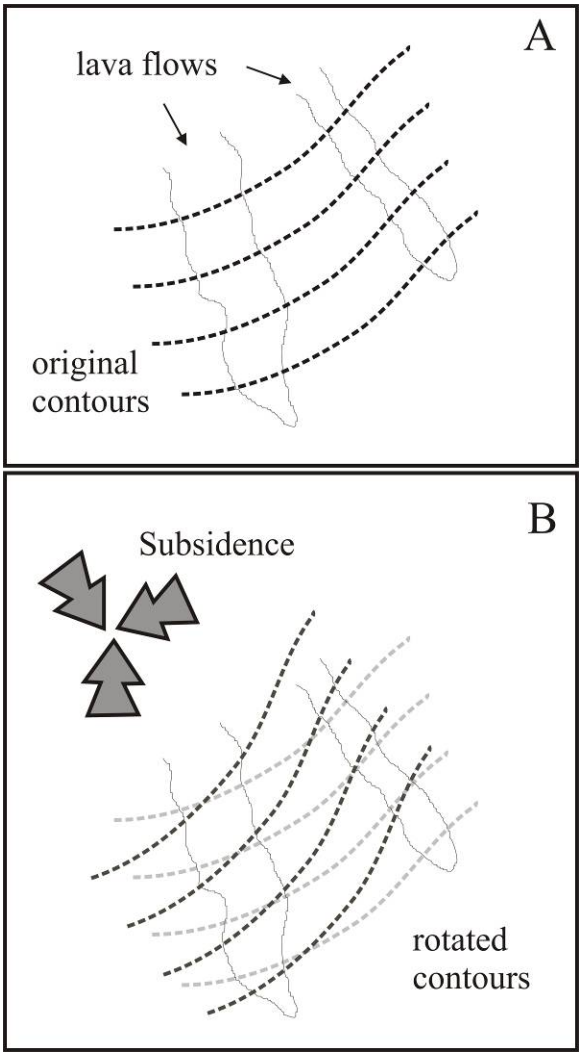


Figure 3. Inset area "B" in Figure 1; THEMIS visible-light image showing the average direction of the calculated regional slope (white arrow) and average direction of digitized linear lava flows in the area, showing a 28 degree difference and a clockwise rotation of the topographic vector relative to the flows.

Tectonic Deformation: Figure 4 illustrates the effect of tectonic uplift on regional topographic slopes. In 4A, lavas flow downhill in a direction perpendicular to local topographic contours. In 4B, contours are subsequently deflected by a subsidence (or uplift) event that changes the regional topography, and the lava flows no longer appear to flow directly downhill. In the area shown in Figure 1, this deformation may be due to subsidence of the Olympus Mons magmatic system in its waning stages of activity. The topographic deviations identified in this study are being used to model the mechanisms and magnitudes of late-stage (post-flow) Tharsis tectonism, which may have been dominated by cooling and subsidence.



References: [1] Zimbelman J. et al., (1991) *Proceedings of Lunar and Planetary Science, Vol. 21, 613-626*. [2] Frey H. and Grant T., (1990), JGR vol. 95, 14,249-14,263. [3] Banerdt W. B. and Golombek, M., 1990, *Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles*, LPI Tech. Rept. 90-06, 63-64. [4] Wettmore, P. H. (1998), Master's Thesis, Idaho State University, 118 pages.