COMPRESSIVE STRAIN IN LUNAE PLANUM-SHORTENING ACROSS WRINKLE RIDGES; J. B. Plescia, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91109

Wrinkle ridges have long been considered to be structural or structurally-controlled features. Most [e.g., 1,2,3,4,5], but not all [6] recent studies have converged on a model in which wrinkle ridges are structural features formed under compressive stress; the deformation being accommodated by faulting and folding. However, the fault dip and the relative importance of folding and faulting remain controversial [c.f., 2,3]. Given that wrinkle ridges are compressive tectonic features, an analysis of the associated shortening and strain provides important quantitative information about local and regional deformation.

Lunae Planum is dominated by north-south trending ridges extending from Kasei Valles in the north to Valles Marineris in the south. This region was selected for detailed because of the well-developed ridges, the relatively simple geologic setting, and the lack of interference from other structures. Lunae Planum is Hesperian-age "ridged plains material" [7] that thicken westward from an eastern contact with Noachian-age highly modified heavily cratered terrain.

To quantify the morphometric character, a photoclinometric study was undertaken for ridges on Lunae Planum using the technique of [8]. Phase-dependent photometric coefficients for the clear and minus-blue filters are presented by [9], the coefficient for the red filter is from [10]. Profiles are typically about 20 km in length and include all of the ridge visible in the image and extending onto the plains on either side; however, profiles could not be extended to adjacent ridges because of albedo variations. Clearly, this is a limitation in the data set, but one which is unavoidable. Comparisons between stereogrammetric topography and shadow determined relief indicate that, under carefully controlled conditions, photoclinometric results are within 10-15% of the relief determined by the other methods. Accuracy of this level is sufficient to estimate the morphometry of ridges. When used in the context of a specific model of formation and internal structure, the morphometric data can be used to asses the amount of compression accommodated by faulting and folding and thus the local and regional strains.

More than 25 ridges were examined between longitudes 57° and 80°, latitudes 5° to 25°N. For each ridge, several (1-15) profiles were obtained along its length. Ridge width, total relief, and elevation offset were measured for each ridge. Width is defined as the distance across the ridge for which relief relative to the surrounding plains is observed. Total relief is defined as the relief from the lowest plains unit to the summit of the ridge. Elevation offset is the difference in elevation of plains on one side of the ridge relative to that on the opposite side [2,11,12,13]. For ridges measured on Lunae Planum, widths ranged from 1.5 to 14 km (mean of 5 km), total relief varied from 16 to 370 m (mean of 127 m), and elevation offsets were 0 to 225 m (mean of 55 m).

Using the model of [1,2] for the internal structure of a wrinkle ridge--anticlinal deformation of the surface above a low-angle thrust fault; the fault presumably breaking the surface--the morphometric data can be used to estimate the shortening due to folding and faulting. Shortening due to faulting is proportional to fault dip and the elevation offset. Shortening due to folding is the difference between integrated surface length across the ridge and the horizontal point to point straight-line distance across the ridge. The dip of the proposed thrust fault is unobserved, but it has been estimated to be about 25° (see [2] and references therein for a complete explanation).

Using these relations, the total shortening due to faulting across the ridges that were measured varied from 0 m (no offset) to about 480 m; the mean value of shortening is 117 m. Shortening due to folding is 1 to 75 m with a mean value of 10 m. The ratio of shortening due to faulting to that due to folding is about 12, similar to values derived for lunar wrinkle ridges [2]. Using this same data set, the net compression and strain across Lunae Planum at 20°N was examined. Seventeen ridges are crossed by this profile which extends from 72° to 59° longitude. The values for each ridge represent the average of all measurements along that ridge. The profile has a total length of 641 km (measured from the westernmost to the easternmost ridge). Total shortening amounts to 1840 m (faulting shortening is 1712 m; folding shortening is 128 m); average shortening per ridge is 108 m. This corresponds to a net compressive strain along the profile length of 0.29% (faulting strain is 0.27%; folding strain is 0.02%). These values are similar in magnitude to shortening strain estimated from kinematic models of lunar mare basins (e.g., Humorum) of 0.16-0.31% [14].

Ridges are not uniformly spaced in longitude across Lunae Planum. Ridges are typically smaller, less well developed, and more numerous east of longitude 65° than to the west. Eleven ridges occur east of 65°W compared with six to the west. Total shortening west of 65° amounts to 924 m (average ridge shortening is 132 m); east of 65° it is 916 m (average ridge shortening is 92 m). Clearly, the net shortening is the same in the two areas, but individual ridges to the west accommodate greater amounts of shortening than those in the east. The relative and absolute magnitudes of faulting and folding shortening are similar in the two regions. The compressive strain in the west is 0.26% and 0.31% to the east, essentially indistinguishable. These data indicate that the net shortening and the net strain, at least within Lunae Planum, is relatively uniform with distance from Tharsis.

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