A GEOMETRIC ANALYSIS OF THE GANYMEDE FURROW SYSTEM: A TEST FOR LATERAL MOTION OF DARK TERRAIN. M.T. Zuber, Dept. of Geol. Sci., Brown Univ, Providence, RI 02912.

Since Voyager images first revealed the nature of Ganymede's surface, the style of tectonics which led to the emplacement of bright terrain has been brought into question (eg. 1,2). Insight into this can be gained by an analysis of the amount of lateral displacement which has occurred on the planet's surface. Since certain models of bright terrain formation require significant lateral motion, recognition of possible shear displacement should constitute an important test for distinguishing between various styles of global tectonics.

Observational evidence for shear displacement on Ganymede is localized and small scale. Several displaced craters have been identified, with offsets of not more than a few km (2). The apparent offset of several bands of bright terrain may also indicate shear movement, however there is no evidence that these sulci did not form with an offset against a pre-existing fracture in the lithosphere.

Another group of structural features which may be indicative of lateral motion is the rimmed furrow system, a regional array of arcuate, sub-parallel features that traverse several areas of dark terrain. The furrows have been interpreted as ring graben formed by an early impact into Ganymede's lithosphere (3,4). In Galileo Regio where the pattern is most distinct, individual furrows are approximately 10 km wide, 50 km apart and run for hundreds of km across the surface (4). The system continues into adjacent Marius Regio, however furrows in this region exhibit marked morphological differences from those in Galileo Regio. The Marius furrows occur as shorter segments, are spaced approximately 16 km apart, and average about 6 km in width.

The system of furrows is not concentric (4) and it has been suggested (5,6) that some degree of right lateral motion and clockwise rotation of Marius terrain blocks would restore the system to a circular geometry. If indeed the system was initially circular, then the present separation between centers of the furrow system in different regions of dark terrain would be a measure of the global scale lateral motion that has taken place on Ganymede.

In this study, centers of the system in three areas of dark terrain were determined from a data set of over 300 digitized furrows. The method employed a non-linear least-squares fit of segments to small circles around an assumed center. The best-fitting center minimized the mean square deviation of furrows from circularity and produced the best visual match of furrows to small circles about the center.

Centers of the furrow system are shown in figure 1. The center of the Galileo Regio system is better constrained than those of the Marius region because furrows in Galileo Regio are longer and more arcuate. In addition, a faint secondary trend in furrow orientation is present in Marius Regio where about 9% of the furrows trend at angles greater than 30° from the local mean segment orientation. These points were removed from the analysis. Furrows within dark regions divided into radii and sector subgroups yielded centers which did not significantly differ from those found for the full sample. This result, combined with the reasonable visual fit to small circles shown in fig. 1, places a limit on the amount of large-scale deformation which has occurred within presently intact dark regions.

If the furrows initially formed a concentric system, lateral movement implied by the present location of furrow centers requires that shear deformation has taken place. If such deformation occurred after the emplacement of

bright terrain, initially circular craters in bright terrain should be deformed into elliptical shapes. By inspection, craters do not appear markedly non-circular, however analysis is in progress to further test this hypothesis. The complexity of bright terrain in the Uruk Sulcus region infers that its emplacement occurred in progressive stages (7). If bright terrain formation coincided with the time of shear deformation, evidence of crater deformation within this region should be visible. If deformation preceded bright terrain formation, old craters along the periphery of dark areas might show evidence of ellipticity, however shear deformation would not be directly related to the emplacement of bright terrain.

References: 1) Parmentier, E. M. et al., (1982) Nature, in press. 2) Lucchitta, B. (1980) Icarus, 44, 481. 3) McKinnon, W. B. et al., (1980) Icarus, 44, 454. 4) Smith, B. et al., (1979) Science, 206, 927. 5) Passey Q. R. et al., (1982) The Satellites of Jupiter, (D. Morrison, ed.), Univ. of Arizona Press, in press. 6) Shoemaker, E. M. et al., (1982) The Satellites of Jupiter, (D. Morrison, ed.), Univ. of Ariz. Press, in press. 7) Golombek, M. P. et al., (1981) Geophys. Res. Lett., 8, 1139.

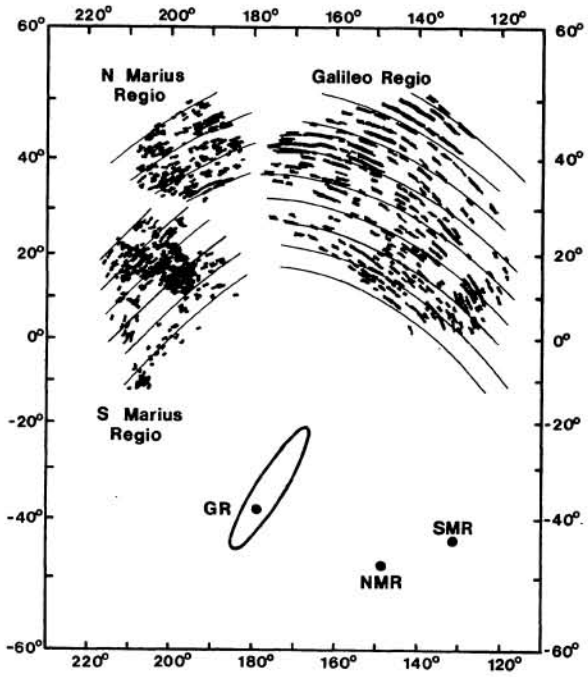

Figure 1. Centers of the furrow system in Galileo Regio (GR), North Marius Regio (NMR), and South Marius Regio (SMR) with corresponding small circle fits. The center of the Galileo Regio system is shown within a 95% confidence ellipse.