PHOTOGEOLOGICAL ANALYSIS OF EUROPAN TECTONIC FEATURES; B. R. Tufts, Dept. of Geosciences, University of Arizona, Tucson, AZ 85721

Preliminary photogeological analyses of the Pelorus Linea and Sidon Flexus regions of Europa were conducted to explore the proposal by Schenk et al that lateral motion of crustal blocks has occurred in a "rift zone" including possible strike-slip, tension fracturing, and geometric plate rotation about an Euler pole [1]. (Figs. 1 and 2) These analyses revealed features interpreted as tensional structures and block rotation in a strike-slip regime consistent with the Schenk et al hypotheses and implied the presence of at least two stages of crustal deformation consistent with a chronology developed by Lucchitta et al [2]. Confirmation of regional scale Euler pole rotation was ambiguous however. Up to 80 kilometers of possible extension was identified in the rift zone; to accommodate this, "cryosubduction" is speculatively proposed here as a mechanism for recycling Europan "ice lithosphere [1]."

The cumulative width of wedge-shaped bands included in the rift zone was measured [8] and plotted versus distance from the inferred rotation pole. (Figs. 2,3) Three sharp decreases in the total width were noted. These occur roughly where certain triple bands cross the rift zone suggesting that the bands are structural features that predate and influence the zone. While the curve hints at one or more sinusoidal relationships consistent with rotation geometry, given the low photographic resolution and the preliminary nature of this examination the question of whether the observations represent *coherent regional* rotation *modified* by crosscutting structures or instead imply *independent local* rotations *separated* by these structures is unanswered by this analysis.

The rift zone and neighboring areas were examined for local structures that suggest lateral motion. Parallelogram-shaped features in the rift zone and near Libya Linea (Fig. 4) resemble "pull-apart basins," a tensional structure found in terrestrial strike-slip settings (Fig. 5) [3]. One of these may exhibit reactivation of a possible bounding triple band. Lineations crossing curvilinear features were seen to be slightly offset implying rotation of rounded blocks, possibly associated with regional shear.

Inferred extension represented by the 80 km maximum cumulative band width in the rift zone must be compensated in some way. Presumably, in the context of the hypothesized mobile ice shell and underlying ocean [1], the relatively light (ice I) Europan lithosphere would be unlikely to subduct into denser ocean water or brine. However, depending on rheology, cryosubduction of Europan ice lithosphere might occur in two ways, obviating the need for theorized global expansion [4]. Compression could bring about simple pressure melting of ice I at block boundaries or could be accommodated by local thickening of the ice shell, forming ridges [1,2,5] and below-water keels as with terrestrial sea ice. Depending on P-T conditions, melting of the ice keels might occur putting meltwater into the aqueous aesthenosphere. Remaining overlying ridges would sink, restoring Europa's low-relief topography. Whenever the ice shell cracked, water would fill the gap and freeze, completing the cycle.

References: [1] Schenk, P. and Seyfert, C.(1980) EOS Trans. AGU 61, 286; Schenk, P.(1984) NASA TM-86247, 3-111; Schenk, P., and McKinnon, W.(1989) Icarus, 79, 75-100. [2] Lucchitta, B.K., and Soderblom, L.A. and Ferguson, H.M. (1981) Proc. Lunar Planet. Sci. Conf. 12B, 1555-1568; Lucchitta, B.K., and Soderblom, L.A. (1982) Satellites of Jupiter, 521-555. [3] Harding, T.P., Vierbuchen. R.C., and Christie-Blick, N.(1985) SEPM Spec.Pub. no. 37, 51-78. [4] Smith, B.A. et al (1979b) Science 206, 927-950; Finnerty, A.A. et al, (1981) Nature (London) 289, 24-27. [5] Nolan, M.C. and Greenberg, R.(1990) in print. [6] Cox, A., and Hart, R.(1986). [7] Chase, C.(1991) personal communication. [8] USGS map, Je-3; Je 5M 0/180 CM (1985). [9] USGS map, Je-3, Je 5M 0/180 AN.(1984).

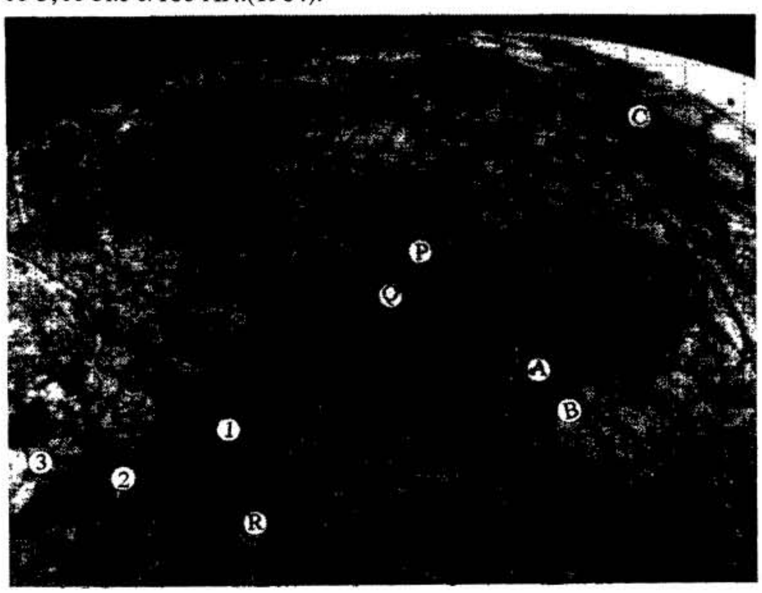
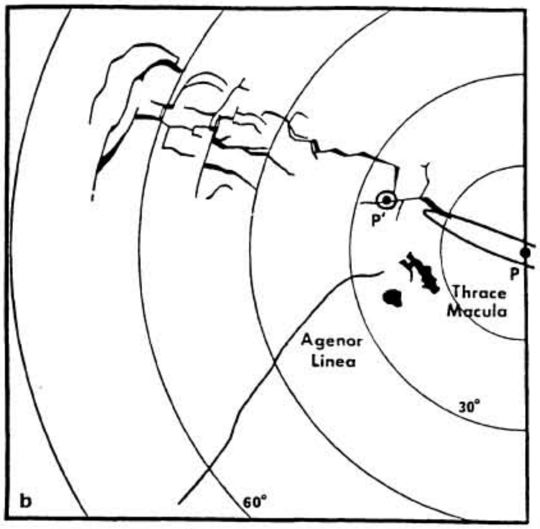


Fig. 1. The Pelorus Linea region of Europa containing the rift zone proposed by Schenk et al [1}, and showing triple bands Pelorus Linea (A), Echion Linea (B), and Argiope Linea (C) [9]. Features P,Q, and R resemble terrestrial "pull aparts." [3) Lineations bounding the ends of feature R are sharpest where differential motion would be predicted, suggesting reactivation. The northern such lineation may be a triple band. Lineations crossing curvilinear features show slight right-lateral offset at points 1,2, and 3. North is to the right. (NASA photograph)



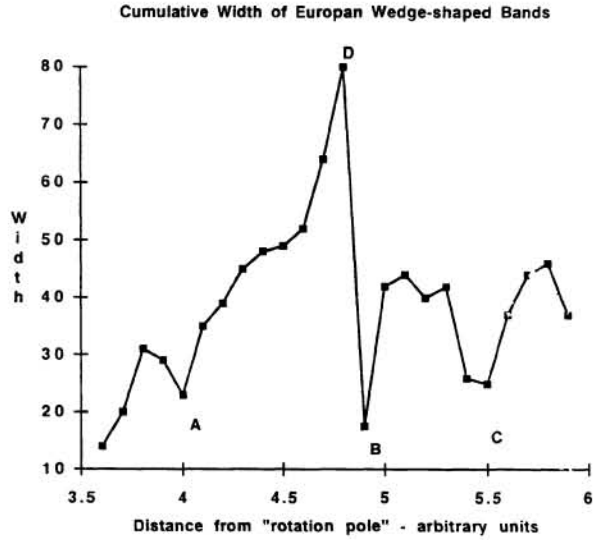


Fig. 2, above left. The cumulative width of "wedge-shaped bands" included by Schenk in the "rift zone" was measured parallel to small circles centered at the proposed Euler pole (P) and plotted against distance from that pole [1]. In terrestrial plate tectonic settings plates rotating about an Euler pole show a velocity proportional to the sin of the angular distance from the pole [6]. Breaks in the pattern suggest the presence of a transform fault [7]. On Europa, cumulative width of the wedge-shaped bands must be taken as a proxy for velocity in the absence of a rotation velocity indicator like paleomagnetic stripes. North is up. (After Schenk and McKinnon, 1989)

Fig. 3, above right. Total spreading (km) measured along individual small circles is plotted against the surface distance (in arbitrary units) between the small circles and the Euler pole, spanning the rift zone. The breaks in the curve suggest changes in the kinematics of rotation at those points, i.e. a change in rotation poles and the presence of a structure. Prominent NE-SW trending triple bands including Pelorus Linea (A), Echion Linea (B), Argiope Linea (C) seem to cross the rift zone at points roughly corresponding to the width drops; occasionally, they truncate individual wedge-shaped bands at those points. This possible relation of triple bands with a change in "rift zone" kinematics is consistent with Schenk et al's division of the rift zone into southeast and northwest portions [1] although the results here also suggest additional structural complexity. The strong initial rise in the curve is consistent with rotation about a nearby Euler pole. However, the remaining pattern does not clarify whether the apparent crosscutting structures modified a broad rotation pattern or simply separated smaller ones. The lack of measured band width near the pole raises questions about pole location or measurement technique.

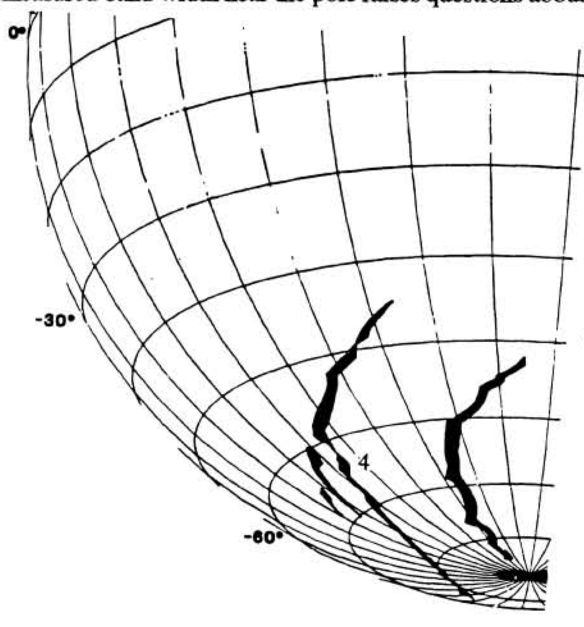


Fig. 4, left. A parallelogram-shaped feature can be seen at point 4 on a branch of Libya Linea. North is up. (After Lucchitta and Soderblom, 1982)

Fig. 5, below. Structures, including "pull-aparts," found in certain terrestrial strike-slip systems. (After Harding, Vierbuchen and Christie-Blick, 1985)