RIFTING AT DEVANA CHASMA, VENUS: STRUCTURE AND ESTIMATION OF THE EFFECTIVE THICKNESS OF THE ELASTIC LITHOSPHERE, D. A. Senske, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109.

To understand the relationship between extension and sites on Venus interpreted to be associated with mantle upwelling, the characteristics of the northern part of Devana Chasma in Beta Regio are examined. The structure of this rift is compared to that of terrestrial continental rifts. To ascertain the degree to which the lithosphere at Beta might be thinned, estimates of lithospheric thickness are calculated using a plate flexure model. These values are compared to those determined for other parts of the planet (1, 2, 3).

Northern Devana Chasma falls along a N-S strike, covering a distance of 650 km between Theia Mons and Rhea Mons (Fig. 1). The rift crosses two major units: (1) radar-dark plains that contain numerous local volcanic centers, and (2) tesserae, an elevated, complexly deformed terrain. Small shields (diameters of 2- to 5-km) and their deposits make up a large portion of the plains, suggesting that the most recent episode of plains emplacement on this part of Beta is associated with local volcanic centers. Near 31.5° N, Devana intersects a region of tesserae that is irregular shaped in plan view. The lack of infilling of the rift by rock debris and volcanic material makes it possible to map pre-rift structure between the major border faults. In several locations, these faults strike obliquely to the tesserae fabric, indicating that the tesserae are not being formed by rifting, but are being disrupted by it.

The style of rifting varies along the length of Devana Chasma. Three zones (Fig. 1) are identify in a south to north direction, beginning North of Theia Mons and ending to the North of Rhea Mons. Within the first zone, the rift contains two distinct troughs separated by a major horst. The entire zone of deformation, including both troughs, averages 227 km wide. The second zone, is made up of a single trough (average width of 177 km), is asymmetric, and forms a half graben. The western side of the rift is bound by two major scarps separated by a distance of 60- to 85-km. Topography data show that the region between the faults is rotated in a counter clockwise direction by as much 1.5°. The third section of the rift lies completely within and deforms a unit of tesserae. Along this section, Devana is narrowest (average width of 139 km) and is a single trough that is asymmetric.

Comparison to terrestrial rifts. Previous analyses have likened Devana Chasma to terrestrial continental rifts (4). To assess the similarity and differences between extensional zones on Venus and Earth, the structure of terrestrial rifts are compared to northern Devana.

Terrestrial continental rifts are typically segmented into series of en echelon basins (i.e., Baikal, Rio Grande, and East African rifts (5, 6, 7, 8)). In cross section, they are half graben with the throw on one fault being substantially greater than that on the others. At the East African rift, the sense of asymmetry typically alternates between basins with the major border fault switching from one side of the rift to the other between consecutive basins.

Devana Chasma possesses some similarities to its terrestrial counterparts. Along part of its length, the rift is asymmetric, forming a half graben with the main border fault located on the western side of the rift. Unlike terrestrial rifts that are made up of interconnected basins, Devana is a single trough. Also, unlike a number of terrestrial rifts, the major border fault does not switch back and forth between opposite sides of the rift.

Rift segmentation is thought to be related to reactivation of pre-existing zones of weakness in the crust (9), reorientation of stress fields during individual episodes of rifting (10), and rift propagation (11). Devana is in general not segmented. Map patterns show that northern Devana and its internal structure are oriented parallel to the fabric within the tesserae on the east flank of the highland. On the basis of its distribution and stratigraphic relationships, tesserae is suggested to underlie a greater part of Beta (12). If this is the case, then the N-S strike of Devana may be controlled by pre-existing structure. If rift segmentation is caused by the reorientation of stresses, then the continuous linear nature of Devana may indicate that extension has persisted along an E-W trend for much of the rift's history.

Flexural Model of Flanking Rift Structure. To examine the properties of the subsurface at Beta, topography profiles of the uplifted rift flanks are used to evaluate a model of lithospheric flexure at Devana. The results of this analysis provide an estimate of the effective thickness of the elastic part of the lithosphere. To constrain this thickness, the concave structure of the rift flanks is matched by calculating the deflection of a thin plate due to the mass deficit at the rift.

Two profiles striking perpendicular to Devana are modeled. The first profile is located within a unit of tesserae, just to the North of Rhea Mons (Fig. 2). Models with plate thicknesses of 30- to 40-km provide good fits to the structure of the eastern flank. The fit for the western flank is not as well constrained, with approximately 1- to 2-km of residual topography present. The western border fault in this area is associated with a part of the rift that is an asymmetric half graben. If this fault penetrates to a great depth, then a broken plate model may be more appropriate. The second profile, to the North of Theia Mons, crosses the part of Devana where two distinct troughs are present (Fig. 2). The flanking structure is best fit by a plate with a thickness of 20- to 30-km. Plates with greater thicknesses also provide good fits to the observed topography, suggesting that the values calculated here may represent a lower bound on the thickness of the elastic layer.

Conclusions. Extensional deformation at Beta is restricted to the 139- to 227-km wide zone of rifting at Devana. Evidence showing a lack of large-scale offset of features suggests that extension is limited and is interpreted to be actively driven by dynamic processes in the mantle. Plate flexure models indicate effective lithospheric thicknesses comparable to those at coronae (35- to 40-km) (2) and substantially greater than those at Freyja Mons (11- to 18-km) (1) and Juno Dorsa (8- to 20-km) (3). The implication for thicknesses obtained here suggests that in comparison to the low land plains (2, 3), the lithosphere at Beta may not be substantially thinned. Depending on its composition, a thick lithosphere may act as a barrier, preventing the upward migration of magma. This might explain the lack of volcanic deposits within Devana. If relatively large amounts of magma are not reaching the surface, then much of the domical structure of topography may be the result of intrusion, underplating and dynamic uplift by the plume rather than volcanic construction.

References: (1) Solomon, S. C. and J. W. Head, *Geophys. Res. Lett.*, 17, 1393-1396, 1990. (2) Sandwell, D. T. and G. Schubert, *J. Geophys. Res.*, 97, 16069-16083, 1992. (3) Evans, S. A., *et al.*, *Inter. Colloq. on Venus*, 30-32, 1992. (4) McGill, G. E., *et al., Geophys. Res. Lett.*, 8, 737-740, 1981. (5) Logatchev, Y. A. *et al.*, *Tectonophysics*, 94, 223-240, 1983. (6) Kelly, V. C., in Rio Grande Rift: Tectonics and Magmatism, pp. 57-70, AGU, Washington, D.C., 1979. (7) Bosworth, W., *et al.*, *Eos Trans.*, 577-583, 1986. (8) Ebinger, C., *Tectonics*, 8, 117-133, 1989. (9) McConnell, R. B., *Geol. Soc. Am. Bull.*, 83, 2549-2572, 1972. (10) Ebinger, C., *Geol. Soc. Am. Bull.* 101, 885-903, 1989. (11) Bosworth, W., *Nature*, 316, 625-627, 1985. (12) Senske, D. A., *et al.*, *Geophys. Res. Lett.*, 18, 1159-1162, 1991.

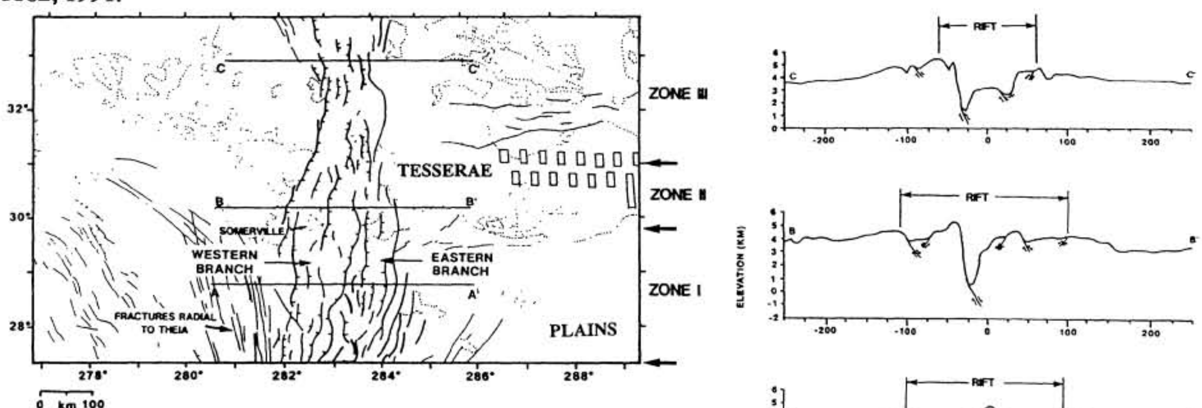

Fig. 1 Map showing fault patterns and variability in structure along the strike of Devana Chasma. The rift crosses two units, radar-dark plains and tesserae (outlined by the dotted pattern).

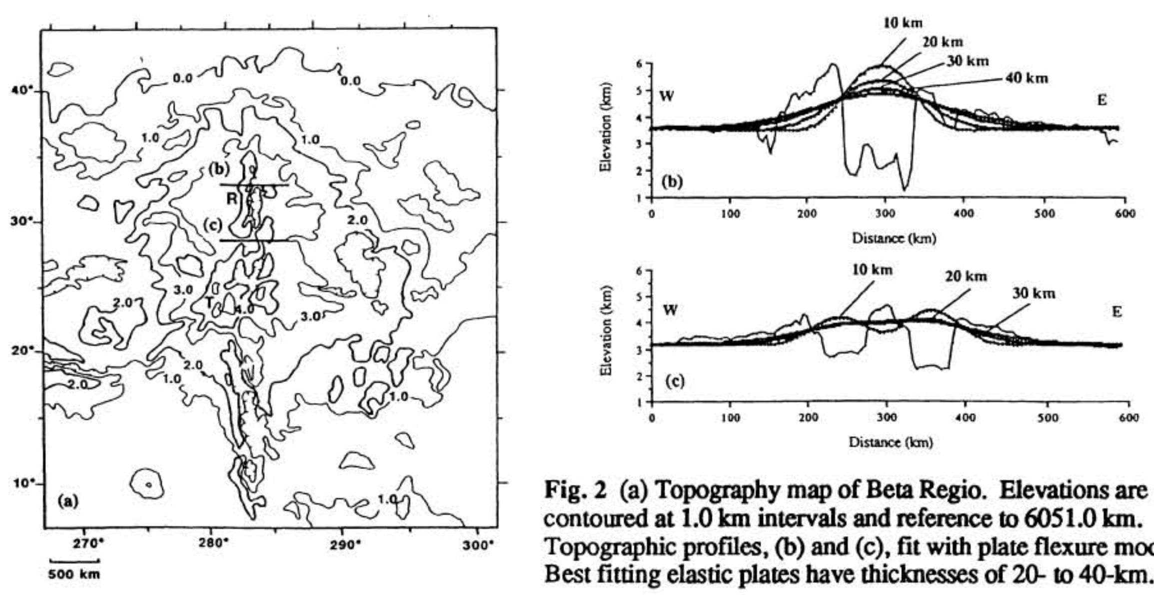

Fig. 2 (a) Topography map of Beta Regio. Elevations are contoured at 1.0 km intervals and reference to 6051.0 km. Topographic profiles, (b) and (c), fit with plate flexure models. Best fitting elastic plates have thicknesses of 20- to 40-km.