TOPOGRAPHIC AND STRUCTURAL ANALYSIS OF DEVANA CHASMA, VENUS: A PROPAGAGTING RIFT SYSTEM. Laura C. Swafford[1] and Walter S. Kiefer[2], [1]Dept. Of Geological Sciences, Michigan State University, East Lansing MI 48824, swafford@msu.edu. [2]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston TX 77058, kiefer@lpi.usra.edu.

Introduction: Devana Chasma is a rift system on Venus that formed due to extensional stresses from the Beta Regio and Phoebe Regio mantle plumes [1-9]. It has often been compared to the East African Rift system on Earth [1,6]. Kiefer and Peterson [9] modeled the gravity and topography of Devana Chasma in terms of crustal thickness variations and mantle density anomalies. They found that low-density material, interpreted as hotter than normal mantle, is present under most of Devana Chasma. There is a discontinuity in the mantle density anomaly near 8° North, where the trend of the rift is laterally offset by 600 km. Based on the rift offset, the low density of faulting within the offset zone, and the discontinuity in the inferred mantle structure, they interpreted Devana Chasma as being two distinct rifts. One propagated southward from the Beta Regio mantle plume, and the other propagated northward from the Phoebe Regio mantle plume. When the two rift tips approached each other within a critical distance, the interaction of the two stresses fields allowed the rift tips to propagate toward each other, forming the faults in the offset zone [9].

To further test the propagating rift hypothesis, we have analyzed variations in rift zone topography and structure as a function of distance along the strike of the rift. Our study region is the portion of Devana Chasma in the plains between Beta Regio and Phoebe Regio, from 20° North to 4° South. Figure 1 shows a radar image of the entire study region and Figure 2 shows a close-up of the offset segment of Devana. We collected topographic profiles normal to the strike of the rift roughly every one-half degree of latitude (53 km). Several example profiles are shown in reference [10]. Using these profiles, we measured how the rift flank elevation, rift depth, rift width, and horizontal extension varied with distance along the rift. The rift zone width, measured as the distance between the east and west rift flank topographic highs, is typically 150 to 250 km wide but is occasionally wider. The maximum depth is typically –1 to –3 km relative to the mean planetary radius. Neither the rift width nor the maximum depth shows a strong trend along the strike of the rift.

Rift Flank Topography: For each topographic profile, we calculated both the maximum rift flank elevation as well as the average elevation of the east and west rift flanks. The average flank height produces a smoother profile and is shown in Figure 3, using

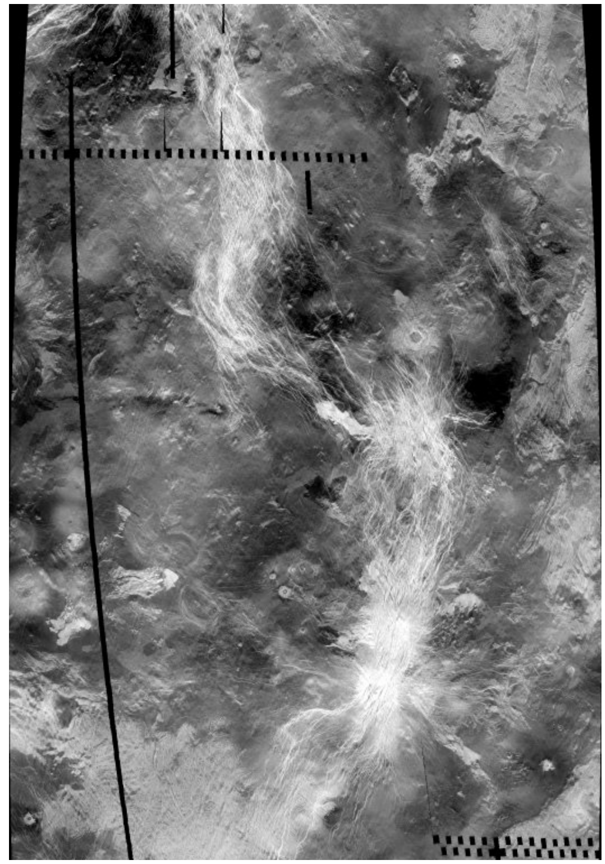

Figure 1: A *Magellan* radar image of Devana Chasma. The region shown is from 21° North to 9° South and from 275° to 295° East.

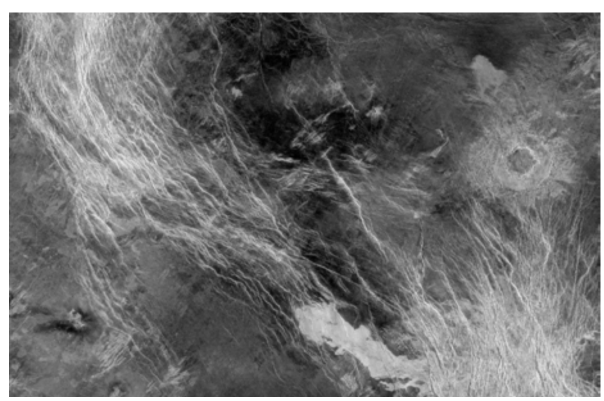

Figure 2: A *Magellan* radar image of the offset zone in Devana Chasma. The region shown is from 6° to 12° North and from 281° to 290° East. The image is 940 km across.

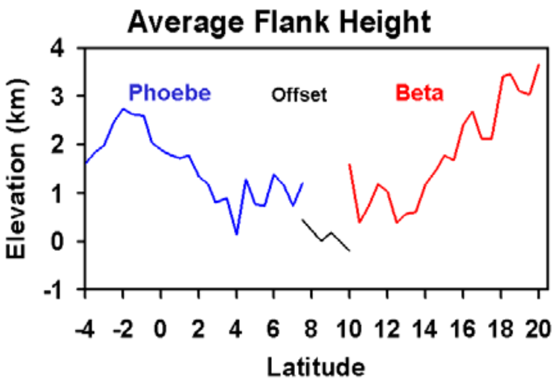

Figure 3: Average rift flank height as a function of latitude along the Devana Chasma rift system. Results are color-coded to identify each rift branch.

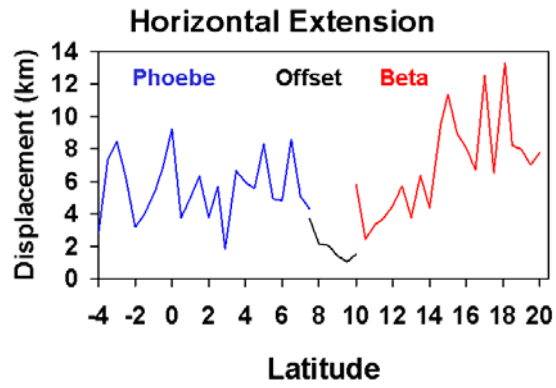

Figure 4: Horizontal extension as a function of latitude along the Devana Chasma rift system. Results are color-coded to identify each rift branch.

latitude as an indicator of distance along the rift strike. The total profile length is 2500 km.

The results in Figure 3 are color-coded to identify each branch of the rift system: blue for Phoebe Regio, red for Beta Regio, and black for the offset region between the two major rift branches. In both the Beta and the Phoebe branches, the flank elevation is greatest near the edges of the highland and decreases with distance into the plains. The rift flank height is probably thermally controlled, with the maximum lithospheric thinning occurring near the upwelling mantle plumes. Lithospheric thinning and hence rift flank height decreases with distance from the hot plumes. In the offset region, the rift flank height is not continuous with either the Phoebe or the Beta trends. The virtual absence of rift flank topography in the offset zone is consistent with the absence of hot mantle and lower lithosphere, as inferred previously from gravity data [9].

Rift Extension: Using the altimetry profiles, we measured the vertical offsets within the interior of the rift basins. Assuming that these offsets were due to normal faulting, we calculated the horizontal extension across a given topographic profile as $E = \Sigma h \cot\theta$, where E is the total horizontal extension, Σh is the cumulative vertical offset on faults in a given profile and θ is the characteristic dip of the faults, assumed here to be 60^{o}. A similar approach has been previously applied to the northern part of Devana Chasma [7] and to Valles Marineris and graben systems on Mars [11,12].

Our results are shown in Figure 4. There are significant fluctuations in the amount of horizontal extension as a function of location along the rift. The overall trend in the Beta Regio branch of the rift is a strong decrease in extension with increasing distance from Beta Regio, which is consistent with the expected decrease in stress level with increasing distance from the mantle plume source. No systematic trend with distance is obvious in the Phoebe segment. The extension in the offset zone is much smaller (usually < 2 km) than in most places along either the Beta or Phoebe branches. This is consistent with the low density of faulting observed in Figure 2.

Conclusions: We have documented systematic variations in both the average rift flank height and the horizontal extension as a function of distance along the Devana Chasma rift system. The near-zero rift flank height in the offset zone supports the absence of hot mantle in this region, as inferred previously from gravity modeling. The low horizontal extension in the offset zone quantifies the visual observation that faulting is less dense in this region than elsewhere along the rift. Overall, these observations support the model that the Beta Regio and Phoebe Regio branches of Devana Chasma formed as distinct rift systems [9].

References: [1] G. E. McGill et al., *Geophys. Res. Lett.* 8, 737-740, 1981. [2] D. B. Campbell et al., *Science* 226, 167-170, 1984. [3] W. S. Kiefer and B. H. Hager, *J. Geophys. Res.* 96, 20,947-20,966, 1991. [4] S. C. Solomon et al., *J. Geophys. Res.* 97, 13,199-13,255, 1992. [5] D. A. Senske et al., *J. Geophys. Res.* 97, 13,395-13,420, 1992. [6] A. Foster and F. Nimmo, *Earth Planet. Sci. Lett.* 143, 183-195, 1996. [7] J. A. Rathbun et al., *J. Geophys. Res.* 104, 1917-1927, 1999. [8] C. Connor and J. Suppe, *J. Geophys. Res.* 106, 3237-3260, 2001. [9] W. S. Kiefer and K. Peterson, *Geophys. Res. Lett.* 30, doi:10.1029/2002GL015762, 2003. [10] W. S. Kiefer and L. C. Swafford, abstract 1607, this volume. [11] R. A. Schultz, *Planet. Space Sci.* 43, 1561-1566, 1995. [12] J. B. Plescia, *J. Geophys. Res.* 96, 18,883-18,895, 1991.