GRADIENTS IN EXTENSION AND STRAIN AT BETA REGIO, VENUS. J. A. Rathbun, D. M. Janes, S. W. Squyres, *Department of Astronomy and Space Sciences, Cornell University, Ithaca, NY 14853, USA.*

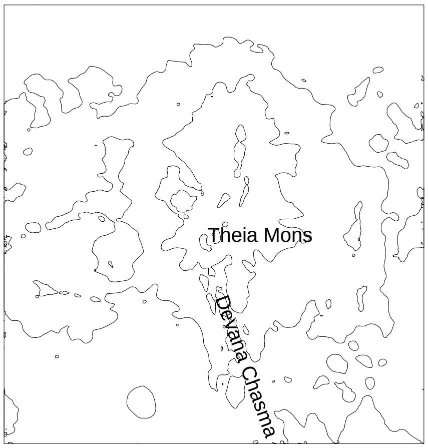

Figure 1: Contour map of Beta Regio. Contours are at 2 km intervals.

Beta Regio is a major highland region on Venus (fig. 1), rising to more than 5 km above the mean planetary radius. A large shield volcano, Theia Mons, lies near its center. The highland is elliptically shaped and about 25003000 km in size, with the long axis oriented north-south. Three major rifts radiate from Theia Mons. One extends to the south (Devana Chasma) and another to the north; these have been interpreted as a single feature, with Theia Mons superimposed on it [1]. Devana continues south to Phoebe Regio. The northern chasma transects Rhea Mons, a shield-shaped topographic high of tessera terrain just north of Theia Mons. The third rift extends southwest from Theia.

Many authors have interpreted Beta to be the site of a mantle upwelling [1,2,3]. We investigate the amount of extension involved in the Beta rifts, and how it changes along the length of the rifts, in order to help place quantitative constraints on Beta's evolution.

We have used Magellan altimetry data to quantify rift topography in Beta Regio, taking profiles across the axes of all three major rifts at 50-km intervals. By assuming that vertical offsets in topography are caused by normal faulting, the altimetry difference along each profile can be used to estimate the extension across the rift [4]. Each significant vertical offset is assumed to be a normal fault (or a collection of faults). The extension is then given by

$$E = O \tan(90^\circ - \theta) \qquad (1)$$

where E is the extension, O is the vertical offset, and θ is the fault dip angle.

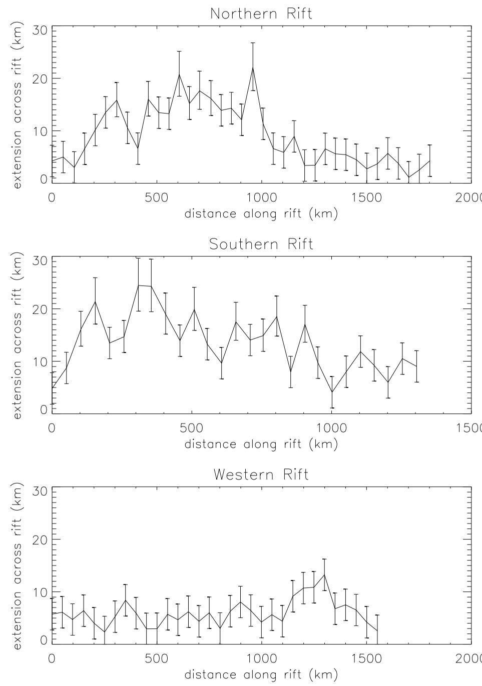

Figure 2: Extension across the rift as a function of distance along the rift. Error bars are due to the uncertainty in measuring the "dip angle" with the crater Somerville.

This technique for estimating strain can be complicated by uncertainties in the appropriate fault dip and by vertical offsets that are not resolved adequately in the altimetric data. We are able to address these problems because the northern rift of Beta fortuitously cuts the 37-km crater Somerville [2]. Assuming an initially circular crater shape, the current rim positions indicate that approximately 10 km of extension has occurred since the crater formed. The altimetry across the rift that cuts Somerville shows a total vertical offset of 7 km on two primary faults. We are therefore able to derive with some confidence (for this location) a relationship between horizontal extension and apparent fault offset.

It is interesting to note that if we were to assume that only faults whose offsets are resolved in the altimetry accommodate strain, we would obtain what is probably an unrealistically low fault dip (35°) at Somerville. This observation implies that faults not resolved in the altimetry here do indeed accommodate significant strain. Because the relationship between vertical offset and horizontal extension we obtain from Somerville is rigorously correct at that location and is independent of both unrecognized faults and fault dips that would otherwise have to be assumed, we use it to infer

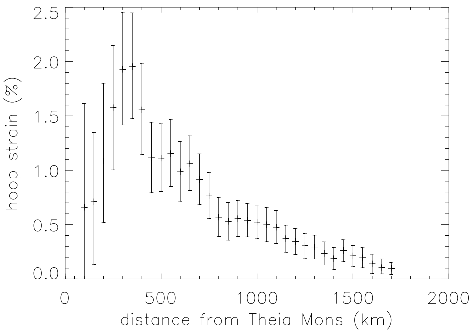

Figure 3: Total hoop strain as a function of distance from Theia Mons.

extension throughout the entire Beta rift system. We then calculate strain from the inferred extension and the total rift width.

Figure 2 shows extension across the rift as a function of distance from Theia Mons for each of the three main Beta rifts. The large northern and southern rifts accommodate as much as 30 km of extension at some locations. The variation of measurable extension with distance from Theia Mons is very similar for these two rifts. Extension is low near Theia, increases sharply with distance from it, and then drops gradually toward the periphery of Beta. Extension across the southwestern rift is smaller, and is more nearly constant with distance from Theia.

Figure 3 illustrates the total hoop strain across Beta that is accommodated by measurable deformation on the rifts. Again, the measurable strain is low near the center, increases sharply with distance from the center, and then drops off gradually toward the periphery. The low inferred strain very near the center is surely due in part to partial filling of rifts by the Theia volcanics. However, these rifts are remarkably free of volcanic infilling along most of their lengths [5], suggesting that in all but the innermost region our technique yields a good estimate of the strain accommodated by rifting.

The pattern of hoop strain in Figure 3 is consistent with that expected from a broad-scale mantle uplift under Beta. The problem of stresses created by an axisymmetric mantle upwelling was addressed by Janes and Melosh [6]. The stress depends on the thickness of the lithosphere, the depth of the upwelling, the density contrast of the upwelling, and the upwelling's size and shape. We are using the determination of hoop strain as a function of radius, along with the altimetric and gravimetric signatures of Beta, to help place constraints on these parameters.

References: [1] Stofan, E.R. et al. (1989), *Geo. Soc. Am. Bull.*, **101**, 143. [2] Solomon, S.C. et al. (1992), *J. Geophys. Res.*, **97**, 13199. [3] Senske, D.A. et al. (1992), *J. Geophys. Res.*, **97**, 13395. [4] Schultz, R.A. et al. (1995), *Planet. Space Sci.*, **43**, 1561. [5] Senske, D.A. et al. (1995), *LPSC XXVI*, 1267. [6] Janes, D.M. and Melosh, H.J. (1988), *J. Geophys. Res.*, **93**, 3127.