INTERPRETATION OF MAGELLAN GRAVITY DATA FOR LARGE VOLCANIC SWELLS ON VENUS: IMPLICATIONS FOR INTERIOR STRUCTURE; Suzanne E. Smrekar, California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA, 91109.

Introduction. Numerous large volcanic swells on Venus have been interpreted as likely sites of mantle upwelling, or hotspots [e.g. 1,2]. In the absence of terrestrial-style spreading ridges, these swells provide one of the most conspicuous manifestations of mantle heat loss. As such they offer important information about the thermal history of Venus. In this study I use Magellan line-of-site (LOS) gravity data to investigate the interior structure beneath two large volcanic swells: Atla and Bell Regiones. Initial interpretation of the admittance spectra (the ratio of the gravity to the topography in the Fourier transform domain) in these areas shows that flexural compensation is important in both regions. Although absolute values of the effective elastic thickness, Te, are not well determined, the elastic thickness appears to be smaller at short wavelengths than at long wavelengths in both areas. This is consistent with thinning beneath the large volcanic edifices, which load the plate at wavelengths shorter than those of the broad topographic swells. A thinned plate further suggests that a thermal perturbation, presumably due to a mantle plume, is (or was once) located beneath the swells.

Data Analysis. To facilitate forward modeling and interpretation, I employ a linearized, least-squares approach to invert the LOS data to obtain a vertical gravity field [3]. The vertical gravity field is used to produce admittance (Figures 1 and 2). As the interpretation of gravity data alone is non-unique, the admittance is compared to three different models: Airy (or crustal) compensation, flexure plus Airy compensation, and a hotspot compensation model. The hotspot model [4] assumes that the crust and elastic plate are loaded from above at short wavelengths by a volcanic edifice (or edifices), and that a deep thermal anomaly loads the crust and elastic plate from below at wavelengths comparable to that of the swell. Thus the hotspot model differs from the flexure model in that it assumes a specific loading scenario and it includes a second compensation depth, referred to as the swell compensation depth, in addition to the crust-mantle boundary.

Results. Airy compensation does not provide a good fit to the admittance spectra at Bell and Atla Regiones. The Airy compensation depth varies from 5 to 50 km at Bell Regio. At Atla Regio the longer wavelength data are fit by Airy compensation depths of 50-100 km; Airy compensation does not fit the shorter wavelength data. When flexural compensation is included, the longer wavelengths are still isostatically compensated. The vertical position of the model curve is controlled by the Airy compensation depth. Loading of the elastic plate controls the shape of the model curve at shorter wavelengths; loading from above or below the plate produces a very different admittance curve [5]. When the longest wavelength value of the spectrum at Bell Regio is fit with a crustal compensation depth of 50 km, the short wavelength part of the spectrum gives $T_e = 35\pm5$ km and a ratio of bottom to top loading of 2 (Fig. 1a). Since the long wavelength portion of the admittance spectrum does not fit a single Airy compensation depth, the vertical position of the model curve is not well constrained. Thus a model with a thinner crust, a thinner elastic plate, and top loading alone will also fit the data. At Atla Regio, the best fitting depth of Airy compensation at long wavelengths is 110 km (Fig. 1b). The short wavelengths require dominantly bottom loading with $T_e = 80\pm5$ km. The best fitting hotspot model at Bell Regio has a short wavelength $T_e =$ 5-15 km and a long wavelength value of 50 km, with a swell compensation depth of 100-150 km (Fig. 2a). Since the crustal thickness is unknown and the thickness of the crust and swell compensation depth trade off, I assume a crustal thickness in the range of 10-50 km and find a corresponding range of swell compensation depth. A swell compensation depth of 100-175 km with $T_e = 30$ km fits most of the spectrum at Atla Regio (Fig. 2b). The shortest wavelength admittance value is consistent with top loading and $Te \leq 20$ km.

Discussion. Modeling of the admittance spectra at Bell and Atla Regiones shows that Airy compensation at a single depth is unlikely. Flexural compensation is evident in both areas. In the absence of the additional constraints, it is difficult to accurately determine the absolute value of T_e. Both the flexure and hotspot models provide a reasonable fit to the data at Bell and Atla Regiones. The hotspot model is preferred at Atla Regio, since a crustal compensation depth of 110 km is implausible for Venus. As a crustal thickness of 50 km is at least plausible, the choice of hotspot vs. flexure models at Bell Regio is less clear. The long wavelength portion of the hotspot model is poorly determined (with only two data points), yet it does provide a better fit to the data than the flexure model. If we make the case that the hotspot model is most appropriate at Bell Regio as well as at Atla Regio, T_e at short wavelengths is somewhat less than that for long wavelengths (5-35 km vs. 50 km at Bell and <20 km vs. 30 km at Atla). This interpretation implies possible local thinning of the elastic plate beneath the volcanos and the presence of a thermal anomaly. Further work is underway to improve estimates of T_e and to include additional hotspots in this study.

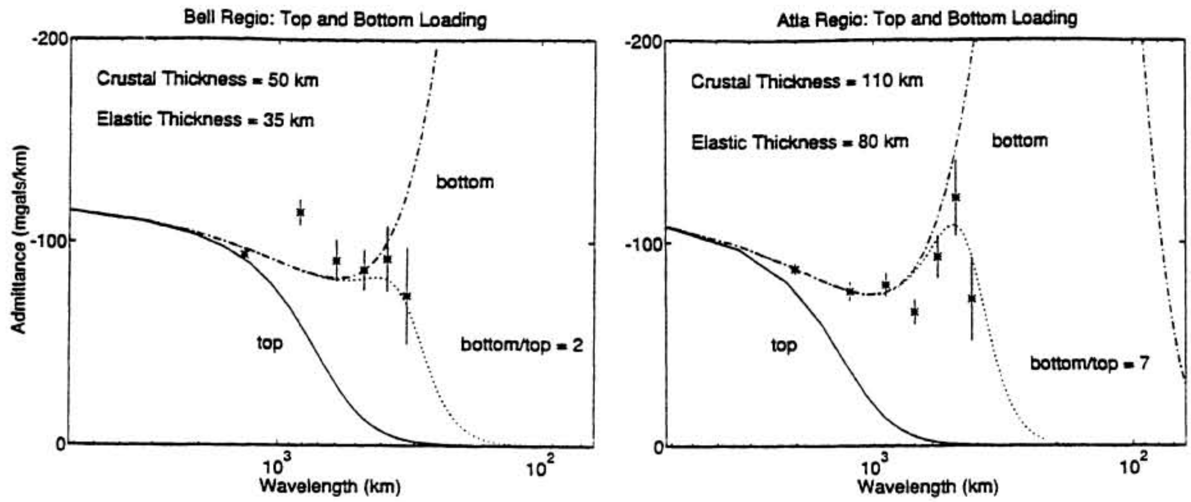

Figure 1. Admittance spectra calculated from the Bouger gravity and topography for (a) Bell and (b) Atla Regiones with combined crustal and flexural compensation models. Solid lines are for top loading only, dash-dot lines are for bottom loading only, and dotted lines are for a models with both bottom and top loading.

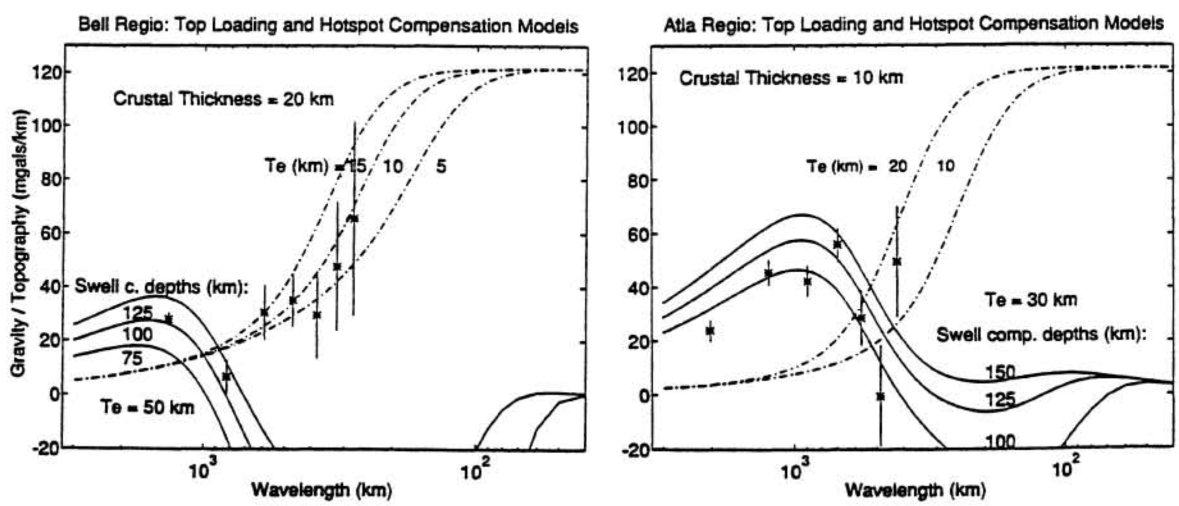

Figure 2. Admittance spectra calculated from the free air gravity and topography for (a) Bell and (b) Atla Regiones with hotspot compensation models. Dash-dot lines are for top loading only, and solid lines are for swell compensation depths. Note that the best fitting effective elastic thickness at short and long wavelengths differs.

References. [1] S.C. Solomon et al., *JGR, 97*, 13,199, 1992; [2] S.E. Smrekar and R.J. Phillips, *EPSL, 107*, 582, 1991; [3] R.E. Grimm and R.J. Phillips, *JGR, 93*, 11,911, 1988; [4] M.K. McNutt and L. Shure, *JGR, 91*, 13915, 1986; [5] D.W. Forsyth, *JGR, 90*, 12,623, 1985.