LITHOSPHERIC FLEXURE MODELING AT NARINA THOLI: EVIDENCE FOR A LOCALLY THINNED LITHOSPHERE.

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Introduction: Lithospheric flexural signatures have previously been identified on Venus, in particular at chasmata and coronae [e.g., 1, 2]. These signatures allow the elastic thickness of the lithosphere and the corresponding heat flow to be estimated by comparing observations to the predictions of thin elastic plate models. Until recently, observations of flexure have been restricted to large features due to the limited spatial resolution of the Magellan Global Topographic Data Record (GTDR) [3]. Higher resolution topographic data derived from stereo Magellan Synthetic Aperture Radar (SAR) images [4] has allowed the systematic study of smaller coronae [5], with many of these features showing substantially thinner lithosphere and correspondingly larger heat flows than previously estimated.

Tholi, or steep-sided domes, are a class of volcanic features intermediate in size that are common on Venus. They range from 10 to 70 km in diameter [6], larger than typical terrestrial volcanic domes. Here we investigate a possible flexural signature associated with one such steep-sided dome using stereo-derived topography [4].

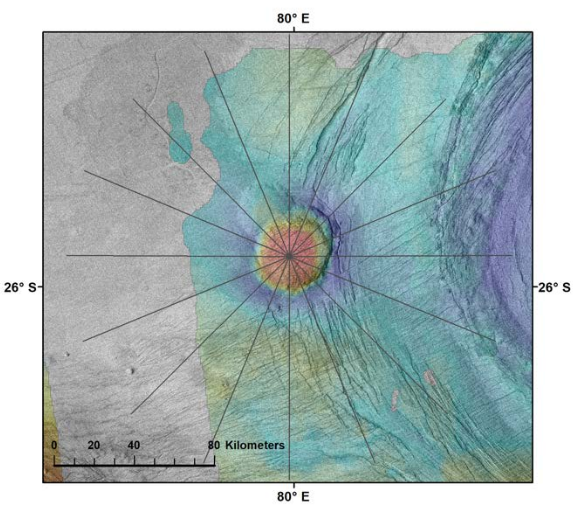

Figure 1: Narina Tholi. Colors correspond to stereo elevation (-1200m (dark blue) to +175m (red)) [4]. The image spans approximately 2° in the north-south and east-west directions. Stereo coverage is limited to the eastern part of the region. The Magellan SAR right-look global mosaic is shown in grayscale. Gray lines indicate locations of profiles extracted and shown in Fig. 2. The fracture annulus of Aramaiti Corona is seen in image center and right.

Narina Tholi: Narina Tholi is a steep-sided dome thought to comprise multiple emplacement events, and is spatially associated with the western outer fracture annulus of Aramaiti Corona, located south of Ovda Regio. Stereo-derived topography covers Narina and the immediate region (Fig. 1). Superposition relationships suggest that the tholi postdates the local corona fracture annulus [7]. Associated with the tholi is Oilule Fluctus, a large mapped flow that continues to the northwest. Narina Tholi is about 40 km across (D_R) and rises about 1 km above the surrounding terrain (Fig. 2). The positive relief is immediately surrounded by a topographic low, characteristic of a flexural moat (Fig. 1). With the exception of Oilule Fluctus, there is no evidence for filling of the trough by flows or debris. Peak-to-trough relief (from the top of Narina Tholi to the base of the surrounding low) is over 1 km.

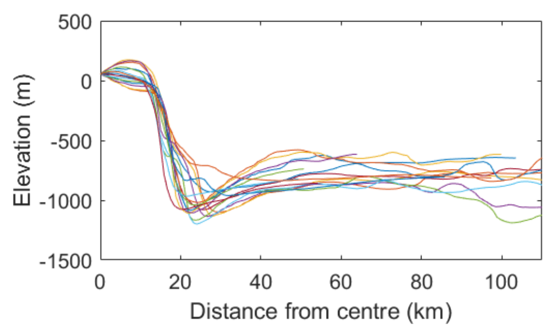

Figure 2: Topographic profiles centered on the tholi, extracted from the stereo elevation data in ArcGIS.

Elastic Flexure Modeling: We investigate elastic flexure models for the topography surrounding Narina Tholi. Figure 2 shows topographic profiles centered on Narina extracted from the stereo-derived topography using ArcGIS. Profile lengths are about 110 km, but are dependent on the coverage of the stereo topography. Assuming an axisymmetric disk load of radius, R, [2, 5], we solve for the load, P_0, as well as the background mean elevation and regional slope for a range of elastic plate thicknesses, h_e. The root-mean-square (RMS) misfit of the best-fit model to the observations is computed for each value of h_e.

Results and Discussion: Flexural modelling of four of the longer profiles yields a best-fit elastic thickness of 2-3 km (e.g. Fig 3), suggesting a very thin lithosphere in the vicinity of Narina Tholi. Observationally, the absence of fracturing concentric to Narina, indicates that bending stresses are too low for failure to occur and this is supported by the flexural modeling.

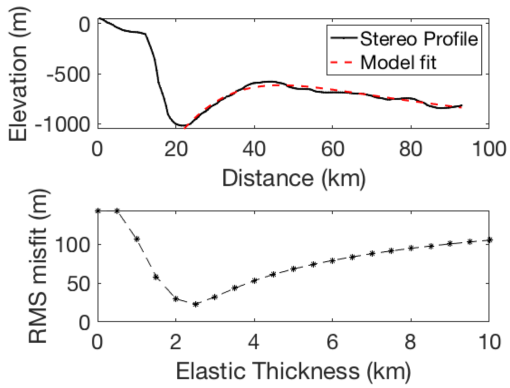

Figure 3: Example of elastic flexure model results for topographic profile to the SSE from Narina. (Top) Profile (black solid line) and best-fit axisymmetric flexure model (red dashed line). (Bottom) Root-mean-square (RMS) misfit of the best-fit model to the data versus elastic thickness.

A previous study [5] derived an elastic thickness at Aramaiti Corona of 13 ± 3 km and 10 ± 5 km using the axisymmetric and Cartesian models respectively. Profiles used in these models were taken across the north/north-west and the south of the corona, well away from Narina Tholi (i.e., outside of the limits of Fig. 1). These elastic thickness values are significantly larger than those obtained for Narina, and are reasonably interpreted as an estimate of the regional effective elastic thickness in the vicinity of Narina. The associated regional surface heat flow, q_s = 103 mW m^{-2} is slightly larger than the median value from modeling of 19 coronae globally [5], and consistent with the median terrestrial value [8]. The thin elastic thickness estimates obtained here suggest local heat flows in the vicinity of Narina that may be up to three to four times larger than this regional average. Local lithospheric thinning and higher heat flow are consistent with the emplacement of the volcanic construct relatively late in the evolution of this corona.

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