INTERPRETATION OF THE NORTHERN BOUNDARY OF ISHTAR TERRA FROM MAGELLAN IMAGES AND ALTIMETRY . S. Mueller, R.E. Grimm, and R.J. Phillips, Dept. of Geological Sciences, Southern Methodist University, Dallas, TX 75275.

Introduction. Part of the controversy on the origin of western Ishtar Terra concerns the nature of Uorsar Rupes, the northern boundary of Ishtar Terra. In the hypothesis of lithospheric convergence and underthrusting [1], Uorsar Rupes is held to be the main boundary thrust fault at the toe of an accretionary wedge. A topographic rise parallel to the scarp was interpreted as a flexural bulge similar to those of terrestrial subduction zones, and quantitative models of this feature seemed broadly consistent with the expected lithospheric structure of Venus [2]. In the alternative mantle-upwelling hypothesis for western Ishtar Terra [3], the outer margins of the highland are thought to be collapsing [4], and Uorsar Rupes has been interpreted as a normal fault [5]. Here we interpret Magellan images and altimetry for this region and reassess the hypothesis that a flexural signature can be distinguished.

Geologic Description. Uorsar Rupes rises over 2 km within the width of a single footprint of the Magellan altimeter (~ 20 km). The scarp is generally radar-dark and dissected by fine crenulations. At the foot of the scarp there is a group of narrow ridges (**srg**, Fig. 1). The top of the scarp is a complexly deformed radar-bright unit, previously termed "ridge-and-dome" [1] (**rd**). A sharp break in this unit occurs at 337E and is suggestive of right-lateral offset. The scarp itself takes a more gentle bend just east of here and an S-shaped ridge separates the scarp crest from an isolated rd unit at lower elevation; the planform strongly suggests that this block has detached from the scarp. The belt of basal ridges widens in the vicinity of 345E and some show broad asymmetric arches and a tight crenulation on one side, very similar to mare ridges. Plains adjacent to the basal ridge group are generally dark and featureless (**pd**), although a bright embayed unit (**pb**) grows in prominence toward the east and mottled plains (**pm**) also appear. The dark plains are very low to the west (the "foredeep") and the northern boundary of this basin (the "outer rise") is marked on its inner slope at 78.5-79N by a unit of intermediate radar backscatter showing east-west lineations (**rlg**). This unit continues even where the rise is no longer evident to the east (Fig. 2). Numerous dissected and embayed units occur throughout the study area, usually as radar-bright blocks of narrowly spaced grooves (**gt**). The units at 79N, 335E are abruptly truncated to the south by dark plains along an E-W line; this boundary corresponds to a drop of 300 m along orbit 520. To the north of the rise crest, the topography slopes down linearly and the number and size of western gt units decreases.

Altimetric Interpretation. We consider three models for the topography north of Uorsar Rupes: (1) the entire trend represents an "outer rise complex," (2) some component is flexural, but superimposed upon a more dominant trend (thermal, compositional, or structural), and (3) there is no geophysically significant flexure. In (1), topographic variations between 84 N and the boundary scarp imply a forebulge amplitude > 0.5 km and an outer rise wavelength of at least 500 km. Although the trench depth in orbit 510 is only about 500 m (small by terrestrial standards), the forebulge amplitude is comparable to maximum values observed on Earth and the wavelength significantly exceeds any terrestrial analog [6,7]. Therefore if a flexural response to loading at the scarp is apparent in the data it must be partially obscured as in (2). Following projection of the profiles normal to the scarp, we attempt to remove non-flexural trends by subtracting a least-squares line from the entire profile fit only to that portion between 400 and 800 km from the scarp (Fig. 3). Orbits 550 and 560 lack even a trench, whereas orbits 500 and 520 show abrupt variations. Orbit 510 so processed exhibits a distinct, gentle topographic high adjacent to the trench and so represents the best profile upon which to attempt flexural modelling. Fig. 4 shows a series of elastic flexural profiles superimposed on orbit 510; these solutions assume zero bending moment at the trench [2,7], zero in-plane force, and a range of elastic plate thicknesses from 5 to 25 km. Clearly the scale of topographic variations far exceeds flexural behavior. Calculations for non-zero in-plane forces yield similar results.

Discussion. Although we find no evidence for flexure in Magellan altimetry, this conclusion does not rule out the possibility that lithospheric underthrusting is occurring: flexure could be masked by the topographic signatures of a variety of geologic units or else extensive faulting may not allow integral plate behavior. The scarp ridge group could be the compressional deformation where subduction is imminent and the rise lineament group, which bears some resemblance to ridge belts, may represent a new locus of crustal shortening.

Alternatively, the altimetry and images may also be interpreted under the hypothesis that the northern boundary of Ishtar Terra is undergoing extensive normal faulting, disruption, and gradual burial. The detached rd unit at 77N,340E may be the most immediate manifestation of this process: Uorsar Rupes is the present boundary fault of Ishtar Terra, analogous to the western boundary of the Sierra Nevada. The adjacent ridges are simply the local result of edifice stresses due to the sharp relief. An earlier boundary may be recorded in the rise lineament group, where the intervening basin has down-dropped and pre-existing structures (eastern gt units) buried by plains. The scarp at 79N,333E is most likely a steep normal fault, and the western gt units are being gradually buried as the topography slopes gently down to the north.

Conclusion. Magellan images of the northern boundary of Ishtar Terra show evidence of crustal shortening adjacent to Uorsar Rupes, but extension and burial dominate northwards. Altimetric profiles display the same long-wavelength trends visible in Venera data [2], but no clear evidence of lithospheric flexure. We favor a model of regional extension and burial, but regional compression cannot be ruled out.

References. [1] J.W. Head, *Geology, 18*, 99, 1990; [2] S.C. Solomon and J.W. Head, *GRL, 17*, 1393, 1990; [3] A.A. Pronin, *Geotectonics, 20*, 271, 1986; [4] A.T. Basilevsky, *Geotectonics, 20*, 282, 1986; [5] A.M. Nikishin, *EMP*, in press, 1991. [6] D.L. Turcotte and G. Schubert, *Geodynamics*, J. Wiley & Sons, 1982. [7] D.C. McAdoo et. al., *GJRAS, 54*, 11, 1978.

Fig. 1. Geologic sketch map of Uorsar Rupes (hachured) and surroundings; units described in text except **tu**, undivided tessera. Altimetry ground tracks shown as dashed lines.

Fig. 2. Altimetric profiles, ending at Uorsar Rupes. Orbit 500 referenced to mean planetary radius, others offset by 500 m each for clarity.

Fig. 3. Altimetric profiles processed by projecting normal to scarp and removing linear trend.

Fig. 4. Elastic flexural profiles superimposed on processed version of orbit 510, plate thicknesses 5-25 km.