FORMATION OF EASTERN ISHTAR TERRA, VENUS: A COMPARISON OF MODELS.
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Introduction: The Ishtar Terra higland is characterized by extensive tectonism and volcanism [1-8]. Western Ishtar Terra is dominated by a 3-4 km high volcanic plateau, Lakshmi Planum [3,4,7,8], and is surrounded by the 4-11 km high compressional mountain belts Akna, Freyja, Maxwell, and Danu Montes [1-8]. Eastern Ishtar Terra (including Fortuna Tessera) covers an area from 0-90E longitude between 60 and 80N latitude and is characterized by a complex morphology of ridges, valleys, scarps, and chasmata at altitudes from 0 to 6 km. This intricate morphology and topography has been interpreted as resulting from a variety of processes. Sukhanov [9] suggests 'crustal flow' involving "subcrustal asthenospheric flow" and gravitational sliding of preexisting and 'plume-generated' crustal blocks; Kozak and Schaber [10,11] favor disruption of preexisting crust through rifting, gravity spreading, and fold/thrust belt formation; and Vorder Bruegge and Head [12] propose horizontal convergence and crustal thickening of preexisting crustal blocks. The purpose of this abstract is to characterize the nature of Eastern Ishtar more fully and to critically examine each of the suggested models.

Provinces: We have examined the the patterns of ridges, scarps, troughs, and chasmata throughout Eastern Ishtar Terra and examined their correlation with topography. Maps used in this analysis have been presented elsewhere [13]. Based on the consistency of features across broad areas, four major provinces are defined in Eastern Ishtar Terra (Figure 1). Maxwell Montes/Western Fortuna Tessera includes a 6-11 km high orogenic belt and a 5-6 km high, N-S-trending plateau characterized by a continuous pattern of long, NNW-striking ridges and valleys that are sometimes disrupted by obliquely-striking conjugate troughs. Central Fortuna Tessera is characterized by a N-S linear topographic low between 1 and 4 km high, with a blocky pattern of short, WNW-striking, parallel ridges which terminate along parallel linear troughs and flat-floored chasmata which strike perpendicular to the ridges in the NNE direction. Eastern Fortuna Tessera is a long, E-W-striking topographic arch, 2-4 km in altitude, characterized on its northern flank by a complex pattern of short, intersecting ridges and valleys without a dominant orientation. Longer, sub-parallel linear troughs occur here close to the strike of the arch. The southern flank of the Eastern Fortuna arch consists of high-standing plains occasionally interrupted by long arcuate ridges. Finally, Northern Fortuna Tessera is characterized by a steep topographic decrease from 4 km in the S to < 1 km in the N. This topographic decrease occurs predominantly across NNE-facing scarps which trend WNW, parallel to the linear ridges and valleys that are present in narrow belts within this region. Also present are narrow troughs running along the base of these scarps and low rises outboard of the troughs.

Consideration of Models: Each of the proposed models makes some predictions which can be compared to the observations. We will concentrate here on the predictions that can be assessed with the present data. The model of 'crustal flow' involves 'subcrustal asthenospheric flow' which 'drags crustal plates' and 'thermal-gravitational sliding and plastic deformation' of these 'crustal plates' [9]. Features that are to be expected from asthenospheric 'plumes' are high topography through doming and associated extensional deformation. In addition, 'plume-generated crustal flow' in Eastern Fortuna is suggested as creating an 'accumulation zone' further to the east [9]. The 'thermal-gravitational sliding' is driven by topographic gradients and so should produce tension and detachment-like features in the high, central portions and compression, thrusting , and lobate flows with concentric, convex patterns in downslope directions. High topography is present in Eastern Ishtar, both at Maxwell Montes and along the Eastern Fortuna arch, but neither area shows any prominant tensional, detachment-like features which would be associated with either doming or gravitational sliding. The 'plume-generated flow' suggested in Eastern Fortuna [9] moves parallel to the topographic arch there, but half-way down the northern flank, and there is no obvious topographic signature of such a flow. Additionally, the proposed 'accumulation zone' for this flow occurs at a shallow topographic low, where a high should be expected. As noted, gravity-driven extension is not observed at the highest regions, nor are compressional, lobate features consistently observed downslope. The northern and southern regions of Western Fortuna, in particular, are dominated by ridges that strike close to perpendicular to the topographic contours. Finally, most lobate features identified as flows [9] do not show concentric, lobate ridges in their interiors. Instead, ridges within many of these lobes are perpendicular to the lobe edge.

The model of crustal disruption through rifting, gravity spreading, and fold/thrust belt formation suggests that the topographic low in Central Fortuna Tessera and another low south of Fortuna represent parts of a global system of rifting [10,11]. Features associated with this model include low topographic rifts characterized by medial graben, high rims, and regional slopes approximately orthogonal to the rifts [10,11]. Additionally, we would expect some structural continuity across the rifts. Gravitational spreading is anticipated off of the rift-induced highs, including tensional features and detachments upslope, and convex, compressional folds and thrusts downslope. Finally, fold/thrust belts are anticipated in subparallel orientations to the rift zones. Although low topography and features morphologically similar to graben are present through Central Fortuna and to the south, the other suggested features are absent. There are no distinctive high rims, nor are the regional slopes orthogonal to these low zones (note the N-S plateau of Western Fortuna and the E-W arch of Eastern Fortuna). Finally, we have not been able to identify structural continuity from Central Fortuna to Eastern Fortuna. The same problems the previous model encountered with gravitational effects hold for this model: we find no evidence for large detachments upslope, nor concentric, convex folds and thrusts downslope. Finally, the suggestion of fold/thrust belts parallel to the rifts is observed at Maxwell Montes and south of Fortuna, but a fold/thrust belt (Dyan-Mu Dorsa) in Northern Fortuna also occurs immediately adjacent to the Central Fortuna low in an oblique orientation, and it is concave downslope.

The final model involves east-west horizontal convergence and crustal thickening through collision of distinctive crustal blocks [12]. This model predicts individual, steep-sided crustal blocks, high, asymmetric topography, compressional features such as folds, thrusts, and strike-slip faults, and a correlation between structure and topography. Individual crustal blocks with steep sides are recognized in Fortuna Tessera by the discontinuity of patterns across topographic lows. The asymmetric topography, compressional features and and their correlation are also present, as described in [12]. On the basis of these observations, we favor a model of horizontal convergence and crustal thickening through the accretion of crustal blocks as the dominant mechanism in the formation of Eastern Ishtar Terra. The details of this model are presented elsewhere [14].

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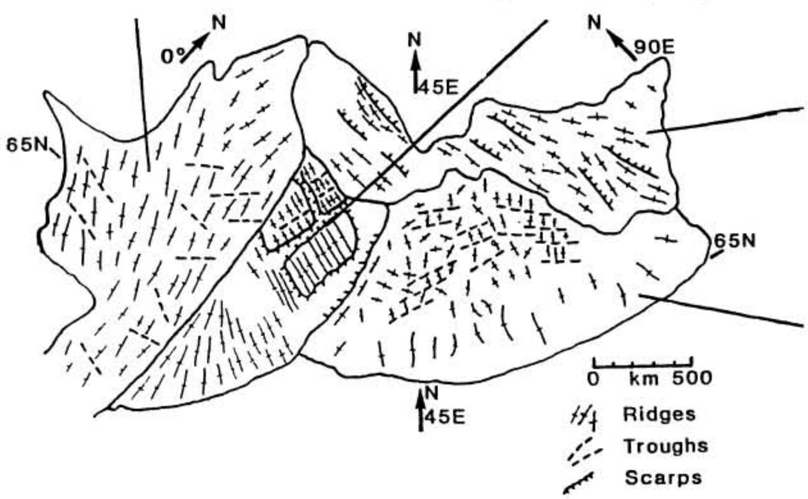
Figure 1. Generalized province map of Eastern Ishtar Terra, Equal Area Projection.

<u>Maxwell Montes/Western Fortuna</u>
6-12 km high orogenic belt
5-6 km high N-S plateau
NNW-trending, continuous ridges
Oblique, conjugate troughs

<u>Central Fortuna Tessera</u>
1-5 km, complex topographic low
WNW-trending, short ridges
NNE-trending, continuous troughs & scarps in an orthogonalpattern



<u>Northern Fortuna Tessera</u>
Steep topographic decrease, S to N
4 km down to less than 1 km
WNW-trending, continuous scarps
WNW-trending, continuous ridges

<u>Eastern Fortuna Tessera</u>
E-W topographic arch, 2-4 km
Northern flank, complex ridge & trough pattern
Southern flank, plains and long, arcuate ridges.