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ARCHITECTURE OF OROGENIC BELTS AND CONVERGENT ZONES IN WESTERN ISHTAR TERRA, VENUS;
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Linear mountain belts in Ishtar Terra were recognized from Pioneer-Venus topography[1], and later Arecibo images showed banded terrain interpreted to represent folds[2]. Subsequent analyses[3] showed that the mountains represented orogenic belts[4], and that each had somewhat different features and characteristics[5,6]. Orogenic belts are regions of focused shortening and compressional deformation and thus provide evidence for the nature of such deformation, processes of crustal thickening (brittle, ductile), and processes of crustal loss. Such information is important in understanding the nature of convergent zones on Venus (underthrusting, imbrication, subduction?), the implications for rates of crustal recycling, and the nature of environments of melting and petrogenesis. In this study we identify and examine the basic elements of four convergent zones and orogenic belts in western Ishtar Terra, and then assess the architecture of these zones (the manner in which the elements are arrayed), and their relationships. The basic nomenclature of the convergent zones is shown in Fig. 1.

Danu Montes ranges in width from about 75 to 175 km and extends for over 1200 km along the southern and southwestern edge of Lakshmi Planum, rising up to 2.5-3.0 km above the adjacent plains. It is characterized by parallel to sinuous linear bands interpreted to be folds. The inboard foreland area of Lakshmi Planum generally tilts slightly upward toward Colette and Sacajawea calderas, and volcanic plains can be seen to embay parts of the mountains[7]. Outboard of Danu, there is no plateau region, and the terrain descends directly to the base of the adjacent foredeep along Vesta Rupes, a 50-150 km wide scarp whose base is 2-2.5 km below the elevation of Lakshmi Planum. Outboard of the foredeep, a broad rise (Ut Rupes) about 200-300 km wide parallels Danu Montes at a distance of 450-500 km. Danu Montes rises topographically from the west toward the east, and is most well-developed at the bend at the southeast edge of Lakshmi Planum. At this bend, and to the east, Clotho Tessera is developed between Danu and Ut Rupes, and the foredeep characteristic of western Danu is replaced by the complex positive topography of the tessera sloping down to the adjacent plains. The general direction of compression appears to be normal to the strike of western Danu Montes, and as Danu turns towards the north it, and the adjacent tessera, are characterized by a series of parallel linear features interpreted to be strike-slip faults, and the tessera region appears to be an approximately 300 km wide shear zone. Where Danu is best developed, it is interpreted to be at least partly transpressional in nature.

Akna Montes trends in a NE direction, ranges in width from about 200-250 km, and extends for 800-900 km along the western edge of Lakshmi Planum, rising up to 2.5-3.0 km above the adjacent plains. High topography is best developed in its southern half and it is characterized by a series of features typical of orogenic belts[4]. The inboard foreland area of Lakshmi Planum is characterized by a broad depression opening to the south between Akna and Colette caldera. Volcanic plains can be seen to embay parts of the mountains, and parts of the orogenic belt has deformed the plains[7]. Outboard of Akna there is a distinctive plateau region (Atropos Tessera) extending about 900-1000 km outboard of Akna. At the western edge of Atropos, the terrain descends slowly to the the adjacent plains (Snegorochka Planitia) dropping down about 2 km over a distance of several hundred km. Neither the outboard scarp, nor the foredeep and rise are distinctly developed here. The southwestern edge of Atropos Tessera is characterized by a NW trending linear scarp in excess of 1000 km in length against which Akna Montes terminates; this has been interpreted as a shear zone[8] and syntaxis structures[9] are developed where it coincides with Atropos Tessera.

Freyja Montes trends in an EW direction and connects along its western edge with Akna Montes in a zone characterized by a syntaxis structure[9]. Freyja extends over 800 km along the northern edge of Lakshmi Planum, is 200-300 km wide, and rises up to 2.5-3.0 km above the adjacent plains. High topography is best developed in its eastern half and like Danu and Akna it is characterized by a series of features typical of orogenic belts[4]. The inboard foreland area of Lakshmi Planum is characterized by a gentle slope extending to the south and the volcanic plains have been tilted upward and deformed

into ridged plains[7]. Outboard of Freyja there is a distinctive plateau region (Itzpapalotl Tessera) 200-400 km wide characterized by a range of terrain types interpreted to represent compressional deformation and zones of localized faulting[6]. At the northern edge of Itzpapalotl, the terrain descends abruptly to the adjacent plains dropping down about 3 km over a distance of less than 100 km (Uorsar Rupes), and there is a foredeep filled with young lava plains and an adjacent outboard rise[6]. Freyja Montes and the associated terrain have been interpreted to represent generally N-S oriented convergence resulting in flexure, underthrusting, and crustal imbrication[6]. At its eastern edge, the topographic trend of the edge of the plateau turns SSE, producing a broad topographic indentation into Ishtar Terra. Along the western edge of this indentation, the deformation changes style to produce a series of transpressional ridges.

Maxwell Montes is broader and more equant in planform than the other mountain ranges and rises over 6 km above the surrounding plain. Although Maxwell shares the common characteristics of an orogenic belt[4], it also contains distinctive cross-strike structures that have been interpreted to represent strike-slip deformation of an Akna-like linear mountain range as it was transported westward between two converging shear zones[5,10]. Inboard of Maxwell the plains dip slightly inward toward Lakshmi, but locally there are depressions in the plains along the base of the steep Planum-facing scarp. Outboard of Maxwell is an arcuate plateau and the complex and distinctive structure and topography of Fortuna Tessera[3]. The distinctive scarp, foredeep and rise typical of Danu and Freyja Montes are not readily visible here; instead the deformation is much more widespread and distributed. Analysis of the Fortuna has lead to the interpretation that it represents complex deformational patterns associated with convergence, lateral transport of material, and large-scale ductile deformation and crustal thickening[11].

Identification and mapping of the basic elements of convergent zones illustrates the different architecture of the orogenic belts and suggests that different processes or different levels and styles of similar processes are operating in different belts. We tentatively order the orogenic belts in a sequence from simple to complex as follows: Danu, Freyja, Akna, Maxwell. The rise, scarp, and foredeep characteristic of Danu and Freyja Montes suggests that large-scale flexure[12], underthrusting[13], and crustal loss are typical of these environments. The distinctive altitude differences between the outboard plains and the foreland region suggest that the orogenic belt represents the boundary between crusts of two different thicknesses. Akna and Maxwell Montes display similar topographic elevations both inboard and outboard and this may represent convergence of crust of more equal thickness, and the consequent emphasis on more distributed deformation and ductile crustal thickening, particularly in the case of Maxwell Montes.

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Figure 1. Cross section and nomenclature of convergent zones and orogenic belts in the Ishtar Terra region of Venus.