TECTONICS OF ARTEMIS CORONA, VENUS: IMPLICATIONS FOR FORMATION AND EVOLUTION

C. David Brown and Robert E. Grimm, Dept. of Geology, Arizona State University, Tempe, AZ 85287-1404.

Introduction. Artemis, the largest corona on Venus at 2600 km diameter, is a feature of particular interest due to the insight on the thermal and mechanical structure of the lithosphere provided by analysis of the presumed flexural topography on its margin. The processes responsible for the peripheral trench–outer rise system and the deformation in the corona interior are also relevant to the general nature of venusian tectonics. It is unlikely that Artemis can be completely explained by the standard corona evolution model of surface uplift by a plume or diapir, transition to a plateau, and eventual gravitational relaxation [1,2]. Elastic flexure modeling has shown the need for large applied bending moments, suggesting the presence of a subducted slab [3]. Inelastic flexure models require an inplane force an order of magnitude larger than that inferred from the geoid, a large moment, and a mantle rheology stronger than that measured for dry olivine in laboratory experiments [4,5]. The extreme conditions imposed by the models indicate that our understanding of the rheology, thermal state, and forces acting on the lithosphere is inaccurate, or the assumption that the topography is flexural and induced by subduction is in error. The present work concentrates on the interpretations of the geologic structures comprising the annulus and interior of Artemis, and their implications for the mechanisms responsible for the formation of the chasma and forebulge. This abstract focuses on C1-MIDRP 30S135, although the conclusions encompass observations of most of Artemis. This study has relied on the Magellan cycles 1 and 2 synthetic aperture radar F- and C1-MIDRPs, shaded relief images created by combining the left- and right-looking SAR images [6], and gridded altimetry data. A schematic map of the preliminary interpretations is illustrated in Figure 1; parenthesized letter callouts in the text denote locations of features that may not be visible in the figure.

Annulus Structures. The Artemis annulus includes structures formed by both shortening and extension [1], but folding is prevalent on the southeastern margin (A) [7]. Evidence for a compressional origin of the structures found in the chasma includes their sinusoidal cross-sections, continuity over ~200 km, and tapered terminations as well as the absence of steep scarps and associated radar layover common to extensional features. Anastomosing graben are observed along the inner trench slope and corona rim (B), and may reflect gravitational sliding [7]. Horsts and graben on the outer trench slope, while ubiquitous at terrestrial subduction zones, are absent along most of the Artemis annulus. This observation might be explained by the influence of a large compressive inplane force. Radial fractures of unknown origin tend to correlate in density with the height of the outer rise (C). The identity of the structures in the trench north of the termination of folding (D) is ambiguous. Outer trench slope graben are found where annulus folding is absent (E). At its northern terminus (F) the Artemis annulus intersects a rift zone.

Interior structures. The interior of Artemis is dominated by a northeast trending belt of deformation superimposed on smooth, unbroken volcanic plains (G). Interpretation of this unit in the context of shortening or extension is made difficult by structures characteristic of both modes of tectonics. Observations in favor of compression include imbricate thrust faults (H), a plunging anticline (I), tapered ridge terminations, sinusoidal and symmetrical cross sections of some ridges, >100 km length of some ridge-trough pairs, and convex outward arcuate fault scarps. The flat trough floors are similar to graben, but this is a result of infilling by lava. The high northeast edge of the deformation belt bows outward into the annulus (J); this shape and the presence of northwest oriented thrust faults is consistent with a compressional origin. The volcanism and low topography are typical of extensional regions; in addition, many flat-topped ridges resemble horsts and some scarps appear to be normal faults. However, it is generally easier to explain such structures as special cases of compressional deformation than to cast the evidence for shortening in terms of an extensional origin [8]. A structure that is especially difficult to explain with extension is a prominent fault scarp paired with a high, smooth ridge (K). A fine scale (~1 km) of deformation parallel to the ridge appears to result from the buckling of a thin surface layer. The length (~300 km), continuity, and splaying behavior of the scarp are characteristic of thrust faults. Features posed as possible fracture zones [9] are located within a "sub-corona" and may be associated with its formation rather than back-arc spreading in the whole of Artemis coupled with rollback subduction at the chasma. The geometry of two parallel shear zones (L) [9] is inconsistent with an Earth-like system of spreading ridges and transform faults. Shear zones like these are rare in Artemis, and a distributed form of spreading in the interior appears unlikely.

Conclusions. The southeast limb of Artemis Chasma is distinguished by folding; this fold belt and the adjacent flexural topography possibly have a common origin in a large northwest directed inplane force. Difficulties with this model are that the magnitude of the required force greatly exceeds the predicted forces due to mantle flow coupling [10], and the trench-forebulge on the northeast and southwest limbs requires an alternative explanation. A compressional origin for the northeast trending interior deformation belt is favored. However, this interpretation is

TECTONICS OF ARTEMIS CORONA Brown C. D. and Grimm R. E.

difficult to reconcile with the low topography of the region; compression resulting from the collapse of the uplifted surface or local downwelling is a possible rationale. The amount of extensional strain in the interior is small relative to shortening, and insufficient to maintain back-arc spreading. The relative ages of the interior and annulus fold belts is not obvious; while the interior belt overthrusts the trench, the annulus folding generally appears more pristine than that of the northeastern portion of the interior deformation. Therefore an ancient episode of back-arc spreading coupled with peripheral rollback subduction seems improbable, and the annulus folding may be unrelated to the flexural topography. It is difficult to speculate on a model of origin for Artemis Chasma that is more consistent with all the observations, but it is anticipated that this analysis will aid the development of such a model.

References. [1] Stofan E. R. *et al.* (1992), *JGR, 97,* 13,347. [2] Squyres S. W. *et al.* (1992), *JGR, 97,* 13,611. [3] Sandwell D. T. and Schubert G. (1992), *JGR, 97,* 16,069. [4] Brown C. D. and Grimm R. E. (1993), *LPS, XXIV,* 199. [5] Brown C. D. and Grimm R. E. (1993), *Eos, 74,* 378. [6] Kirk R. L. (1993), *LPS, XXIV,* 803. [7] Suppe J. and Connors C. (1992), *JGR, 97,* 13,545. [8] Pappalardo R. T. and Greeley R. (1993), *JGR,* submitted. [9] McKenzie *et al.* (1992), *JGR, 97,* 13,533. [10] Phillips R. J. (1990), *JGR, 95,* 1301.

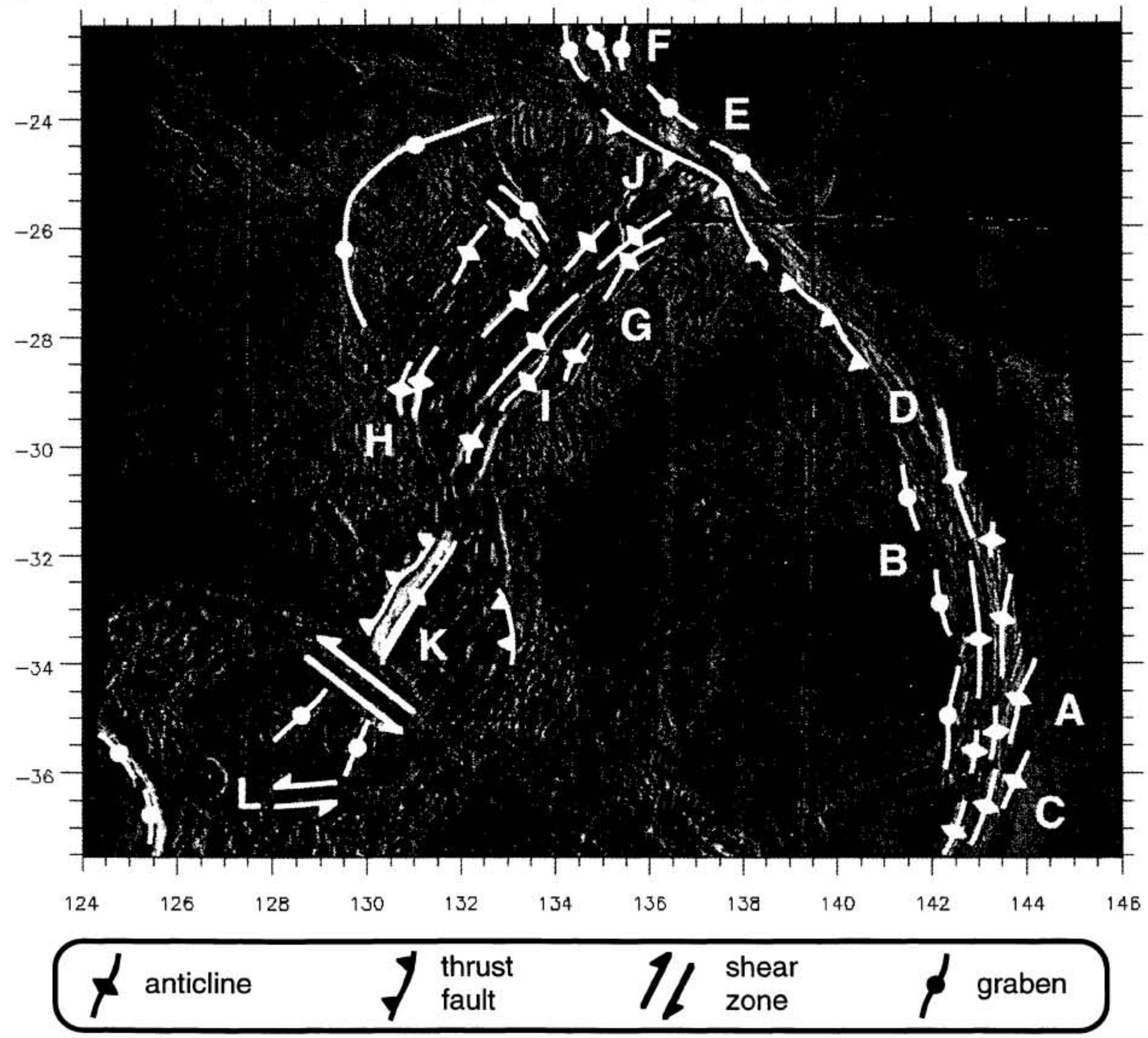

Figure 1. Schematic map of Artemis Corona structural geology. Base image is a shaded relief composite of cycles 1 and 2 C1-MIDRPs 30S135 in an equidistant cylindrical projection. Map symbols are intended to represent the style of tectonics where drawn, and do not necessarily correspond to specific structures.