BILATERAL SYMMETRY ACROSS APHRODITE TERRA

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Introduction

There are three main highland areas on Venus: Beta Regio, Ishtar Terra and Aphrodite Terra (1). Aphrodite Terra is the least known and the least mapped of these three areas, yet existing analyses of Aphrodite Terra based on available Pioneer-Venus orbiter data (1) suggest that it may be the site of extensive rifting (2, 3). Some of the highest resolution (30 km) PV data (SAR) included most of the western half of Aphrodite Terra. Recent analyses of the SAR data together with Arecibo range-doppler topographic profiling (10 x 100 km horizontal and 10 m vertical resolution) across parts of Aphrodite (4), further characterized the nature of possible tectonic processes in the equatorial highlands. The results of that study (4) indicated the existence of distinct topographic and radar morphologic linear discontinuities across the nearly east-west strike of Aphrodite Terra. Another prominent set of linear features is distinctly parallel to and orthogonal to the ground tracks of the PV spacecraft and are not included because of the possibility that they are artifacts. Study of the northwest trending cross-strike discontinuities (CSD's) and the nature of topographic and morphologic features along their strike suggest the presence of bilateral topographic and morphologic symmetry about the long axis of Aphrodite Terra.

Data Analysis

Data covering the Aphrodite region are limited and include PV altimetry, PV imagery (SAR) and Arecibo altimetric profiling. Venera 15/16 coverage is all above approximately 30 degrees north (5), whereas most of the features discussed here lie within 30 degrees of the equator. Arecibo high-resolution imaging (6) covers the hemisphere antipodal to Aphrodite and only Arecibo altimetry has been obtained of Aphrodite.

In order to further understand the nature of the CSD's identified earlier (4), the PV topographic and PV radar image characteristics of CSD's were examined along their strike and compared to the existing high-resolution Arecibo altimetric profiles which cross the strike of the CSD's. Seven of the most distinct CSD's were chosen showing strong linear topographic signatures in PV topography and steep radar backscatter gradients in SAR images. These CSD's are located in Figure 1 on a PV-based topographic contour map of western Aphrodite. As noted previously (4) CSD's mark distinct transitions of discontinuities in the large (thousands of kilometers) and intermediate (hundreds of kilometers) scale structure of Aphrodite Terra including distinct linear right offsets in regional morphologic boundaries of the plateau-like highlands responsible for the segmented shape of Aphrodite.

Examination of the topographic profiles across Aphrodite Terra, adjacent and parallel to the CSD's (Fig. 2), illustrates that the general character of topography across the highlands parallel to the CSD's differs significantly from that seen in profiles along the strike of the highlands and across the strike of the CSD's. When examined parallel to the CSD trends, the dominant characteristic of topography is a strong bilateral symmetry (Fig. 2a-d) which is not apparent in topographic profiles along other directions, including those profiles differing only slightly from the dominant CSD orientation (Fig. 2e). In addition to a broad symmetrical bell-shaped curvature or convexity of the highlands and the surrounding lowlands, there is also a finer-scaled symmetry in which peaks and troughs on one flank have similar or conjugate features on the opposite flank. Conjugate topographic features occur at the same distance from the center of regional bell-shaped symmetry.

Axes of symmetry defined by many adjacent profiles parallel to and between adjacent CSD's generally fall along lines striking about N70E; this is approximately parallel to the ridge and valley structure of Ovda Regio. The centers of symmetry of two adjacent profiles constructed parallel to and separated by a prominent CSD generally do not align on single lines as do those between two prominent CSD's. The axes of symmetry so defined have distinct right lateral offsets and are at least partly responsible for the large-scale segmented appearance of Aphrodite Terra.

In addition to the bilateral symmetry visible in topographic profiles, conjugate landforms are visible on PV altimetric maps. A linear ridge (x-y) 3000 km NW of the Ovda Regio axis of symmetry, as defined in profiles, is mirrored in the linear ridge (x'-y') 3000 km SE of Ovda Regio. A more striking example of mirrored or conjugate topography is an arcuate trough 3500 km NW of Thetis Regio which is similar in size and map shape to the arcuate Artemis Chasma 3500 km SE of Thetis Regio. The east and west extents of both arcuate troughs are tangent to the trend of the same east and west CSD's outlining distinct elements of Thetis Regio.

Conclusions

Cross-strike discontinuities (CSD's) in Aphrodite Terra reported previously (4) define the boundaries of distinct topographic and morphologic offsets of Aphrodite Terra. Topographic profiles constructed from PV altimetry data parallel to these CSD's show extreme bilateral symmetry on both regional (thousands of kilometers) and local (hundreds of kilometers) scales. The existence of a mirror image or conjugate of the arcuate Artemis Chasma illustrates the scale, extent and degree of bilateral symmetry across Aphrodite Terra.

We find the symmetric cross-strike profiles of Aphrodite, the conjugate minor topographic features and the offset axes of topographic symmetry to be broadly comparable to terrestrial oceanic thermal topography, topographically symmetric crustal spreading (7, 8) and transform faults. We conclude that these structures may represent evidence for crustal spreading on Venus. Other processes that may form the observed bilateral symmetry, evident on a scale of thousands of kilometers, include: 1) distributed rifting across a regional thermal uplift; 2) crustal traction and folding over bilaterally symmetric mantle plumes; and 3) global-scale block rotation between latitudinal strike-slip faults (9, 10). We are presently investigating the relationship of CSD's to tectonic features in mid and high latitudes, and the east-west extent of symmetry, in order to clarify which of these, or other possible mechanisms, are responsible for the topographic and morphologic bilateral symmetry across Aphrodite Terra.

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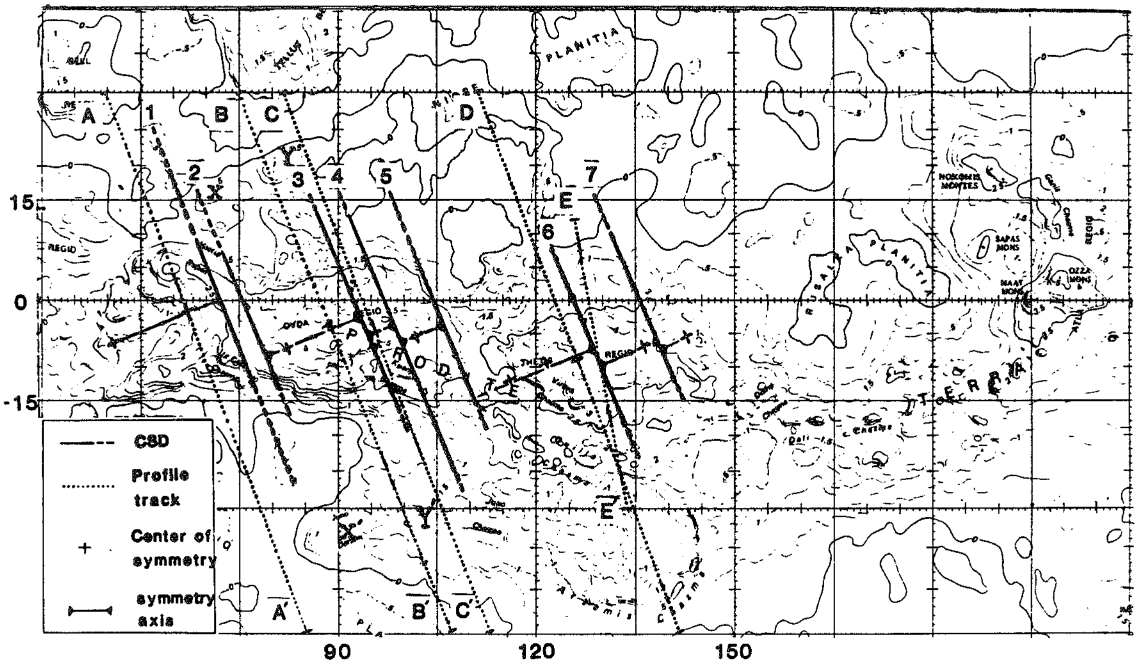

Figure 1

Fig. 1. Location of main cross-strike discontinuities, profiles of Figure 2, and axes of symmetry.

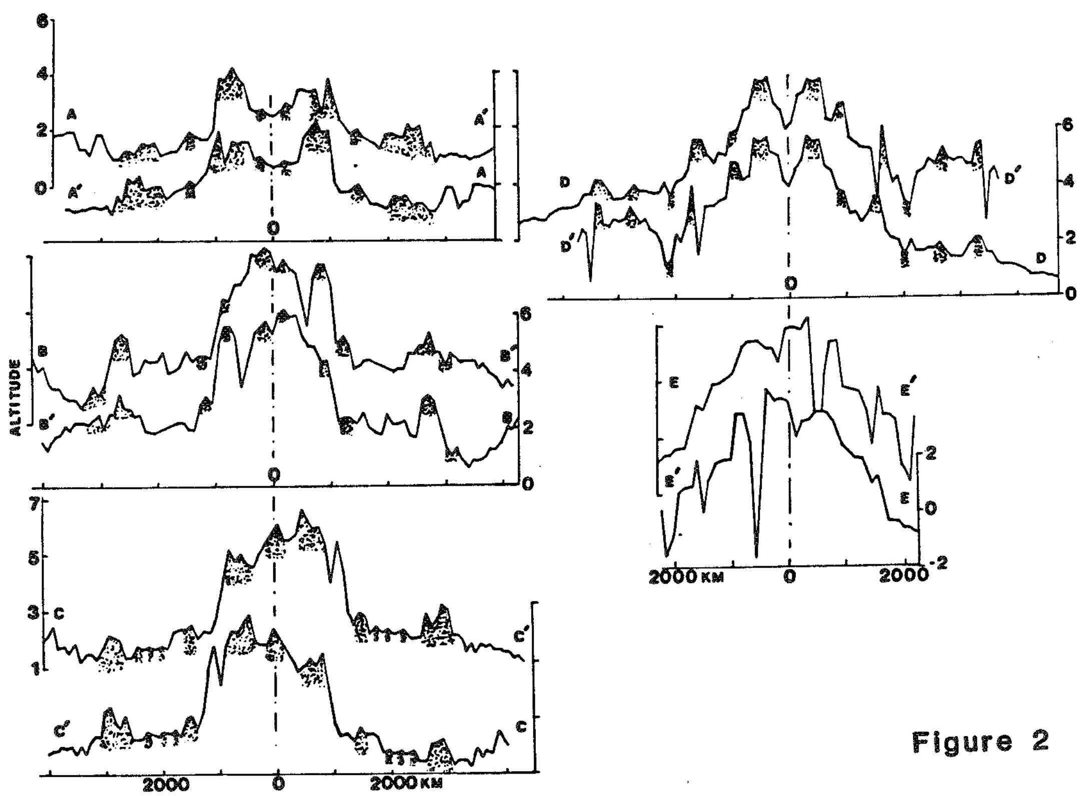

Figure 2

Fig. 2. Altimetry profiles across Aphrodite Terra and parallel to CSD trends. PV raw data.