ANALYSIS OF GRAVITY DATA OVER APHRODITE TERRA, VENUS

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Aphrodite Terra is a large, elevated, equatorial region on Venus. It is roughly the size of South America and covers from 0° to 30°S and 60° to 150°E on Venus. Because it is the largest elevated region on Venus, it is at the center of all discussions of planetary tectonics on Venus. It has been described as anything from a spreading ridge (1) to a string of volcanoes (2). Most analyses of this region have relied primarily on the topographic data provided by the Pioneer Venus Orbiter (PVO). This study uses the PVO gravity data to aid analysis of this region.

The PVO gravity data was obtained from Doppler shifts in the orbiter's radio tracking data. Using forward modeling an effective Airy depth of compensation was obtained along the "ridge line" of Aphrodite Terra. Ninety-one evenly spaced orbital arcs were modeled along Aphrodite Terra. The arcs each covered 20 degrees of latitude and were centered latitudinally over the highest part of Aphrodite Terra. Each arc was modeled with a 30 X 30 degree topographic grid with one degree grid spacing. The arcs were centered in this grid. Using point-mass surfaces, the gravity data was modeled using the topographic grid and several different depths of Airy compensation. A crustal density of 2.8 g/cm³ was assumed. The models were compared to the data using the least-squares method until an Airy compensation depth for each arc was determined to a precision of ±10 km. Bad data points were discarded based on 1) low accuracy in calculated depth (wide range of compensation depths give models fitting the data almost as well as best-fit model), 2) poor fit between model and data, and 3) low signal strength in data. Figure 1 shows how the ridge line of Aphrodite Terra was followed by the centers of the arcs and Figure 2 shows the resulting profile of depth of compensation versus longitude.

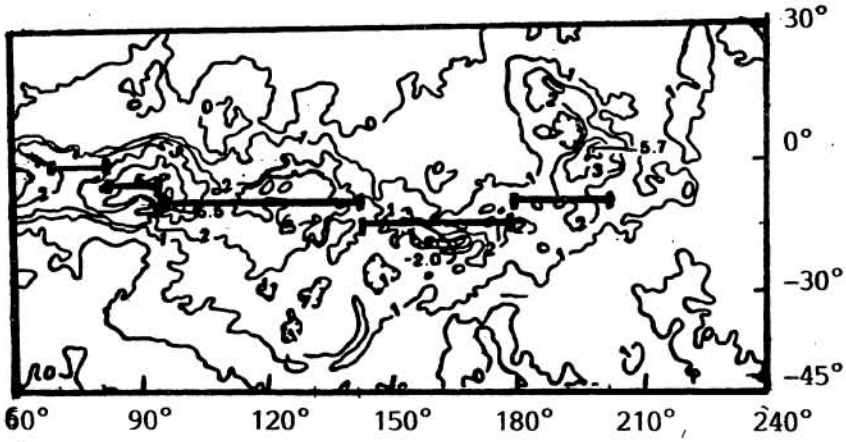

Fig. 1. Topography of Aphrodite Terra with thick black lines indicating centers of orbital arcs modeled.

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Figure 2 shows a large difference in Airy compensation depth between western and eastern Aphrodite Terra. The average compensation depth is 70 km west of 136°E and is 250 km east of this line. This difference is too great to be accounted for by a change in crustal density. It is also unlikely the difference is due merely to a change in crustal thickness, as 250 km is too deep for passive compensation to be maintained. Therefore, eastern Aphrodite Terra is probably a tectonically active region maintained by dynamic compensation, while western Aphrodite Terra is passively compensated.

References: (1) Head and Crumpler, 1987, Science, 238, 1380-1385; (2) Phillips and Malin, 1983, Venus, 159-214.

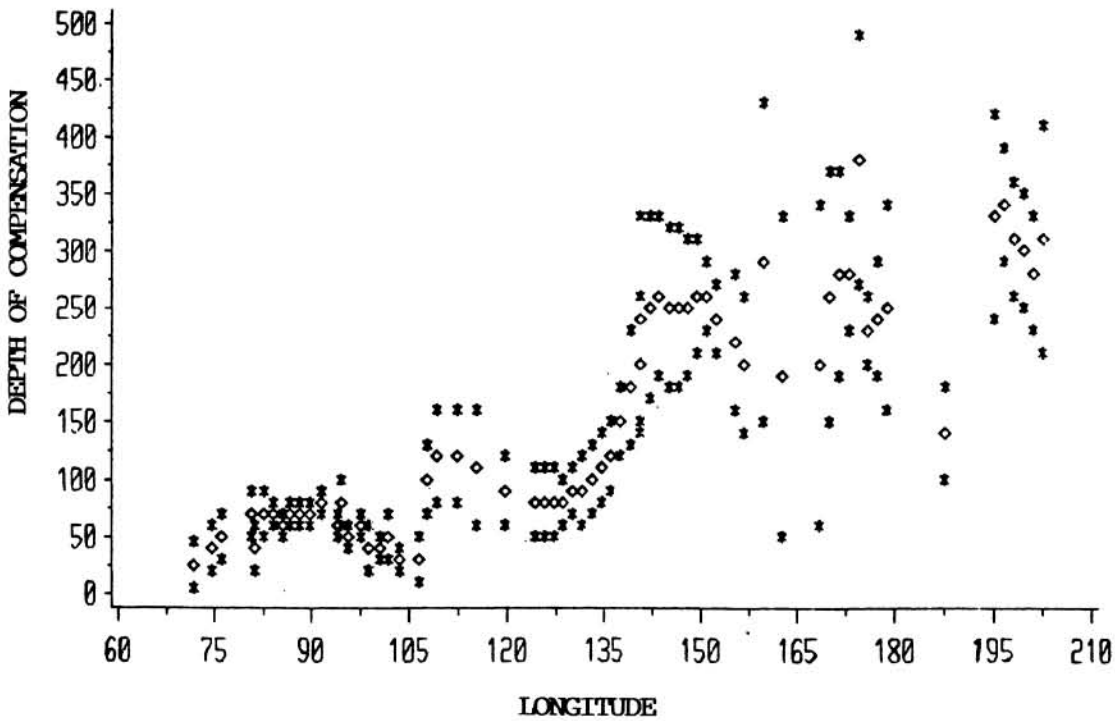

Fig. 2. Effective Airy depth of compensation along ridge line of Aphrodite Terra. Diamonds are compensation values and asterisks are error bars.