VENUS TOPOGRAPHY; CLUE TO HOT-LITHOSPHERE TECTONICS?

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One of the fundamental problems of Archean Earth history is the style of tectonics, especially whether or not some form of plate tectonics occurred (1, 2). The feasibility of Archean plate tectonics revolves around the questions of lithosphere temperature, thickness, and buoyancy, and of crustal thickness and composition.

Venus has a very hot surface (470°C) and thus, by inference, a hot crust and lithosphere. All current models for the thermal structure of Venus predict a hot and thin lithosphere (3, 4), and most workers agree that this implies a positive buoyancy for the lithosphere (5, 4) and thus the absence of "trench pull", one of the favorite driving forces for plate tectonics on Earth. Only one small region, Ishtar Terra (Fig. 1) exhibits topographic features consistent with plate convergence; a high

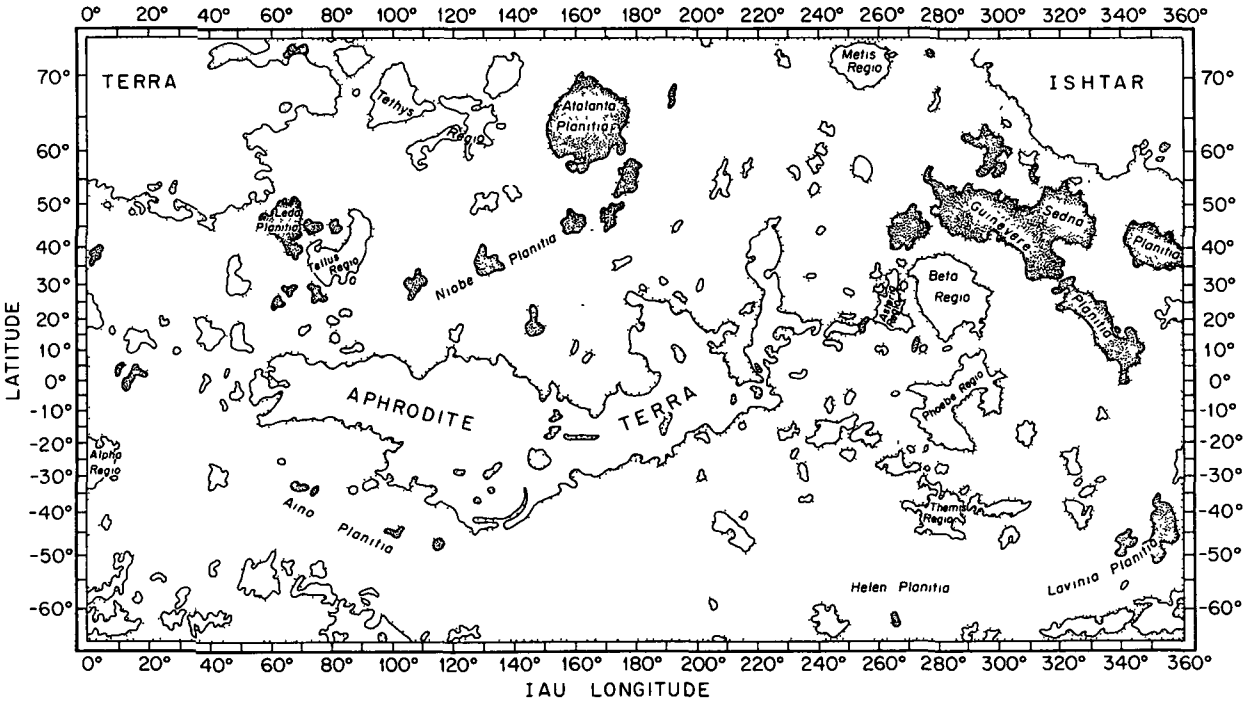

Fig. 1. Major physiographic regions of Venus. Heavy stipple, >1 km below median elevation; light stipple, median elevation ±1 km; unstippled, >1 km above median elevation.

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plateau with marginal linear mountain belts (6). In contrast, there are extensive regions consistent with plate divergence (Beta Regio-Phoebe Regio, Aphrodite Terra, and others). These tend to be long, narrow, relatively elevated zones characterized by closed depressions with flanking elevations, relatively high

rms slopes at meter scale, and relatively high surface roughness at centimeter scale (7). The closed-depression-flanking-high topography varies from long rift systems surprisingly similar in dimensions and general characteristics to continental rift systems on Earth (Fig. 2)(8), to shorter and less continuous rift-like features (Fig. 3), to irregular closed depressions and associated elevations of various sizes (Fig. 4). One

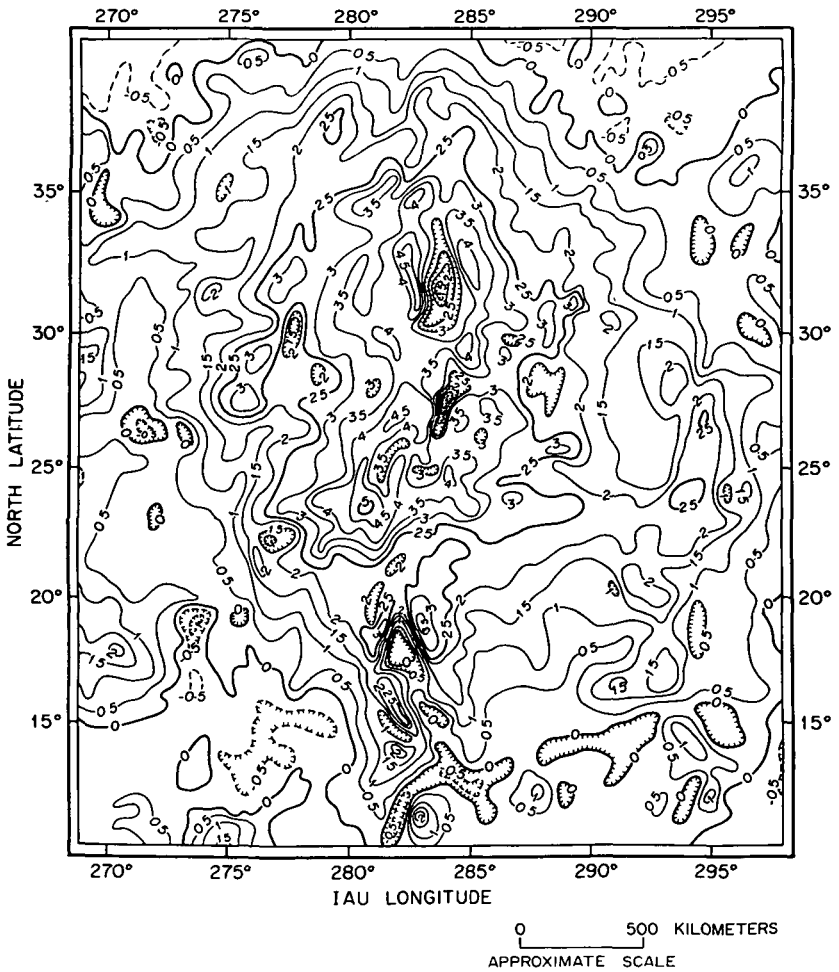

Fig. 2. Topography of Beta Regio
Contour interval 0.5 km; datum is median elevation

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possible tectonic style for a hot-lithosphere planet involves heat loss through numerous hot spots; regions of abnormally thin lithosphere, high conductive heat loss, and active volcanism (4). The abundance of closed depressions and associated elevations lying along linear elevated zones on Venus suggests that these "hot spots" are, in fact, concentrated along what amount to incipient divergent boundaries (9); regions of high heat flow, thermally elevated terrain, active volcanism, and limited (a few km) extension resulting in crustal collapse expressed as rifts or volcano-tectonic depressions. Except for the difference in H_2O abundances (Archean Earth was wet;

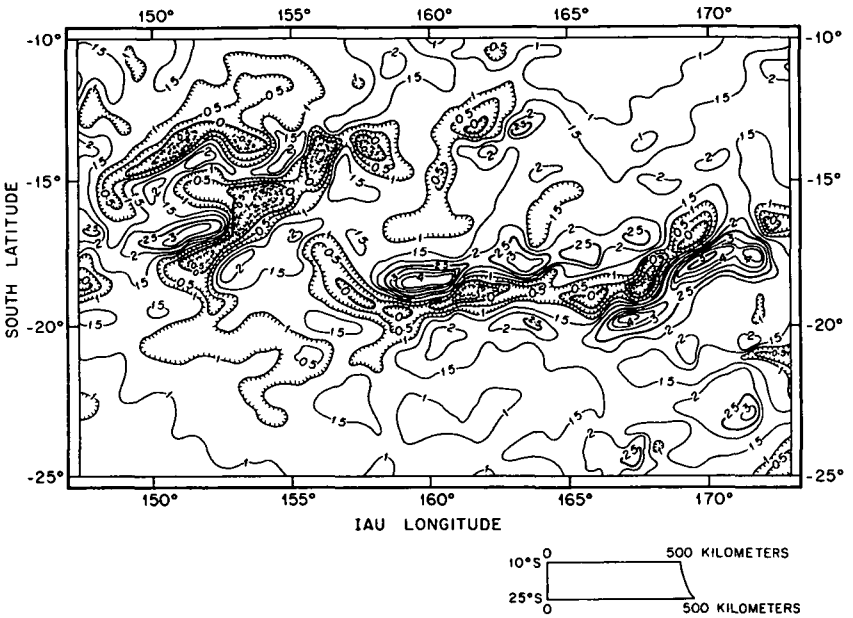

Fig. 3. Topography of central Aphrodite Terra. Contour interval 0.5 km; datum is median elevation.

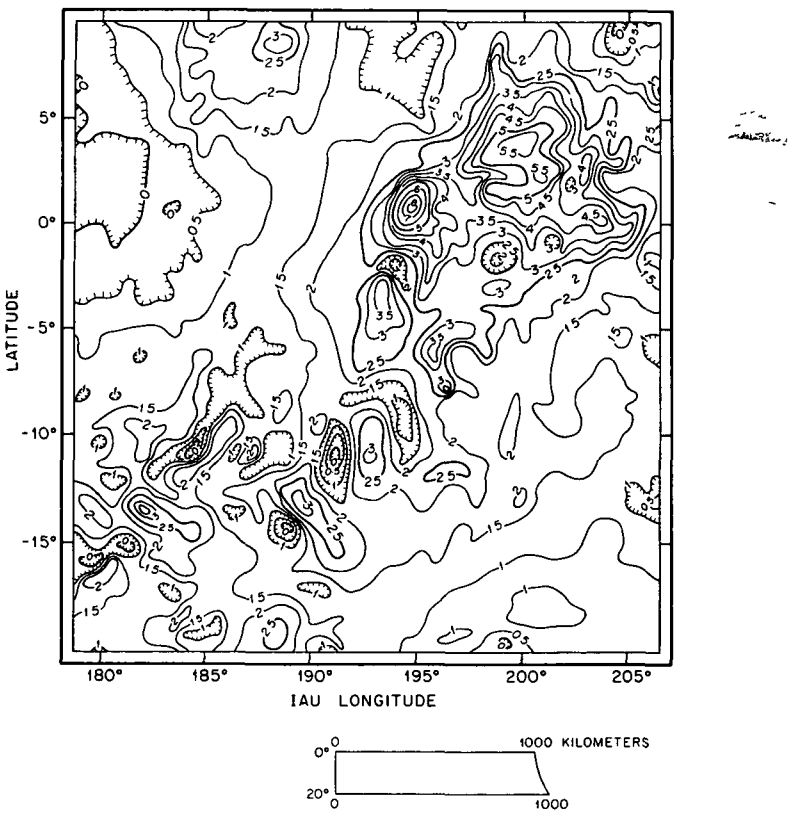

Fig. 4. Topography of eastern Aphrodite Terra. Contour interval 0.5 km; datum is median elevation.

modern Venus is very dry), these linear zones on Venus may be analogous to the tectonic settings for some Archean greenstone belts.

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