REGIONAL SLOPE CHARACTERISTICS OF GLOBAL TOPOGRAPHY: A COMPARISON OF VENUS AND EARTH. V. L. Sharpton and J. W. Head (Department of Geological Sciences, Brown University, Providence, Rhode Island 02912)

Introduction. Encoded within topography is information fundamental in understanding the nature and extent of the various processes which act on a planetary surface. Consequently, efforts to constrain the geology of Venus have focused on attempting to understand its topographic characteristics[1]. Unfortunately, as its surface is obscured from view by dense cloud cover, little is known about the shape of the Venus surface aside from a few *Venera* lander[2] images of small areas in the *Beta-Phoebe* region, some moderate (~5 km spatial; ~200 m vertical) resolution Earth-based radar topography for a minor portion of the surface[3], and the large-scale global topography retrieved by the *Pioneer-Venus* radar altimeter[4]. It is therefore important to extract from the *PV* data as much information on the global geomorphology of Venus as the resolution permits.

Masursky *et al,* [5] have divided the surface of Venus into three major provinces on the basis of elevation characteristics derived from the *PV* topography: *(1) Lowlands* are regions below the Venus datum (0.0 equals a planetary radius of 6051.0 km) and comprise ~27% of the surface. *(2) Upland rolling plains* are extensive regions with elevations from 0.0 to 2.0 km. This province includes ~65% of the surface of Venus. *(3) Highlands* include those surfaces above 2.0 km which make up ~8% of the total mapped surface of Venus.

While elevation information is an important component of topography, *regional slope* is another topographic parameter that is fundamental to the description of a geologic surface. Regional slope describes the planar gradient of a given area. Spatial variations in regional slope values express broad variations in the topography. To better understand the shape of the Venus surface as described by the *PV* topography, we have assessed and compared the regional slope characteristics of Venus and Earth. In a companion paper[6] we analyze the global statistics resulting from this study and treat the effects of removing the load of the earth's oceans on regional slope measurements. Here we discuss the surface distribution of regional slope values for Venus and compare it with that of Earth.

Method. Resolution of the *PV* and Earth *(Rand*[7] *)* data are comparable: 1° by 1° spatial resolution, ±200 m vertical accuracy. The slope of the *least-squares* planar fit to each 3° by 3° region of the topography was calculated using a spatial filtering technique. The resolution of the topographic data permits accuracy in slope measurement to within ~0.06°; in this study, however, we use 0.1° as a conservative upper limit to the uncertainty in regional slope calculation.

Results. Regional slopes range from 0.0° to ~2.4° for both Venus and Earth. Fig. 1 summarizes the regional slope values for major features on both planets. On Earth, the stable interiors of the continents, as well as ocean abyssal plains, appear as extensive regions of 0.0° slope. There are no such continuous regions on Venus suggesting, perhaps, that its surface is less modified by planation processes (erosion and deposition on the continents; deposition on abyssal plains). Although certain of the lowland and upland rolling plain surfaces are dominated by small (≤5°) areas of 0.0 - 0.1° slope, these units are interrupted by numerous circular, arcuate and linear features with regional slopes of 0.1 - 0.2°. These features are roughly equivalent in size, character and magnitude to terrestrial regional slope features associated with old mountain belts, such as the Appalachians or the Urals. Within the lowlands and upland rolling plains provinces, slope values do not increase systematically with elevation; in regional slope characteristics, there is little if any distinction between these units. In general, however, there is a higher concentration of 0.1 - 0.2° features as elevation increases. This appears to explain the correlation in mean regional slope *vs.* elevation presented by Sharpton and Head[6].

The major highland regions on Venus are bounded by zones of distinctly higher regional slope than characteristic of the lowlands or the majority of the upland rolling plains (Fig. 1). While this is also typical of terrestrial continents, the magnitude of the continental margin slopes greatly exceed those associated with *most* Venus highlands; only in Ishtar Terra are the highland margin slopes comparable in magnitude to those of continental margins on earth. Furthermore, the

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mountain systems that encircle Lakshmi Planum in western Ishtar have regional slope characteristics that are similar to major compressional features on Earth (oceanic subduction zones, active continental margins, zones of continental convergence such as the Himalayan Front in the Tibetan Plateau). In this way also, Ishtar is unique among the Venus highlands.

Marginal slopes associated with Aphrodite Terra are less steep than those of Ishtar and are best developed on the north and south flanks of western Aphrodite. The steepest slopes in eastern Aphrodite occur along the highland axis and appear to be associated with the extensive system of *chasmata* found in this region. Beta Regio is bounded by slopes of 0.1 - 0.4°, best developed on the east and west flanks. The interiors of western Aphrodite and Beta are areas of 0.1 - 0.3° regional slope most similar in regional slope characteristics to the Rocky Mountains in the western U.S. or slow-spreading ocean ridges such as the Mid-Atlantic Ridge.

Major *chasmata* such as Artemis, Diana, Dali, and Devana are similar in regional slope expression; magnitudes are typically in the range of 0.1 - 0.4°. These values are comparable to those of the East African Rift on Earth thus supporting the interpretation that *chasmata* on Venus are rift valleys[5]. There is an apparent relation between the orientation of the *chasmata* associated with highlands and the development of highland margin slopes: the well-developed north and south margins of Aphrodite parallel the trend of Dali and Diana Chasmata; in Beta Regio, the steeply sloping east- and west- facing flanks are alligned with Devana Chasma. Thus regional slope characteristics for Aphrodite and Beta appear to suggest that the formation of these regions, unlike Ishtar Terra, are associated with large-scale extensional deformation.

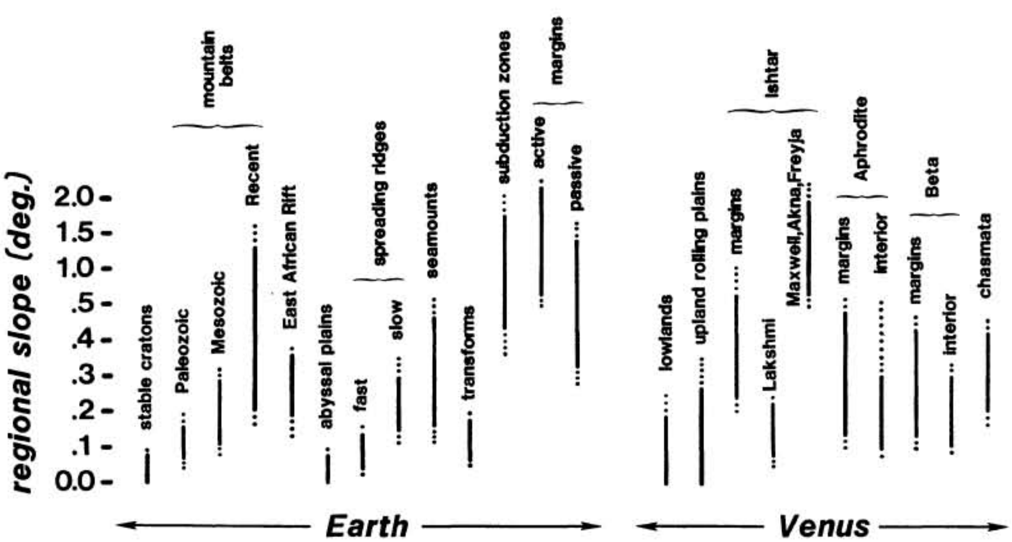

Figure 1. Regional slope values for major surface features on Earth and Venus calculated over 3° by 3° areas. Solid line denotes range of typical values; dots include full observed range.

References. [1] McGill, *et al* (1983) in *VENUS*, 69-130. [2] Moroz (1983) in *VENUS*, 45-68. [3] Goldstein *et al* (1978) Icarus, *36*, 334-352. [4] Pettengill *et al* (1980) J.G.R., *85*, 8261-8270. [5] Masursky *et al* (1980) J.G.R., *85*, 8232-8260. [6] Sharpton and Head (1984) *this volume.* [7] Nat'l Geophys. Data Center (1980) *D.A. 1980(SE-D), Rev.*, NOAA.