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measurements indicate low contents of K, U, and Th, typical for tholeiitic basalts [18,4].

Vega 2 landed at the transitional zone between Rusalka Planitia and the eastern edge of Aphrodite Terra rise. The landing circle is centered at 7.14°S, 177.67°E, about 1500 km south of the Vega 1 landing site. Most of the landing site consists of a densely fractured radar-bright plain with radar-dark plain to the northeast. The southwestern portion of the site has ridges and fractures associated with a 300-km-diameter coronalike feature. No television panoramas were made at the site but both gamma ray spectroscopy and X-ray fluorescence spectroscopy measurements were taken. The gamma ray measurements of K, U, and Th and the X-ray fluorescence spectroscopy measurements of bulk chemistry indicate a composition close to tholeiitic basalt [18,4].

Discussion: We have shown that within all the Venera/Vega sites the dominant type of terrain is plains. These plains include (1) mottled (Venera 8, 10, and Vega 1), (2) homogeneously dark (Venera 13), (3) dominated by prominent lava flows (Venera 14), and (4) fractured (Venera 9 and Vega 2). The plains are associated with coronalike features (Venera 8(?), 13, 14, and Vega 2), fracture belts and swarms (Venera 8, 13), and tesserae (Venera 8(?), 9, 10). This diversity reflects the global diversity of the venusian plains.

For the two sites (Venera 8 and 13) where nontholeiitic compositions of the surface material were determined, the steep-sided domes resembling those described by Head et al. [11] and Pavri et al. [12] have been found. For the five sites where geochemical signatures of tholeiitelike basalts were identified (Venera 9, 10, 14, and Vega 1, 2), these steep-sided domes have not been observed inside the landing circle. We believe that this correlation favors a nontholeiitic origin for these steep-sided domes.

The television panoramas from the Venera 9, 10, 13, and 14 landers show a microlandscape with characteristics that correlate well with the Magellan observations. At these four sites, the panoramas all showed bedded outcrops. Before the Magellan mission, these bedded rocks were considered as either basaltic tuffs or lavas [14,15]. Magellan imagery does not resolve the lava vs. tuff issue, although the presence of prominent lava flows at the Venera 14 site favors a lava interpretation of the bedded rocks. The very low bulk density of these rocks estimated from Venera 13 and 14 overload measurements (1.5 g/cm^3) favors the tuff interpretation. Therefore, the origin of these bedded rocks still remains an enigma.

Conclusion: Joint analysis of Magellan and Venera/Vega data on the Venera/Vega landing sites has shown that the panoramas and geochemistry measured by the landers agree well with the morphology seen in Magellan imagery of the site. This observation suggests that it is possible to extrapolate our geochemical and morphologic results to the remaining Magellan imagery of Venus.

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GLOBAL DEFORMATION ON THE SURFACE OF VENUS.

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Large-scale mapping of tectonic structures on Venus shows that there is an organized global distribution to deformation. The structures we emphasize are linear compressive mountain belts, extensional rifted zones, and the small-scale but widely distributed wrinkle ridges. Ninety percent of the area of the planet's compressive mountain belts are concentrated in the northern hemisphere whereas the southern hemisphere is dominated by extension and small-scale compression [1,2]. We propose that this striking concentration of fold belts in the northern hemisphere, along with the globe-encircling equatorial rift system, represents a global organization to deformation on Venus. A great circle that connects the northernmost branches of a globe-encircling rift system roughly separates the tectonic hemispheres [1] (Fig. 1). South of this tectonic equator [1] there are a few well-formed fold belts at the edges of small crustal blocks within the global rift system, but the globally significant deformation is the rift system and the wrinkle ridges.

Compressional structures on Venus can be divided into two major styles: linear fold belts and wrinkle ridges. Figure 2 shows that the major difference between these two styles is the distribution and localization of strain. Wrinkle ridges represent deformation that is distributed over thousands of kilometers whereas fold belts show concentrated deformation along narrow bands. Venus is the only terrestrial planet other than Earth that has linear compressive mountain belts [3]. Venusian fold belts, similar to those at plate margins of the Earth, are the dominant compressional structures in the northern tectonic hemisphere. They are typically about 100 km wide and thousands of kilometers long. The relatively small amount of erosion on Venus allows us to image fault-related folds forming over regionally extensive decollement horizons within the belts [4]. This supports the notion that these mountain belts are analogous to the thin-skinned fold-and-thrust belts of Earth. Wrinkle ridges are the dominant style of compressional deformation in the southern

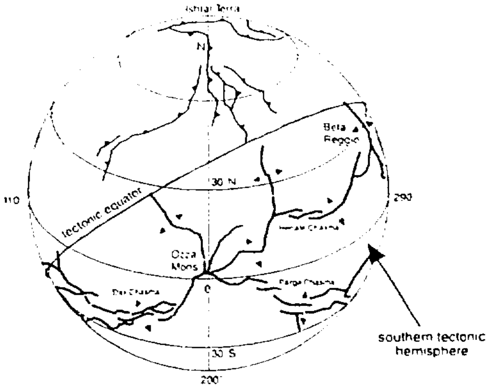

Fig. 1. Generalized tectonic map of Venus after [3]. Rift zones are indicated by the heavy black lines. Ninety percent of the area of foldbelts lies in the northern hemisphere while the southern tectonic hemisphere is dominated by extension and small-scale compression in the form of wrinkle ridges.

Furthermore, there is a high correlation between wrinkle ridge trends and long-wavelength topography. Within these trends we observe quite regular interridge spacing of 15–30 km. Preliminary studies of wrinkle ridges reveal that individual structures may accommodate up to 1.5 km of shortening. Therefore the distributed shortening in the southern plains that is accommodated by wrinkle ridges is about 1–5%. A higher-resolution investigation of wrinkle ridges is necessary to refine these results and gain a better understanding of the stresses involved in wrinkle ridge formation on Venus. Thus the low-intensity wrinkle ridge deformation of the plains has consistent patterns that approach a global scale.

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COLDSPOTS OR HOTSPOTS? THE ORIGIN OF PLATEAU-SHAPED HIGHLANDS ON VENUS.

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A compelling question for the terrestrial planets is the origin of the highland regions on Venus. Data on the topography, gravity signature, and surface morphology returned by the Pioneer Venus, Venera 15/16, and Magellan spacecraft represent a basis for dividing these highlands into two distinct groups: volcanic rises and plateau-shaped highlands [1]. Volcanic rises are generally thought to be due to mantle upwellings in the form of large mantle plumes [2] and are thus similar in origin to terrestrial hotspots. There is less agreement as to the origin of plateau-shaped highlands (PSH) [1,3,4]. Coldspot mantle downwelling can lead to the formation of a highland region under Venus conditions [3], and previous to Magellan some PSH (particularly W. Ishtar Terra and Ovda and Thetis Regiones) were suggested to be compressionally deformed regions of thickened crust created by mantle downwelling [5,6,7]. A hotspot model proposes that such regions are formed by magmatism and tectonism related to the near-surface ascent of either the diapir-shaped large mantle plume [8] or a solitary disturbance propagating up a plume conduit [9]. The intent of this abstract is to (1) briefly review the characteristics of both volcanic rises and plateau-shaped highlands on Venus and the models for their formation and (2) consider tests that may help to make clear which model best explains the plateau-shaped highlands.

Characteristics of Venus Highlands: Highlands on Venus can be divided into volcanic rises and plateau-shaped highlands (PSH) on the basis of their topography, long-wavelength gravity-topography relationships, and geologic features (Table 1). Volcanic rises are characterized by roughly circular topographic rises with domical cross sections, relatively large geoid-topography ratios (GTRs), and the presence of large volcanic constructs, widespread flows, and extensional tectonism (commonly manifested as radially trending rifts). They include Beta, Atla, Bell, Imdr, and Western and Central Eistla Regiones. Plateau-shaped highlands (PSH) are so named for their shape in cross sections and are characterized in plan view by a variety of shapes, by steep margins and rugged interiors, by lower GTRs than volcanic rises, and by surfaces dominated by the heavily deformed complex ridged terrain (or tessera). They generally appear to share a common sequence of tectonism: shortening (commonly margin-parallel) followed by relatively small amounts (<10%?) of extension [1]. These regions include Ovda, Thetis, Alpha, Tellus, and Phoebe Regiones, Fortuna and Laima Tesserae, and W. Ishtar Terra [1]. The inclusion of W. Ishtar Terra is arguable given its large apparent depth of compensation (ADC) [10] and GTR values as well as the presence of extensive volcanic plains and two large volcanic constructs (see Table 1). For the purposes of this work, W. Ishtar Terra is considered a PSH on the basis of its topography and the overwhelmingly compressional tectonics manifested in its orogenic belts.

Models for Plateau-shaped Highlands: Observations that must be explained by a successful model for PSH include topography, long-wavelength gravity anomalies, and surface morphology. The latter includes the abundant deformational features that dominate their surfaces. A successful model should therefore explain the style(s) of deformation (i.e., compression, extension, etc.) and the relative ages and geometries of these various structural features, information that can be derived from Magellan images because of

TABLE 1. Characteristics of Venus highlands.

Characteristic	Volcanic Rises	Plateau-shaped Highlands
Topographic cross section	Domical	Steep-sided, rugged interior
Topographic planform	Circular to elongate	Circular to polygonal
Gravity anomaly	Positive, centrally located	Positive or negative, offset from center
GTR/ADC values	~20–35 m/km ~150–300 km	~10–15 m/km ~30–90 km
Volcanic features	Shield volcanos, extensive plains, and flows	Minor plains, flows, and domes
Extensional tectonics	Rifts, numerous graben, and fractures	Small (<10 km), late-stage graben
Compressional tectonics	Largely absent	Broad (10–20 km) ridges, marginal belts