LINEAR MOUNTAIN BELTS AND RELATED DEFORMATION ON VENUS; John Suppe and Chris Connors, Department of Geological and Geophysical Sciences, Princeton University, Princeton NJ 08544

The linear compressive mountain belts of Venus (Fig. 1) are fairly similar to those of Earth: 100+ km wide and thousands of kilometers long with foredeep flexures (Fig. 2), marginal fold-and-thrust belts composed of 2-10 km wide fault-bend folds above regionally extensive decollement horizons (Fig. 3), and flat high-plateau interiors analogous to the Altiplano (Fig. 2) [e.g. 2, 3, 4, 10]. They exist (1) as fold belts at the margins of crustal blocks such as plateaus, tessera highlands, and a few coronae and (2) as ridge belts within the low plains. Modelling to date demonstrates that the topography is consistent, as on Earth, with critical-taper brittle-plastic wedge mechanics of accretionary wedges, but modified for the conditions of Venus—zero fluid-pressure effect because of low fluid density, high-cohesion diabase, and high surface temperature (390-470°C) close to the brittle-plastic transition [6, 10]. The regional topographic relief of mountain belts—measured between the deformation toe and the flat crest—displays a remarkably unearthly roughly linear dependence on absolute elevation (Fig. 2), ranging from 6 km for Maxwell Montes at an elevation of 10 km to a few hundred meters at the lowest planetary elevations (0 to -2 km) [3, 10]. This phenomenon is proposed to be an effect of the vertical change in atmospheric temperature (390-470°C) on the depth to the brittle-plastic transition along the decollement, amplified by secondary processes [6, 10].

The distribution of linear compressive mountain belts and rift systems on Venus—as on Earth—reflects a global pattern to the deformation of the lithosphere. The linear fold belts and rift systems shown on Fig. 4 are the most obvious, and apparently the youngest deformational zones of substantial global extent. Most linear compressive mountain belts are concentrated in the northern hemisphere as the single high mountainous complex of Ishtar Terra (about the size of Australia) plus a low-elevation system of longitudinal ridge belts, passing through the North Pole, and largely confined to the longitudes 150°-250°. In contrast, linear extensional tectonics is largely confined to the equatorial and southern latitudes as a near globe-encircling branching rift system. These linear fold belts and rift systems were already recognized from pre-Magellan data [e.g. 4, 7, 9].

It is perhaps surprising that Venus can be fairly accurately divided into extensional and compressional hemispheres separated by what might be called a tectonic equator, which is inclined about 40 degrees to the planetary equator [11]. The pole to this tectonic equator is at about 63°, 44°N, within Leda Planitia. In addition there is significant distributed low intensity deformation, especially wrinkle ridges, which typically display consistent orientations for thousands of kilometers [e.g. 1]. Furthermore some local compressive mountain belts exist associated with small subplates and local deforming environments, particularly within the globe-encircling rift system. This global arrangement of young linear mountain belts and rifts (Fig. 4) can be described in a simple kinematic model as an unearthy kind of plate tectonics consisting of two deformable superplates [11], the boundaries between the two being the observed near globe-encircling rift system. According to the simple model—which need not assume large displacements—one superplate is growing and the other shrinking. The shrinking superplate must be internally deforming as it converges toward the tectonic pole, whereas the growing plate need not deform. However, the shrinking superplate on Venus is currently the larger superplate, therefore it must be in extension south of the tectonic equator because of the required increase in small-circle radius with displacement south of the equator. It is the observation of this extension in the shrinking superplate south of the tectonic equator that argues for this simple model. Eventually, if large deformation and plate motion are now occurring—which is by no means certain based on past cratering [5, 7, 9]—the growing superplate will become the larger and only a minor portion of the planet will display linear compressive mountain belts.

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Fig. 1 100 km wide foldbelt [10]

Fig. 2 Elevation dependence of relief [10]

Fig. 3 Fault-bend folds, Artemis [10]

Fig. 4 Two deforming superplates [11]