TABLE 6a. Calculated Properties of Thin Lava Flow Units on Venus: Flows for Which the Morphology is Controlled by the Rheology

$F/(m^3 s^{-1})$	W_t/km	D_c/m	X/km
α=0.01 rad, D_b=0.1 m, Y=24.64 Pa, η=1200 Pa s			
10	0.71	0.84	0.01
100	1.62	1.27	0.63
1000	3.73	1.93	4.11
α=0.01 rad, D_b=0.01 m, Y=2.46 Pa, η=120 Pa s			
10	0.86	0.29	0.02
100	1.98	0.45	0.18
1000	4.56	0.68	1.17

thin flow units are produced by lava flows moving down valleys defined by the preexisting topography, there is no longer any simple coupling between the rheology, the effusion rate, and the morphology. There is still, however, the usual relationship between the mean velocity u of the moving lava and its depth D_c in the middle of the guiding depression, arising as a result of the balance between the gravity component down the slope and the viscous resistance of the fluid

$$u \approx \frac{D_c^2 \, g \, \rho \, \alpha}{8 \, \eta} \tag{36}$$

which can be used in place of equation (25) for u to provide a value of the maximum flow length X from equation (26). Table 6b shows some values of X found for α = 0.01 and two values of η (1200 and 120 Pa s) for values of D_c in the range 0.5-4 m. Again it is possible to produce flows hundreds of meters wide having internal layers with thicknesses of a fraction of a meter.

Although the above calculations show that the layered structures seen at the Venera landing sites can be produced in thin tholeiitic lava flow units erupted at rates similar to those commonly encountered on Earth, they also show that such flows can only extend for distances of at most a few hundred meters (a conclusion reached just on the basis of the rate of growth of the cooled skin by Frenkel and Zabaluyeva [1983]). If one wishes to interpret the layers seen in the lander images as being produced by such flows, therefore, it is necessary to accept that each lander is located within a few hundred meters of a vent. The distances between the essentially randomly located Venera landing sites are typically a little greater than 2000 km, and so one would be driven to conclude that volcanic vents were spaced no more than about a kilometer apart over an area of more than 2 x 10^7 km^2. If this interpretation were to be supported by data from future missions, it would have profound implications for the structure of the Venus lithosphere. Such a situation has not been encountered on any of the other terrestrial planets and must currently be regarded as improbable. We therefore favor the conclusion of Garvin et al. [1984] that the surfaces viewed by the Venera landers in the Beta-Phoebe region represent the partly eroded upper surfaces of lava flows having thicknesses in excess of at least a meter.

TABLE 6b. Calculated Properties of Thin Lava Flow Units on Venus: Flows for Which the Morphology is Controlled by Preexisting Topography

D_c, m	Values of X for α = 0.01 rad, m	
	η = 1200 Pa s	η = 120 Pa s
0.5	8	79
1.0	126	1260
1.5	638	6380

See text for discussion and definition of parameters.

<u>Domes and cones.</u> Barsukov et al. [1984a, b, 1986] reported on a series of domelike hills which often occur in clusters on the plains in numerous locations on Venus. These features have diameters ranging from the limits of resolution (1-2 km) up to 10-15 km. Occasionally, a summit crater is seen. Barsukov et al. [1986] point out the similarity in morphology of these features to volcanic domes or cinder cones on Earth and Mars. The widespread nature of these cone and domelike features is an indication of the local and regional significance of volcanic activity and the abundance of individual vents on Venus. However, the present level of description and knowledge of these features is insufficient to assign specific eruption conditions to them as a class or even to determine if they represent more than one class of eruption styles. On the basis of our predictions we offer some initial observations and some guidelines for further analysis in order to establish the eruption style or styles represented by these features. As described by Barsukov et al. [1984a, b, 1986], these features could represent edifices dominated by effusive activity, explosive activity, or a combination of the two. Predominantly effusive activity could produce small domelike shield volcanoes similar to those observed in the Snake River Plain on Earth [Greeley and King, 1977] and in the lunar maria [Head and Gifford, 1980]. On Earth and the moon these features range in size up to 15-20 km diameter and several hundred meters in height and tend to occur in clusters. Summit craters are often seen on lunar and terrestrial domes and are systematically larger (relative to dome base) on lunar domes. Summit crater diameters on the moon increase with dome size and are in the 1-3 km range [Head and Gifford, 1980]. Thus the Venus features share many of the characteristics of small shields built by effusive activity on Earth and the moon.

Explosive activity is also capable of building features matching this general description. Strombolian activity on Venus could produce pyroclastic cones with maximum diameters in excess of several kilometers without requiring the presence of more evolved magmas (Figures 16 and 17). Cinder cones produced from such activity are common on Earth and often occur in local clusters and fields in various tectonic environments [Settle, 1979b]. Although cone diameter sometimes exceeds 2 km in terrestrial situations, average cone diameter for a wide range of locations is less than 1 km [Settle, 1979b]. Although Strombolian activity is plausible in the Venus environment, we have no reason to believe that average cone diameters should greatly exceed terrestrial dimensions, which are approximately the limit of resolution of the Venera 15/16 radar system (1-2 km). Pyroclastic cones could also be built from air fall and