pyroclastic flow deposits of Pelean activity on Venus (Figures 16 and 17) if more evolved magmas and higher volatile contents are involved. However, in this case we also anticipate that the cone diameter would on the average be less than about 5 km, although larger edifices could be built. Size-frequency data on the features observed on Venus would be helpful in determining whether the majority of the cones fall within, or at the upper end of, the size range of landforms predicted for Pelean activity (Figures 16 and 17). Mixed effusive and explosive activity to produce stratovolcanoes also cannot be ruled out. An additional possible interpretation for the Venus features is that they represent extrusive domes comparable to domes formed from the extrusion, deformation, and subsequent intrusion of very viscous magma. Such features are common on Earth within large calderas and in other volcanic provinces [Smith and Bailey, 1968] but are generally restricted in diameter to less than 5 km. Domes morphologically similar to the terrestrial examples are observed on the moon and reach diameters of 20 km [Head and McCord, 1978]. In general, Venus conditions would favor flow formation rather than internal dome growth for such magma types over terrestrial conditions because reduced volatile exsolution would lead to lower viscosities, producing initially wider, lower flows, less susceptible to subsequent intrusion.

In summary, several types of additional data will be useful in determining the eruption style or styles of the features described by Barsukov et al. [1984a, b, 1986]. The detailed characteristics of cone/dome size distribution will be of extreme importance in determining average diameters and the general diameter range. Data on heights of features, statistical data on landform shape in profile and planform, and information on the nature of the boundary between the base of the structure and surrounding terrain (sharp or subdued and transitional) will allow better assessment of the various eruption conditions. Finally, assessment of associated features, such as nature, size, and abundance of central craters, evidence for cone breaches, presence of associated flows, cone/dome symmetry and asymmetry, and relation to surrounding structural features will provide data required to assess further the eruption conditions represented by these features.

Possible pyroclastic deposits. Barsukov et al. [1986] have described a section of the flanks of Bell Regio containing a distinctive, continuous, radar bright region which, based on its elongation downwind from the summit area, may be a pyroclastic fall deposit. In total extent the region measures 100 by 300 km, but its outline is irregular in places. Based on the regularities expected in the plan view of an air fall deposit (see Figure 12), we estimate that the width of the deposit lies between 65 and 100 km.

Modeling calculations on the shapes of volcanic eruption clouds [e.g., Wilson, 1976; Sparks and Wilson, 1982] imply that the width of an air fall deposit near the vent is approximmately equal to the height of the cloud which deposits it. Figure 10 then shows that eruption cloud heights in the range 65 to 100 km imply mass eruption rates in the range of $3 \times 10^{10}$ to $3 \times 10^{11}$ kg/s (i.e., 30-300 $km^3/h$). Though higher than eruption rates associated with basaltic activity on Earth or the moon, these values lie within the range deduced for Plinian and ignimbrite-forming eruptions of silicic magma on Earth. Examination of Figure 13 reveals that a high volatile content is required in a magma on Venus to allow eruptions forming air fall deposits to proceed at these rates: if the transition to pyroclastic flow formation is to be avoided, $CO_2$ contents in excess of 8 wt % or $H_2O$ contents in excess of 6 wt % are implied. Thus, if the air fall nature of the Bell Regio deposit is confirmed, its presence provides strong evidence for the eruption of a very volatile-rich magma on Venus.

## 6. Summary and Conclusions

### 6.1. Present Venus Volcanic Environment

Present conditions on the surface of Venus (high surface temperatures and atmospheric pressures) result in a thermal gradient difference such that the temperature is higher at a given depth on Venus than on Earth, and a pressure distribution difference leading to much smaller ratios of subsurface to surface pressure on Venus than on Earth. There are several significant consequences for styles of volcanism on Venus:

1. Although the implied minimum mass eruption rates are in the same range as terrestrial values, there will be less cooling of magma in the final stages of approach to the surface because the erupting magma will be hotter, and narrower fissure widths are required. For lava flows on Venus the high atmospheric gas density causes convective heat losses to be much more important than on Earth and to exceed radiation losses at temperatures less than about 1000 K. At temperatures above about 900 K the heat loss rate from a lava flow surface on Venus will be about 1.5 times greater than from a comparable terrestrial flow. Relationships of flow surface temperature and thickness of the rigid crust on the flow surface with time show that only for the first half hour after leaving the vent is the crust thickness greater on Venus than on Earth, while for the first hour, surface temperatures will be greater on terrestrial flows. After this time, temperatures will be higher on Venus flow surfaces and the crust thinner. A consequence of this is that flows ceasing after less than about an hour will be longer on Earth by a factor of about 1.3 and those traveling for times greater than an hour will be systematically, but only slightly, longer on Venus than on Earth. These relationships also suggest that behavior in the first hour of flow may enhance the formation of a crust sufficiently to encourage tube-fed rather than open-channel flows, thus possibly enhancing flow lengths on Venus. The same cooling relationships suggest that the transition from pahoehoe to aa texture on flows should occur at times about one-third earlier on Venus (and so closer to the vent) than on Earth. In general, our treatment suggests that there is no reason to expect large systematic differences between lava flow morphology on Venus and Earth. For a given fissure width, we do not anticipate different effusion rates on Venus unless there are systematic differences between magma rheologies. Even if magmas are relatively dry on Venus compared to Earth and have viscosities a factor of 3 greater, yield strengths should be about the same, and levee widths and thicknesses about the same on the two planets. Other