that the maximum height above the mean surface to which magma can be raised to produce a volcanic edifice is an increasing function of the mean density difference. Lower density differences on Venus would therefore be expected to lead to smaller typical heights of volcanoes built up largely from deep-seated eruptions. For example, if density differences on Venus were limited to the approximately 100 kg/m^3 difference between basaltic solid and liquid densities (implying that the magma sources were located only within the crust), then volcanic edifice heights would be systematically about a factor of 4 less than on Earth, where effective density differences for magmas originating in the mantle range up to about 400 kg/m^3.

Analyses of crack geometries given by Weertman [1971] and Secor and Pollard [1975] show that the consequence of reducing the driving density contrast acting on a migrating magma-filled crack is to make the crack narrower for a given vertical crack height or magma volume. This will increase the amount of cooling experienced by a given batch of magma and decrease its ability to reach the surface. This implies that larger minimum magma volumes may be required to ensure surface eruptions (as distinct from crustal intrusions) on Venus than Earth, thus making intrusive rather than extrusive events statistically more frequent and adding to the problem of constructing high volcanic edifices. Also, since the minimum fissure width and length needed to permit an eruption to take place are larger than on Earth and since the mass flux per unit horizontal length of a fissure is an increasing function of fissure width [Wilson and Head, 1981], it is likely that when an eruption does take place, it will do so at a higher mass eruption rate than on Earth, thus helping to explain the apparently common occurrence of long lava flows on Venus.

The possibility that magma sources are located at systematically shallower depths on Venus than on Earth also has a bearing on the observation that large-scale, steady explosive eruptions appear to be rare: Table 3 shows that carbon dioxide is useless as a potential cause of such activity unless sources have depths between 35 and 80 km. However, water (or any volatile having a similar pressure dependence of solubility) could produce explosive activity in magmas ascending from depths in excess of 1-3 km. It may be, therefore, that the paucity of extensive explosion products, if confirmed by future investigations to be planet-wide, can be taken as direct evidence of the current depletion of such volatiles in the Venus interior.

6.3.3. Volcanic calderas and lithospheric structure. Depressions identified as volcanic calderas on Venus (e.g., Colette, Sacajawea, and the summit depression of Theia Mons) range in size from 90 to about 200 km, a factor of 10 larger than the sizes of most terrestrial examples [Wood, 1984]. On Earth there is evidence that the diameters of calderas are approximately equal to the diameters of high-level magma reservoirs [Ryan et al., 1981, 1983], the draining of which during one or more eruptions is the main reason for caldera formation. Additionally, the shapes of the stress fields generated in the crust by the inflation of magma chambers during preeruption periods [Mogi, 1958] are such that the diameters of the resulting calderas are comparable to the depths of the magma bodies. This relationship breaks down, on Earth, for relatively deep magma reservoirs, however. Evacuation of such bodies is more likely to lead to formation of a broad, regional downwarp [Walker, 1980] than a caldera. The reason is presumably related to the fact that the amplitudes of stresses induced at the surface by deep, inflating magma chambers are not great enough to cause the fracture patterns required for caldera collapse.

If we attempt to take the sizes of the larger calderas on Venus as representing the depths to the corresponding magma bodies, we obtain depths which are of the order of 5 times as great as current estimates of the thickness of the thermal lithosphere [Solomon and Head, 1982, 1984]. A simple way of resolving this paradox is again to assume that the Venus lithosphere is unusually thin, at least in the immediate vicinity of the calderas, and that caldera formation is controlled directly by the stress field induced by magma accumulation in a large region which amounts to an upwarp of the asthenosphere. This assumption has the added attraction that it provides a reason for the presence of the large magma volumes (of the order of 100 km^3) which must be removed (either by eruption to the surface nearby or by injection into the crust as intrusions) to justify the caldera volumes.

6.4. Observations From Future Venus Missions

There are a number of critical observations relating to volcanic eruption styles and the relationships between volcanic and tectonic processes on Venus that could be made from future missions.

1. It is important to establish whether the apparent near-absence of large-scale explosive activity seen in those parts of Venus examined so far is true of the whole surface of the planet. If it is, this will imply a severe depletion of all high-solubility volatiles in the Venus interior for the last several hundred million years and will reinforce the arguments that we have given about the length of time that the present-day atmospheric conditions have existed.

2. Information is required about the small cone and dome structures at higher resolution than that currently available. It is important to establish the frequency of occurrence and sizes of summit pits and craters on these features and the presence or absence of related lava flows or pyroclastic deposits, since this will help to reduce the ambiguities in assigning their formation mechanism.

3. More detailed morphological information is needed for the features identified as lava flow deposits. Regrettably, it is very hard to see how current radar techniques will be able to yield information on flow thicknesses. However, if widths can be established for levees and central channels and if the lengths of individual flow lobes can be established unambiguously, more information can be deduced about eruption rates and lava rheological properties and hence likely magma compositions.

4. Higher-resolution images of shield volcanoes are needed to establish vent locations for summit and flank eruptions, the detailed structures of the summit calderas, and the time order in which these features formed. This information