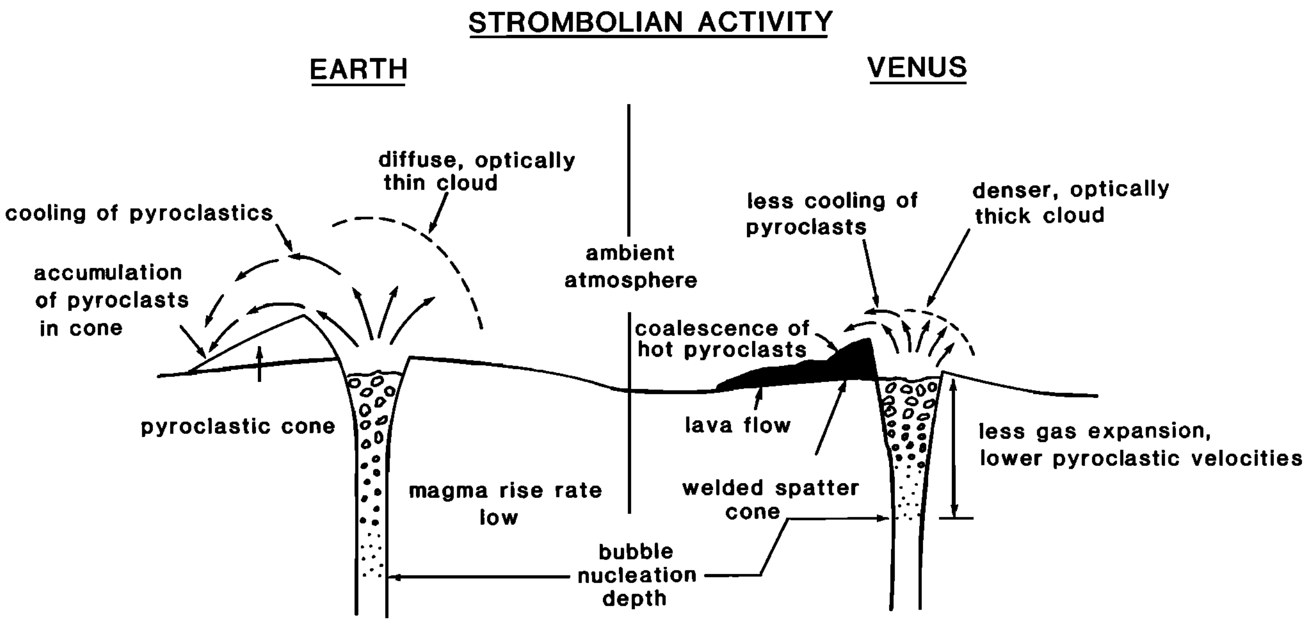

Fig. 7. A comparison of the characteristics of Strombolian eruptions on Earth and Venus. Smaller amounts of gas expansion produce lower pyroclast velocities, denser fire fountains, less opportunity for cooling of clasts, and smaller pyroclast ranges on Venus.

crust density contrast). If the magma exsolves volatiles, gas bubbles nucleate and grow in the magma as a result of both decompression during rise toward the surface and addition of the volatile phase by continuing diffusion. Each growing gas bubble is buoyant in the magmatic liquid and rises through it at a speed which depends on the magma rheology, the bubble size, and the ambient pressure (which controls the gas density). If the rise speed of the magma in the fissure is much greater than the rise speed of the bubbles in the magma, the bubbles remain effectively locked to the magma and do not move appreciably relative to one another: Sparks [1978] showed that these conditions hold for all highly silicic magmas (on all the terrestrial planets). However, if the bubbles can move through the magma at a sufficiently great rate relative to the magma rise speed through the crust, there is time for large bubbles to overtake and coalesce with smaller bubbles. A runaway condition can be reached where single, very large bubbles reach the surface having swept essentially all of the gas out of a long, vertical section of the magma-filled conduit. The eventual bursting of each of these bubbles at the surface is the cause of the explosion. (Figure 7). This process can only take place to a significant extent in magmas with relatively low viscosities ($\lesssim$ 1000 Pa s) rising in narrow ($\lesssim$ 1 m wide) fissures at low ($\lesssim$ 1 m/s) speeds [Wilson and Head, 1981]. Furthermore, it is a necessary condition for this kind of activity that the magma volatile content be small enough to prevent complete disruption of the magma into pyroclasts (i.e., smaller than the values given in Table 3); otherwise, the eruption style is by definition Hawaiian or Plinian.

Explosions of this kind on Venus have already been examined in some detail by Garvin et al. [1982], who showed that coalescence may produce bubbles with sizes up to at least 10 m. The excess pressure in these large bubbles, together with their appreciable rise speeds through the magma itself, cause them to blow off a layer of magma trapped between the upper boundary of the bubble and the free surface of the magma in the vent at speeds of up to 10-30 m/s. The sizes of the pyroclasts so produced can range from some meters (if the magma volatile content exceeds about 0.5 wt %) down to millimeters or less. The coarse fraction (clasts larger than 0.3 m) will decouple quickly from the upward gas flow since their terminal fall velocities in the rising and decelerating gas will be comparable to the upward gas speed; the ejection ranges of such clasts are likely to be no more than 100 m.

Clasts smaller than about 10 mm can be entrained into a convecting eruption cloud over the vent if such a cloud forms. If, as discussed earlier, the explosion repetition rate is great enough to produce such a cloud, the dispersal of small pyroclasts will depend on the height of the cloud (and the ambient wind conditions). Since intermittent explosive activity of this type can only occur when magma rise speeds are less than about 1 m/s in conduits or fissures having widths of order 1 m, it follows that typical magma discharge rates in this kind of activity should range up to 2×10^3 kg/s (for circular conduits) or 3×10^3 kg/s per meter of horizontal fissure length (for elongate fissures). In most terrestrial eruptions, individual active sections of fissures exhibiting this kind of activity are no more than a few tens of meters long, so that the total discharge rate of magma giving rise to an individual eruption cloud is not likely to be more than 10^5 kg/s. Furthermore, analyses of the gas to pyroclast mass ratio in terrestrial Strombolian explosions shows that only a few percent of the total magma reaching the surface is expelled in the explosive events [Blackburn et al., 1976], so that