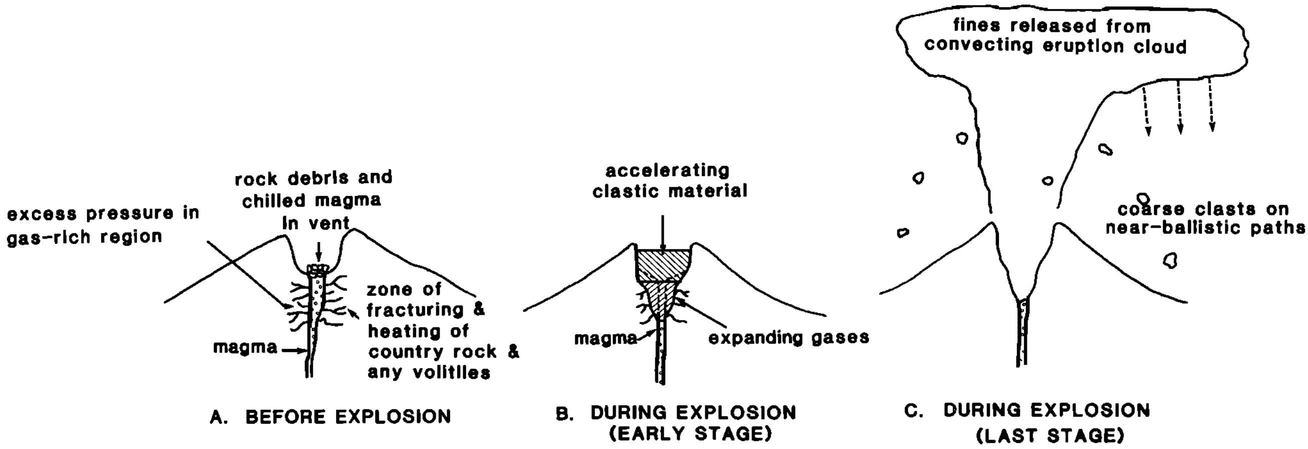

Fig. 14. (a) The geometry assumed for a cone being invaded by fresh magma prior to a Vulcanian explosion on Venus. (b) Conditions during the early phase of acceleration of the explosion products. (c) Conditions late in the explosion process.

case of an upward directed explosion) or the ground (in the case of a lateral blast, or a pyroclastic flow formed by the collapse of an initially upward directed debris cloud). However, the average particle size of the mainly juvenile clastic material produced in a Pelean explosion is likely to be much smaller than that of the products of a Vulcanian explosion. As a result, in the Pelean case a much larger fraction of the ejected material is likely to be fully entrained into a stably convecting eruption cloud, if one is able to form, or into a pyroclastic flow.

When upward directed Pelean explosions produce convecting eruption clouds on Venus, these will rise to about 60% of the height of a cloud of the same mass on Earth, as discussed in earlier sections. Without estimates of the masses involved in such explosions it is hard to give a quantitative estimate of cloud rise heights and pyroclast dispersal areas. Unfortunately, little work has yet been done on the stability of structures such as extrusive domes and near-surface intrusions. It is clear that relationships must exist between such parameters as magma rheology, magma extrusion or intrusion rate, cooling rate of the outer skin of the magma body, and accumulation rate of trapped gases, but we do not have even empirical information about these relationships for terrestrial cases. We note, however, that the widths and thicknesses of domes involved in Pelean activity on Earth generally range up to at most a few hundred meters, implying masses of order 10^{11} kg and that if all this material is injected into a transient eruption cloud, its rise height on Venus as given by equation (30) will be about 10 km, leading to an air fall deposit with a diameter of the same order.

Pelean explosions on Venus could produce pyroclastic flows, either by collapse of upward directed eruption clouds or by direct generation of laterally directed clouds. The run-out distances of flows from collapsing eruption clouds will be reduced relative to those on Earth by the same amount as flows produced in Plinian activity. The Venusian environment will also lead to a reduction in the run-out distances of flows produced in lateral blast explosions. This is a result of the effect noted for Vulcanian explosions, whereby the ratio of the absolute pressure in the compressed magmatic gases driving the explosion to the atmospheric pressure which they will ultimately reach after expansion is much less than in the corresponding events on Earth. We have modeled the maximum velocities likely to be reached by lateral blast clouds using the formulation given by Eichelberger and Hayes [1982] in which the magmatic material is accelerated by an expansion wave which propagates into it from the free surface and decelerated by a compression wave which forms between the expanding debris cloud and the undisturbed atmosphere. Table 4 shows values of the peak velocities of such clouds for three magma volatile contents on Earth and Venus (at the 40- and 100-bar pressure levels) using H_2O as the magmatic volatile. If CO_2 were used, the velocities would be about two thirds of those generated by H_2O: the velocity scales approximately as the reciprocal of the square root of the volatile molecular weight. Also shown in Table 4 are values for the speeds of acoustic waves within the blast cloud and in the surrounding atmosphere. It will be noted that terrestrial lateral blast clouds propagate at speeds which are potentially so high that the initial stages of their acceleration are in fact controlled by choking in the vent and involve the generation of complex patterns of shock waves, as modeled numerically by Kieffer [1981a, b]; however, this complication may well be absent for such events on Venus, since cloud velocities are so much less there. If we assume that the run-out distances of blast clouds are proportional to their initial kinetic energies (this was the assumption made earlier for pyroclastic flows from Plinian-type eruptions) and so to the squares of their velocities, comparison of the velocities in Table 4 suggests that such clouds should travel at least 10 times less far from the vent on Venus than on Earth, restricting their ranges to at most a few kilometers.

5. Volcanic Deposits and Landforms on Venus

5.1. Summary of Predictions

In previous sections we have outlined the nature of effusive and explosive eruptions in the