Domes

Viscous lavas pile up over their vents to make steep-sided volcanic domes, or tholoides (Williams, 1932; Macdonald, 1972, p. 108-121). Some domes are only a few meters across and a few meters high. Others are as much as 2,000 m across and 600 m high. Some domes, such as that of Santa Maria, Guatemala, continue growing for many years. Most domes grow largely by expansion from within, as additional magma is squeezed into the core of the dome. The expansion results in cracking and crumbling of the solidified exterior, and loosened blocks tumble more or less continuously down the side of the dome to build a heap of "crumble breccia" around its base. Rolling and bounding blocks can constitute a menace to persons or animals near the base of the dome. Lava escaping from the interior may form flows down the dome flanks over, or interbedded with, the breccia. Protrusion of viscous magma through fractures in the carapace of the dome forms spines, commonly very numerous, and some of them reaching heights of more than 100 m above the surface of the dome. One such, formed at Mt. Pelée in the eruption of 1902-3, grew to a height of 300 m and had a volume of 90 million cubic meters. Spines are commonly very unstable and tend to collapse, owing to undermining by explosions around their bases, or to movements of the dome. Collapse of large spines may produce hot or cold rock avalanches, which present a potential threat to areas near the base of the dome.

Most domes grow in the crater or on the upper flanks of volcanoes, remote from inhabited areas, and in themselves pose little threat to lives or property. The comparatively rare domes which grow on the lower slopes may spread over cultivated land, but their growth is so slow that much property can be removed before it is destroyed. The most serious threat from domes is the formation of Merapi-type glowing avalanches, and lahars resulting from entrance of the avalanche debris into streams, both discussed in later sections. Small to moderate explosions are common around the base of some domes, and may cause death and destruction nearby. For these reasons it is best to evacuate areas within a few kilometers of the dome, and along valleys subject to glowing avalanches and lahars, so long as the dome is active. Domes also signal a condition of the volcano that may lead to cataclysmic eruptions of Peléean or Plinian type, both of which are often related to the existence of the viscous magmas that form the domes. Special attention probably should be paid to potentially active volcanoes (plate 1) on which dome growth has taken place.

Tephra

The fragments thrown out by explosions are collectively known as pyroclastic material, or tephra. They range from several meters across to fine dust. Fragments larger than 6 cm in diameter are called bombs if they were fluid when they were thrown out and take on rounded or aerodynamically moulded shapes during flight; or if they were solid, or nearly so, and remain angular, they are called blocks. Fragments between 60 and 2 mm in diameter are called lapilli (singular = lapillus) regardless of their shape, and those smaller than 2 mm are called ash. Many bomb- and lapillus-size fragments, ejected in a fluid condition, are irregular in shape and highly vesicular. They are called scoria, or cinder. Extremely vesicular scoria, commonly with the vesicles drawn out into long thin tubules, are called pumice. (For more detail on pyroclastic materials and their classification, see Macdonald, 1972, p. 122-135.)

Most ash is formed not from attrition of previously solid rock, but from disruption of still-fluid lava froth, scoria and pumice, by continued expansion of the contained gas bubbles. The septa between the bubbles are stretched until they rupture.

The fragments of the septa are cooled so rapidly, by contact with air or water and by the adiabatic expansion of the gas, that they remain predominantly glass. The importance of the glass in contributing to soil fertility has already been pointed out.

Tephra thrown into the air by explosion is deposited as a blanket of fragments that usually decrease in average size with increasing distance from the vent. The coarsest fragments commonly pile up directly around the vent to form a scoria cone or a pumice cone (plate 5). The finer material is carried by the wind, sometimes to distances of thousands of kilometres (fig.5), and the resulting ash deposit may be very unsymmetrical, extending many times farther down wind than up wind. Furthermore, winds at different levels may blow the ash in very different directions (fig. 6).

Rain falling through clouds of ash in the air may form mud balls (accretionary lapilli, or pisolites) as much as a centimetre in diameter, and heavy falls may result in layers of these in close proximity to each other, or even coalescing, over areas of a few square kilometres. The ejection of large amounts of water along with ash and other debris, as in some eruptions through lakes, may result in blankets of mud over considerable areas. One of the best-known examples was the Tarawera eruption of 1886, in New Zealand, where part of the erupting fissure crossed Lake Rotomahana, and a considerable part of the ejected debris was lake-bottom mud. The phreatic eruption of 1933 in the Suoh Basin on Sumatra threw out mud from the swamp in which it occurred. The layer of mud covered an area of about 32 km 2/, and at its center was 20 m thick.

Within a period of a few weeks cementation commonly forms a thin hard crust on such deposits of ash or mud. The crust greatly reduces permeability and increases runoff, contributing to the formation of flash floods and lahars. It also retards the re-establishment of vegetation.

On and close to the volcano falling bombs and blocks may break branches from trees, crash through roofs and walls of houses (plate 6), start fires, and injure or kill animals and men. During the 1968 eruption of Arenál, Costa Rica, falling blocks crashed through houses 3 km from the erupting vent. On Heimaey, Iceland, bombs started fires in the town of Westmannaeyjar.

The finer ash is seldom hot enough when it reaches the ground to start fires. Commonly, however, the weight of deposited ash causes roofs to cave in. Thus, during the 1971 eruption of Fuego, in Guatemala, a thickness of 30 cm of ash 8 km west of the volcano caused about one fifth of the roofs in the town of Yepocapa to collapse (Bonis and Salazar, 1974). When it is dry, the ash may be light enough for the roof to support it (plate 7), but rain may rapidly increase its weight and result in sudden collapse of the roof. There have been very numerous examples of collapse of roofs under loads of ash since the destruction of Pompeii in 79 A.D., and not uncommonly people have been killed as a result. An obvious remedy, employed for instance in Westmannaeyjar, is to shovel the ash off the roof before the load gets too great.

Working outdoors during a heavy ash fall may be difficult, however, due to breathing of the ash-laden air and to the intense darkness that often prevails. The sharp ash particles are extremely irritating to the respiratory passages, and inhalation of excessive amounts of ash may result in death. Ordinary industrial dust masks are very effective, although the filters may have to be cleaned frequently; an ordinary cloth tied across the face, especially when it is dampened, provides reasonably good protection. Goggles may be desirable to prevent irritation of the eyes by the sharp particles.

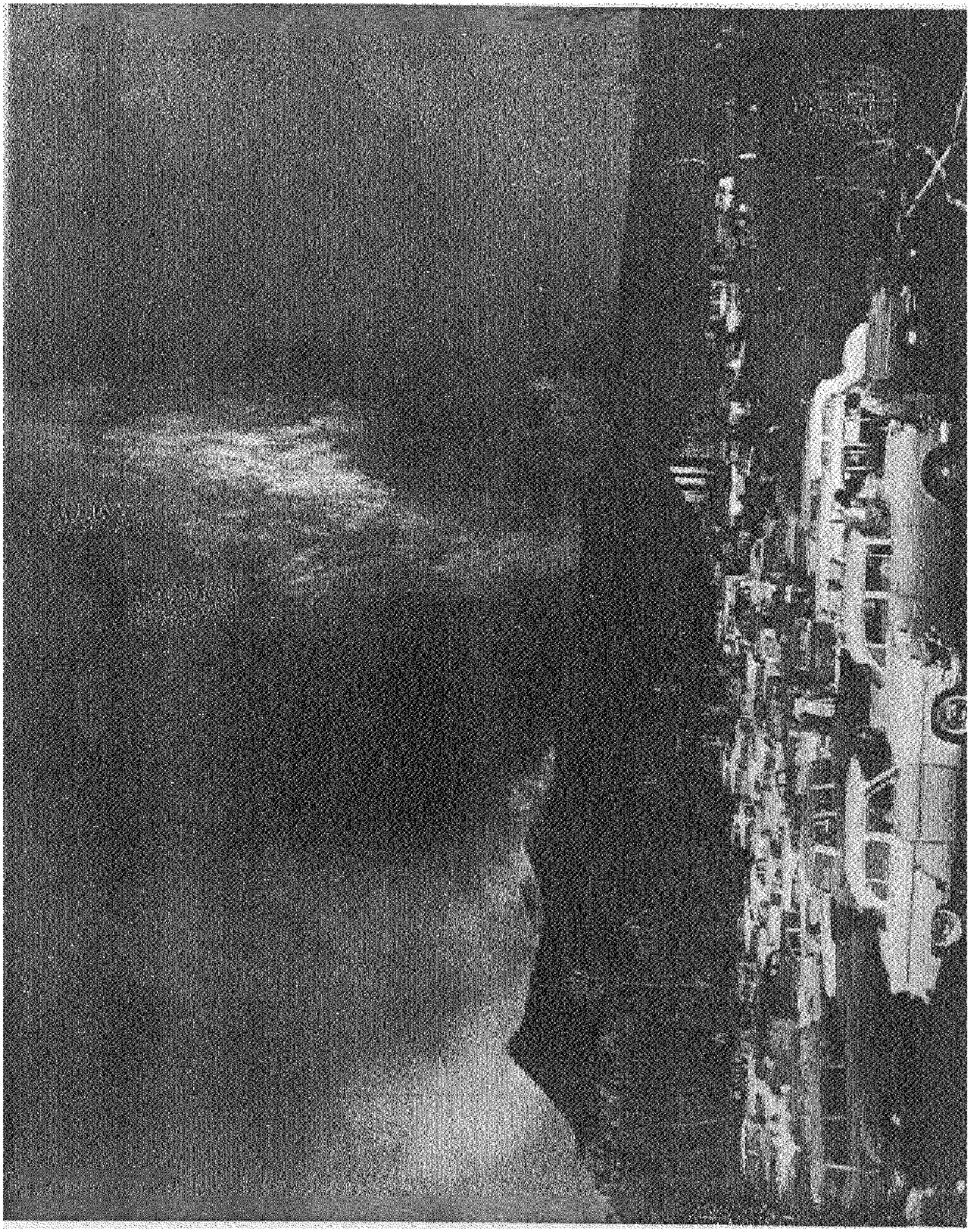

Plate 5. Lava fountain 225 meters high building a cinder-and-ash cone in the outskirts of Kapoho, Hawaii, in January 1960. The cars in the foreground represent a new problem in volcanic eruptions: the larger number of spectators, who had to be hurriedly moved out of the area from time to time as veering wind brought showers of hot cinder to the observation area.

(Source: Honolulu Advertiser, Gordon Morse).