Chapter 2

SOME EXAMPLES OF VOLCANIC EMERGENCIES

In order to illustrate some of the practical problems which may arise in a volcanic emergency, the uncertainties regarding the onset and time-span of destructive activity and the areas likely to be affected, and hence the difficulty in deciding whether and when to evacuate people from these areas, some recent cases will be described. These include, at one end of the scale, a major evacuation not followed by an eruption of the destructive intensity which had been feared; at the other end of the scale, a violent eruption which occurred unexpectedly, catching the civil authorities by surprise.

2.1. La Soufrière (Guadeloupe, French Antilles), 1976

The 1976 eruption of La Soufrière on Guadeloupe (French Antilles) consisted of a sequence of some 20 moderate steam-blasts during a period of nine months. The onset of the eruption was by no means a surprise, because abnormal earthquakes beneath the volcano had been detected by the local observatory during the preceding 12 months. These had been reported to the authorities and to the public, and emergency plans had been reviewed. However, there was no immediate warning of the first steam-blast, and this emitted a cloud of fine dust which drifted downwind over the densely populated lower flanks of the volcano, causing semi-darkness. Most of the population was acutely conscious of the devastation and loss of life caused by the 1902 eruption in the nearby island of Martinique, and large numbers of people took to their cars and drove hastily away from the volcano, causing considerable traffic jams on the few available escape routes. Activity declined within an hour and the dust settled during the course of the day. Within a day or two, the people returned, having been re-assured by the authorities that there were no signs of more or larger eruptions. Six weeks later, a second, similar outburst occurred, followed by others every few days and accompanied by increasingly frequent local earthquakes, of which the largest were felt strongly but caused no significant damage.

These events led to increasing alarm among the population and also among the authorities, who were given contradictory opinions by different scientists; on the one hand they were told that a major eruption was inevitable; on the other, that such an event was unlikely and that there was absolutely no reason to call an evacuation. After consulting with senior metropolitan government officials, and on being advised that *no* risk was to be taken for the population, an evacuation was called of the 72,000 people living around the volcano, who represented one fifth of the population of the island. The evacuation took place by phases (sick and elderly first) over several days, without panic and with a high level of support and control by police, civil defence, military and other government agencies, including advisers and equipment brought specially from mainland France.

The evacuation lasted for three and a half months, during which time moderate steam and ash explosions continued, whilst after the first few weeks the seismic activity showed a distinct decline. Conscious of this, and of the views expressed by certain of the scientists that no major eruption would occur, an increasing number of evacuees became impatient to return. Nevertheless, the abnormal volcanic activity continued and the authorities took a serious view of their obligation to prevent any loss of life.

The Guadeloupe evacuation was one of the largest ever undertaken in response to a volcanic emergency. It was carried out efficiently and according to a detailed plan, with a high level of logistical support. When the activity which was feared did not materialize, there was inevitably dissatisfaction on the part of those whose lives and work had been disrupted. This dissatisfaction was heightened by the knowledge that there had been a controversy among the scientists over the criteria for evacuation, and some errors of scientific observation. The event led the civil authorities and the population to recognize the need to agree upon and to define what increase in risk to property and life can be accepted in such situations. It showed how desirable it is that all scientific observations and their interpretation should be integrated by the scientists concerned into a statement expressing their consensus on the degree of hazard, before being communicated to the civil authorities or to the news media. It also raised the fundamental question whether people in the hazard zones should be obliged to move and prevented from returning or whether, once the risks have been assessed and explained as fully as possible, people should be allowed to make their own individual decisions on when to leave and when to return to the danger zone.

2.2 Mt. St. Helens (USA), 1980

The 1980 eruption of Mt. St. Helens (Washington, USA) is an example of a major eruption in a thinly populated area of a large country. Many local earthquakes and hundreds of steam-blast explosions (not dissimilar to those at La Soufrière of Guadeloupe in 1976) had occurred for almost two months before the violent climax (the main characteristics of which are briefly described in chapter 1 above). Although the eruptive activity had become sporadic in late April and early May, both the seismicity and the rate of displacement of the bulging north flank of the mountain remained high. Most scientists anticipated the possibility of more vigorous volcanic activity, although none could be certain of its ultimate character.

It was also thought that, with the extensive monitoring in progress, there was a good chance of detecting precursory signs of an impending climax at least a few hours before any destructive paroxysm. An evacuation had been ordered soon after the onset of mild eruption, but the authorities were meeting with growing public pressure, which they generally resisted, to allow residents, timber workers and tourists to enter the area.

The loss of 57 lives, when the violent paroxysm did occur, was due to the fact that it was not immediately preceded by any notable precursory signs and that the initial, most vigorous release of energy was directed laterally rather than vertically. It is estimated that, had there been free access to the area, and had the destructive event not occurred on a Sunday when few timber operators were at work, there might have been more than a thousand fatalities.

Severe losses were caused by the disruption of the local timber industry (forest damage was estimated at $US 450 million), destruction and damage to property ($103 million), agricultural losses, mainly of hay production ($39 million), and clean-up costs which amounted to $363 million. Although these losses were very high, they were largely absorbed by Federal Government relief grants without significant impact on the national economy.

2.3 Galunggung (Indonesia), 1982

In the 1982 eruption of Galunggung volcano in West Java, the onset of activity was violent and unexpected (there were no monitoring instruments in the vicinity prior to the eruption), but fortunately consisted only of vertical emissions of ash and scoria. Activity of a much more destructive nature, including pyroclastic flows and lahars, occurred in a second climax three days later. Immediately after the first climax the Volcanological Survey of Indonesia, recognizing the high probability that more destructive activity would ensue (as had occurred during the major eruption in 1822 with the loss of 4,000 lives), recommended the evacuation of the two highest-hazard zones (298 km^2) delineated on maps made several years earlier as part of a routine hazard assessment and disaster preparedness programme. Over 30,000 persons were moved to safety and were given shelter initially in public buildings, private homes and tents in the nearest town and villages beyond the danger area. During the course of the first three months 23,300 of these people were progressively moved into camps consisting of temporary "barrack" buildings (ten rooms, one per family, in each barrack unit) sited at various locations around the periphery of the two highest-hazard zones. It is estimated that the total number of people who fled temporarily after the second outburst was over 60,000. These included part of the population living in the third and lowest-hazard zone (a further 405 km^2 around the foot of the volcano with some 200,000 permanent residents), which had been classified as one in which certain dangers existed but from which evacuation was not necessary.

Initial plans provided for the care of evacuees for two months, but in reality the violent activity continued at irregular intervals for 6 months (during which 29 major explosive phases occurred, each lasting several hours), after which the intensity and frequency of activity declined. During the first three months of the eruption the evacuees were provided with basic food; during the following four months, a feeding programme was managed by the Indonesian Red Cross.

In fact, the pyroclastic flows and the larger mudflows did not extend beyond the two highest-hazard zones, but the surrounding areas, including some of the tent and barrack camps, were affected by falling ash and lava fragments during the strongest vertical eruptions. It was evident that tents do not give effective shelter in such circumstances.

Many mudflows occurred during the rainy season which started at about the time when the eruption began to decline. Special precautions had been taken to build protective embankments to contain or divert these mudflows, as well as collecting "ponds" to reduce the volume of mudflow material reaching the lower and more densely populated parts of the valleys. These protective works provided employment for some of the evacuees.

A notable feature of the Galunggung emergency was that, in order to prevent or at least to limit the reoccupation of the highest-hazard zone, part of which had in any case been devastated and could not be redeveloped immediately for agriculture, arrangements were made to resettle permanently as many as possible of the evacuees in other parts of Indonesia (including Sumatra, Kalimantan and Sulawesi). This was part of a general programme to redistribute the population more evenly in Indonesia as a whole.

One further feature of the Galunggung eruption merits special mention: on two occasions following explosive climaxes, a large commercial airliner flew through thick ash clouds drifting downwind at high altitude and came close to disaster when ash blocked and temporarily stopped the turbines. This emphasized the need for a monitoring and warning system to identify the density, height, direction and down-wind extension of volcanic ash clouds, and for close and rapid liaison for this purpose between volcanic observatories, satellite monitoring systems and air traffic control centres on a regional or global scale.

The losses resulting from the Galunggung eruption included physical damage to housing, bridges, roads and irrigation systems which amounted to $US 9.6 million. The loss of agricultural production and the cost of looking after evacuees totalled $US 35.2 million. There was no official report of any lives lost during the eruptive climaxes, but it was estimated that inadequate shelter and feeding, and the inhalation of volcanic dust, contributed to 58 subsequent deaths.

2.4 Heimaey (Iceland), 1973

The island of Heimaey lies off the south coast of Iceland. On the north side of the island there is an excellent harbour which is the home of the largest fishing fleet in Iceland. The town of Vestmannaeyjar, with 5,300 inhabitants in 1972, lies close to the harbour. Its inhabitants are mostly employed in the fishing fleet or in the large fish-processing factories. About a mile to the south-east of the town there is a volcano, Helgafell, whose last eruption occurred some 5,000 years ago.

At 2 a.m. in the morning of 23 January 1973, one of the inhabitants of the town saw fire on the slopes of Helgafell and immediately alerted the town's fire brigade. On going up to the mountain, the firemen discovered a line of fissures on the northern slope, from which fountains of incandescent lava were issuing at a rapidly increasing rate.

The Icelandic Civil Defence Organization was informed, and ordered an immediate evacuation of Vestmannaeyjar, where ash from the eruption was already beginning to fall. Because there was no safe refuge on the island, the whole population had to be moved as quickly as possible to the mainland. Fortunately, the wind was carrying the ash away from the island's airstrip, which lies south-west of Helgafell, so that this could be used by small aircraft. Furthermore, because of severe storms during the preceding days, the fishing fleet was in harbour.

The inhabitants were all alerted immediately by sirens, and by 6 a.m. they had assembled either at the airstrip or at the harbour, and were being evacuated by air or by sea. Each was allowed to take only one bag of personal belongings. Reception centres were organized on the mainland, and by 10 p.m. on the same day temporary accommodation had been found for all the evacuees and arrangements had been made for the children to go to schools the following day. There were no casualties.

As the eruption continued during the following days and weeks, building up a new volcanic cone named Eldfell, ash continued to fall on the town and houses in the part nearest to the volcano were set on fire by lumps of incandescent lava falling on them. Specially equipped teams were sent to the island to rescue furniture and other movable property for shipment to the mainland, to remove the ash accumulated on roofs, to keep roads clear, and to protect houses by fitting steel sheets to roofs and windows. The 10,000 sheep on the island were also evacuated, mainly by air.

By early February, the eastern part of the town was covered by ash several metres deep, and both the town and harbour were threatened by a slow but steady advance of viscous lava. The efforts made to slow down the advance of the lava by water spraying are described in chapter 4 below.

The speed and success of the evacuation was no doubt mainly due to the fact that the Icelandic Civil Defence Organization had, long before the eruption, prepared contingency plans for dealing with just such volcanic emergencies.

2.5 Nyiragongo (Zaire), 1977

The 1977 eruption of Nyiragongo in eastern Zaire provides an example of the destructiveness of fast-moving (low viscosity) lava flows. Since 1928, a permanent lake of molten lava had existed within the large summit crater, but there was no record of lava flows down the flanks of the mountain (as there had been at the nearby volcano of Nyamlagira). Even though the lava lake at Nyiragongo reached unprecedentedly high levels prior to the 1977 eruption, and was clearly exerting considerable pressure on the crater walls, it was not anticipated that the resulting lava flows might inundate populated areas, and no protective measures were taken.

In fact, during the 1977 eruption, five fissures opened on the flanks of the volcano and the entire contents of the lake drained in less than an hour, producing a flood wave of rapidly flowing lava which covered an area of more than 20 km^2, killing 72 people and destroying over 400 houses and a section of highway over 10 km long (figure 10). The largest of the five lava streams travelled at a speed of about 40 km/h, reaching a length of over 10 km and stopping only a short distance from the outskirts of the nearest town.

The disaster demonstrated that lava flows of low viscosity can be as destructive of life and property as other forms of volcanic activity. There is evidently a need for hazard mapping at volcanoes capable of producing fast-moving lava flows, for preparedness planning and for the issue of warnings when eruptions threaten.

Bibliography
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