STUDIES IN GEOPHYSICS

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Explosive Volcanism: Inception, Evolution, and Hazards

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Geophysics Study Committee
Geophysics Research Forum
Commission on Physical Sciences,
Mathematics, and Resources
National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1984

NATIONAL ACADEMY PRESS 2101 Constitution Avenue, NW Washington, DC 20418

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The Geophysics Study Committee is pleased to acknowledge the support of the National Science Foundation, the Defense Advanced Research Projects Agency, the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, and the U.S. Department of Energy (Grant # DE-FGO1-82ER12018) for the conduct of this study.

Library of Congress Cataloging in Publication Data

Main entry under title:

Explosive volcanism.

(Studies in geophysics)
1. Volcanism—Addresses, essays, lectures.
I. National Research Council (U.S.). Geophysics Study Committee. II. Series.
QE522.E97 1984 551.2'1 83-23610
ISBN 0-309-03393-4

Printed in the United States of America

Volcanologists, Journalists, and the Concerned Local Public: A Tale of Two Crises in the Eastern Caribbean

13

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INTRODUCTION

Explosive volcanism has long been a topic of great interest to scientists, as witnessed in part by the variety of reports contained in this volume. Even more obvious, however, is the fact that explosive volcanism has always been of vital concern to the people and governments immediately affected by such activity. When a potentially explosive volcano enters a period of crisis, interested scientists and a concerned, if not terrified, local community are brought into what euphemistically might be called a challenging relationship.

This paper is concerned with the challenging relationships that developed among scientists, civil authorities, and journalists during two volcanic crises that took place in the eastern Caribbean—on Guadeloupe in 1976 and on St. Vincent in 1979 (see Figures 13.1 and 13.2). Despite the close geographical proximity of these two islands and the similar geologic framework in which the erupting volcanoes are situated, the relationships between scientists and various aspects of the "real world" were markedly different. Brief consideration of these relationships can be instructive, not only to understand what happened in the eastern Caribbean during the 1970s but also to improve scientist/real-world relationships during the volcanic crises that are certain to occur elsewhere in the years ahead.

GUADELOUPE, 1976

When La Soufrière volcano on the eastern Caribbean island of Guadeloupe thundered to life on July 8, 1976, one of the most interesting chapters in modern volcanology began to unfold. By mid-August 1976, wire services and newspapers around the world were carrying daily accounts of the worsening situation, as an apparent volcanic disaster approached. One French official flatly announced, "We have begun what we think is the countdown. The volcano cannot turn back." Fear spread rapidly from Guadeloupe, and people living as far away as Puerto Rico and Central America began to gird themselves for the onslaught of tidal waves that they thought would be triggered by a large and disastrous eruption. The anxious island, and indeed the world, awaited the coming paroxysm, which never occurred.

The first indication that La Soufrière was returning to life was provided by an increase in the number of tiny earthquakes that originated beneath the volcano. During a normal month, 1 to 10 earthquakes might have been recorded, but in July 1975 the number of events jumped suspiciously to 30. After returning to normal levels for several months, the earthquake count in November 1975 surged to 209. In March 1976, 607 local earthquakes were recorded, a number of them large enough to be felt by local inhabitants. The seismicity remained at abnormally high levels through the spring and early summer of 1976, but at about 9 A.M. on July 8, 1976, the situation took a dramatic turn for the worse.

The volcano, which up to that point had not actually erupted, suddenly began to belch forth steam and ash. Billowing clouds of sooty grey ash boiled from fissures at the summit of the volcano, and the prevailing winds carried this material to the west, showering it on the city of Basse Terre, the capital of Guadeloupe. The roaring emission of steam and ash was accompanied by continuous shaking of the ground, which added to the consternation of nearby residents. As the ash clouds became more dense, the mid-day Sun was almost completely obscured, and an eerie pall settled over the leeward flank of the volcano. Terrified residents, having almost to feel their way through the murky air, jumped into cars and trucks and some-

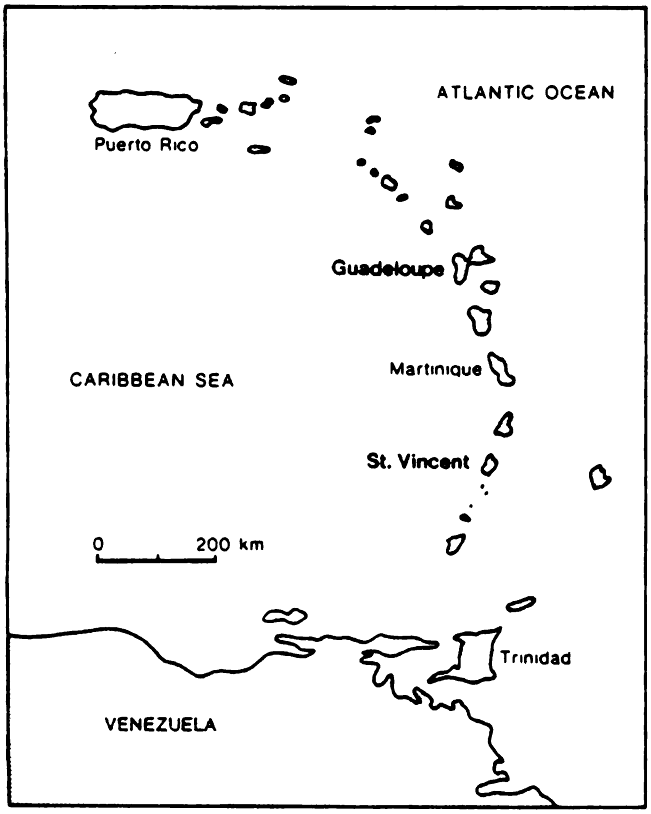

FIGURE 13.1 Map of the lesser Antilles showing the location of Guadeloupe, Martinique, and St. Vincent.

how made their way down the side of the volcano. Many of those who clung to the outside of these vehicles were completely covered by the sticky gray ash, and they were said to resemble living statues when they arrived at the foot of the volcano—unhurt but thoroughly terrified.

The tempo of activity at La Soufrière continued to increase. Steam issued from the summit of the volcano continously, and larger quantities of gray ash erupted on several occasions. The number of local earthquakes continued to rise—1220 events in July, almost 6000 in August. Increasing numbers of these quakes jolted the ground and were easily felt by people living on the flanks of the volcano.

On August 12, 1976, scientists studying La Soufrière issued a statement that unquestionably influenced the course of events on Guadeloupe. They announced that the ash, which was being erupted from the volcano in ever increasing amounts, now contained a significant component of fresh volcanic glass. The clear implication was that new magma had risen to high levels within the volcano and that tiny bits of this material were being carried upward to the surface along with the plumes of steam that were continuously boiling into the sky. Because this glass had not been identified in the ash prior to August 12, its appearance seemed to indicate that the volcano was about to enter a very dangerous phase of activity.

In this atmosphere of grim expectation and on the advice of one group of French scientists, the *prefet* (governor) of Guadeloupe, Jean Claude Arroseau, ordered the immediate evacuation of all 72,000 people living on the slopes of the volcano (see Figure 13.3). This order triggered a series of events that embroiled scientists and civil authorities in arguments and confrontations that grew more bitter as the evacuation continued for almost 4 months. Not known at the time, however, was a fact that would have colored, if not altogether altered, the course of events in those days of increasing apprehension. The identification of the fresh volcanic glass in the erupted ash—which seemed to indicate that the volcano was about to erupt violently—was a mistake. For all intents and purposes, fresh volcanic glass was not contained in the ash, and there was in fact no clear evidence that magma was about to erupt to the surface. The authorities on Guadeloupe, of course, did not realize this at the time, and so the volcano was thought to be far more dangerous than it actually was.

The evacuation was carried out with considerable efficiency. Within 2 days about one quarter of the island's population, 72,000 people, were ordered from the flanks of the volcano to other parts of the island, far from the areas of danger. Besides imposing an obvious hardship on the displaced people, the evacuation resulted in severe political and economic problems. Massive amounts of financial aid were required from France in order to provide shelter and food for the evacuees, and tax revenues collected by the government of Guadeloupe were sharply reduced because of the drop in the island's productivity. But perhaps almost as bad was the virtual cessation of tourism on Guadeloupe. The word that La Soufrière was about to erupt had been spread far and wide in both North America and Europe, and tourists responded by staying away.

The stillness of the evacuated cities and towns surrounding the volcano contrasted dramatically with the bustle of scientific activity on the slopes of the volcano. Most of the scientists present were French, grouped into two main teams, but other geologists and geophysicists from Trinidad and the United States also arrived. At times, 20 to 25 scientists were present, many of whom had never worked on the slopes of an active volcano. A volcano observatory was established deep inside the dungeon-like chambers of the seventeenth-century Fort St. Charles, on the southwest flank of the volcano, and a highly sophisticated volcano watch was put into operation. The network of seismometers, installed to monitor local seismicity, was expanded. Recording magnetometers were deployed and were beginning to yield intriguing information on internal changes of the volcano.

Volcanic gases were collected and analyzed. Precise leveling surveys (the so-called dry tilt technique) were initiated to detect the possible inflation of the volcano that often precedes eruptions. But despite the diversity of this scientific program, it is important to note that most of these monitoring techniques were not deployed on La Soufrière until July or August 1976—about a year after the initial buildup had begun. Thus, because there were inadequate baseline observations against which telltale changes could be compared, there was always an imperfect understanding of the physical changes that may have taken place within the volcano during the early stages of its activity. Had these early changes been monitored, it is possible that

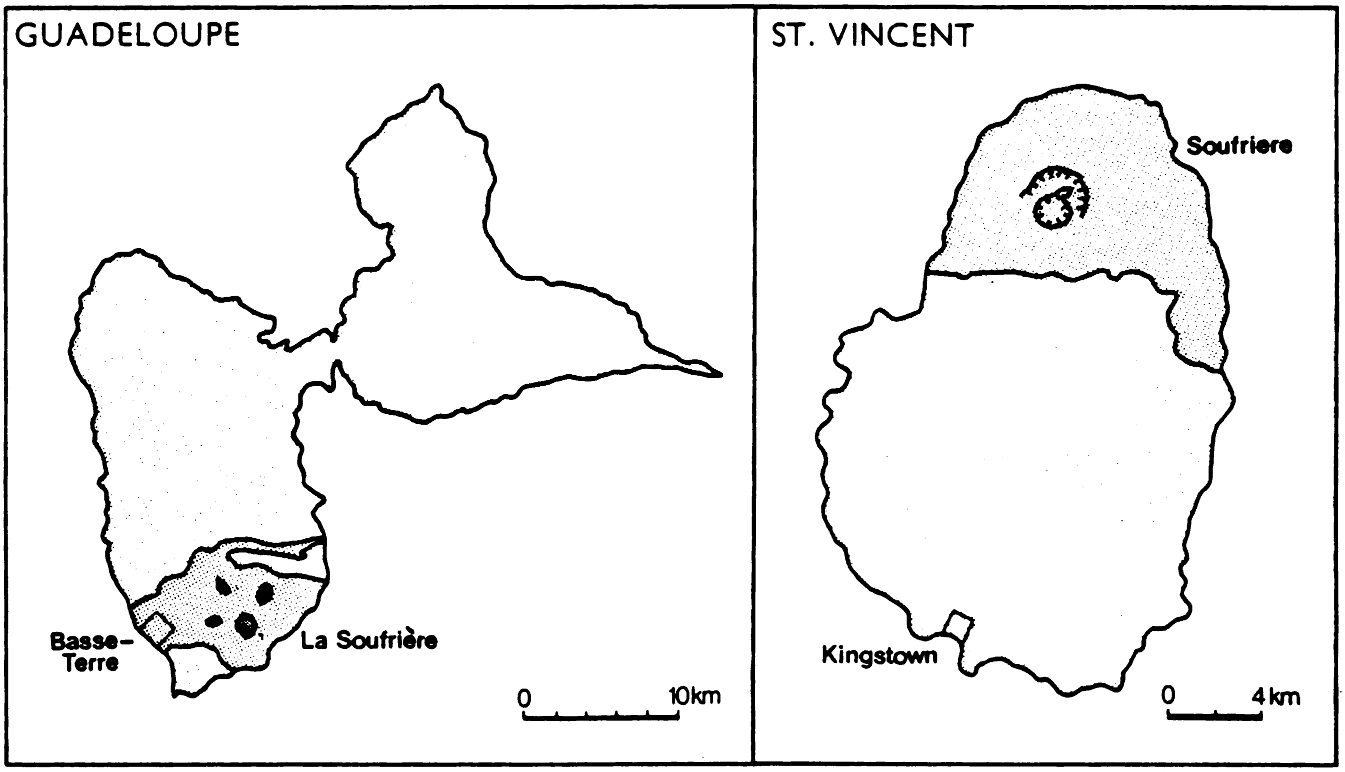

FIGURE 13.2 Maps of Guadeloupe and St. Vincent. La Soufriére and Soufriere volcanoes are shown in the denser stipple pattern. The capital cities of Basse-Terre and Kingstown also are shown.

the actual hazard posed by the volcano might have been far more accurately assessed.

In some ways, August 30, 1976, might be regarded as the climax of the eruption. At that time, just 2 weeks after the evacuation, several hundred earthquakes were being recorded every day, and a plume of gritty ash-laden stream drifted almost constantly from the top of the volcano. On the morning of August 30, 12 scientists climbed to the summit to inspect the activity. Shortly after 10 A.M., just after the party had stepped back from the gaping fissure at the top of the volcano, steam and ash began to explode to the surface, traveling at such high velocity that jagged blocks up to 1 m in diameter were carried high into the air. This debris fell back to Earth, narrowly missing the scientists as they scrambled to safety. Four members of the group were struck glancing blows by smaller fragments, and, had it not been for the hard hats strapped firmly to their heads, their injuries would have been far more serious.

This explosive emission of steam and debris was certainly impressive to those who had the misfortune to view it at close quarters, but from a volcanological point of view it represented a rather trivial outburst. However, for an hour or two after the event, and especially during the period when the extent of injuries sustained by the summit party was still uncertain, journalists sent out the news that the volcano had entered a serious episode of eruptive activity. In North America, due to garbling of the story after it had been transmitted from Guadeloupe, the American public was informed in front-page headlines that La Soufrière had at last delivered up the long-awaited eruption. Misled and enticed by the grossly exaggerated stories, a Miami-based team of newsmen scrambled into a chartered jet and raced to Guadeloupe—only to be told, during the course of a filmed interview with me at 1 A.M., that the day's eruption, while providing momentary excitement, actually constituted a trivial volcanic event and in no way was to be confused with the expected "big bang."

From that time onward, North American journalists behaved as if they had somehow been jilted by La Soufrière. Frustrated by the absence of a catastrophe and no loss of life and property, they relegated the story to the inside pages of newspapers and then dropped it altogether. From a North American point of view, the ongoing crisis simply ceased to exist.

In Guadeloupe, and in metropolitian France, this was hardly the case. About 72,000 citizens were still in a state of evacuation, Guadeloupe's economy was in serious trouble, and the volcano was still belching forth steam and ash. It was in this highly charged atmosphere that disagreements between the two main teams of French scientists intensified and spilled into the public arena, via newspaper and newsmagazine articles, television debates, and at least one full-length book.

One team supported the evacuation and maintained that the volcano indeed posed a continuing hazard. The other team maintained from the outset that the volcano posed little danger and that there would be adequate advance warning if the situation took a turn for the worse. In this atmosphere of scientific

FIGURE 13.3 Deserted street in Basse-Terre, Guadeloupe, during the evacuation of 1976. The smoldering summit of La Soufrière is seen in the background.

controversy, civil authorities did not know whom to believe, and the evacuation rapidly became a nightmare.

In my judgment there is no question that the situation was exacerbated by the fact that journalists seemed to have unrestricted access to the disagreeing scientific teams during this period of crisis. Even though an evacuation was supposedly under way, hardly a day passed without television or radio crews appearing at the scientific headquarters at Fort St. Charles. Scientists were interviewed singly or in groups, and the journalists eagerly sought out differences in opinion regarding the state of the volcano and the hazard that it posed. In many instances, more media attention was focused on the disagreements among the scientists than on what was actually happening at the volcano.

As the weeks dragged by, into September and October 1976, there was increasing agitation to allow the 72,000 people to return to their homes. To complicate matters, it was becoming clear by mid-October that the tempo of the eruption was beginning to slow; the number of recorded earthquakes was diminishing, and the volume of ash reaching the surface was noticeably reduced. But the volcano was still showing signs of activity, and some of France's most respected scientists were locked in fierce public disagreement over the handling of the crisis. In this difficult moment, what could possibly be the rationale for sounding an "all clear" and ending the evacuation?

In what must be considered an unusual, if not unprecedented, move, authorities in Paris decided to seek the advice of foreign scientists, and an ad hoc *Comité Scientifique International sur La Soufrière* of six non-French scientists was convened in Paris in November 1976. Two Americans were named to the *Comité*, then MIT Professor Frank Press (who served as chairman) and myself. Others included Franco Barbari and Paulo Gasparini from Italy, Gudmundur Sigvaldason from Iceland, and Shigeo Aramaki from Japan. The *Comité* heard statements from various French scientists who had been involved with the La Soufrière situation, and at the end of 3 days prepared a report stating that the volcano, while still requiring close monitoring, appeared to pose less of a hazard at that time. Within hours of receipt of this report, Overseas Territories Minister Oliver Stirn announced an end to the evacuation.

As people returned to their homes and everyday life gradually returned to normal on Guadeloupe, the volcano appeared to oblige by becoming even more quiet. The number of local earthquakes and the abundance of steam emissions continued to diminish, and by early 1977 it was over. The crisis had come and gone; the disaster never occurred.

ST. VINCENT, 1979

It came as a considerable surprise that just 3 yr later, in April 1979, the Soufriere Volcano of St. Vincent burst into activity to initiate another volcano crisis in the eastern Caribbean. In contrast to La Soufrière, Guadeloupe, there was absolutely no doubt that the Soufriere Volcano of St. Vincent posed a hazard to the surrounding populus. From April 13 to 26 a series of powerful vertical explosions blasted through the lake and island that formerly occupied the crater of the volcano and sent clouds of debris to heights as high as 20 km (see Figure 13.4). Small pyroclastic flows and mud flows were triggered by this activity, and they poured down several of the valleys that head on the volcano. By the end of April 1979 the explosive phase of the eruption ended and a new phase began, characterized by the quiet emission of a dome of basaltic andesite on the floor of the summit crater. This dome continued to show measurable growth until October 1979.

In contrast to Guadeloupe, where relatively few baseline geophysical measurements had been made prior to 1976, a number of such preeruption measurements had been made on St. Vincent. During the 1970s a seismic network was established in the lesser Antilles by the staff of the Seismic Research Unit of the University of the West Indies, and seismic signals from St. Vincent and other islands in the lesser Antilles were routinely telemetered to Trinidad for real-time monitoring and interpretation. In 1977, 25 months prior to the eruption, 2 dry tilt stations were established on the eastern flank of Soufriere, St. Vincent, and these stations provided the first indications

FIGURE 13.4 Eruption cloud rises from Soufriere, St. Vincent, on April 22, 1979.

FIGURE 13.5 Dry tilt measurements being made on St. Vincent in March 1977, more than 2 yr before the 1979 eruption. Data obtained from this station helped confirm that the volcano was inflating.

that the volcano was beginning to inflate (see Figure 13.5). Routine temperature measurements were made in the crater lake of the volcano during the 1970s, and these gave telltale indications before April 1979 that the volcano was behaving anomalously.

When the volcano exploded to life in the early morning hours of April 12, the 22,000 people living on the slopes of the volcano did not have to wait for an order to evacuate. Remembering the story of the disastrous 1902 eruption of Soufriere, St. Vincent, when more than 1500 islanders were killed, people living on the slopes of the volcano removed themselves quickly and efficiently from the areas of danger (see Figure 13.6). The government of St. Vincent enforced a continuation of this evacuation throughout the explosive phase of the eruption, while the volcano obviously posed a hazard.

Only 5 to 7 scientists were working on St. Vincent during the explosive phase of the eruption, and these people constituted a single group or team. Most came from the scientific staff of the Seismic Research Unit of the University of the West Indies, although the team was augmented occasionally by scientists from the United States and England. This team supplied a single stream of information to the government of St. Vincent, via telephone conversations and written communications. This information was straightforward in content, represented only one concensus of events at the volcano, and offered a minimum of speculation as to what might happen.

Especially noteworthy was the way in which civil authorities on St. Vincent dealt with the journalists who rushed to the island when the eruption began. Stated simply, the journalists were absolutely prohibited from entering the danger zone. Because the hurriedly established volcano observatory was located only 9 km from the volcano, well within the area of evacuation, the journalists were not able to visit the observatory or to interview scientists in the field. The members of the press corps received information about the volcano from government officials in the capital city of Kingstown, who passed along informaton that had been supplied to them by the scientific team. To my knowledge, only one journalist insisted on being allowed to enter the evacuated zone. He had indicated that, if

FIGURE 13.6 Residents fleeing areas of danger near Soufriere, St. Vincent. The populace responded spontaneously to the hazards posed by the volcano.

such permission was not granted, he would write stories describing the censorship of information on St. Vincent rather than the events that were taking place at the volcano. I am not aware of the details of what transpired between this journalist and the St. Vincent government, but we later learned that he was deported summarily.

DISCUSSION

There were, of course, many differences between the 1975-1977 crisis at La Soufrière, Guadeloupe, and the 1979 crisis at Soufriere, St. Vincent. Among these, however, the following points (see Table 13.1) seem especially pertinent when considering the relationships between scientists, journalists, and the public.

There is little doubt that the volcanic crisis was far more challenging on Guadeloupe than it was on St. Vincent. If more scientific information had been available on Guadeloupe, in the form of a geologic and geophysical data base, the anomalies observed there in 1976 could have been assessed in a better way. In addition, the relatively slow buildup of activity at Guadeloupe and the lingering threat of violence allowed all too much time for apprehensions and expectations to grow. There was nothing inherently disadvantageous in having many more scientists on the scene in Guadeloupe and having the scientists grouped into two main teams. Nor was there anything wrong with the fact that the scientific teams on Guadeloupe had differing interpretations as to what was likely to happen at La Soufrière. The main problem was that these teams were not communicating effectively with each other, and they were espousing markedly different opinions directly to competing journalists. Because the journalists seemed to have total and unrestricted access to all levels of the local scientific hierarchy, disjointed and often conflicting media coverage resulted. In the cacophony that surrounded the entire Guadeloupe affair, the fact was largely overlooked that the citizens of Guadeloupe, and especially the 72,000 people who had been ordered from their homes during the evacuation, were being presented with a very confusing account of the ongoing situation—an account that was laced with invective between some of the scientists involved. This made a very bad situation much worse than it really had to be.

Considering these aspects of the Guadeloupe and St. Vincent experiences, the communication between scientists, journalists, and the public during a future volcanic crisis—not simply an erupting volcano but also one that poses a demonstrable threat to nearby populations—could be improved if the following actions were taken:

1. Gather some amount of geologic and geophysical information about threatening volcanoes *before* a crisis begins, so that scientists can have a basis for assessing abnormal patterns of volcanic behavior. Of course, it would not be feasible to maintain a program of continuous monitoring at all volcanoes of this type, but modest programs involving the intermittent gathering of baseline data, such as patterns of local seismicity, ground deformation, or thermal emissions, can yield enormous dividends, especially at potentially dangerous volcanoes located near population centers. Realizing in many cases that the "past

TABLE 13.1 Differences Between Hazard Response During the 1975-1977 La Soufrière (Guadeloupe) and the 1979 Soufriere (St. Vincent) Volcanic Crises

GUADELOUPE	ST. VINCENT
Less complete data base	More complete data base
Slow buildup of activity	Rapid buildup of activity
Threatened violence	Demonstrated violence
20 to 25 scientists	5 to 7 scientists
Several scientific teams	One scientific team
Differing interpretations	One interpretation
Poor communication between working scientists	Good communication between working scientists
Unlimited access for journalists to working scientists	No access for journalists to working scientists

is prologue," there is also great advantage in knowing earlier patterns of eruptive behavior by means of preeruption geologic studies as a guide to what is likely to happen in the future.

2. Once a crisis evolves, have an experienced chief scientist who, while not suppressing scientific disagreements, would attempt to coordinate the activities of the scientists involved into a single group effort, to increase communication between the scientists, and to help ensure that a single and complete stream of information is made available to civil authorities and journalists. Crises in developed parts of the world will often attract teams of workers from more than one organization, and it should be the responsibility of the chief scientist to stimulate the activities of the various teams and to make them feel part of the group effort. A volcano in crisis needs the attention of many different specialists working together and communicating freely. A certain amount of redundancy in the scientific arena is not necessarily undesirable, because scientists will be gathering large amounts of information in a short period of time. Competition between scientific teams for media attention, however, is simply irresponsible. Such competition can lead to biased and incomplete news accounts, which almost certainly will heighten the anxieties of an already apprehensive population.

3. Working scientists—those who gather the data that become part of the body of scientific understanding—should realize that their responsibilities often extend far beyond their individual scientific activities, especially with regard to their interactions with journalists. In general, individual scientists should acknowledge that they do not necessarily have a balanced view of all of the scientific investigations under way at a particular crisis. Thus, when interviewed by a journalist seeking an angle or exclusive aspect of a story, both the scientist and the journalist should realize that undue emphasis on the part of the story that happens to be the specialty of that particular scientist can lead to unbalanced, and in many cases misleading, reporting. Added to this is the all-too-human temptation of the scientist to pontificate far beyond the confines of his or her true expertise—in response to the somehow intoxicating influence of having the undivided attention of a journalist. I have found myself doing this on more than one occasion and have been shocked at the results in the following day's newspaper.

4. Journalists must realize that they should not feel entitled to monitor scientists as they communicate with each other during times of crisis. Scientists need to discuss among themselves a multitude of speculative possibilities, and the most efficient way to do this is in their own jargon, without concern for misinterpretation by nonspecialists. The mere presence of a journalist at such discussions limits free communication between scientists, which is vital during a volcanic crisis.

5. If the crisis is of such proportions that numerous journalists are attracted to the scene, an information officer (ideally drawn from the scientific ranks) should be appointed. Such a person should work closely with the chief scientist to ensure that a single and complete stream of information is made available. This person should not suppress scientific disagreements that might exist between working scientists but should express them freely in terms of the limits of overall scientific understanding. It is common for scientists to disagree, and such disagreements should be reported publicly in a balanced and nonpersonalized way.

In conclusion, it is worth emphasizing that the two examples of volcanic crises cited here, Guadeloupe in 1976 and St. Vincent in 1979, clearly represent extremes with regard to scientist/journalist interactions. Few people would endorse either the open-door policy of Guadeloupe or the closed-door policy of St. Vincent. What we are left with, therefore, is the search for the most appropriate middle ground. In times of a genuine volcano crisis, we must seek to maximize the flow of information from scientists to the public in a way such that journalists (who must play an essential role) can enhance the process. It is up to us to provide this flow of information in a balanced, forthright, and timely way. If there is any lesson to be learned by the scientific community from the volcanic crises in the eastern Caribbean during the 1970s it is that the challenge posed by the scientist/journalist relationship is mostly ours to solve.

ISBN 0-309-02393-6