NEVADO DEL RUIZ, 1985

Russell J Blong

[This account of the Ruiz eruption is based on information published in various issues of the monthly Smithsonian Institution Scientific Event Alert Network Bulletin, Volcanoes of the World (Hutchinson Ross, 1981), INGEOMINA publications and papers and discussions at the February 1986 International Association of Volconology and Chemistry of the Earth's Interior (IAVCEI) meeting in New Zealand. The author, Russell Blong, is Associate Professor in Earth Sciences at Macquarie University and author of Volcanic Hazards - A Sourcebook on the Effects of Eruptions (Academic Press, 1984)]

INTRODUCTION

On November 13, 1985 the 5,400 m Colombian volcano Nevado del Ruiz erupted killing more than 20,000 people. This death toll is the highest attributed to a volcano disaster since 1902 and the fourth highest toll in the 400 years for which reasonable records exist. Most of those killed died in the city of Armero, 46 km ENE of the summit crater and 5,000 m lower in elevation. They died in lahars (volcanic mudflows) which swept down the Azufrado and Lagunillas valleys as mixtures of ash, rock, debris, water and ice. Most of those who died drowned in the mud, evidently having made little attempt to evacuate the city.

In an age of satellite monitoring, rapid response of international experts and instantaneous communications, we must ask why so many people died. Was the volcano unpredictable? Was the eruption larger than anticipated? Were the consequences of the eruption unanticipated? Was the civil defence system adequate for the task? Did the local populace not receive warning of the eruption? Were the populace aware of the probable consequences of an eruption?

To date no findings of any official enquiry have been released. However, it seems that the answer to most of these questions is an equivocal "No".

Before considering some aspects of each of these questions in more detail we should remember that a warning system has several components. In the case of a volcano which offers a hazard these include monitoring the volcano's vital signs, evaluation and interpretation of these signs by one or more "experts", establishment of those areas at risk (and, if possible, the degree of risk), communication of this risk assessment to the appropriate officials and community leaders, and dissemination of ALL relevant information to ALL of those at risk. If each of these components function as planned there is an excellent chance that the prediction and warning system will perform adequately and that few human lives will be lost, even though the destruction of property and other items of community infrastructure may be almost beyond comprehension.

WAS THE VOLCANO UNPREDICTABLE?

The short answer to this question is an unequivocal "No!". From a natural hazards or civil defence point of view, Nevado del Ruiz behaved in an exemplary fashion. It was recognized as being "active" for more than one year before the tragic event of November 13, 1985. By contrast, the 1886 eruption of Tarawera in New Zealand which killed 150 people was preceded by only 6 hours of premonitory activity.

Seismic activity was felt on the flanks of Ruiz in November 1984. Increased thermal activity began in early 1985 culminating in a short but vigorous eruption on September 11, 1985 which produced a trace of ash in Manizales, the provincial capital 30 km WNW of the crater, and a lahar which travelled 27 km down the Rio Azufrado (toward Armero) on the NE flank of the volcano (see Figure 1 for locations). This lahar travelled at an estimated 10-30 km per hour and left the river channel at various locations sweeping 10-20 m high up canyon walls. Valley residents were placed on alert but were not evacuated. It is worth noting that this information and much more was compiled from Colombian sources and distributed world-wide by the Smithsonian Institution Scientific Alert Network in Washington D.C., USA long before the November 13 eruption.

Predicting that an eruption is going to occur in weeks or months is one thing. Determining the day of an eruption and it's magnitude is quite another. Kilauea volcano in Hawaii, for instance, has erupted dozens of times this century and is well instrumented. It is possible, using various measures of seismic activity and determinations of earthquake foci, together

with evidence of the inflation of the volcano (using sensitive tiltmeters), to estimate fairly accurately the time an eruption will start and the volume of the magma that has moved upwards in the volcano's plumbing system. Such estimates are dependent upon adequate instrumentation and a record of instrumented eruptions which allow the volcano's vital signs to be interpreted. However, each volcano behaves idiosyncratically so that firm predictions for one cannot be based on a comparison of results gained from other volcanoes which have better instrumentation or have longer records.

At Ruiz there was no instrumentation until a few months before the November 1985 eruption, except for regional data about earthquakes. Instrument networks were incomplete and there was no background information to assist in interpreting the precise meaning of the data that was available. Accurate short-term predictions of the time or style of eruptive activity were not possible. In short, Ruiz gave a year's warning of increased activity. For reasons which will become clearer below, general predictions at Ruiz about eruption style were far easier than at most volcanoes but it was not possible to state when an eruption would occur or how big it would be.

WAS THE ERUPTION LARGER THAN ANTICIPATED?

Preliminary estimates put the volume of the airfall eruptive products at about 39 million cubic metres. The eruption cloud reached a height of about 27 km but the ash fall at Armero was only 1-2 mm. The volume of the mudflows which swept down the Azufrado and Lagunillas rivers (both towards Armero - see Figure 1) and the Guali and Chinchina valleys was about 30-60 million cubic metres plus 30-90 million cubic metres of water, the latter representing 6-18% of Ruiz's pre-eruption icecap.

The size of an eruption means different things to different observers. Firstly we must be clear that we are talking about the size of the eruption and not the size of the consequences. While Ruiz (1985) produced the fourth largest volcano disaster death toll in the last 400 years it does not necessarily follow that it was the fourth biggest eruption in the same period. Should we measure the size of an eruption by the distance to which the products (lava, ash, lahars) travel, by the volume of the new volcanic material produced, by the "explosivity" of the eruption, or by the rate (volume of material per second) at which material is ejected from the vent? Each of these measures would provide valid but different measures of eruption size.

The November 13 eruption was not a big eruption. On the VEI (Volcano Explosivity Index), a closed scale commonly used used by volcanologists, the eruption was probably of magnitude 3. This can be compared with the 1937 eruption of Rabaul, Papua New Guinea, (VEI = 4), 1883 Krakatau (VEI = 6), 1886 Tarawera, New Zealand (VEI = 5) and 1980 Mount St Helens, USA (VEI = 5). Approximately 19% of the eruptions in the last 10,000 years have been as large as, or larger than the 1985 Ruiz eruption.

Little of this information directly answers the question, "was the eruption larger than anticipated?". However, the answer seems to be "No" because (1) it was well recognised by various volcanologists that eruption "size" on volcanoes like Ruiz is less important than the fact that any moderate-size eruption will melt a significant portion of the icecap thus generating lahars; and (2) the areas affected were within the zones identified on the volcano risk map (Figure 1).

WERE THE CONSEQUENCES OF THE ERUPTION UNANTICIPATED?

It is certain from the hazard map and from discussions with some of the volcanologists involved that the very high probability that massive lahars would be generated was clearly recognised by those producing the risk map. This is because even minor eruptions of an ice-clad volcano have the potential to melt enormous quantities of ice. Furthermore, historic activity at Ruiz in 1595 (VEI = 4) and 1845 (VEI = 2) produced lahars. Lahars produced in the 1845 eruption resulted in about 700 fatalities. Thus, the earliest efforts of those involved in producing the 1985 map focussed on the risk from lahars rather than on other major risks (primarily from fast-moving, often incandescent flows) offered by a moderate-sized eruption.

In other words, not only was the November 13 eruption not "larger" than anticipated, but also the consequences of an eruption were correctly assessed.

WAS THE CIVIL DEFENCE SYSTEM ADEQUATE FOR THE TASK?

The volcanic risk map (Figure 1) which was produced by geologists from INGEOMINAS (Colombian Instituto Nacional de Investigaciones Geologico-Mineras) and Universidad de Caldas with some assistance from international experts was presented to Colombian officials and the press before the November 13 eruption. This excellent map recognised that the risk from lahars extends to 100 km from the volcano and that the sector east of the volcano was particularly vulnerable because of the 5 km drop in elevation from the summit to Armero. This map was published on October 7, 1985. According to one volcanologist, sufficient copies of this map were produced so that one was available for everyone in Armero. In addition, an expert team of Italian volcanologists delivered a report to the local administrators and the Civil Defence Committee on October 22. This brief report emphasises the danger of lahars and indicates that evacuation should occur immediately after the beginning of an eruption.

Despite these comments one should not leap to the conclusion that the civil defence system was not equal to the task. We are not familiar with either the organisational responsibilities of the civil defence in Colombia or of the legal and political influences. Thus it is not possible to provide adequate answers to the question. Presumably various official enquiries will be held.

DID THE LOCAL POPULACE RECEIVE WARNING OF THE ERUPTION?

It appears that the explosion which initiated the November 13 eruption occurred at 1530 hours depositing a fine layer of ash around the summit and NNE of the volcano. According to one report, ash fell in Armero

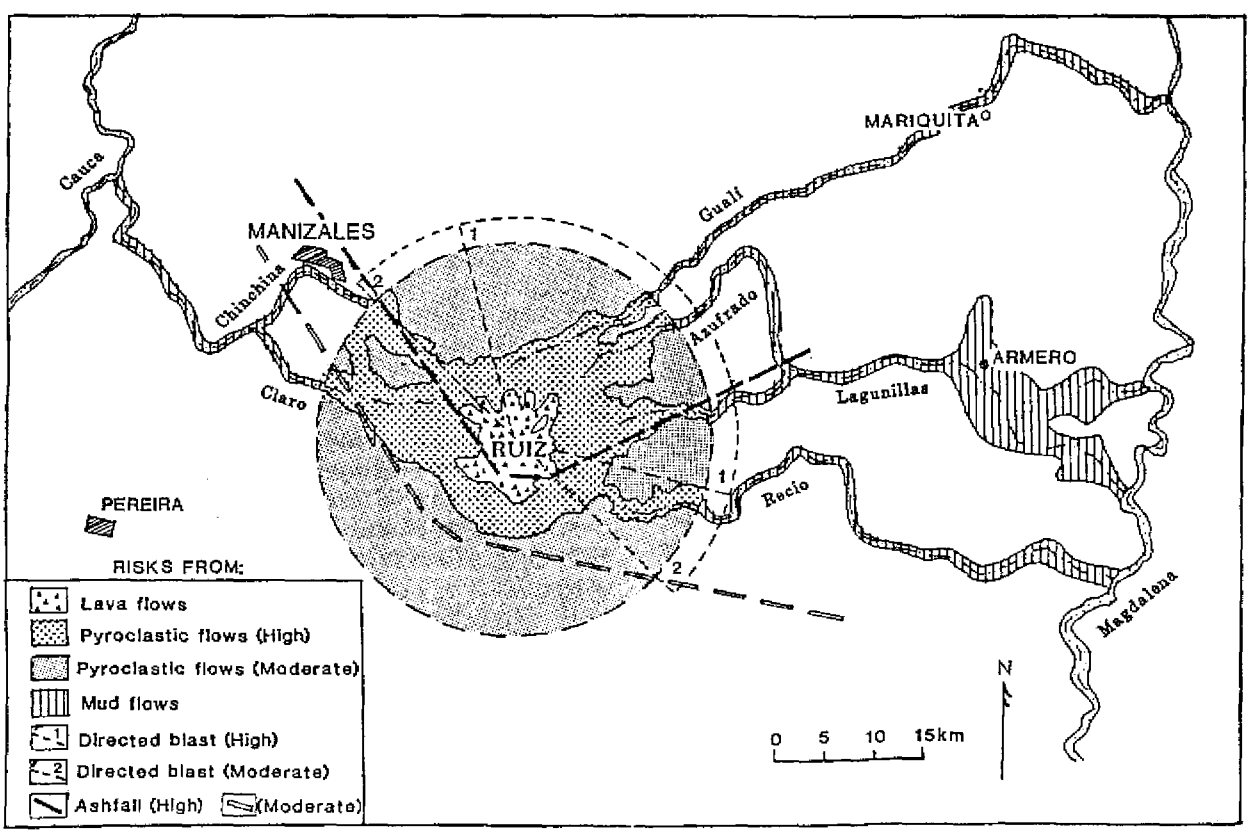

Figure 1: Volcano risk map presented by geologists from INGEOMINAS and the Universidad de Caldas to officials and the press before the 13 November eruption. This map has been reproduced from the Smithsonian Institution's Scientific Event Alert Network (SEAN) Bulletin (Volume 10, Number 11, November 31, 1985). Some redrafting has been done by officials at the Smithsonian Institution to facilitate reproduction, but boundaries of hazard zones are unchanged.

at about 1730 hours. The main explosion occurred at 2108 hours with strong activity lasting 20-30 minutes. Cold pyroclastic surges (very dangerous fast-moving lateral blasts of debris) extended about 30 km downvalley. Lahars were triggered by snow avalanches into the valleys.

Warnings were telephoned to the city of Armero, where it was raining at the time. Warning sirens were activated. While conflicting accounts make it difficult to know precisely what happened in Armero, it seems that the fire department advised evacuation, while priests and (possibly) the mayor suggested that evacuation was unnecessary. At least some of this information was broadcast on a local radio station. At about 2300 hours the first lahar reached the city. Lahars swept over all but a small high area of the city for the next four hours. Yes, the local populace did receive warning of the eruption.

WERE THE POPULACE AWARE OF THE PROBABLE CONSEQUENCES OF AN ERUPTION?

I believe there can be little doubt that the people of Armero were aware that they were likely to be affected by lahars in the (probable) event of an eruption of Ruiz. However, this does not mean that they were aware of the effects of a (major) lahar on their city. The last significant eruption of Ruiz had occurred in 1845. The September 1985 eruption, just prior to the major eruption in November, produced a lahar that stretched (only) 27 km downvalley - perhaps the populace thought they would also be little affected by subsequent eruptions. If the populace was aware of the probable consequences why did most people not evacuate? Clearly we need to await the results of an official enquiry before these questions can be answered.

SOME ISSUES

The incomplete (and possibly inaccurate) account presented here suggests that the volcanological part of the warning system worked relatively well. While no prediction of an eruption was made other than that one or more eruption/s were likely, the map of volcanic risk was accurate and was produced with adequate time for dissemination before the November 13 eruption. While volcanologists could do better with more lead time and adequate instrumentation (and the expenditure of considerable amounts of money), the risk offered by the volcano was accurately defined. The townsfolk of Armero were warned by the explosion which occurred at 1530 hours on November 13, and by telephone, radio and sirens of the immediate danger up to six hours before the first lahar reached the city. Exactly what went wrong is a question that cannot be answered here.

Volcanologists at a meeting of the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) held in New Zealand in early February 1986 were clearly pleased that the risk had been accurately assessed but were also concerned that they might have been able to do more. Questions, which may or may not have relevance to the Ruiz tragedy, were raised (again!) about the ethical responsibility of volcanologists. Such questions focus around the issue: "if volcanological warnings are not taken seriously by local officials should appeals be made to the media and/or the international community?". This question involves issues of belief, integrity, professionalism, legality and politics. There is certainly no easy or quick solution.

Members of IAVCEI's Working Group on the Mitigation of Volcanic Disasters also spent considerable time looking at ways in which IAVCEI could help to educate the media, officials and community leaders, and citizens about the potential effects of volcanic eruptions. In the next few years the Group intends to produce a media kit illustrating the likely and potential effects of all types of volcanic hazards, and to produce films of actual eruptions and effects so that media coverage can be made more accurate and appropriate to individual situations. At the same time, the Working Group will lend its support to an international training scheme for volcanologists from Third World countries.

Despite the lack of active volcanoes in Australia, the potential for a moderate or a major volcanic eruption in the Pacific region, in particular one which may affect a South Pacific island nation, is reasonably high. Australia has considerable expertise in matters volcanological and has strong representation on the IAVCEI Working Group. Both Australian scientists and aid personnel have important roles to play in ensuring that "unnecessary" volcanic disasters do not occur.