Hazard study of french (Lesser Antilles) and Central American explosive volcanoes

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Volcanological research on potentially dangerous volcanoes requires that a knowledge of their past eruptive behavior be studied well enough so as to yield well constrained assessment of hazards and their zonation.

Two years ago and under IDNDR auspices, we started a basic knowledge program, building on available information, that specifically addresses the study of our active Lesser Antilles volcanoes in Martinique (Mount Pelée) and Guadeloupe (Soufrière), F.W.I. These are volcanoes which show a low frequency of highly damaging eruptions (cf. the 1902 eruption of Mount Pelée: 30,000 casualties). Selected Central American volcanoes were also chosen for study, by bilateral agreement between national communities, so that experience could be shared between the scientists envolved. At present, these are the Rincon de la Vieja and Arenal (Costa Rica). The selection was guided by two principles: (1) volcanoes with relatively high eruption frequency or permanently active, and (2) similarity of behavior with Lesser Antilles volcanoes. This type of arrangement also follows the IDNDR recommendations for technological transfer towards developing nations and reciprocal use of their exposure to natural disasters.

The french Lesser Antilles volcanoes have now been studied by a limited number of scientists for over 15 years. General geological and volcanological research has established the main trends of their activity since birth several hundreds of thousands of years ago. In addition, a limited number of Holocene (last 10,000 years) and historical eruptions were sudied in detail. These studies form a preliminary data base which has been used for establishing a first draft of hazard zonation maps.

Our purpose in initiating a cooperative program between the french organisms in charge of volcano monitoring and hazard mitigation and regional Caribbean nations, was to study a much larger number of eruptions on selected volcanoes, possibly all in a given time span, so that hazard mapping and zonation would not be biased. In addition, we wanted to focus on the volcanological precursors to major eruptions which, today, are poorly studied. The latter enterprise is aimed at relating the data from surveillance networks run by volcano observatories to accurate forecasting of future eruptions and their development. Financing was obtained from the french ministries of national education and research and the cooperation division of ministry of foreign affairs.

Lately, we have concentrated our study on the last characteristic eruptions of the chosen volcanoes to which future eruptions will most probably resemble. We proceed by several steps, starting with field studies of the detailed stratigraphy, areal extent, and structure of eruptive products. Samples for laboratory work in the disciplines of sedimentology, petrology and geochemistry, and age determinations are collected at this stage. Field and laboratory data are synthesized so as to produce a detailed scenario of the pre-eruptive and eruptive conditions of the given eruptions. Hazard assessment for future eruptions are then constrained from the data base; their zonation is based on reconstruction of past destructions.

THE RECENT ERUPTIONS OF RINCÓN DE LA VIEJA VOLCANO, COSTA RICA : RECURRENT ACTIVITY OF AN ACTIVE HYDROMAGMATIC SYSTEM

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Rincón de la Vieja, located in the northern part of the Costa Rica volcanic range, is an active composite volcano. During historical times (since 1851), 26 explosive eruptive crises have been recorded, originating from the summit active crater. In spite of its frequent activity, very few data are presently available on the eruptive history of the volcano, the eruptive mechanisms and associated products.

In 1993-94, field and laboratory studies were carried out on the depositional sequences of the historical and prehistorical eruptions. In particular, the deposits of the two last most important eruptions (1966-70 and 1991-92) were characterized and studied in detail. These data combined with eyewitness accounts, allow a preliminary reconstruction of the evolution and the eruptive style of recent eruptions.

Three types of eruptions are characteristic of the historical period : hydrothermal, phreatic and phreatomagmatic with a vulcanian component. Their occurrence was controlled by the relative interaction between (1) shallow magma plug, (2) crater water lake and (3) active hydrothermal system. The areas destroyed by the surge and air-fall products of the major eruptions are limited to a few km^2 in the summit region. For the future, the presence of a water lake in the active crater is the main hazard. Most of the eruptions, phreatic or phreatomagmatic, begin by violent explosive activity which involves at once the upblowing of the water lake, producing - like in May 1991 - primary mudflows in the valleys of the northern flank and threatening people in several villages.

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VIOLENT REACTIVATION OF A DORMANT VOLCANO: THE 1968 EXPLOSIVE ERUPTION OF ARENAL VOLCANO, COSTA-RICA.

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Before the 1968 explosive eruption, Arenal volcano (Costa-Rica) had remained in a dormant state since the XVIth century. After several years with precursory signals, paroxysmal eruptive activity occurred between 29-31 July, 1968. During three days, strong explosions caused 78 casualties, destroyed about 15 km^2 on the western side of the volcano and covered with ash an area of 230 km^2, initiating a new period of activity which has continued till now. Based on eyewitness accounts (Melson and Saenz, 1973) and the study of the pyroclastic deposits, we reinterpret the eruptive sequence related to the paroxysmal events.

The eruption began by the opening of a radial fracture on the western flank of the volcano. Three small craters were successively formed. Pyroclastic products were mainly emitted from the lower vent. Three phases of explosive activity, have been recognized: 1/ An initial vent-clearing phase produced ballistic fragments (accidental and juveniles). Very large blocks were responsible for the formation of impact craters (decameters in size). A destructive laterally directed blast followed immediatly. 2/ A sustained eruption collumn, of moderate height, produced proximal fallout layers consisting of dense to vesiculated blocks and lapilli. 3/ Several discrete explosions occurred during the waning phase of the eruption producing surge deposits with typical dune structures.

Despite the present moderate activity, our reinterpretation of the 1968 eruption and the recognition of deposits from plinian or sub-plinian prehistoric eruption indicate that hazards from more significant explosive activity must be considered in the future.

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