ANATOMY AND BEHAVIOUR OF A POST-ERUPTIVE RAIN LAHAR TRIGGERED BY A TYPHOON ON MAYON VOLCANO, PHILIPPINES

MORPHOLOGIE ET COMPORTEMENT D'UN LAHAR POST-ÉRUPTIF DÉCLENCHÉ PAR UN TYPHON SUR LE VOLCAN MAYON, PHILIPPINES


Abstract

Mayon Volcano in the Philippines, one of the world's most active, is situated in a moist, tropical-maritime climate with frequent typhoons. A third of Mayon's eruptions generate destructive lahars (volcanic debris flows and hyperconcentrated streamflows). Lahars also occur during quiescent periods when monsoons and typhoons deliver rains of appropriate intensity and duration to the loose debris on the volcano slopes. Both eruption- and post-eruptive lahars occur most frequently during the typhoon-prone October-December season of the Northeast Monsoon. Post-eruptive lahars, the most poorly documented, are exemplified by a debris-flow event triggered by Saling, a typhoon of only moderate intensity, that occurred in Mabinit Channel on the southeast Mayon flank on October 17-18, 1985, one year after the last Mayon eruption.

Detailed pre- and post-Saling surveys document channel deepening of up to 4 m and maximum lateral erosion of 66 m. The debris flows left prominent, discontinuous multi-level terraces along the length of Mabinit Channel, either from pulsations due to temporary channel blockage, or as levee deposits. A significant volume of debris overtopped channel bends at 250-200 m elevations, coalescing to cover a 200,000 m² area of 4.5° slope with bouldery lateral deposits 1 m thick on the average. Channelized flows below this level plugged 0.5 km of the original channel and replaced it with a new conduit of comparable size.

The Saling debris-flow deposits have a remarkably uniform sand-silt mode and less prominent, more variable modes in the pebble-boulder range. Shear strengths of the lateral flows ranged from 0.46 x 10⁴ to 2.32 x 10⁴ N cm⁻²; those of the channelized flows at the plug were significantly higher. Reconstructed flow velocity was 3.8 m sec⁻¹.

Réssumé


La surveillance détaillée du chenal avant et après Saling a montré un approfondissement atteignant 4 m et une érosion maximale de 66 m. Les coulées ont laissé des terrasses étayées discontinues le long du Mabinit Channel, causées soit par des pulsations dues au blocage temporaire du chenal soit par dépôt latéral. Un volume important de débris couvrait une surface de 20 hectares avec une pente de 4.5° avec un dépôt latéral, épais d'environ 1 m. Les coulées en-dessous de ce niveau, colmataient le chenal d'origine sur 0.5 km et remplaçaient ce dernier par un nouveau chenal de taille comparable.

Les dépôts des lahars dus au typhon Saling présentaient un mode dans les sables-limons remarquablement uniforme, et au contraire plus varié au niveau des cailloux. La résistance au cisaillement du dépôt latéral est de 0.46 x 10⁴ à 2.32 x 10⁴ N cm⁻²; est nettement plus élevée pour le matériau qui remplissait le chenal. La vitesse des coulées a été estimée à 3.8 m sec⁻¹.

Introduction

This report is a contribution to a wider study of debris flows commissioned by the International Association of Engineering Geologists. It will describe the geological and climatologic setting of Mayon Volcano in the Philippines, and its 370-year record of eruptive and post-eruptive lahars. Focussing on post-eruptive lahars, it will present, as a case study, a single event that was triggered by heavy rains during a typhoon of only moderate intensity: Typhoon Saling, which occurred on October 17-18, 1985.

Mayon Volcano (Fig. 1) is one of about 600, or 46% of the world's active volcanoes that are located in the tropics (Simkin et al., 1981). The flanks and aprons of most tropical volcanoes have fertile soils...

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Rain lahars are still not well understood. Most tropical volcanoes are located in developing countries, where scientifically trained personnel are very scarce, and where records of lahars are not systematically maintained. The world-wide incidence of rain lahars is not known, in large part because those that are not directly associated with eruptions generally are not recorded; for example, they are not included among the volcanic phenomena catalogued by Simkin et al., (1981).

In the years following the last Mayon eruption in late 1984, a collaborative Lahar Study Group of the Philippine Institute of Volcanology and Seismology (PHIVOLCS) and the Department of Geological Sciences of the University of Illinois at Chicago (UICDOGS) has mapped the detailed topography and associated features of the 1984 and subsequent lahar deposits at a scale of 1:1,000 by plane table and alidade (Rodolfo, 1989), and analyzed the lahar sediments (Arguden and Rodolfo, 1986). A principal scientific objective of the mapping was to observe how the morphologies of lahar channels evolve, testing the hypothesis that channel configurations influence the behaviour of subsequent flows. Mabinit Channel, the conduit for the Saling lahar, was one of the areas mapped. Only two weeks after its survey was completed, Typhoon Saling triggered a major lahar event that drastically modified the channel and overtopped it, leaving deposits over a large field. The channel and deposits were re-mapped in January-February, 1986 to document the effects of the Saling lahar.

Lahars

A note on the usage of the term lahar in this report is in order. Volcaniclastic debris flows and hyperconcentrated streamflows are collectively referred to in the Bicol language of the Mayon area as bahanin dugi—literally, "floods of mud", but we defer to the better known Indonesian term lahrs, which Scrivenor (1929) translated into "mudstreams". These terms are misnomers in strict geological usage because the flows generally contain very little "mud", or silt and clay. Nonetheless, lahar will be used in this report, despite some feeling among experts (e.g. cf. Smith, 1986) that the term should be discarded because its loose usage in the literature is confusing. According to this view, the only valid terms are "debris flow" and "hyperconcentrated streamflow" or "hyperconcentrated floodflow". People who live on the aprons of Philippine and Indonesian volcanoes, and the 370-year record of flows at Mayon, do not make this sophisticated rheological distinction. Furthermore, at Mayon, Mt. St. Helens (Janda et al., 1981; Pierson and Scott, 1985) and elsewhere, individual lahar events have exhibited both non-Newtonian debris-flow and Newtonian hyperconcentrated flood-flow behaviour. It is such multi-phase events, and even events that were entirely hyperconcentrated crater lakes are breached (Fisher and Schmincke, 1984).

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