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Flow velocity during 2001 lahar in Popocatépetl volcano (México)

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Popocatépetl volcano (19º02'N, 98º62'W; 5424 m.a.s.l.) is located in the center of the Trans-Mexican Volcanic Belt (TMVB), 80 km from México City. The volcano started its last eruptive period on December 21, 1994 and was active until the end of 2003. During this time there were many eruptions that caused the glacier, situated on the northern face, to melt and generate lahars as long as 17 km. One such lahar that formed on January 22, 2001, travelled 12 km down the Huiloac valley.

It was important to determine the flow velocity of this lahar to obtain essential parameters for the prevention of future lahars and for application in numerical models. The parameters include turbulence, impact force, dinamic viscosity and shear stress, among others, which are very important for hazard assessment studies, to obtain building parameters for house construction and finally, to elaborate an evacuation plan for the people who live in the affected areas. Since photographic and acoustic techniques are complex to apply, this study proposed calculating flow velocity by using the debris ridges (leveés) left by the lahar as it travels around bends. The principle is based on radial acceleration and, assuming all stream lines have equal velocity and an equal radius of curvature, it applies Newton´s Second Law of Motion to centrifugal action in the curve (Costa, 1984).

The following equations are applied in this study, which are based in Chow, (1959), modified and applied by other authors (Costa, 1984, Johnson, 1970, among others):

$v = (r_c g \cos S \tan \theta)^{0.5} -> $ m/s=m*m/s*grade*grade

-where:

is the radius of curvature,

is the channel slope,

is

(Where

is the elevation difference between the flow surface on the inside and outside of the bend and

is the width) and g is gravity acceleration.

The lahar was generated at about 4200 m.a.s.l. and flowed to approximately 2850 m.a.s.l. The formula was applied at tree points along the Tenenepanco-Huiloac Channel, and the results indicate a flow velocity of 8.840 m/s at the highest elevation (3940 m.a.s.l.), 1.569 m/s at the second point (2972 m.a.s.l.) and 1.457 m/s at the lowest point (2951 m.a.s.l.). The results are very similar to those obtained for the lahars on Pinatubo volcano in June 1991 (Pierson et al. 1997). In order to extrapolate the flow velocity values to the entire path of the lahar, more data is needed for a statistical correlation. The final goal is to use this data as a GIS layer and to implement it to obtain the rest of the parameters.

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