Post-laharic evolution of the proglacial gorge on Popocatépetl volcano (Mexico)


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Introductions and objectives

Volcanic activity on Popocatépetl (19.02 N; 98.62 W; 5450 m) renewed in December 1994 after nearly 50 yr of total calm. The most important events took place in April 1995, July 1997, and January 2001, and were characterized by violent explosions that produced great quantities of pyroclasts, many of which landed on the north side glacier. This caused sudden fusion of glacial ice and triggered the formation of lahars that flowed downslope through several proglacial gorges. The lahars that occurred in 1997 and 2001 were particularly powerful and grew in size as smaller flows from other gorges converged in a single current in Huiloac Gorge and traveled down the volcano to a distance of 12 km from the crater. Masses of sediments refilled the bottom of the gorge. Following the last significant eruption in January 2001, multiple secondary lahars were generated that were very fluid but smaller in size. These flows were triggered by the partial fusion of the glacier and precipitation. They not only lifted older deposits from the channels, but transported them over long distances and ultimately became a threat to neighboring towns (Palacios et al. 2001). This prompted the need to establish hazard prevention measures, and efforts focused on carefully monitoring erosion dynamics and sedimentation activity in Huiloac Gorge, what was carried out by “Elaboration of an Integrated System of Hydrovolcanic Hazards Prevention Project” (REN2003-06388, Spanish Government). The methodology used in monitoring these postlaharic processes consisted of establishing an accessible, 500 m long control section along the gorge channel. During two seasons of field work (February 14 and October 15, 2002) a detailed geomorphologic maps (scale 1:200) and a collection of 31 transects were produced.
Methodology

A.- Cad analysis: contrast of the cross sections from different dates

Individual comparative studies were performed using a CAD to superimpose the 31 cross sections found in this stretch of the gorge, and this was followed by a statistical study of the data, which provided estimates for erosion and sedimentation rates.
B.- Gis analysis: contrast of the DEMs from different dates
A GIS was used to process the data and a comparative analysis of the maps helped to determine variations in the channel, to distinguish the more heavily eroded edges of the channel in contrast to surfaces that showed greater sedimentation and to obtain values for the erosion/sedimentation areas.

The coordinates assigned to the points used in drawing the transects provided the data to create a Digital Elevation Model (TIN interpolation) for each of the dates. Raster models were also generated from the DEMs and by comparing the results, we were able to estimate the total volume of material deposited and eroded between February 14 and October 15, 2002.
Conclusions

The applied methodology is useful in analyzing post-lahar tendencies and improving simulations models. In fact, it could be considered an efficient tool in preventing future flow hazards (Major, 1997 and Bursik et al. 2003). The results are conditioned by the origin of the data. In this case, the GIS techniques were able to use detailed data in the cross sections, but had to estimate and interpolate the sections between the transects. The CAD analysis calculate the sedimentation and erosion areas in each transect, but had to assume lineal tendencies between the cross sections to obtain the total sedimented and eroded volume.

The CAD analysis indicates a lost of 656.60 m³ and an accumulation of 139.56 m³. The DEM analysis indicates a total erosion of 767.43 m³ and a sedimentation of 533.53 m³. In the future, a better and more detailed field topographic work will be done between the transects, introducing many reference points, in order to obtain DEM more complete and reduce the error.