Volcano – glacier interactions and related hazards during the 2007 and 2008 eruptive crisis at Nevado del Huila, Colombia

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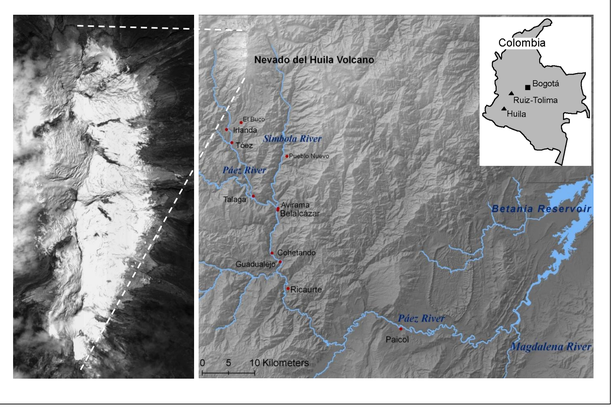
Introduction

Ice- and snow-covered volcanoes may produce important mudflow (lahars) and flood events because of possible interactions between volcanic activity and the subsequent and abrupt melting of snow and ice.

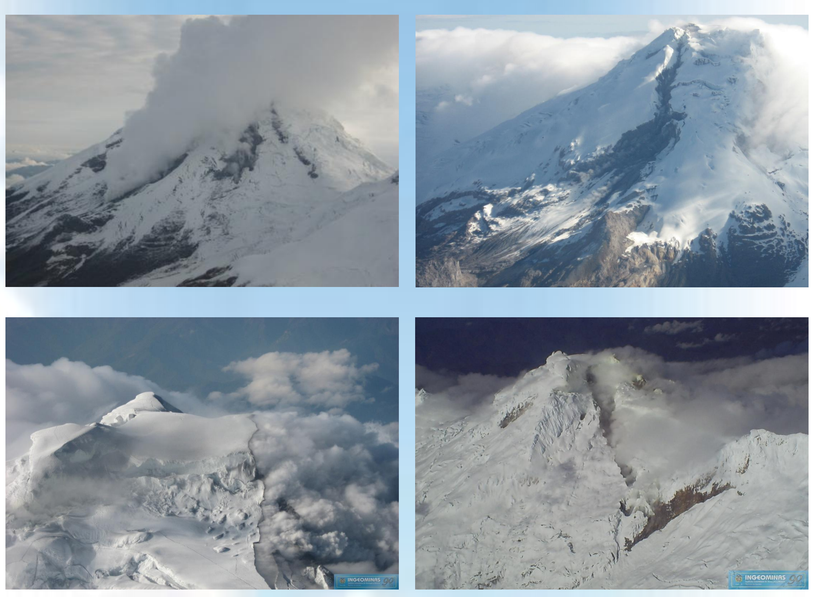
Nevado del Huila, a glacier-covered volcano in the South of Colombia's Cordillera Central, has not experienced any historical eruptions, till in February and April 2007 and in November 2008 the volcano erupted with phreatic and phreatomagmatic events. The eruptions produced lahars that travelled 150 km down the Páez River, with flow volumes of several million m^3, ~30 million m^3 and ~300 million m^3 for the February 2007, April 2007 and November 2008 events, respectively. The water content of the flows are estimated to be 60% by volume.

Although glaciers on Nevado del Huila are shrinking due to climate warming and volcanic activities, volcano – glacier interactions will remain a major thread in the future posing a potential source of lahar formation.



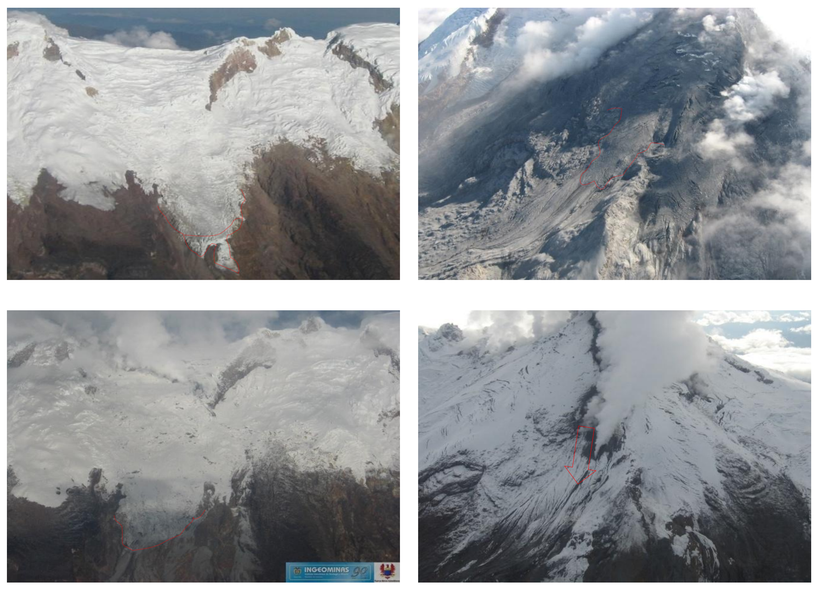
Eruption related glacier evolution during the 2007 events

Formation of fissures



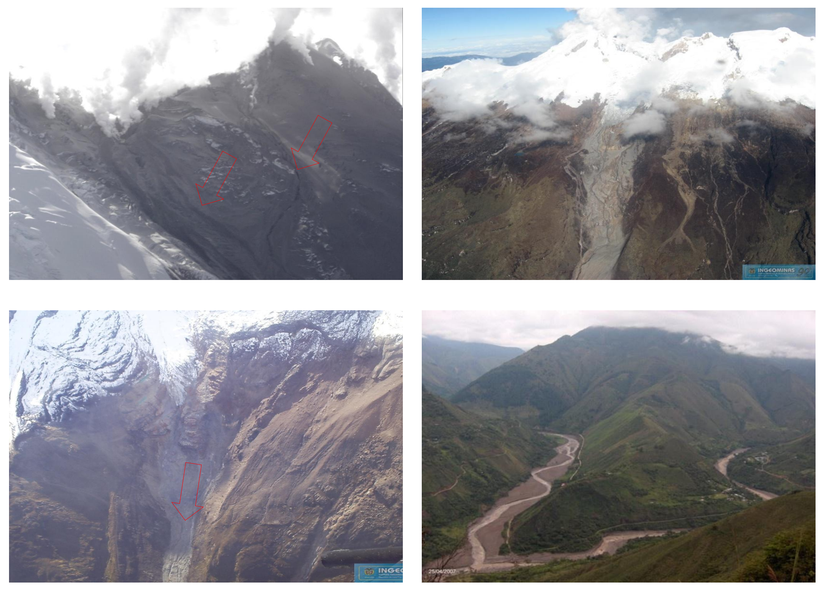
Each eruption at Nevado del Huila was accompanied by the formation of a large fissure in the Huila summit region of 2 km length and 50-80 m width with continued strong fumarolic activity after the eruptions.

Failure of glacier tongues



The lowermost part of the El Oso and El Ratón glacier failed, probably as an avalanche. The mechanism could be related to hot water released from the summit fissures that entered the base of the glacier and provoked a sudden reduction of shear strength at the glacier-bedrock interface.

Water flow



Glaciers were not affected by the eruptions in a magnitude that would correspond to the amount of ice-melt generated water necessary to produce the observed lahar volumes. Most of the water that formed the lahars was expelled from the fissures, stemming from hydrothermal water reservoirs.

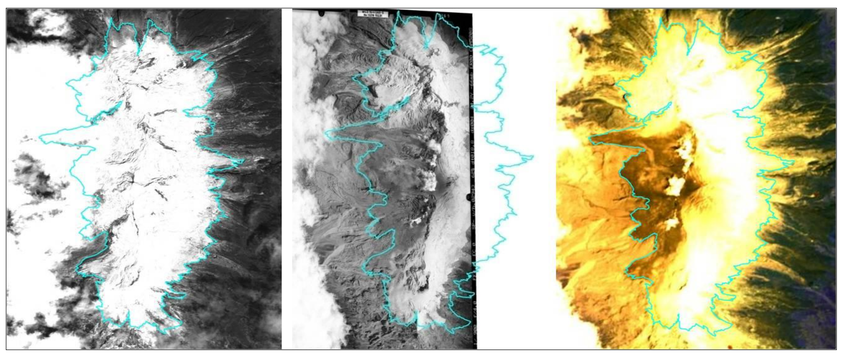
The eruption in 2008

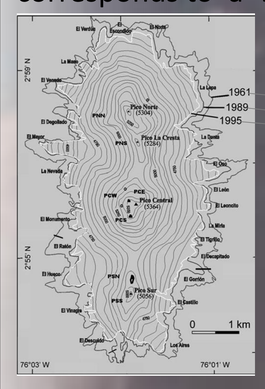
In November 2008 Nevado del Huila produced a phreatomagmatic eruption that generated a devastating lahar. During this event a crater with an approximate diameter of 400 m was generated from which a dome is arising. Due to a possible collapse of the dome a detailed monitoring is important. This is done by seismic surveillance, aerial inspections and a web cam.

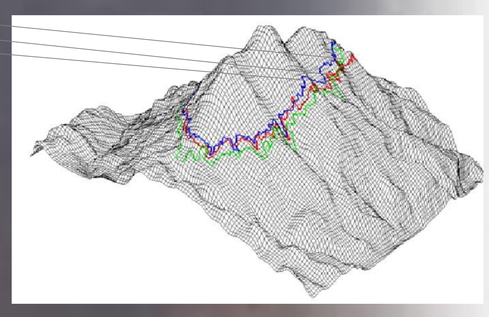
The glacier on the west flank was fractured heavily during the outburst.

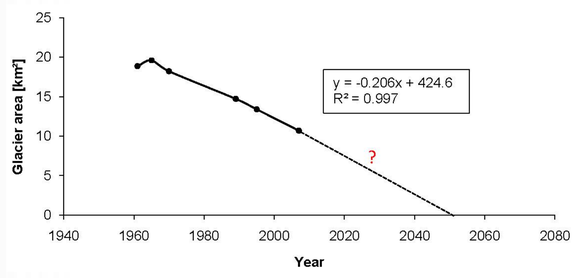
Ice covered area and glacier retreat

To consider the hazard potential of the glacier that covers the Nevado del Huila Volcano, it is important to know its dimensions for estimating the amount of stored water that could be released when volcanic activities interact with the ice cap. For this purpose, we had a Quickbird and an ASTER satellite image and an aerial photograph at our disposal, all taken in February 2007. Digitising the limits of the glacier yields to a total glacier area of 10.7 km^2. In field studies it was found that the average ice thickness is 48 metres, hence a glacier volume of approximately 462 million m^3 is resulting. This corresponds to a water equivalent of 410 million m^3.









The glacier area was analyzed by Pulgarín et al. (2005) for 1961, 1965, 1970, 1989 and 1995. It was found that the glacier had shrunk from a maximum area in 1965 of 19.06 km^2 continuously. It is likely that the glaciers will continue to respond to ongoing atmospheric warming. The current rate of retreat suggests glaciers could disappear completely in the second half of the 21st century.

Conclusion

The glacier on Nevado del Huila represent an important hazard element when interacting with volcanic activities. Although - as a result of climate warming - ice will not be present in the future on Nevado del Huila, it does not mean that a lack of volcano-ice interactions will render it free of hazard. The 1994 lahar, triggered by a seismic earthquake at the base of the volcano, is a prominent example of volcanic threat without involving water from the ice cap. The steep slopes of Nevado del Huila Volcano could be destabilized due to glacier retreat and permafrost thawing with the possibility of rock falls, rock avalanches, landslides, lahars or even flank collapse.