Geophysical Research Abstracts, Vol. 7, 09540, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09540

Nevado del Ruiz, Colombia, 20 years after: Evolution of the ice cap, re-assessment of volcano-snow interaction processes that feed lahars

J. Ramirez C. (1) **, J-C. Thouret** (2), J.L. Naranjo H. (3), C.A. Vargas (4), and F. Valla (5)

(1) INGEOMINAS, Bogotá, Colombia (jairamir@ingeominas.gouv.co) (2) Laboratoire Magmas et Volcans, université Blaise Pascal, Clermont-Ferrand (thouret@opgc.univ-bpclermont.fr / Fax: +33 4 73 34 67 73 / Phone: +33 4 73 34 67 44) (3) Universidad de Caldas, Manizales, Colombia (jnaranjo@emtelsa.multi.net.co). (4)Universidad Nacional de Colombia, Bogotá, Colombia (cavargasj@unal.edu.co). (5) Division Etna, CEMAGREF, Saint-Martin d'Hères, France (francois.valla@tele2.fr).

Volcano-ice interactions include a variety of processes, such as rapid thermal melting, ice and snow avalanches, superficial abrasion, gullying or mechanical scouring. An EU-funded "IMIP" project (1995-99: INGEOMINAS and Universities of Caldas, Grenoble 1, and Blaise Pascal) has focused on volcano/ice interaction processes that generated deadly lahars during the 13 November 1985 eruption of Nevado del Ruiz. The ultimate goal is to re-assess lahar hazards that ice and snow interactions with pyroclastic debris pose as far as 100 km distance away of the Nevado del Ruiz ice cap (5320 masl.).

On 13 November 1985, the most significant loss of snow and ice occurred where pyroclastic flows and surges scoured the snowpack, and steep-sided glaciers failed. In contrast, the loss was smaller on glaciers with gentle slopes, where tephra fallout was deposited passively. Mapping of the volcano summit (1986-1998) showed that the ice cap lost has much as 55% in area (11.58 km^2 in 2000 compared to c.21 km^2 at the end of the 1985 eruption) and roughly 30% in volume (now 0.57 km^3 compared to c. 0.69-0.75 km^3 in 1985). Record of the ice cap changes is based on photographs, visible and Radar remote sensing, while coring and portable radar helped to measure snow, firn, and ice thickness. The geometry of the ice cap has been an object of detailed radar-based profiles measured by our Colombian colleagues across the ice cap since 1996

(Ramirez et al., 2000).

The ice field $\geq$50 m thick, covered by loose snow on the summit plateau, contrasts with hard ice $\leq$30 m thick, devoid of snow, on the steep northern and eastern margins. The ice thickness, 49 m on average, is as much as 190 m beneath Glacier Nereidas (NW). The ice retreat uncovered five domes surrounding the plateau (as mapped earlier by Thouret et al., 1990), where ice 50 to 190 m thick probably fills a summit caldera. The ice-free Arenas crater is open to the northern rim of that 4 km-wide caldera.

Laboratory experiments suggest that thermal models with turbulence are more efficient than heat conduction to generate heat transfer from hot tephra to snow. Turbulent pyroclastic density currents that mechanically mix snow can produce a melting rate of several cm/minute, compatible with a volume of 38-44 million m^3 of meltwater generated in 30-90 minutes during the 1985 eruption. Percolating meltwater, shear stress, and particle collisions at the base of pyroclastic density currents contribute to increase the efficiency of heat transfer, as well as mechanical processes such as dynamic mixing, fluid drag, and ice mass failure.

Reassessing lahar hazards leads to the conclusion that two ice fields, which can fail and/or be swept by pyroclastic flows and surges, are likely to feed mixed avalanches and lahars in the future: (1) the headvalleys of the Rio Azufrado and Rio Lagunillas drainages to the East of Arenas, where retreating glaciers form unstable cliffs cut in hydrothermally altered rocks, and (2) the Nereidas-Farallon-Guali-Molinos ice fields to the N and W of Arenas, whose long, gentle slopes $<10^{\circ}$ can be scoured by pyroclastic flows and surges.