THE 1990-92 ERUPTIVE ACTIVITY OF THE NEVADO SABANCAYA STRATOVOLCANO (SOUTH PERU).

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The May 28, 1990, eruption of the Nevado Sabancaya volcano (south volcanic zone of Peru, Western Cordillera) ended an apparent dormant stage of about 200 years in duration. This ice-clad stratovolcano threatens about 35,000 people living in the Rio Colca and Siguas valleys. This study based on remote sensing and limited fieldwork aims to portray the geological and geomorphic features of the summit volcano, to follow the evolution of the explosive activity and the tephra-fall deposits that were expelled in October 1990 and December 1992, as well as to map hazard-zones at and around Nevado Sabancaya.

A remote sensing study based on SPOT images have been used to map the block-lava flows of Holocene age and the young twin domes of the summit volcano. Five SPOT images over the year 1990 have enabled us to follow-up how much the explosive activity has disrupted the summit and crater morphology. They were also used to evaluate how the ice cap has been fractured, carved, and covered by repeated thin tephra-fall, and how runout mudflows have been triggered (fig.1)

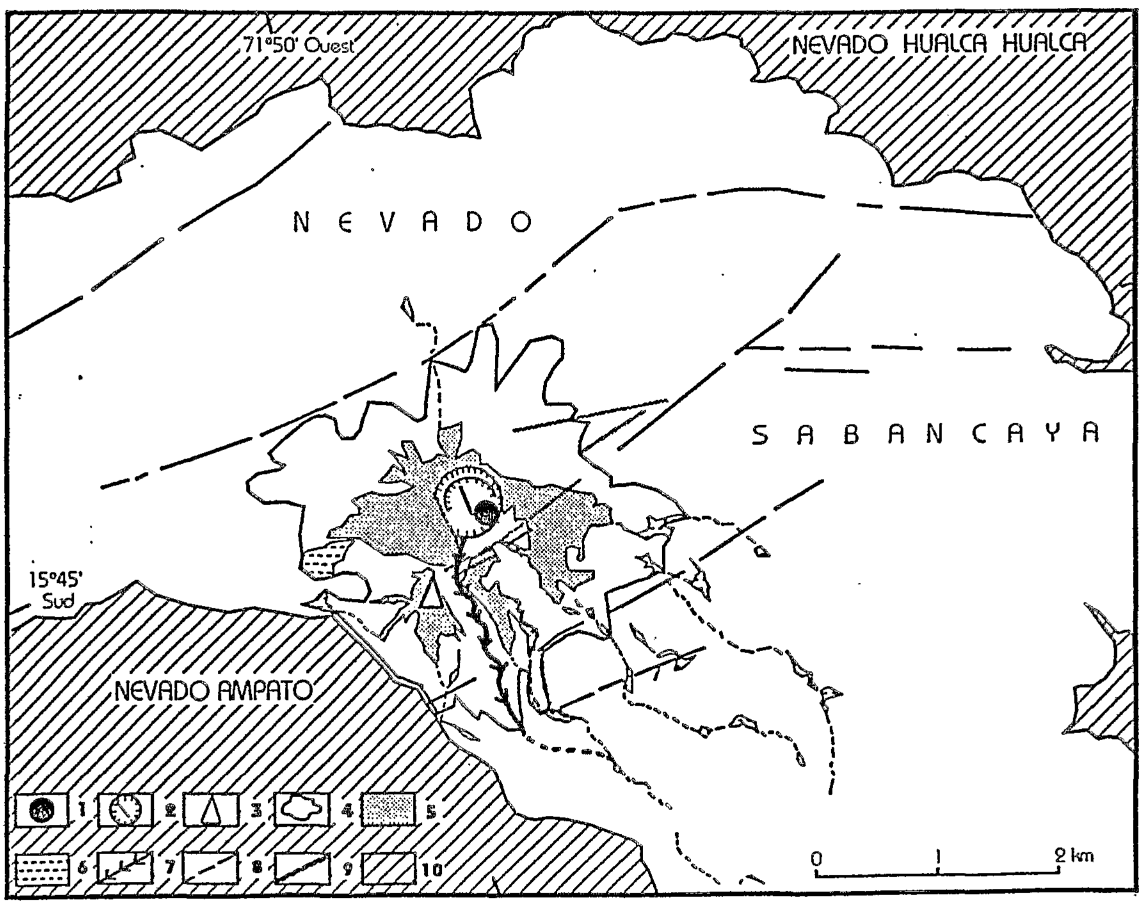
The tephra (ca. 0.025 km^3 in 1990) related to the vulcanian activity of Nevado Sabancaya are compositionally variable, from andesite (58% SiO_2) to dacite (63% SiO_2), in a K-rich calk-alkaline suite. The mineral assemblage of 1990-92 juvenile magma consists of plagioclase, green pyroxene, brown amphibole, biotite, destabilized olivine, and oxydes. From October 1990 to December 1992, the juvenile component increased from 15% to ca. 50 % by volume : there are black, glassy, slightly vesicular fragments, andesitic in composition, and grey fragments, dacitic in composition. In addition, a few mafic inclusions and banding are related to a weak geochemical contrast. Moreover, mineralogical desequilibrium also suggests an interaction between two contrasted magmas : a felsic one, dacitic, including oligoclase and hypersthene and a mafic one, andesitic or basaltic, including labrador, bronzite and olivine phenocrysts. Such preliminary data suggest the mingling of two contrasted magmas, a process that may be evolving during present-day eruptive activity.

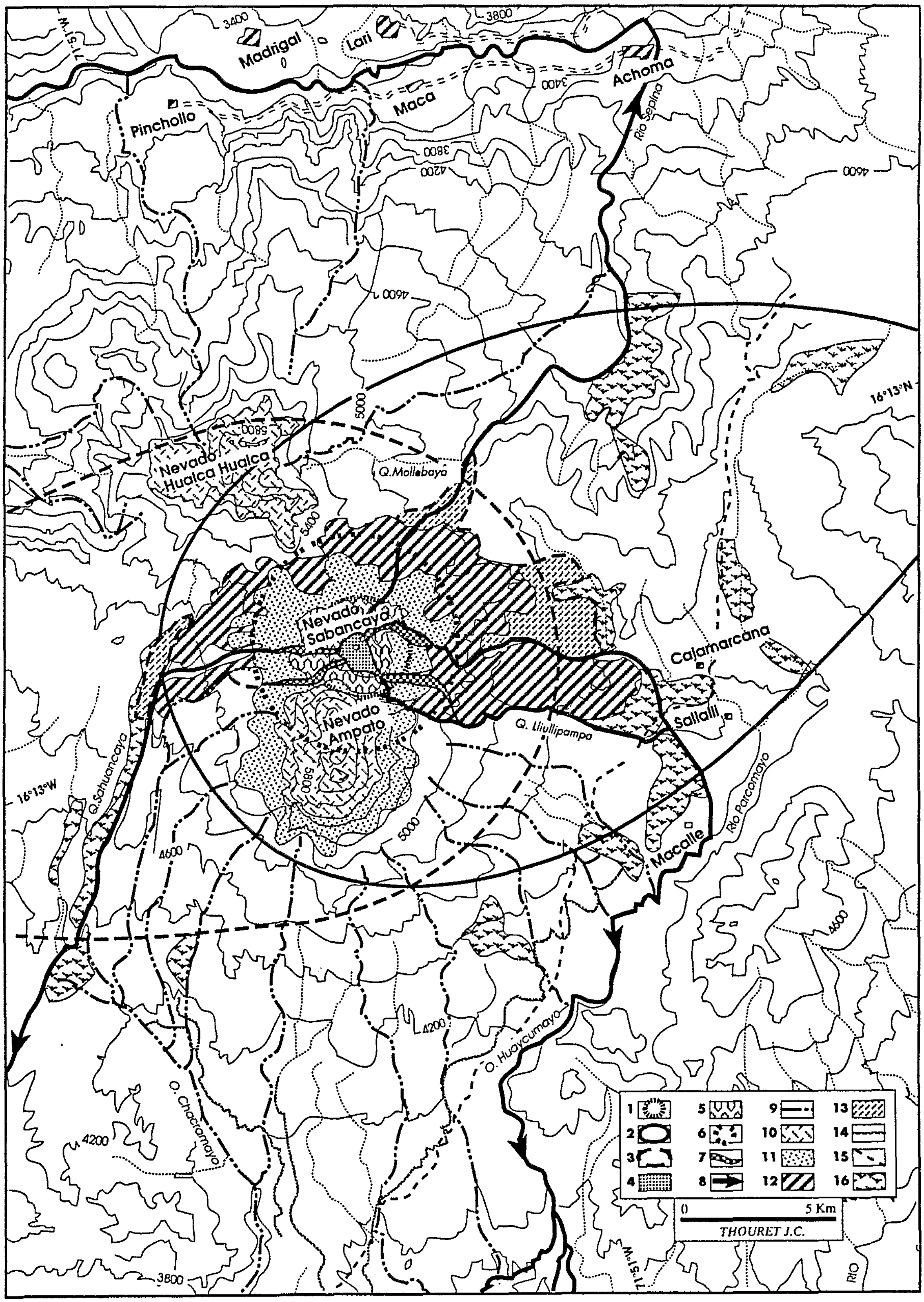
Hazards posed by the the Nevado Sabancaya volcano are bound to the recent behaviour of similar volcanoes in that area, which have had Plinian eruptions over the past 500 years. In addition, Nevado Sabancaya has been active over the past 200 years, and is still ice-clad (3.5 km^2 of glacier ice) despite its two-year-long activity. Block-lava flows Holocene in age cover as much as 40 km^2 around the summit domes. Historical, thin plinian tephra-fall deposits are found as far as 11 km from the crater and block-and-ash pyroclastic-flow deposits as far as 7 km away from the source. Recent lahars have travelled ca. 25 km downvalley towards NE and SW.

Hazard appraisal and hazard-zone mapping are based on geological and geomorphological data, photo-interpretation, remote sensing, as well as on models of tephra dispersion and pyroclastic flowage. One map shows hazard zones for tephra fall, pyroclastic flows, lahars, and also for uncommon but catastrophic potential events (fig.2). These hazard zones are portrayed according to three types of eruptive behaviour : the 1990-92 moderate vulcanian activity, a possible increase of this vulcanian activity, and a potential Plinian large-scale event.

Figure 1. Geological and geomorphic evolution of the Nevado Sabancaya summit volcano over the year 1990.
1. preexisting vent before May 28, 1990 ; 2. crater and fractures as of July 1, 1990 ; 3. south dome ; 4. ice cap ; 5. wet ashfall deposits carried by slope runoff ; 6. fans of ash and debris deposited by rapid snow- and ice-melt ; 7. gully scouring the ice cap as of October 1990 ; 8. scarps or fractures detected by remote sensing (SPOT) and in the field as of July 1990 ; 9. scarps or fractures detected by remote sensing (SPOT) as of December 1990 ; 10. Nevado Ampato and Hualca Hualca ice caps slightly covered by ash and dust from Nevado Sabancaya.

Figure.2. Map showing the eruptive products and the areas likely to be affected by the present-day (1990-92) vulcanian activity or by a potentially increasing explosive activity at Nevado Sabancaya.
I. Areas affected by fallout : 1) present-day ballistic ejecta ; 2) ashfall towards east and 1-cm-thick isopach ; 3) potential ashfall towards west and 1-cm-thick isopach. *II. Areas affected by tephra-laden snow-and-ice avalanches* : 4) present-day area of gullies and avalanches; 5) ice cap covered by tephra and likely to be affected. *III. Areas likely to be affected by pyroclastic flows* : 6) circle line where the energy line of potential pyroclastic flows would intersect the topography of the summit volcano ; 7) presumed paths of potential channeled pyroclastic flows. *IV. Areas likely to be affected by lahars or debris flows* : 8) probable paths of potential lahars that would be triggered by pyroclastic flowage on the ice cap ; 9) possible paths of potential lahars that would be induced by surficial melt of the neighbour volcanoes ice caps ; 10) Nevado Sabancaya ice cap ; 11) seasonal snow cover (December-March) *V. Areas likely to be affected by lava flows* : 12) probable block-lava flows ; 13) possible lava flows. *VI. Other elements prone to risk* : 14) irrigation canals ; 15) unpaved roads ; 16) peat-bogs and pasture grounds.




Madrigal
Lari
Achoma
Pinchollo
Maca
Rio Sepina
Nevado Hualca Hualca
Q.Mollebaya
16°13'N
Nevado Sabancaya
Cajamarcana
Sallalli
Q. Lliullipampa
Nevado Ampato
16°13'W
Q.Sahuancaya
Rio Parcamayo
Macalle
Q. Huaycumayo
Q. Chacramayo
3400
3800
4200
4600
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