

LOWER HOLOCENE PLINIAN ERUPTIONS OF COTOPAXI VOLCANO - ECUADOR

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INTRODUCTION:

Located 50 km south of Quito in the eastern Cordillera of the Andes, Cotopaxi, an ice-clad volcano (5890 m in elevation, Lat. : 0°68'S, Long. : 78°44'W) is one of the large Ecuadorian stratocones. The recent activity of this volcano is very explosive. During the Holocene, this volcano experienced large plinian events which have been responsible for the eruption of large volumes of tephra (ash, scoria, pumice), of andesitic and rhyolitic composition. The geologic description and physical studies of andesitic fallout deposits younger than 2000 y BP and of a giant rhyolitic lahar which occurred about 4500 y BP have been recently carried out (Barberi et al., 1995; Mothes et al., 1998). Nonetheless, the high rates of magma production related to intense and complex cycles of explosive activity during Lower Holocene of Cotopaxi's history and development remain little known. According to Hall and Mothes (1995), Cotopaxi is also remarkable for its bimodal activity, and approximately every 2000 years, during Late Pleistocene and Holocene, has produced large rhyolitic eruptions whose volumes exceed various km³.

Field work carried out since November 1997 aims to characterize the nature and extent of voluminous tephra falls related to large explosive and silicic events which occurred during the Lower and Middle Holocene.

Summarized description of the deposits :

From about 9000 to 4500 y BP, the activity was strongly explosive. Especially, about 6000 y BP, four eruptive events were responsible for the deposition of thick, widely distributed, fallout pumice lapilli layers, rhyolitic in composition. These were also accompanied by large emissions of fine ash. Two lapilli layers (R1 and R2) were transported by dominant winds towards the west (Fig. 1), whereas the lapilli and

ash of the two other events were deposited towards the east. C14 datings show that these four major episodes occurred during a short time interval, i. e. at most over a few centuries. They represent the climatic eruptions of a discontinuous essentially acidic and explosive activity which started between 7000 and 9000 y BP and ended about 4500 y BP. Since 4500 y, Plinian fallout deposits at Cotopaxi are mainly andesitic in composition and are accompanied by andesitic lava and pyroclastic flows.

The good quality of outcrops allowed the recording of numerous key sections in the areas west of the volcano, as well as the elaboration of isopach and isopleth maps of each deposit (Fig. 1. and 2.). R1 and R2 layers are composite pumice and lithic lapilli deposits, several meters thick on proximal sections; They show a complex structure underlined by alternating beds more or less enriched in ash and/or lithics, as well successive normal and reverse grading.

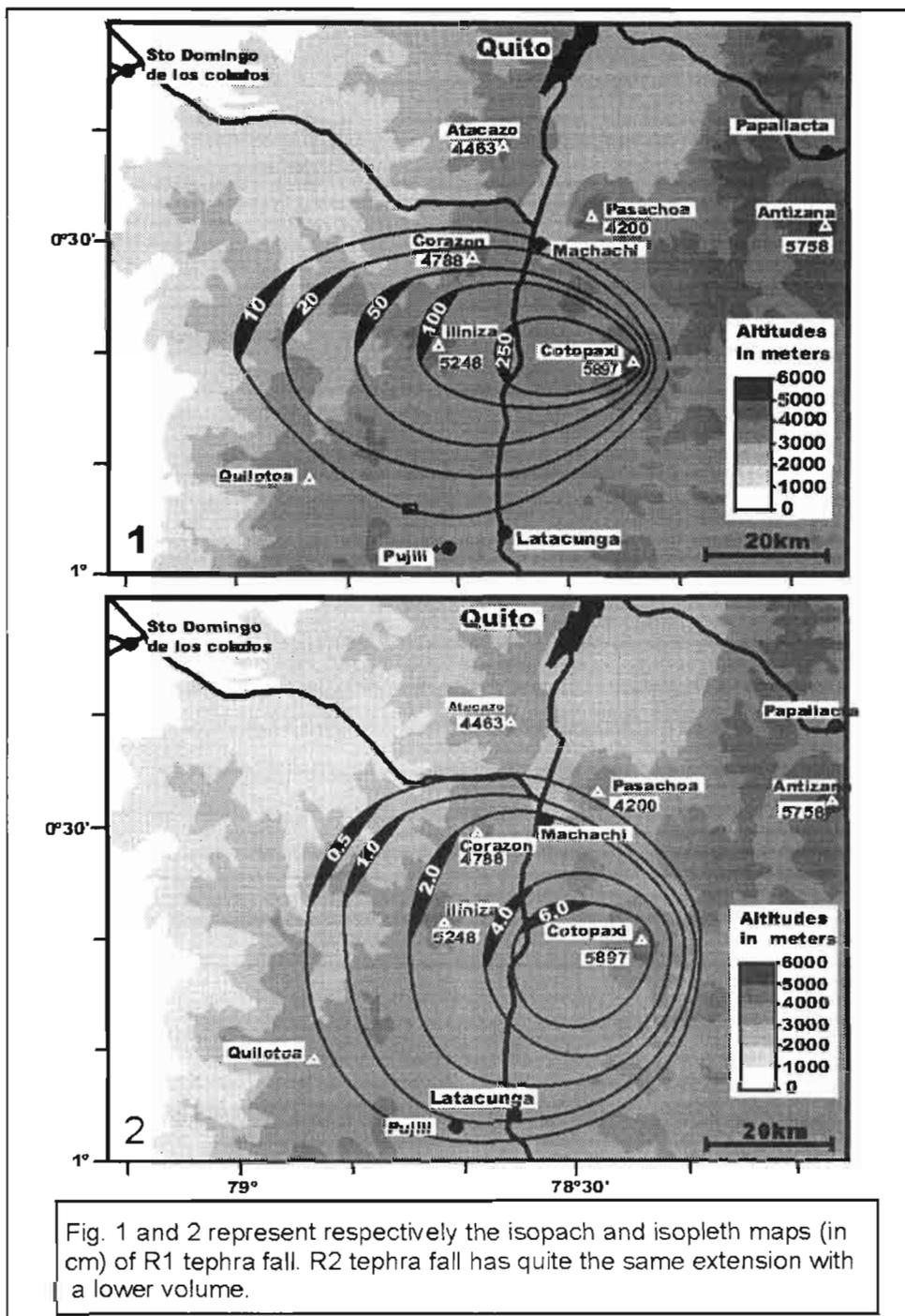
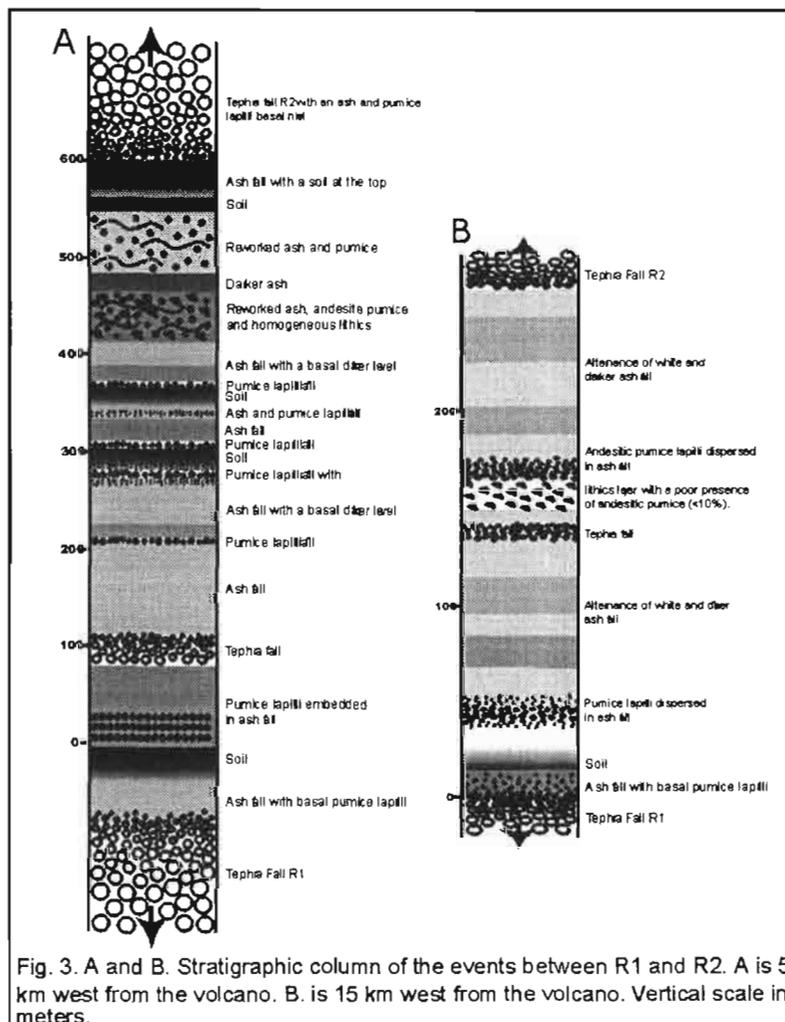


Fig. 1 and 2 represent respectively the isopach and isopleth maps (in cm) of R1 tephra fall. R2 tephra fall has quite the same extension with a lower volume.

Pyroclastic flows of rhyolitic composition (ash, pumice and obsidian blocks) were also emitted during the open-vent eruptions which occurred about 6000 y BP. These extended over the north, east and south-west sides of the volcano. Alternating with these large rhyolitic events, dome activity (rhyodacites) also occurred near or at the summit. During the whole period, from 9000 to 4500 y BP, very few products with an andesitic composition have apparently been erupted. This is demonstrated by subordinate andesitic ash and scoria layers within the thick sequence of rhyolitic fallout deposits that we studied (fig.3).



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Interrelations between the products of dome destruction and the related open-vent eruptions are observed in valleys at the base of the cone. On the contrary, distal tephra deposits (up to 40 km) only consist of fine ash.

Volumes for the R1 and R2 pumice lapilli layers are calculated to be 3.2 and 1.2 km³ respectively (no DRE). Whereas an estimation of the total volume of tephra erupted during the 9000-4500 y BP period is around 14.3 km³ (without considering the volume of pyroclastic flows). These values emphasize the large volume of fine ash produced, a striking characteristic of the rhyolitic sequence as a whole, which in turn indicates a high degree of magma fragmentation during the explosions.

CONCLUSION :

Cotopaxi Lower to Middle Holocene history is dominated by very explosive (Plinian) eruptions which produced large volumes of rhyolitic ash and pumice mainly deposited to the west of the volcano. The climactic phase of this activity occurred about 6000 y BP. A study of the deposits is in progress. It will allow an improved knowledge of the dynamic of this type of event, rare in andesitic stratocones. This study will be of great importance for increasing the knowledge of the hazards represented by Cotopaxi volcano, especially in the formation of large debris flows and tephra fallouts whose extension threatens cities in the Interandean Valley (Lasso, Latacunga and the urbanized zones south-east of Quito).