Preliminary data on the Almas Santas volcanic center from the Ecuadorian frontal arc

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INTRODUCTION

The Almas Santas volcano, that culminates at the Cerro Azul (3745 m asl), is an extinct volcanic center from the frontal arc, located west of the Iliniza Volcanic Complex (**fig. 1**). It is one of the Ecuadorian volcanic centres located the closest to the subduction, at ~230 km from the trench. We present here for the first geological and geochemical results obtained about this previously unstudied volcano.

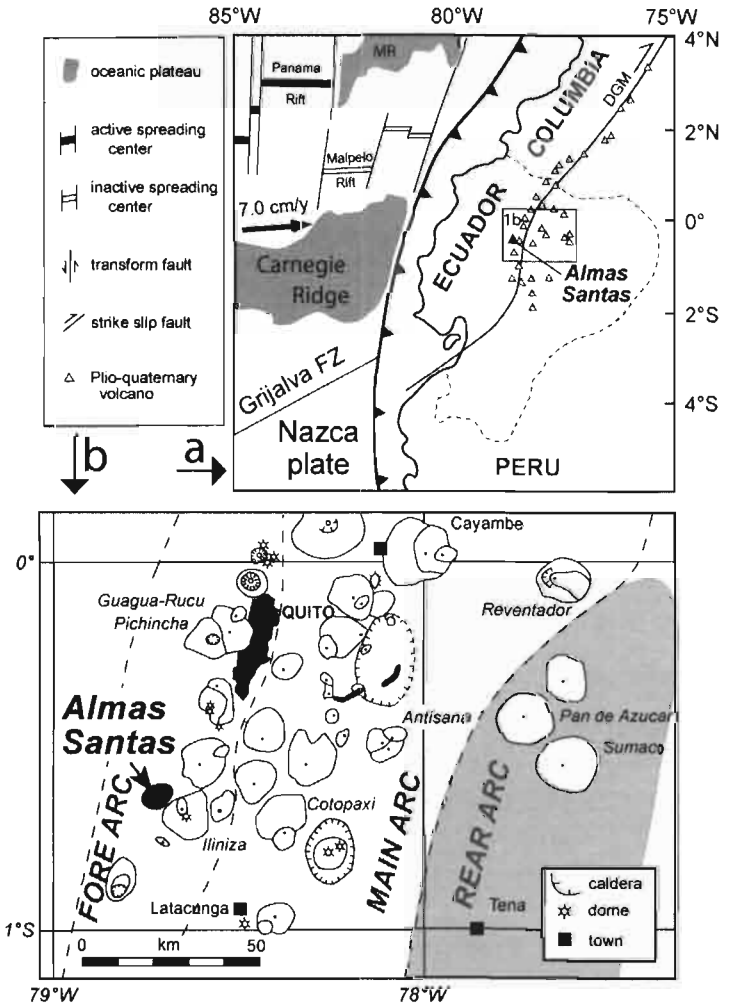

Figure 1 :

A: Geodynamical setting of the Northern Andes (modified from *Gutscher et al., 1999*; relative plate motions according to *Kellog & Vega, 1995*). Grey arrows correspond to the direction of subduction. Full triangle represents the Almas Santas edifice. The numerous Plio-Quaternary Ecuadorian volcanoes are divided in three subparallel rows: the fore arc (Cordillera Occidental), the main arc (Cordillera Real or Cordillera Oriental) and the rear arc area (Oriente), with variations in the geochemical characteristics of erupted magmas across these three rows (*Bourdon et al., 2003*).

B: Location of the Almas Santas extinct volcano in the Ecuadorian fore arc (western cordillera), west the Iliniza Volcanic Complex.

MORPHOLOGY

The Almas Santas appears as an ~1500 m high volcanic edifice (relative ot its basement), elongated following a NW-SE axis, deeply dissected by erosion. But the most striking morphological feature is the presence of a horseshoe shaped caldera, open towards the NW, that occupies most of the central part of the edifice ; it marks the scar left by the partial collapse of a large part of the original edifice. Therefore, we can assume that the altitude of the edifice's summit was initially much higher, probably > 4200 m asl. The lower slope of the edifice consists mainly of thick and extensive andesitic lava flows, whereas several of the higher ridges, as well as the Cerro Azul, consist of more differenciated dacitic and rare rhyolitic complexes of domes and flows.

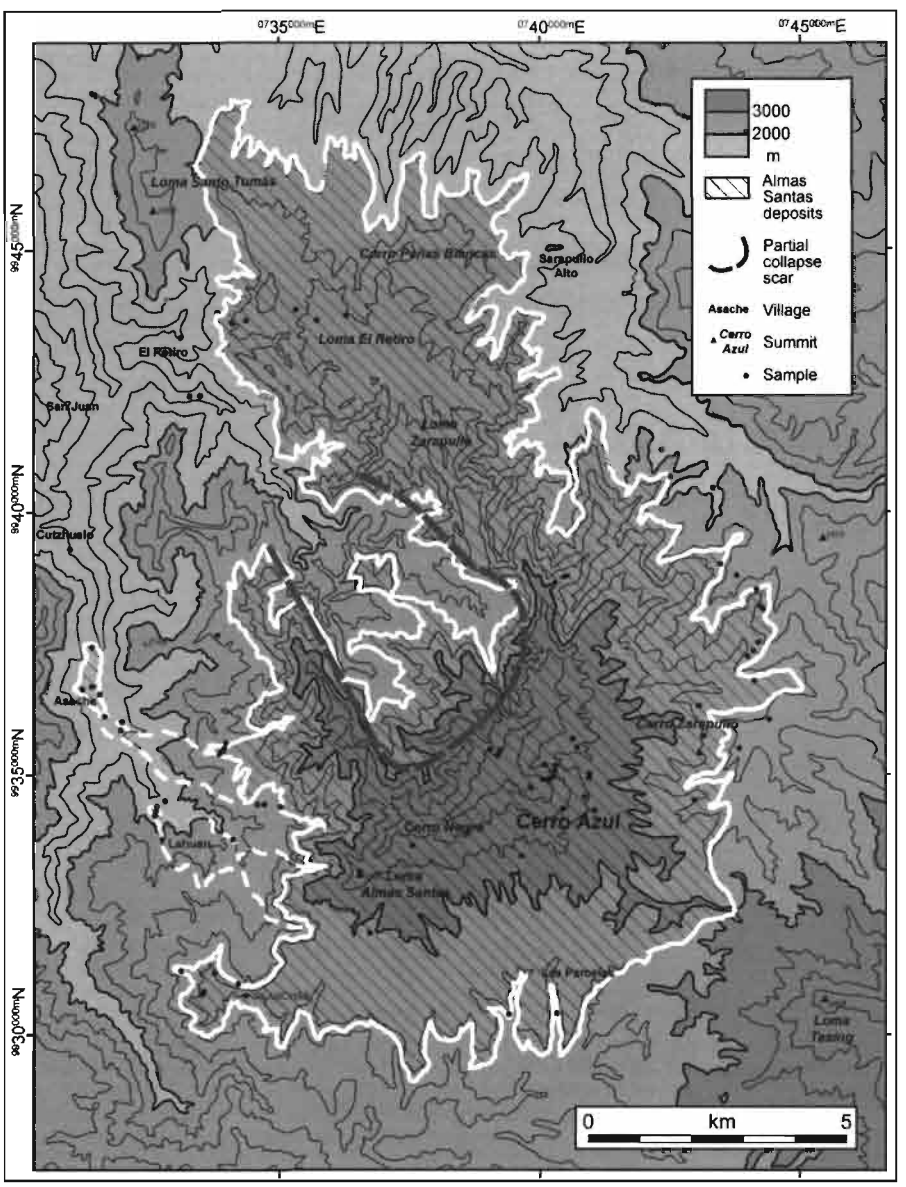

Figure 2: Topography of the Almas Santas volcano, with the delineation of its volcanic deposits, as well as the identification of the partial collapse scar (18M UTM coordinates).

PETROLOGY AND GEOCHEMISTRY

The basic andesites from the basal volcano are generally ±pl + cpx ± oliv sub-aphyric to moderatly phyric lavas whereas the acid andesites are slightly more phyric with a pl + cpx ± opx ± amph paragenesis. Some rare

olivine bearing aphyric to sub-aphyric basaltes have also been encountred, as well as a few high-Mg andesites. The dacites and rhyolites are more phyric, with pl + amph ± biot ± qtz phenocrysts, with some vitreous facies. In a K_2O vs. SiO_2 diagram (**fig. 3**), the Almas Santas series defines a large and but slightly discontinuous trends of medium-K content from basaltic towards rhyolitic compositions. It exibits the largest silica variations known from the Ecuadorian fore arc, much larger *e.g.* that of the nearby Iliniza Volcanic Complex. Almas Santas volcano presents also very low content in Nb, HREE and Y, and other general characteristics from the volcanoes of the Ecuadorian frontal arc.

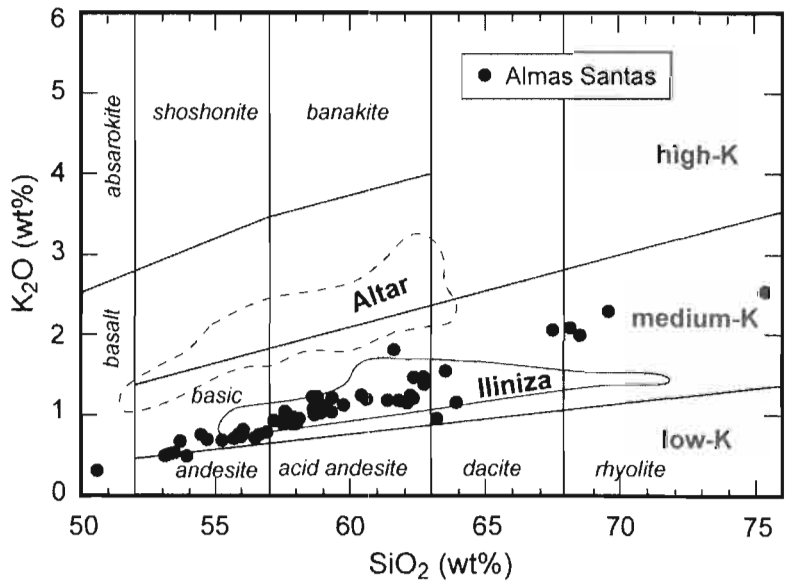

Figure 3 : K_2O vs. SiO_2 diagram showing Almas Santas data compared to the nearby frontal arc Iliniza volcanic complex lavas (Hidalgo *et al., subm.*) and Altar volcano, an edifice belonging to the main arc (data from IRD geochemical data base). Major elements analyses recalculated to 100%, LOI free. Classification following Gill (*1981*).

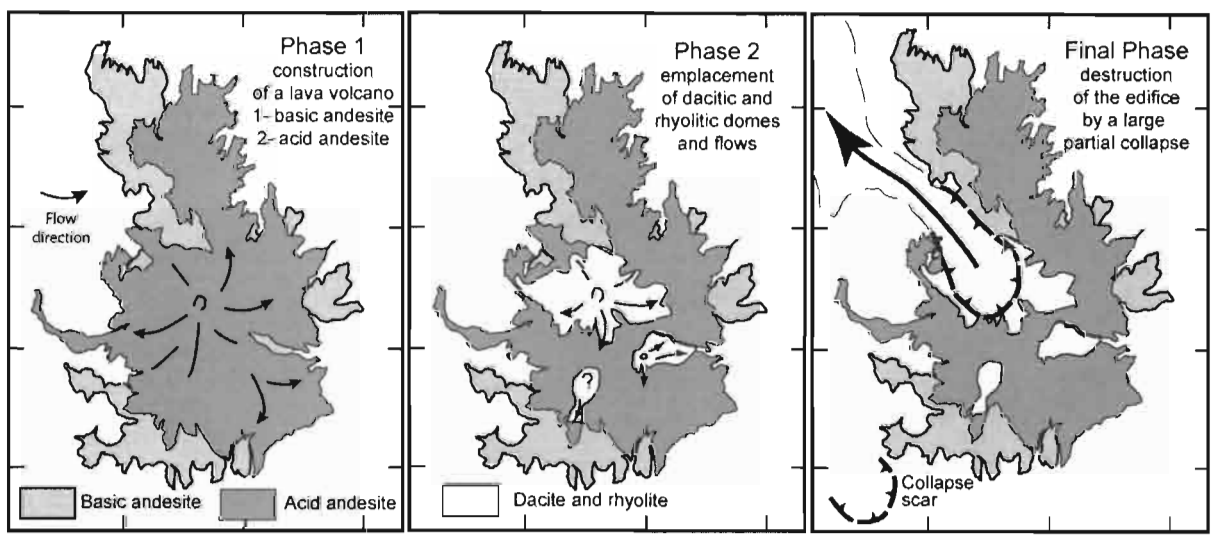

Figure 4 : Skematic evolution of the Almas Santas edifice in three main phases : Phase 1, edification of a lavic andesitic basal volcano by the superposition of several thick lava flows ; Phase 2, emission of more differenciated lavas forming dome complexes with a few viscous lava flows of smaller extention ; Final destruction of the edifice by a large partial collapse towards the NW.

The Sr (~0.7041) and Nd (~0.5128) isotopic ratios obtained on four volcanites of the Almas Santas are identical to those of the other Ecuadorian lavas from the frontal arc, showing the homogeneity of the source,

except for one additional sample which is less radiogenic in Sr. But these data demonstrate the absence of any continental contamination that might have affected these magmas during their ascent towards the surface despite the heterogeneous nature the crust made of different accreted terranes (Kerr *et al.*, 2002).

VOLCANO DEVELOPMENT

Despite the highly dissected morphology of the Almas Santas volcanic centre, it seems that the edifice developped in two main phases (**fig. 4**). First, the emission of voluminous andesitic lava flows constructed a basal lavic edifice, of dominently effusive activity. In a second phase, a dacitic to rhyolitic dome complexes of smaller extension was emplaced, with a few lava flows and little explosive activity associated. Even if we might have not found them due to the degree of erosion and the poor quality of the outcrops, no pyroclastic deposits that could be associed with a explosive caldera formation was encountred. Near the end of its activity, the edifice was partially destroyed by a large partial collapse towards the NW, an event that favorized its subsequent strong erosion.

Preliminary petrogenetical modelisations support the key role played by slab-melts in the genesis of the Almas Santas volcanites, followig the model proposed by Bourdon *et al.* (2003). Some rhyo-dacites could represent almost pristine slab melts emited with very little interaction with the mantle wedge or the continental crust. At the oposite, the high-Mg andesite seems to be slab-melts that have very strongly interact with the mantle wedge, resulting in a melt enriched in Mg, Ni and Cr and strongly depleted in silica. Most of the other volcanites result from the partial melt of a mantle wedge heterogeneously metasomatized by slab-melts, with moderatly subsequent shallower fractionation.

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