RAPID TECTONIC UPLIFT AS REVEALED BY PEDOLOGIC CHANGES: THE OÑA MASSIF, SOUTHERN PART OF CENTRAL ECUADOR.

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INTRODUCTION

Tectonic uplift rates are usually determined by radiogenic dating and also combined fission-track dating of apatite and zircon (Spikings et al., 1998). Here, we present with a new approach how pedological changes may reveal uplift rates in our studied case of an ultisol which has been formed in situ above of rocks of the Oña Massif in the southern part of central Ecuador (Fig. 1). The Oña Massif which is located 50 km south of Cuenca has an altitude of 3000m and is covered by a high altitude grassland, the so-called Páramo. There the soils are up to 6m thick and overlie Miocene flows being dacitic and rhyolitic in composition of which effusion took place above of Miocene marine sediments. The soils are red in colour at their base and yellow on their top and were considered as humults (humiferous ferrallitic soil). Their upper organic horizons are black, 40cm thick, and have andic-like properties such as (a) high C contents (12 to 8 g/100g), (b) low bulk density (0.6), (c) a water retention at 0.3 kPa of 60g/100g, and finally (d) a (Al+1/2 Fe) oxalate extract being between 1.1 to 1.3%. The lower yellow and red horizons contain (a) much lower C contents, (b) a bulk density of 1.2, (c) a water retention at 0.3 kPa of 35g/100g and (d) a (Al+1/2 Fe) oxalate extract less than 0.4%. These upper-organic horizons have been compared to andisols (melanocryand) of the Cajas Massif located 50km north of the Oña massif, formed above of recent volcanic ashes (> 10,000 years B.P.) which were previously thought to have been originated by the active volcanoes of Sangay and/or Tungurahua, both located more than 100 km north of the Oña Massif (Fig. 1). Resistant relicts from weathering of a parent-rock suite such as the presence of coarse-grained quartz (>2mm in diameter) in these black horizons cast doubt on the origin of the recent ash deposits from sources that far away. An additional fact to the mentioned doubt is the clay-mineral composition which is predominantly made up by kaolinite with small amounts of chlorite as the exclusive clay component in the organic part of that horizons, while the lower yellow horizons is exclusively made up of kaolinite with small amounts of goethite. Geochemical determinations based on rare earth elements confirm the uniformity of the whole profile with Eu/Eu* of 1.15±0.05, Ce/Ce* of 0.67±0.31 and Gd_N/Yb_N of 3.84±0.33 strongly implying not to have any contribution of volcanic ash deposits compared to such as the andosolic profile of the Cajas Massif with Eu/Eu* of 0.97±0.03, Ce/Ce* of 1.08±0.07 and Gd_N/Yb_N of 1.55±0.10.

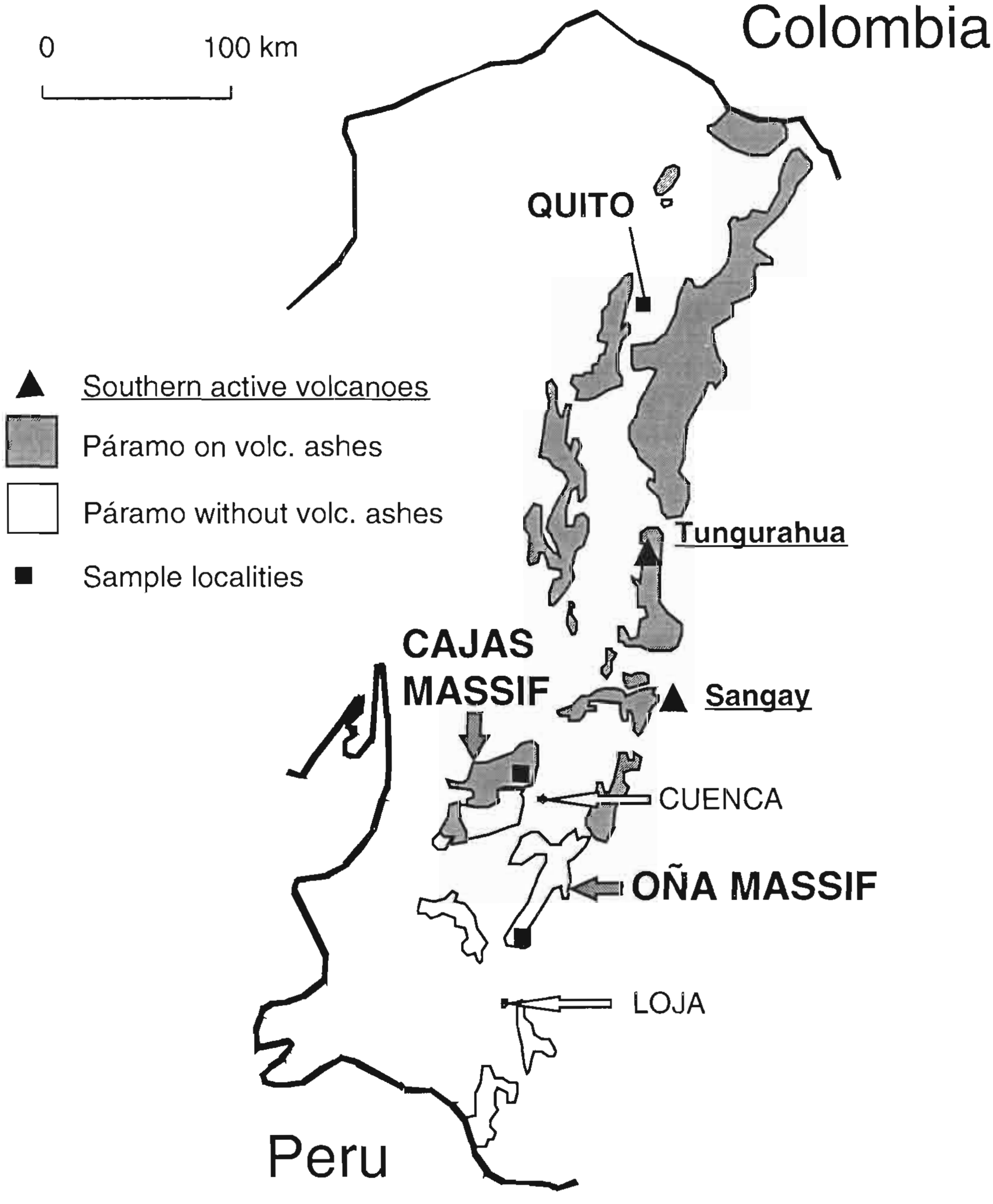

Fig. 1: Distribution of the Pàramo in Ecuador and sample localities.

A major climatic change might be a possible explanation for this major change in the pedological outcome. The evolution of this ultisol into andisols could be the result of rapid tectonic uplift of this area accompanied with weak erosional process of the soils due to the absence of strong slopes on the top of this massif. The high uplift rate is hereby explained by the limited formation of kaolinite. Kaolinite can only be formed with an average temperature far above 20°C (Tardy, 1993; Segalen, 1994). In past time the massif was close to sea level with an annual average temperature of 25°C, high annual average temperature favoured exclusively neoformation of kaolinite derived out of Si and Al-rich solutions. Considering the mechanical erosion rate and a temperature decrease of -0.6°C per 100m, while soils are now located at 3000m height with an average annual temperature around 12°C a calculated uplift rate fits with previously obtained data with independent methods of the same area to be higher than 0.6 mm/year. Nowadays average annual temperature became lower, kaolinite becomes unstable, favouring the presence of oxides, goethite and amorphous components which dominate the present stage. These amorphous components associated with lower temperature and low pH values (<5.0) also limit presently the carbon mineralization.

This proposition is also confirmed by the orientation of south-west trending altitudinal winds which carry high amounts of fine volcanic ash from the active volcanoes of Tungurahua and Sangay. They generally affect with that spreading mainly areas such as the Cajas Massif or west-Saraguro which are located in the direction of these winds, while the massifs located to the south remain unaffected from these emissions.

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