

Geochronology, eruptive source parameters and dynamism of the "San Marcos" event at Nevado Cayambe Volcano, Ecuador

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Constraining the age and the eruptive dynamisms of volcanic events is a key step of hazard assessment, especially for volcanoes showing recent unrest episodes such as Cayambe. Cayambe volcanic complex, located in the Eastern Cordillera of the Ecuadorian Andes, approximately 60 km northeast of Quito, is composed of two main volcanic edifices: Viejo Cayambe and Nevado Cayambe. The eruptive activity of Nevado Cayambe during the Holocene is mainly characterized by extrusion of domes, viscous lava flows, pyroclastic density currents, lahars and tephra falls (Samaniego et al., 1998). The "San Marcos" eruption, whose deposits dammed the Azuela river (north of the volcano) to form the San Marcos lake, is considered the largest Late Holocene eruption of the volcano and it is proposed as one of the possible eruptive scenarios in Cayambe hazard assessment. However, there are still large uncertainties about its age, size and deposits' extent. This study presents new radiometric data, a revised stratigraphic column and an improved mapping of the pyroclastic density currents deposits of the "San Marcos" eruption. Accordingly, the deposits are constituted by two pyroclastic density currents units covered by a pyroclastic fall layer. The lower unit is a massive block-and-ash flow deposit with a thickness > 60 m concentrated in Angureal and Chimborazo ravines, covering ~6.8-7.5 km². It contains pumice and dacite blocks with radial fractures and banded textures. Its volume is estimated between 0.35 and 0.53 km³, and its run-out distance is ~7-7.5 km for a drop height of 1.8-1.9 km, giving a H/L of 0.24-0.27. The intermediate unit is a stratified pyroclastic surge deposit that was previously interpreted as a separated event. Its thickness reaches 8.5 m and it covers a fan-shape area of ~18-22 km² on the northern and northwestern flanks with a maximum run-out distance of 8-9 km. Its volume is estimated at 0.065-0.1 km³, which is ~3 times larger than the previous estimation (Samaniego et al., 1998). The upper unit corresponds to a poorly exposed pyroclastic fall deposit found mostly to the southwest of the summit. Its thickness reach 5-10 cm at 5 km from the source and is composed of medium ash, pumice lapilli and dense fragments with a similar dacitic composition. Two new ¹⁴C datings obtained from charcoal samples found in the "San Marcos" deposits yield 376 ± 18 BP (1448 – 1522 Cal AD) and 316 ± 15 BP (1513 – 1600 Cal AD). These new data suggest that the event occurred before the Spanish colonization in Ecuador (1534 AD), which is coherent with the lack of written chronicles of the event. This study allows to better constrain Cayambe volcanic history and to re-interpret the "San Marcos" sequence of events, that is critical for hazard assessment.