The AD 1300–1700 eruptive periods at Tungurahua volcano, Ecuador, revealed by historical narratives, stratigraphy and radiocarbon dating

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Abstract

Tungurahua is a frequently active and hazardous volcano of the Ecuadorian Andes that has experienced pyroclastic flow-forming eruption in 1773, 1886, 1916–18 and 2006–08. Earlier eruptions in Late Pre-Hispanic and Early Colonial times have remained poorly known and are debated in the literature. To reconstruct the eruptive chronology in that time interval we examine relevant historical narratives recently found in Sevilla, Spain, and Rome, Italy, and we combine stratigraphic field constraints with 22 new radiocarbon age determinations. Results show that pyroclastic flow-forming eruptions and tephra falls took place repeatedly since ~ 700 ^{14}C yr BP, when the Tungurahua region was already populated. Radiocarbon ages averaging around 625 yr BP reveal a period of notable eruptive activity in the 14th century (Late Integration cultural period). The associated andesitic eruptions produced ash and scoria falls of regional extent and left scoria flow deposits on the western flanks of the edifice. The fact that Tungurahua was known by the Puruhás Indians as a volcano at the time of the Spanish Conquest in 1533 perhaps refers to these eruptions. A group of ages ranging from 380 to 270 yr BP is attributed to younger periods of activity that also predates the 1773 event, and calibration results yield eruption dates from late 15th to late 17th centuries (i.e. Inca and Early Colonial Periods). The historical narratives mention an Early Colonial eruption between the Spanish Conquest and the end of the 16th century, followed by a distinct eruptive period in the 1640s. The descriptions are vague but point to destructive eruptions likely accompanied by pyroclastic flows. The dated tephras consist of andesitic scoria flow deposits and the contemporaneous fallout layers occur to the west.

These findings reveal that the eruption recurrence rate at Tungurahua is at least one pyroclastic flow-forming event per century since the 13th century and the occurrence of such eruptions in 2006–08 is thus fully consistent with the rate inferred for the past seven centuries. In addition, historical chronicles suggest that a notch opened in the crater margin during the 1640 decade, as has occurred repeatedly in the past millennium at Tungurahua. Such small-volume collapse events represent a previously unrecognized source of hazards which deserve special attention for risk assessment purposes in the context of the currently ongoing eruption.

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