Geophysical Research Abstracts
Vol. 18, EGU2016-14113, 2016
EGU General Assembly 2016

The 12.4 ka Upper Apoyeque Tephra, Nicaragua: stratigraphy, dispersal, composition, magma reservoir conditions and trigger of the plinian eruption

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Highly-explosive plinian eruptions belong to the most devastating phenomena of volcanic activity. Upper Apoyeque Tephra (UAq), erupted in close vicinity of the Managua city region in west-central Nicaragua with two million inhabitants, was formed by a rhyodacitic plinian eruption at 12.4 ka BP. The fallout tephra was dispersed from a progressively rising plinian eruption column that became exposed to different wind speeds and directions at different heights in the stratosphere, leading to an asymmetric tephra fan with different facies in the western and southern sector. Tephra dispersal data integrated with geochemical compositions of lava flows in the area facilitate to delimit the source vent to the south of Chiltepe Peninsula. UAq, Lower Apoyeque Tephra, Apoyeque Ignimbrite, and two lithic clasts in San Isidro Tephra together form a trend distinct from that of the younger tephras and lavas at Chiltepe Volcanic Complex in a TiO_2 versus K_2O diagram, compositionally precluding a genetic relationship of UAq with the present-day Apoyeque Volcano. Apoyeque Volcano in its present shape did not exist at the time of the UAq eruption. The surface expression of the UAq vent is now obscured by younger eruption products and lake water.
Pressure-temperature constraints based on mineral-melt equilibria indicate at least two magma storage levels. Clinopyroxenes crystallised in a deep crustal reservoir at ∼24 km depth as inferred from clinopyroxene-melt inclusion pairs. Chemical disequilibrium between clinopyroxenes and matrix glasses indicate rapid magma ascent to the shallower reservoir at ∼5.4 km depth, where magnesiohornblendes and plagioclase fractionated at a temperature of ∼830°C. Water concentrations ranged at ∼5.5 wt. % as derived from congruent results of amphibole and plagioclase-melt hygrometry. The eruption was triggered through injection of a hotter, more primitive melt into a water-supersaturated reservoir.