The 3640-3510 BC eruption of Chachimbiro volcanic complex, Ecuador: a violent directed blast produced by a satellite dome

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Located in northern Ecuador, the Chachimbiro volcanic complex developed since about 500,000 years. The recent activity of this complex is marked by recurrent explosive eruptions, the most powerful of which occurred between 3640 and 3510 BC. This eruption produced a complex pyroclastic density current (PDC) deposit that covers an area of about 50 km2. In this area, the PDC overpassed four valleys and adjacent hills, transverse to the flow direction. The thickness of the deposits varies from few decimeters on the hills to several meters in the valleys, highlighting an important topographical control of the sedimentation process. Isopach and isopleth mapping show that this PDC was not issued from Chachimbiro's main and central vent, but from a satellite dome, located 6 km to the east. This eccentered origin is confirmed by the fact that no rock of composition similar to that of the PDC components (SiO2 = 69 wt.percent) has been encountered in the central edifice. The absence of a well-defined edifice in the area of maximum thickness of the deposit suggests that most of the dome was destroyed by the eruption. Due to the location of the source on an abrupt slope, recent landslides might have also buried possible remnants. The shape of the deposit and the fact that the PDC crossed four valleys indicate a high-energy event. The deposit shows different valley and interfluve facies. The valley facies comprises at least two massive units characterized by a very poorly sorted and coarse grain size distribution. No significant evolution of the valley facies is observed between the proximal and the distal area. The interfluve facies is more complicated. In the proximal area, its characteristics are similar to those of the valley facies while in the distal area it is much more stratified with a better sorting and a finer grain-size. Density measurements made on juvenile clasts show a very wide range of vesicularity with two peaks of vesicularity at 30-35 percent and 45-50 percent, that probably corresponds to two vesiculation stages during the eruption. These characteristics of the PDC deposit suggest that the 3640-3510 BC eruption produced a powerful multi-stage lateral blast. This blast destroyed a large rhyodacitic dome formed near Cerro la Viuda and traveled more than 10 km southeastward. The event was apparently not associated with a large volcanic landslide, differing in that manner from examples like that of Mt St Helens 1980 eruption. Additionally, the grain-size and density analysis show some discrepancies from typical directed blast deposits that can be attributed to the high-silica composition of the lava. Due to its amazing destructive power, this eruptive style must be integrated in the hazard assessment in volcanic arcs with high-silica satellite domes like the active Frontal Volcanic Arc in Ecuador and Colombia.