Perspectives for the analysis of the internal structure of Colima volcano using muon radiography

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Colima volcano (Mexico) is one of the most active in the North-American continent. The geological record shows major eruptions occurring in the Holocene, including massive sector collapses. One of the largest of such events destroyed most of the ancient Colima volcano, blanketing an area over 1000 km2, and leaving a 5 km diameter semi-circular somma crater. In the center of this crater, the present Colima volcano slowly grew up in the Holocene. The actual date of this event is still controversial. Nevertheless, the present volcano was probably born as a dome of the somma crater left after the destruction of the paleovolcano. That dome grew at a remarkably constant rate, forming an almost perfect volcanic cone, currently reaching about 840 m over the floor of the somma crater floor (at nearly 3000 m asl). The historical record (last 500 year) includes at least 29 eruptions with VEI greater or equal than 2, six of them with Plinian phases (VEI=4). The Colima volcano modes of activity show that decades-lasting periods of high explosive activity, in which most of the VEI=4 eruptions occur alternate with periods with a lower rate of explosive activity, characterized by effusive dome emplacement and destruction episodes. After the last Plinian eruption in 1913, Colima volcano has remained in a predominantly effusive phase, in which different types of domes have been emplaced, from spreading, lava-flow producing domes to plug-flows and even spines. Also, in a previous episode in 1869, a dome was extruded on the NE flank of the volcano. All of this reveals a complex magma plumbing system, and very little is known about the role it plays in determining the nature of the eruptions. This emphasizes the need to study the volcano with a technique that, along with other seismic, deformation, thermal, and geochemical monitoring methods, allows a better understanding of the internal structure of the volcano. Imaging the volcano interior using muon radiography is the first-option technique, since the semi-circular somma ring surrounding the volcano may provide of several adequate sites to set a muon-radiography detector. In addition, Colima volcano summit stands at only 5.5 km of a volcanic observatory located at about the same altitude, in the neighboring Nevado de Colima volcano, an ideal location to measure the horizontal and vertical distribution of muon fluxes, and to explore possibilities to developing high-altitude techniques of volcano muon radiography.