Modelling the frequent transitions between explosive and effusive activity at Volcán de Colima, Mexico

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During the past 14 years Volcan de Colima has transitioned between a large variety of eruptive styles whilst showing a remarkable consistency in the magma composition. The volcano has produced 6 distinct periods of dome growth with mean effusion rates varying over 2 orders of magnitude from 0.02 to 8 m3 s-1. Several domes were destroyed by subsequent Vulcanian explosions with a variation in the interval dividing the two types of activity (from days to several months). In 2005 the explosions were of sufficient magnitude to produce pyroclastic density currents from column collapse which reached up to 5.4 km. However, the largest run-out distances (6.1 km) were achieved by flows resulting from dome collapse in Oct. 2004. Superimposed on top of this activity the volcano has demonstrated a very efficient sealing mechanism preventing continuous gas release and resulting in small Vulcanian explosions on the time-scale of a few hours.

Different data has been used to understand the upper edifice processes controlling magma degassing and crystallization. Seismicity has enabled the tracking of magma ascent rates with precursory swarms of LP events associated with brittle fracturing along the margins of fractures. Variation in fumarole temperatures has reflected the variation in degassing pathways and magma ascent rates, whilst thermal images of domes has given an insight into their emplacement mechanism. The SO2 flux has shown a decreasing trend throughout the 1998-2013 eruptive period, however, there is evidence for relatively large volumes of gas-rich magma which decompressed to drive the sporadically occurring larger explosions. Further insight has been obtained from the comparison between column ascent rate of the explosions and associated seismic and thermal energy release.

Physical evidence in the form of widespread tuffesites found on the dome gives us further insight into the explosive mechanism. These represent fractures that were filled with gas-rich magma prior to the eruption. Failure of the capping dome-rock, lead to rapid decompression and fragmentation within these zones. Some ash entered the eruption column, whilst some re-crystallized to close the cracks, increasing the permeability once more with a new Vulcanian sequence following. A slow growing dome was emplaced between 2007 and June 2011, when there was a moderate explosion, which destroyed a portion and marked the end of its growth. Then there was a remarkable quiet period, but after only a 1.5 year hiatus, it resumed activity during January 2013, with further moderate explosions with magma emplacement within the newly formed crater.

Volcan de Colima represents an excellent case study due to its frequent transitions and interplay between explosive activity of different magnitudes and effusive eruptions. The understanding of these transitions is critical for the interpretation of precursory signals and the evaluation of possible eruptive scenarios and their associated hazards.