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Interpreting Stromboli's shallow plumbing system by observing coupled activity of connected vents.

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Stromboli volcano (Aeolian Islands, Italy) is known for its persistent mild-explosive activity, hosted on the same 300m wide crater terrace since at least 1776. However, the number and location of vents erupting, as well as their activity is highly variable in days-weeks timescales, suggesting that the shallow plumbing system controlling the eruptions pattern can evolve very fast. It has been observed that individual vents can interact with their neighbors displaying recurrent patterns. In particular, twins or triplet-vents are sometimes observed to erupt at the same time, suggesting a strong shallow connection.

In september-october 2017, we observed such patterns from three vents (hereafter labeled S2, S3a and S3b from north to south) erupting simultaneously on the southwest area of the crater terrace. Using a combination of high-speed thermal infrared camera (InfraTec VarioCam 620S) and infrasound sensors (GEM loggers), we continuously recorded about 100 clusters of explosions. We determined for each cluster the relative timing of the explosions from each vent, and, for each vent, (1) the relative amount of gas, ash- and bomb- sized pyroclasts, (2) their ejection velocity, (3) the total erupted volume of gas, (4) the pressure at burst and (5) the duration of the explosions.

Over the 7 days of observations, explosions from S3a and S3b were bomb-rich, while those from S2 were mainly ash-rich. On the S2 vent, puffing was also observed. Different combinations of vents simultaneously erupting were observed. The timing was also variable, with delays between the onsets of the explosions ranging from 0 to 7 seconds. The characteristics of the explosions at each vent (type, duration, ejection velocity, etc.) appear to depend on the combination of erupting vents and the delay among them.

To interpret these observations, we propose a conceptual model where the conduits of the three vents branch at shallow depth from an inclined feeder fracture. The explosive and degassing activity recorded at the different vents reflects the partition of exsolved gas and the relative change in magma density through the feeding fracture. The relative position of the vents would allow the spilling of heterogeneous portion of magma so that small volumes of gas (puffing and small explosions) tend to flow through the S2 conduits, while bigger gas pockets are split through the three conduits, thus leading to clusters of explosions with different characteristics. S3a and S3b conduits, being less active, may interact differently to the arrival of the gas pocket, thus producing the observed delay between the explosions. Our interpretation complements and strengthens previous dikes model of Stromboli plumbing system which are mainly based on seismic data interpretation.