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A bestiary of ordinary vent activities at Stromboli (and what it tells us about vent conditions)

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Normal active degassing at Stromboli (Aeolian Islands, Italy) is traditionally divided in two classes. Puffing correspond to the frequent ($\sim$1 Hz) release of small gas pockets (0.5 – 1 m of diameter) at low exit velocities (5 – 15 m/s). Whereas, Strombolian explosions occur at a frequency of 1 – 10 per hour, and are characterized the ejection of bombs and/or ash at high velocities (50 – 400 m/s).

In order to get a broader overview of two types of degassing, we used a thermal high speed FLIR SC655 camera to monitor the temperature anomalies generated by the expelled gas, ash, and/or bombs. The enhanced time and spatial resolutions of the camera (200 frames per second, 15 cm wide pixels) enables to use numerical algorithms to distinguish and characterize individual ejection events. In particular, for each explosion and puff, we compute the temperature, the volume, the exit point and the rise velocities of the expelled material. These values, as well as the frequency of the release events, are used to portray a total of 12 vent activities, observed during three field campaigns in 2012, 2013 and 2014.

Sustained puffing was visible on 7 cases, with an intensity ranging on at least two orders of magnitude. Although the released gas volume is sometimes highly variable, on some cases, constant sized puffs allows to define a typical discharge frequency ranging between 0.4 and 1.5 Hz. Regular Strombolian explosions, with various duration, intensity and ash contents, are reported in 6 cases, 2 of them simultaneously presenting a puffing activity. In some cases, we noticed modifications of the vent activity just before the explosions. These precursors, usually lasting about 1 second but occasionally reaching 10 seconds, can be sorted into 1) increase of the puffing activity ; 2) emission of gas plumes ; 3) inflation of the visible vent surface. Finally, one vent activity was hybrid between puffing and Strombolian explosions, with frequent explosions (1 Hz) ejecting numerous pyroclasts at an intermediate velocity (15 – 30 m/s).

This latter case suggests that puffing and normal Strombolian explosions are driven by a similar mechanism, modulated by different vent conditions and/or gas supply. Crucial insights about explosion mechanism and vents conditions can be derived from the interpretation of explosion precursors. For example, the amplitude surface inflation is significantly smaller that what would be expected for the decompression of a slug in a single-viscosity conduit, suggesting the existence of a high viscosity plug limiting gas expansion close to the surface. In addition, the release of low pressurized gas or the increase of puffing activity before the Strombolian explosions suppose the existence of a shallow bubble reservoir. We hypothesize that this layer could originate at the base of the high-viscosity plug, where the bubble rise velocity locally decreases. The stress changes preceding the slug rise might decrease the plug viscosity through the generation of fractures, allowing the release of these precursors.