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The 7 September 2008 major explosion at Stromboli volcano: Characterisation of the event and quantification of the ejecta from a multi-parametric analysis

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On 7 September 2008 a major ash explosion occurred from the SW crater of Stromboli volcano. The event was recorded by the Istituto Nazionale di Geofisica e Vulcanologia webcam and seismic networks, as well as by two electric stations just installed at 300 m distance from the SW crater. The electric signals recorded by the two stations during this event were one million times greater than signals recorded during the persistent strombolian activity, and the seismic trace had a bigger amplitude and a longer duration. Webcam image analysis allowed us to infer that a partial obstruction took place at the SW crater three days before the explosive event, suggesting that a constriction within the upper conduit could likely led to magma overpressure.

Many papers have already pointed to a very shallow connection among the Stromboli summit vents located within the crater terrace. Thus, it is possible that a decrease in the activity at one of the summit zones resulted in a cooler crust that acted as a partial obstruction of the upper feeder conduit, which attempted to re-equilibrate the total mass eruption rate of the system with an increased activity at one of the other summit crater zones. However, the increased explosive frequency was too high to be sustained by a vent, that was then affected by inner collapses. In addition, the decrease in activity at one zone increased the thickness of the cold crust that formed in the surrounding of the vent. This process lead to a constrainment in the vent, and gas accumulated in the magma beneath it was eventually suddenly released through a strong explosion. This blew out part of the crater rim, as observed during the 7 September major explosive event, and also during other previous strong explosions at Stromboli. The webcam images allowed us to characterise the explosive event, which consisted of three main pulses and involved the disruption of the upper part of the cinder cone built up around the explosive vent by spatter accumulation. This process is in agreement with the electric data that show a large contribution of lithic material in the production of the ash released by the explosive event. The removal of the cold crust from the vent rim allowed a gradual re-activation of the central crater zone, which showed an increasing number of daily explosive events after the widening of the vent. Data analysis, combined with previous experimental investigations, revealed that the higher energy output of the ash explosion, when compared to the persistent strombolian activity, resulted in a greater magma fragmentation and erupted mass. Integration of the different parameters allowed us to classify the event as vulcanian, and on the basis of the electric signals we have retrieved the total volume of erupted ash, and of the amounts of juvenile, phreatomagmatic, and lithic components. Our observations allowed us to hypothesize that the paroxysms that episodically occur at Stromboli share the same quality of ash explosions, which is brittle magma to ash fragmentation. This mechanism differs from the ductile magma fragmentation of Strombolian-type eruptions typical of the persistent summit activity of this volcano. Here we dealt with the processes occurring in the uppermost portion of Stromboli conduit system that lead to major explosions, but the input of a gas-rich magma from the deeper region of the feeding system is another process that could lead to major explosions and/or paroxysms.