Geophysical Research Abstracts
Vol. 20, EGU2018-14752, 2018
EGU General Assembly 2018

Signals and sources of Strombolian explosions: linking acoustic and thermal infrared recordings with UAV-based vent geometries.

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Strombolian volcanic activity encompasses a broad spectrum of weak explosive volcanic phenomena, and has already been subdivided based on specific acoustic and thermal infrared signatures of the explosions. Transitions between the different explosion types have been recently attributed to changes in the volume of the decoupled gas phase in combination with the dimensions of the vent/upper conduit and the presence or absence of a debris cap, or viscous plugging, of the vent. To test this hypothesis, and to provide a more robust interpretative ground for routinely monitored acoustic and thermal infrared signals from Strombolian activity, we coupled signals with Unmanned Aerial Vehicle (UAV)-based imaging of the active vents over a short field campaign at Stromboli volcano (Aeolian Islands, Italy) in 2017. Several vents were active within the volcano crater terrace. We focused on the activity of two distinct vents in the North-East vent area and three vents, often active simultaneously, in the South-West area. Thermal data were acquired using a FLIR SC 655 camera and a InfraTec VarioCam 620S camera placed on Pizzo locality, about 200 m away and 100 m above the vents. Acoustic recordings of the explosions were performed using a variety of instruments, including one G.R.A.S. 40 AN microphone, an array composed by one G.R.A.S. 40AZ infrasonic sensor and three PCB microphones, and two GEM infrasound loggers. Three DJI UAVs (Inspire, Mavic Pro and a Phantom 4Pro+) were used to acquire high definition images of the active vents. Explosions at different vents produced distinctive acoustic signals, characterized by differences in duration, waveform, and spectral content. These characteristics also varied, at single vents, from one day to another. UAV-derived vent diameter was used to calculate the Mach number of the eruptive jet, thus assessing the sub- or supersonic nature of the explosions based on the acoustic recordings. Similarly, the thermal signature of the explosions was clearly distinct as a function of both the source vent and day. In particular, the relative amounts of gas, ash- and bomb-sized pyroclasts changed, as well as the duration of the explosion and pyroclast exit velocity. We found a clear link between the acoustic and the thermal signatures of the explosions, both within different explosion types but also during single individual explosions. Preliminary comparisons to the UAV imagery also suggest that vent conditions (i.e. size, shape, plugging) do indeed play a role in setting explosion type.