Silent VLPs At Stromboli: Implications For Slug Vs. Plug

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Very long period (VLP) seismic signals observed in volcanic environments are thought to be produced by magma and gas flow through conduits. Stromboli Volcano, Italy, typically produces hundreds of VLPs per day. These have been generally attributed to the flow of gas slugs through the shallow plumbing system and thus linked to the mechanism thought to drive Strombolian explosions. During a 6-day-long seismo-acoustic campaign in May 2018 (a period characterized by relatively low activity) we recorded 1900+ seismic events, the majority of which have significant energy in the VLP (2-100 s) band. We used a coincident STA/LTA trigger to identify seismic events in continuous waveform data and then used the PeakMatch algorithm (Rodgers et al., 2015) to identify seismic multiplets, with a focus on VLPs. To identify explosions, we applied the same coincident trigger to infrasound data, and manually identified gas jetting events using spectrograms and high-pass-filtered (20 Hz) waveforms.

We identified ~250 explosions and ~600 jetting events. Seismic multiplet analysis identified two main families of repeating events. Family 1 (F1) has over 500 events and Family 2 (F2) has over 150 events based on a 0.7 correlation threshold. We find that F1 VLPs coincide in time with ~6% of explosions and ~0.8% of jetting events and F2 VLPs coincide in time with ~28% of explosions and ~2.7% of jetting events (we term these “silent VLPs”). These VLPs do not correspond with lava effusion (Marchetti and Ripepe, 2005; Ripepe et al., 2015). F2 have a higher dominant period (8-10 s) compared to F1 (3-4 s). The repeating VLPs are part of a broadband signal and the higher frequencies start after the VLP. VLP peak amplitudes are generally larger for F1 events. The dip of the VLP particle motion roughly locates the F1 and F2 VLP source centroids beneath the active crater and are stable throughout the dataset. Both VLP displacements show a small outward, large inward, and subsequent large outward motion from the crater. The lack of explosions relative to repeating VLPs does not support the slug model, where a slug rises through a conduit, generates a VLP through interactions with changes in conduit geometry, and then bursts at the lava free surface. Our observations support the plug model (Suckale et al., 2016). We suggest the “silent” VLPs are generated when the gas bubbles interact with and move into the semipermeable plug.
Then the plug behaves as a mechanical filter for gas escape and allows for passive and explosive escape mechanisms.