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# Lava effusion — A slow fuse for paroxysms at Stromboli volcano?

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Stromboli volcano has been almost continuously active for 1300 yr. The steady supply of magma is associated with a bi-flow regime in the conduit, sustained degassing and frequent Strombolian eruptions, punctuated every 4 to 5 yr by much stronger explosions, commonly referred to as paroxysms. These explosions erupt the same highly porphyritic (HP), high-density, crystallised magma associated with typical Strombolian activity and residing within the conduit but mixed with variable amounts of less-porphyritic (LP), low-density, volatile-rich magma ascending directly from an intermediate storage zone at 6–9 km depth. Once injected into the conduit system, this LP magma rises rapidly enough to inhibit crystallisation and gas separation, resulting in limited mixing with HP magma. Paroxysms produce dense plumes that rise 3–4 km above the crater, and almost all of them have had an impact on the settled area. On a small island $\sim$4 km wide and 1 km high, and populated during summer by as many as 6000 people, such events represent a significant hazard; several people were killed as a result of paroxysms in 1919 and 1930. Predicting the occurrence of paroxysms thus assumes considerable importance from a civil protection perspective. At least two patterns of behaviour have been recognised for Stromboli's historic activity: (i) paroxysms followed by lava effusion, and (ii) lava effusion followed by paroxysms. Lava effusions at Stromboli are fairly common, they occur on average every 3.7 yr. The last two episodes occurred in 2002–2003 and 2007. Both were associated with paroxysms that occurred once lava effusion was underway, thus conforming to case (ii) as described above. Depressurisation of deeper regions of the magma supply system, resulting in exsolution and rapid ascent of a buoyant batch of LP magma, is one of the mechanisms invoked to explain Stromboli's paroxysms. The 2007 effusive eruption of Stromboli followed a similar pattern to the previous 2002–2003 episode. In both cases, magma ascent led to breaching of the uppermost part of the conduit forming an eruptive fissure that discharged lava down the Sciara del Fuoco depression. Both eruptions also displayed a 'paroxysmal' explosive event during lava flow output. From daily effusion rate measurements retrieved from helicopter- and satellite-based infrared imaging, we deduce that the cumulative volume of lava erupted before each of the two paroxysms was similar. Based on this finding, we propose a conceptual model to explain why both paroxysms occurred after this 'threshold' cumulative volume of magma was erupted. The gradual decompression of the deep plumbing system induced by magma withdrawal and eruption, drew deeper volatile-rich magma into the conduit, leading to the paroxysms. The proposed model might provide a basis for forecasting paroxysmal explosions during future effusive eruptions of Stromboli. The 2002–2003 and 2007 cases show that the incubation time for a paroxysm depends on the effusion rate. In 2003, a mean eruption rate of 0.5 m3 $s^{-1}$ resulted in a paroxysm after $\sim$3 months of lava effusion, whereas a mean eruption rate of 1.5 m3 $s^{-1}$ in 2007 produced a paroxysm after only two weeks. So long as the volcano maintains its present subsurface storage configuration, we infer that it will be possible to use the same threshold volume to forecast future explosive paroxysmal events.