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Seismicity associated with quiescent-explosive transitions at dome forming eruptions: The July 2008 Vulcanian Explosion of Soufrière Hills Volcano, Montserrat

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During long-lived dome-forming eruptions volcanoes often transition between quiescent, effusive, and explosive behaviour. Soufrière Hills Volcano (SHV), Montserrat, has been erupting since 1995 and has repeatedly transitioned between these different phases of activity. At SHV many of the largest explosions have occurred either during periods of dome growth, or as major dome collapse events at the end of extrusion phases. However, on the 29th July 2008 a vulcanian explosion marked the transition from a quiescent phase (Pause 3) to explosion and then extrusion. This was one of the largest explosions by volume and the largest to occur outside a period of lava extrusion. The eruption was preceded by one of the most intense seismic swarms ever recorded at SHV. In this study we analysed precursory seismic data to investigate the subsurface volcanic processes that culminated in this eruption. We used spectral and multiplet analysis techniques, and applied a simple parameterization approach to relate monitoring observations (seismic, SO_2, visual) to subsurface interpretations. These techniques would be available to most volcano observatories. Our study suggests that an initial VT swarm, coincident with ash-venting events, can be triggered by ascent of decoupled gas ahead of rising magma. A subsequent large LF swarm shows a coincident decrease in spectral content that we interpret as magma ascent through the upper conduit system. An ash-venting event on 27 July (a few hours before peak event rate) may have triggered rapid microlite growth. We observe an increase in the spectral content of the LF swarm that is concurrent with a decrease in event rates, suggesting pressurization of the magmatic system due to inhibited magmatic outgassing. Our results suggest that pressurization of the magmatic system may have occurred in the final $\sim$24 h before the vulcanian explosion. We also observe LP and Hybrid events within the same multiplet, suggesting that these events have very similar source processes and should be considered part of the same classification at SHV. Our study demonstrates the potential for using spectral and multiplet analysis to understand subsurface magmatic processes and for investigating the transition between quiescence and eruption.