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Waveform classification and statistical analysis of seismic precursors to the July 2008 Vulcanian Eruption of Soufrière Hills Volcano, Montserrat

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Understanding the transition between quiescence and eruption at dome-forming volcanoes, such as Soufrière Hills Volcano (SHV), Montserrat, is important for monitoring volcanic activity during long-lived eruptions. Statistical analysis of seismic events (e.g. spectral analysis and identification of multiplets via cross-correlation) can be useful for characterising seismicity patterns and can be a powerful tool for analysing temporal changes in behaviour. Waveform classification is crucial for volcano monitoring, but consistent classification, both during real-time analysis and for retrospective analysis of previous volcanic activity, remains a challenge. Automated classification allows consistent re-classification of events. We present a machine learning (random forest) approach to rapidly classify waveforms that requires minimal training data. We analyse the seismic precursors to the July 2008 Vulcanian explosion at SHV and show systematic changes in frequency content and multiplet behaviour that had not previously been recognised. These precursory patterns of seismicity may be interpreted as changes in pressure conditions within the conduit during magma ascent and could be linked to magma flow rates. Frequency analysis of the different waveform classes supports the growing consensus that LP and Hybrid events should be considered end members of a continuum of low-frequency source processes. By using both supervised and unsupervised machine-learning methods we investigate the nature of waveform classification and assess current classification schemes.