Predicting the unpredictable: using families of low frequency seismicity to forecast volcanic unrest

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The use of volcano seismology has recently been thrust to the forefront of forecasting and managing volcanic unrest primarily because it offers near real time analysis of the activity as it unfolds. It has already been recognised that seismicity associated with volcanic eruptions can be split into a number of sub-types, and it is this that allows us to try and comprehend the processes which are occurring at depth, and therefore relate it to the surface expression of the volcano.

Analysis of swarms of low frequency seismicity prior to dome collapse at Soufriere Hills volcano, Montserrat suggest that the success of the Material Failure Law, which is increasingly applied to many volcanoes worldwide in the forecasting of collapse events, may have some dependence upon whether the entirety of observed low frequency seismicity is used in forecasting, or whether the events are further sub-categorised. It appears that the identification and use of singular low frequency seismic "families" (events which have the same waveform and are therefore considered to be from the same source) allows a more accurate forecasting of the timing of dome collapse.

A multi parameter approach to the use of the material failure law in forecasting collapse events using accelerating event rates, seismic amplitudes and energy released from events is under investigation, both in terms of using all observed low frequency seismicity, and using only one "family" of events. In particular, analysis of swarms prior to collapse events in hindsight suggests that using only a single "family" of low frequency seismicity appears to provide a more concise estimate to the timing of failure when only a few swarms are observed and those swarms are temporally far from the known timing of the dome collapse. Therfore we suggest that the use of the material failure law may need refining further in terms of pre-processing of the seismicity in order to find such "families" when used in real time forecasting scenarios, if the most accurate forecast is to be made.