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Statistical analysis of volcanic explosion data

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Although there have recently been vast improvements, combining different data sets with the goal of forecasting volcanic activity still presents a challenge to volcanology. Probabilistic analyses of temporal data can aid the interpretation of other parameters and provide a quantitative method of providing a forecast. Deciding whether the process is stochastic or deterministic is fundamental to modelling a volcanic system.

Volcán de Colima has recently undergone frequent transitions between effusive and explosive activity, with three periods of effusive activity in the last six years interspersed with periods of vulcanian explosions. The frequency, magnitude and characteristics of these events have widely varied, the larger events having sufficient energy to destroy the lava dome. The frequency has varied from two or three events per day to at least forty. The distribution of repose intervals between explosions has been analysed and compared to the seismic characteristics of the event and certain features of the resulting column or plume, such as thermal emission, volume of SO_2 released and ash content. Frequent changes in the distributions that have been fitted to the data reflect the dynamic nature of this volcano and temporal variation of the upper conduit processes that control its explosivity. For certain periods, a log logistic distribution was fitted. This implies competition, possibly relating to degassing and increased permeability depressurizing the ascending magma, verses increased pressure from gas exsolution and increased viscosity. Events can be grouped by their seismic characteristics, with different groups contrasting statistically given the variation in their distribution.

Clustering within the data has been identified using autocorrelation and fractal dimension analysis, further methods that can identify changes within the system important to forecasting or modelling. The distribution of repose intervals was compared at several other contrasting volcanoes. Each demonstrated particular patterns within the data, reflecting specific characteristics of that volcano. It is clear that analysis of this type

provides a useful tool in the forecasting of events or modelling of volcanic processes.