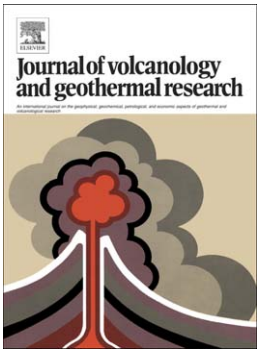


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# Performance of the 'Material Failure Forecast Method' in real-time situations: a Bayesian approach applied on effusive and explosive eruptions.

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## Abstract

Most attempts of deterministic eruption forecasting are based on the material Failure Forecast Method (FFM). This method assumes that a precursory observable, such as the rate of seismic activity, can be described by a simple power law which presents a singularity at a time close to the eruption onset. Until now, this method has been applied only in a small number of cases, generally for forecasts in hindsight. In this paper, a rigorous Bayesian approach of the FFM designed for real-time applications is applied. Using an automatic recognition system, seismo-volcanic events are detected and classified according to their physical mechanism and time series of probability distributions of the rates of events are calculated. At each time of observation, a Bayesian inversion provides estimations of the exponent of the power law and of the time of eruption, together with their probability density functions. Two criteria are defined in order to evaluate the quality and reliability of the forecasts.

Our automated procedure has allowed the analysis of long, continuous seismic time series: 13 years from Volcán de Colima, Mexico, 10 years from Piton de la Fournaise, Reunion Island, France, and several months from Merapi volcano, Java, Indonesia. The new forecasting approach has been applied to 64 pre-eruptive sequences which present various types of dominant seismic activity (volcano-tectonic or long-period events) and patterns of seismicity with different level of complexity. This has allowed us to test the FFM assumptions, to determine in which conditions the method can be applied, and to quantify the success rate of the forecasts. 62% of the precursory sequences analysed are suitable for the application of FFM and half of the total number of eruptions are successfully forecast in hindsight. In real-time, the method allows for the successful forecast of 36% of all the eruptions considered. Nevertheless, real-time forecasts are successful for 83% of the cases that fulfil the