Improvement forecasting of volcanic activity by applying a Kalman filter to the SSEM signal. The case of the El Hierro Island eruption (October 2011)

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The FFM (Failure Forecast Method) is developed from the eruption of St. Helens, being repeatedly applied to forecast eruptions and recently to the prediction of seismic activity in active volcanic areas.

The underwater eruption of El Hierro Island has been monitored from three months before starting (October 10, 2011). This allowed a large catalogue of seismic events (over 11000) and continuous recording seismic signals that cover the entire period. Since the beginning of the seismic-volcanic crisis (July 2011), the FFM was applied to the SSEM signal of seismic records. Mainly because El Hierro is a very small island, the SSEM has a high noise (traffic and oceanic noise). To improve the signal / noise ratio has been used a Kalman filter.

The Kalman filter coefficients are adjusted using an inversion process based on forecasting errors occurred in the twenty days preceding. The application of this filter has been a significant improvement in the reliability of forecasts.

The analysis of the results shows, before the start of the eruption, that 90% of the forecasts are obtained with errors less than 10 minutes with more than 24 hours in advance. It is noteworthy that the method predicts the events of greater magnitude and especially the beginning of each swarm of seismic events. At the time the eruption starts reducing the efficiency of the forecast 50% with a dispersion of more than one hour. This fact is probably due to decreased detectability by saturation of some of the seismic stations and decreased the average magnitude. However, the events of magnitude greater than 4 were predicted with an error less than 20 minutes.