

A会場 | 一般セッション：S09. 地震活動

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[S09] 地震活動

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16:00 ~ 16:15

[S09-04] Analysis of Precursory Seismicity and Transient Changes in b -Value for Near-Real-Time Volcanic Eruption Forecasting

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Many volcanoes produce precursory signals before erupting, reflecting hidden subsurface processes. Forecasting efforts rely on detecting statistically significant deviations from long-term background activity, with seismic data playing a central role. Analyzing changes in earthquake characteristics often enables forecasting an eruption. One way to do this involves analyzing the b -value slope of the Gutenberg-Richter relation, which reflects the ratio of small to large earthquakes. Spatiotemporal variations in b -value have been linked to processes such as differential stress, thermal gradients, pore pressure changes, and fracture density, all indicators of crustal heterogeneity. These observations support the use of b -values to map variable stress conditions in the crust.

In this study, we analyze transient variation in seismicity rate and b -value to assess priming timescales and to identify crustal stress conditions under which seismicity is the most effective for eruption forecasting. We selected 8 well-monitored volcanoes: Eyjafjallajökull, Fagradalsfjall, Grimsvotn, and Holuhraun (Baroarbunga) in Iceland; Mauna Loa in Hawaii (USA); and Kirishima, Ontake, and Usu in Japan, based on their scientific relevance, societal impact, and monitoring quality. First, we assess the completeness of the seismic catalog for each volcano and compute b -value time series using both the Maximum Likelihood Estimation and the b -positive methods. Next, we calculate the background b -value (b_{th}) as the average of all b -values in the time series. If the b -value in the time series deviates from b_{th} , an alarm is triggered. The alarm turns green (green light) if the b -value exceeds 10% of b_{th} (indicating that no eruption is expected), yellow (yellow light) for a change between -10% and +10% from b_{th} (indicating unrest behavior), and red (red light) if it drops 10% or more below b_{th} (indicating a potentially hazardous situation). Then we examine whether eruptions occur within 10 days of each red light.

The clearest outcome is that, although most eruptions were preceded by days, months, or even years of escalating seismic activity, some eruptions occurred with little or no change in seismicity. On the other hand, of the 27 identified cases where b -value significantly deviate from b_{th} , 44% were followed by an eruption, whereas 56% were not. Among the

latter, 67% involved red lights without subsequent eruptions but were mostly linked to the occurrence of large earthquakes, and 33% showed no drop before the eruption. Despite the relatively low percentages, our forecasting success rate is comparable to or slightly better than that reported in studies using GNSS deformation or thermal anomalies. Our overall results suggest that monitoring b -value changes is one of the most reliable indicators of impending eruption. But, to improve reliability, we recommend integrating b -value analysis with other geophysical observables and expert judgment to better distinguish volcanic unrest from imminent eruptions.

Keywords: b -value, priming, eruption forecasting, stress change, seismicity rate, volcanic unrest