

Exploring Statistics of Pre-Eruptive and Non-Eruptive Earthquake Sequences Near Volcanoes Using Global Data

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Seismicity increases near a volcano are often the earliest and sometimes the only sign of an impending eruption, yet volcanoes are typically located in tectonically active areas and non-eruptive swarms due to both tectonic and volcanic processes are common. Although there are many helpful ways to evaluate earthquake sequences near volcanoes, a meaningful and rapid analysis of earthquake statistics is often a challenge, especially at volcanoes that are poorly monitored or lack information on previous pre-eruptive swarms for comparison. We utilize a global earthquake and eruption catalog to compare simple parameters for earthquake sequences that occur near volcanoes before eruptions with those not associated with eruptions. This catalog comes primarily from the ISC global earthquake database and other publicly available sources. We use an automated approach with visual quality control to detect as many earthquake swarms as possible occurring within 20 km of volcanoes.

We characterize identified earthquake sequences using a few simple parameters including: maximum magnitude, seismic event rate, duration of sequence, and the time history of cumulative magnitudes and event rates with respect to swarm onset. When possible, we consider b-values, moment tensors, and locations of swarms with respect to volcanoes. Although local tectonic and crustal properties and characteristics of magma intrusion, such as gas content and intrusion rate, affect how the crust near a volcano responds to magmatic intrusion, we explore which combination of parameters are most commonly diagnostic of pre-eruptive sequences as compared to syn-eruptive and non-eruptive seismicity. We choose simple measures of earthquake swarms to make our results as widely applicable as possible. As an example, early results show that most pre-eruptive earthquakes of M4 and greater occur within 3 days of eruption onset and 5-15 km away from the vent, and although earthquake moment tensors associated with eruptions typically are similar to tectonic and non-eruptive cases, moment tensors with non-double-couple components are more common during eruptions. In addition, we find that unusually high seismicity rates are the most indicative characteristic of pre-eruptive swarms we have yet observed, in comparison to non-eruptive and syn-eruptive swarms. In contrast maximum magnitudes often do not clearly

differentiate eruptive and non-eruptive swarms near volcanoes. These simple measures of seismic swarms allow us to quickly compare new seismicity sequences to previous swarms at that volcano and to other volcanoes around the world.