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Seismicity and deformation associated with reawakening volcanic systems

Andrew Bell (1), Christopher Kilburn (2), and Ian Main (1)

(1) School of GeoSciences, University of Edinburgh, Edinburgh, United Kingdom, (2) ABUHC, Department of Earth Sciences, University College London, London, United Kingdom

Most volcanoes that have erupted in the Holocene have not been active in the last 50 years. Consequently, we can expect many future eruptions to occur at volcanoes reawakening after lengthy repose times and with no records of instrumental monitoring data during activity. Identifying magma-driven unrest and then providing reliable forecasts of the timing, style, location, and size of eruptive activity at such volcanoes will be a considerable challenge. Forecasts must be based on a combination of observational evidence from potentially analogous systems and the predictions of theoretical models. However, currently our record of geophysical data from reawakening volcanoes is limited, and our understanding of the physical processes controlling the approach to such eruptions is relatively poor.

Here we present an analysis of seismicity and deformation associated with reawakening (or potentially reawakening) volcanoes. We consider factors including the duration of unrest before eruptive activity, spatial and temporal patterns, earthquake frequency-magnitude distributions and interevent-time statistics, and the seismic:aseismic ratio. The duration of unrest before eruption ranges from a few hours to many years. Trends in the rates and statistics of seismicity and deformation through time are complex, and generally indicate multiple pulses of magma emplacement and movement before eruption. It remains unclear whether it is possible to identify the combination of magma pressure, crustal stress conditions, and fracturing necessary to bring any given system to an eruptive state. Edifice instability and regional tectonics often play an important triggering role in the final approach to eruption. The observations present a strong case for establishing baseline monitoring at apparently quiescent volcanoes in order to better understand background behaviour and new models for the evolution of unrest.