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Deformation and seismic precursors to eruptions after long repose.

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Recurring patterns of behaviour occur among crustal precursors to eruptions after long repose, supporting the view that reliable forecasts of eruption are a realistic objective. Robust constraints are that an eruption will occur when (1) the total seismic energy released by volcano-tectonic events (or VT events, due to rock fracturing) and bulk strain exceed critical values, and (2) seismic event rate and rate of ground deformation accelerate towards eruption. The behaviour is consistent with the activation and interaction of a population of faults within the deforming crust and volcanic edifice. For seismic event rate, exponential increases with time have been observed at timescales of months or more at volcanoes in several tectonic settings. In subduction-zone settings, the exponential increases evolve into faster-than-exponential trends about 14 days before eruption. In extensional settings, the faster-than-exponential stage may emerge only hours before eruption. Here we present a model for combining deformation and seismic-event data in terms of the partitioning of energy between elastic and brittle behaviour. The model yields self-consistent trends when tested against data from laboratory experiments and from field observations at silicic calderas and basaltic volcanoes. The results identify new constraints on the rate constant that defines the exponential precursors and indicate that forecasts of eruption may be feasible as much as weeks ahead of time.