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Volcanic eruption forecasts from accelerating rates of drumbeat long-period earthquakes

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Accelerating rates of quasi-periodic 'drumbeat' long period earthquakes (LPs) are commonly reported before eruptions at andesite and dacite volcanoes. These apparently systematic and repeatable sequences promise insights into the nature of fundamental pre-eruptive processes and improved eruption forecasts. However, advances have been limited by the availability of appropriate statistical methods and uncertainty regarding the applicability of failure forecast models. Here we apply a new Bayesian MCMC gamma point process methodology to investigate an exceptionally well-developed sequence of drumbeat LPs preceding a recent large vulcanian explosion at Tungurahua volcano, Ecuador. For more than 24 hours, LP rates, amplitudes, and RSAM increased according to the inverse power-law trend predicted by material failure theory (though with different power-law exponents), and with a retrospectively forecast failure time that agrees with the eruption onset within error. LPs resulted from repeated activation of a single characteristic source driven by accelerating loading rates, rather than a distributed failure process, showing that similar precursory trends can emerge from quite different underlying physics. Nevertheless such varied sequences have clear potential for improving forecasts of eruptions at Tungurahua and analogous volcanoes.