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The nature and origin of the interevent-time distribution of volcanic earthquakes

Andrew Bell, Sarah Touati, Mark Naylor, and Ian Main
University of Edinburgh, School of GeoSciences, Edinburgh, United Kingdom (a.bell@ed.ac.uk)

There has been much recent debate on the form and physical origin of the interevent-time distribution for earthquakes, which in turn has implications for the nature of earthquake interactions and time-dependent seismic hazard. The main question is whether interevent-time distributions for different catalogues are consistent with a single "universal" model, i.e. the distribution of earthquake interevent-times is independent of all other local properties such as aftershock productivity, magnitude-frequency distribution and background rate, and can be represented by a generalized Gamma function. Recently, the argument for a universal interevent-time distribution has been supported by claims that this model is also able to explain the interevent-time distribution of earthquakes at volcanoes. Here we test the hypothesis that the interevent-time distribution for volcanic earthquakes is universal. We analyze the well-characterized seismicity from the volcanoes on the island of Hawaii and demonstrate that the interevent-time distribution is instead both spatially and temporally variable. In particular, in space and time windows where magmatic processes (such as dyke injection and pressurization of the magma chamber) control the stress field, interevent-time distributions cannot be modeled by a simple gamma distribution and are frequently bimodal. This dependence on space and time clearly indicates that a universal model is not appropriate for volcanic settings. Rather, we can explain the interevent-times with a model consisting of accelerating and decelerating rates of events preceding and succeeding volcanic activity. The same model is able to explain the interevent-time distributions observed at Vesuvius and Campi Flegrei volcanoes in central Italy, and Mount St Helens, USA.