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Ground motion and unrest triggering on volcanoes

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Dynamic stress perturbations have triggered earthquakes thousands of kilometres away from the source. This process, known as dynamic triggering, occurs due to dynamic excitation from both local and regional earthquakes which trigger volcanic seismicity and can yield additional information about both the pre-eruptive state of volcanic systems and about material behaviour. Earthquakes are more likely to be triggered on faults already close to failure so dynamic triggering also offers a means to investigate the stress state of the subsurface. However, the mechanisms underpinning dynamic triggering remain enigmatic. Current understanding is confined to statistical studies of the response to many triggered earthquakes in many different crustal volumes with seismicity rates being used as a proxy for the state of stress. Generally, the background stress state does not change significantly during the window of seismic observation. This makes it difficult to study the same seismically active region over an extended period at different stress states. Volcanoes are ideal natural laboratories for studying the factors that influence dynamic triggering as they experience rapid, high-amplitude changes in stress due to magma accumulation and withdrawal.

One such example is Sierra Negra, Galápagos Islands, and utilising the current understanding of dynamic triggering observed prior to the 2018 eruption, Sierra Negra, this project aims to resolve some unanswered questions. These include: 1) What new evidence of dynamic triggering is there at Sierra Negra, post-2018 eruption? 2) Is there a critical stress which is reached when Sierra Negra is being reinflated, post-eruption, which leads to subsequent triggering? 3) Are there non-linear wave effects at work? 4) Is there the possibility to compare Sierra Negra to a volcano which may also be demonstrating signs of dynamic triggering e.g., Hekla, Iceland? A collection of seismic data from locations such as Sierra Negra and Hekla will be supported by numerical simulations of dynamic excitation. This project aims to better understand the role that the interplay between ground motion and the properties of a volcanic edifice play in a volcano's pathway to eruption. This project is part of the Seismological Parameters and INstrumentation Innovative Training Network (SPIN-ITN) funded by the European Commission. The overarching goal of SPIN is to advance seismic observation, theory, and hazard assessment. SPIN is divided into 4 work packages (WP) with each WP consisting of 3-4 PhD projects, hosted at different beneficiary institutes. The majority of the SPIN projects began in September-October 2021.