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Stress changes, focal mechanisms and earthquake scaling laws for a magma-filled crack.

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Volcanic swarms share a lot of similarity with seismicity sequences induced by hydrofracturing. Volcanic seismicity is usually generated by transient propagation of fluid-filled cracks inducing fracturing at its propagating edges. The resulting faulting processes therefore results from a complex interaction of pressurized fluid-filled cracks with the host rock and local and regional tectonic setting. In the case of magma-filled cracks (i.e. dikes) it is possible to accurately model the Coulomb stress changes induced by dikes and the source mechanisms of the induced/triggered seismicity. Here we use focal mechanisms data of the energetic swarm induced by the 2000 dike intrusion at Miyakejima (Izu Archipelago, Japan), to study the relation between the 3D dike-induced stresses and the characteristics of the seismicity. We identified the families of focal mechanisms (FMs) through an objective clustering analysis and relate them to the dike stress field and to the scaling relationships of the earthquakes. The clustered families show predominately normal and strike-slip component of the slip. We find that the tension axes of all FMs is consistent with the dike-induced extensional stresses while Pressure and Null axes cover all possible value from normal to strike-slip mechanisms. We demonstrate this is consistent with optimally-oriented faults according to the expected pattern of Coulomb stress changes induced by the dike. We calculate the frequency-size distribution of the clustered sets finding that focal mechanisms with a large strike-slip component are consistent with the Gutenberg-Richter relation with a b-value about 1. Conversely, events with large normal faulting components deviate from the Gutenberg-Richter distribution with a marked roll-off on its right-hand tail suggesting a lack of large magnitude events (Mw>5.5). This can be interpreted as resulting from the interplay of the limited thickness and lower rock strength of the layer of rock above the dike, where normal faulting is expected, and lower stress levels linked to the faulting style and low confining pressure.