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Numerical models and seismological observations of volcanotectonic earthquake triggering on non-ideally-oriented faults

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Calculation of inflation-induced Coulomb stress changes on faults of varying orientation indicates that local faults of almost any orientation are susceptible to slip in response to dike inflation. The affected volume of rock scales linearly with the amount of dike inflation, with dike inflation on the order of one meter producing large ($\geq$ 10 bars) Coulomb stress changes in large ($\sim$5 km) lobe-shaped regions extending from the inflating dike, and dike inflation as small as 10 centimeters producing large Coulomb stress changes in a small volume of rock extending $\sim$0.5 km from the inflating dike. As dikes typically inflate in the direction of regional minimum compressive stress, the sense of inflation-induced strike-slip faulting predicted by Coulomb stress change models is opposite to that expected from regional tectonic forces. Numerous observations of volcanotectonic (VT) earthquake fault-plane solutions with pressure (p-) axes oriented $\sim$90° to regional maximum compression confirm this prediction. In detail, the ranges of fault-plane orientations observed in VT fault-plane solution studies are much narrower than those predicted by Coulomb stress change models. Observed locations of VT seismicity also do not correspond perfectly to modeled areas of Coulomb stress increases. These discrepancies indicate that the orientation and location of pre-existing faults around the conduit ultimately determine the seismic response of host rock to an inflating dike. Furthermore, fault response to dike inflation may vary among volcanic systems, potentially depending on the nature of the host rock, the nature of the volcanic event (including the volume and composition of the ascending magma), and the orientation and magnitude of the regional stress field.