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Volcanotectonic earthquakes induced by propagating dikes

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Volcanotectonic earthquakes are of high frequency and mostly generated by slip on faults. During chamber expansion/contraction earthquakes are distribution in the chamber roof. Following magma-chamber rupture and dike injection, however, earthquakes tend to concentrate around the dike and follow its propagation path, resulting in an earthquake swarm characterised by a number of earthquakes of similar magnitudes. I distinguish between two basic processes by which propagating dikes induce earthquakes. One is due to stress concentration in the process zone at the tip of the dike, the other relates to stresses induced in the walls and surrounding rocks on either side of the dike. As to the first process, some earthquakes generated at the dike tip are related to pure extension fracturing as the tip advances and the dike-path forms. Formation of pure extension fractures normally induces non-double couple earthquakes. There is also shear fracturing in the process zone, however, particularly normal faulting, which produces double-couple earthquakes.

The second process relates primarily to slip on existing fractures in the host rock induced by the driving pressure of the propagating dike. Such pressures easily reach 5-20 MPa and induce compressive and shear stresses in the adjacent host rock, which already contains numerous fractures (mainly joints) of different attitudes. In piles of lava flows or sedimentary beds the original joints are primarily vertical and horizontal. Similarly, the contacts between the layers/beds are originally horizontal. As the layers/beds become buried, the joints and contacts become gradually tilted so that the joints and contacts become oblique to the horizontal compressive stress induced by a driving pressure of the (vertical) dike. Also, most of the hexagonal (or pentagonal) columnar joints in the lava flows are, from the beginning, oblique to an intrusive sheet of any attitude. Consequently, the joints and contacts function as potential shear fractures many of which, when loaded by the dike driving pressure, slip and generate double-couple earthquakes. All types of faulting occur, but strike-slip and reverse faulting are particularly common. Dike-induced faulting is one reason why (mostly small) reverse and strike-slip faults are so commonly observed in palaeorift-zones. Here I present field examples of dike-induced extension fractures and fault slips. I also present numerical and analytical models to explain the effects of mechanical layering and heterogeneity on the likely dike paths and the associated variations in the type and location of the dike-induced earthquakes.

Becerril, L., Galindo, I., Gudmundsson, A., Morales, J.M., 2013. Depth of origin of magma in eruptions. Sci. Reports (Nature Publishing), 3, 2762, doi: 10.1038/srep02762.

Gudmundsson, A., Lecoeur, N., Mohajeri, N., Thordarson, T., 2014. Dike emplacement at Bardarbunga, Iceland, induces unusual stress changes, caldera deformation, and earthquakes. Bull. Volcanol., 76, 869, doi: 10.1007/s00445-014-0869-8.