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Fracture mechanics of volcanoes

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We use a fracture mechanics approach to model seismicity preceding volcanic eruptions. Starting with the fracture mechanics concept of a crack in an elastic body, we model crack growth around the volcanic conduit through the processes of crack interactions, leading either to the propagation and linkage of cracks, or crack avoidance and the inhibition of crack propagation. The nature of that interaction is governed by the temperature and plasticity of the magma. We find that fracture mechanics rules can account for the style of seismicity preceding eruptions and account for false alarms.

We compare our model with results from our laboratory experiments where we have deformed lava at high temperatures under triaxial stresses. These experiments were conducted in dry and water saturated conditions at high effective pressures and temperatures. The behaviour of these magmas was largely brittle under these conditions. We monitored the acoustic emission emitted. These we find are in accord with volcano seismicity and our fracture mechanics model.