



Bidirectional feedback observed between a magmatic intrusion and shallow earthquake

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Moderate volcano-tectonic earthquakes (M 5-6) during volcanic unrest are unusual, and tend to be associated with major stress perturbations to the crust, occurring during episodes of rifting or the onset of volcanic eruptions. The feedback from such events may be positive, easing magma ascent and eruption, or, as we demonstrate here, negative, hindering any further magma movement.

We present measurements of deformation at Chiles-Cerro Negro volcanoes on the Ecuador-Colombian border. There was previously no record of historical activity at either volcano, but between 2013 and early 2015 there were three episodes of unrest characterised by swarms of volcano-tectonic earthquakes of increasing energy and duration and thought to be associated with the hydrothermal system. In October 2014, magmatic processes not only caused many thousands of small earthquakes per day, but culminated in a M_w 5.6 earthquake located on a system of active tectonic faults that last ruptured in 1868. We find that inflation of a mid-crustal magmatic source ~ 10 km south of the volcanoes ceased abruptly at the time of the earthquake, after which time the rate of seismicity also began a gradual decline. The Chiles-Cerro Negro unrest is therefore an interesting example of magma ascent triggering a moderate earthquake on a tectonic fault and subsequently being inhibited by co-seismic stress changes. This is an important observation for the interpretation of moderate earthquakes during volcanic unrest in terms of evolving hazard.