How earthquake-induced static stress change could promote new volcanic eruptions: an example from the Southern Volcanic Zone, Chilean Andes

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The goal of our work is to study the contribution of earthquake-induced static stress changes on a volcanic arc in order to define a possible feedback in promoting new volcanic eruptions. We analyzed the Southern Volcanic Zone of the Andes (SVZ) in Chile, which has been affected by four subduction earthquakes with $M_w \geq 8$ since 1906, occurred in proximity of 60 Holocene volcanoes. We resolved the earthquake-induced static stress change on the magma pathway of each volcano instead of considering the crustal volumetric expansion. Magma pathway geometry and possible chamber depth are based on geological-structural evidence along with petrological and geophysical data. Our analysis includes a total of 16 eruptions following these large earthquakes at 9 different volcanoes. Ten out of 16 eruptions occurred at volcanoes that had no activity in the five years preceding the earthquake. Results indicate that the static stress changes were capable of triggering the observed volcanic phenomena up to a distance of 353 km from the epicenter. Regarding the most recent 2010 M_w 8.8 earthquake, the normal stress change calculated on each magma pathway shows a pattern of stress transfer more complex than crustal dilatation, due to heterogeneity in magma pathway geometries and orientation. N- and NE-striking magma pathways suffered a greater decompression in comparison with E- and NW-striking ones. The fault-slip-induced static normal stress changes on each reconstructed magma pathway have effects as far as about 400 km. The latest earthquake-induced event regards the 22 December 2012 eruption at Copahue volcano. The results of our numerical modelling indicate that the N60°E-striking magma pathway was affected by a normal stress reduction of about 0.236 MPa at a distance of 257 km from the 2010 epicentre. As a consequence, we are suggesting a possible earthquake-induced feedback effect on the crust below the volcanic arc up to at least 3 years after a large subduction earthquake, favoring new eruptions. Our results show that the unclamping of magma pathways plays a fundamental role in dictating unrest at volcanoes that are already in a critical state. These studies contribute to identify those volcanoes that are more prone to seismically-triggered eruptive events.