DOI: http://doi.org/10.2312/GFZ.ILP.2015

Sensitivity analysis of earthquake-induced static stress changes on volcano magma pathways: the 2010 Mw 8.8 Chile case

Bonali F.L. (1), Tibaldi A. (1)

(1) Department of Earth and Environmental Sciences, University of Milan Bicocca, Milan, ITALY

In this work, we studied in detail how a large earthquake is capable of inducing stress changes on volcano magma pathways, resulting in possible positive feedbacks in promoting eruptions. We have developed a sensitivity analysis that considers several possible parameters, providing also new constraints regarding the method. We focused our study on the M*w* 8.8 2010 earthquake that occurred along the Chile subduction zone near 24 historic/Holocene volcanoes, located in the Southern Volcanic Zone. We used six different finite fault-slip models to calculate the static stress change, induced by the coseismic slip, in a direction normal to several theoretical feeder dykes with various orientations. Results indicate different magnitudes of stress change owing to magma pathway geometry and orientation. In particular, the N–S and NE–SW-striking magma pathways suffer a decrease in stress normal to the feeder dyke in comparison to those striking NW–SE and E–W. As a consequence, we reconstructed the geometry and orientation of the most reliable magma pathways below the 24 volcanoes by studying structural and morphometric data, and we resolved the stress changes for each of them. Our findings suggest that pathway orientation plays a more relevant role in suffering stress changes, whereas the depth of calculation used in the analysis is not a key parameter. Regarding the possible positive feedbacks in inducing new eruptions, our results indicate that: i) volcanoes where post-earthquake eruptions took place, experienced earthquake-induced normal stress decrease or very small normal stress increase, ii) several volcanoes that have not erupted yet, are more prone to experience future unrest, from the point of view of the host rock stress state, because of earthquake-induced normal stress decrease. Earthquake-induced magma-pathway normal stress decrease might contribute to promote new eruptions at volcanoes as far as 450 km from the epicentre.

This work is a contribution to the International Lithosphere Program – Task Force II.