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Moment tensor inversion of tremor events at Arenal Volcano (Costa Rica)

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Arenal is a small, andesitic stratovolcano located in north-western Costa Rica, 97 km from the capital San Josè. Arenal's explosive activity is preceded, and accompanied, by different types of seismic events such as long period events, explosions, tremor and sporadic tectonic swarms. Tremor is the most common type of event recorded at Arenal with durations of up to several hours. Both spasmodic (1-6 Hz) and harmonic (0.9-2 Hz) tremor are observed with no clear difference in the genesis of each; the former can progressively evolve into the latter and vice-versa. However, the origin of the tremor is, at present, not fully understood. In order to retrieve the source mechanism generating these types of events, a moment tensor inversion is performed.

A dataset recorded on the volcano, during a seismic experiment carried out in 2005, is used for the inversion. This dataset consists of ten days of data, from which two main groups of tremor at different frequencies (group one at 0.8-1.5 Hz and group two at 1.8-2.5 Hz) have been selected. A major difficulty in any inversion of tremor is that a clear onset can rarely be determined and hence retrieving the direct arrivals from the source is impossible. Usually, these arrivals are heavily contaminated by scattered waves. On Arenal the initial part of the tremor bands can be isolated, therefore offering a good opportunity to invert tremor for the source mechanism.

The Green's functions used in the inversion were calculated using 3D numerical simulations including the real topography of the volcano and the best estimation of the velocity model available for Arenal. This velocity model was retrieved from seismic refraction experiments and sounding using the SPAC method.

For each day, different tremor starting bands have been selected and divided into the groups mentioned above. For each band a source location is determined by performing a grid search through a volume of 4735 possible source points located under the crater summit. From the evaluation of the misfit values, a common source location is determined. The source appears to be located in shallow position, (less than 200 meters deep) under the crater summit. The source mechanisms for each tremor bands are retrieved for each day using the inversion procedure.