Geophysical Research Abstracts
Vol. 20, EGU2018-13858, 2018
EGU General Assembly 2018

Computational analysis of the rock volumes involved during the 2016-2017 Central Italy seismic sequence

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We analysed the seismic sequence that affects the Umbria-Marche Apennine (Central Italy) since August 2016, focusing on the Amatrice and the Norcia mainshocks. We investigate the ground deformation pattern and the source geometry responsible of the 2016 Central Italy seismic sequence by joint exploiting the multisensors and multiorbits satellite measurements (i.e. ALOS 2; e.g. Cheloni et al., 2017) and their integration with the available geological/structural and seismological data. Starting from DInSAR (i.e. ALOS 2) and seismological data (i.e. hypocentral distribution and available focal mechanisms), we computed the rock volumes involved during the earthquake nucleation processes and delimited between the main fault and by an antithetic fault, as suggested by earthquakes hypocentral distribution. In particular, in this work we calculated both the collapsed rock volume and the consecutive uplifted rock volume. In fact, DInSAR results highlight two different ground deformation within the hangingwall block: a larger zone and a smaller area affected by significant subsidence phenomena and by uplift processes, respectively.

The Amatrice-Norcia seismogenic area is inserted in the tectonic setting of the Umbria-Marche Apennine. The seismic sequence began with the Mw 6.0 Amatrice earthquake, nucleated on August 24th, 2016 along the Mt. Gorzano extensional fault (e.g., Lavecchia et al., 2016). Then, on October 26th, two seismic events, occurred with Mw 5.4 and Mw 5.9 respectively, nucleated nearby Ussita and Visso (Chiaraluce et al., 2017), activating another major fault called the Mt. Vettore Fault System. Finally, on October 30th the largest event of the sequence (Mw 6.5) occurred near the town of Norcia along the Mt. Vettore Fault System.

To estimate the volumes involved in the earthquake processes and starting from the DinSAR measurements, we employed four different methods (based on mathematical laws) and we obtained comparable results. Our results highlight a mass deficit within the crustal volume involved during the earthquake. Specifically, we observe a volume loss in response to a high strain rate deformation (i.e. during the earthquake nucleation). We suggest that the sudden closure of previously open fractures at depth can account for the observed volume loss. These fractures could be localized within a fractured and dilated zone located antithetically respect to the main fault. According to Doglioni et al. (2015), when the stresses related to gravitational energy exceed the strength of the fractured and dilated zone the rock volume collapses slipping along the main fault and generating the earthquake.

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