The Mw 4.9 Le Teil seismic event (France): a possible case of triggered seismicity

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In the last decades, the triggered seismicity has represented one of the most debated issue. Fluid pressure changes with/without fluid flow in rock fractures/pores, thermal stress changes due to temperature gradients, and the volumetric changes or mass removal/accumulation can be included in the geoengineering processes that can induce or trigger seismic activity.

In this work we analyse the Le Teil earthquake (LTe), which occurred on November 11, 2019 (Mw 4.9) in Ardèche region (south-eastern France), as a possible triggered event originated by rock mass removal in the Lafarge quarry operating since 1833. The structural area where LTe occurred is part of the St. Thomé-La Rouvière fault system, located in the Cévennes fault bundle, which marks the south-eastern border of the Massif central over almost 150 km long; this fault presents a NE-SW trend and its geometry characterized by several uncertainties due to the absence of dip measurements.

As first step, to estimate the removed volume of rock in the Lafarge quarry, we use multi-temporal digital surface models and, in particular, the archive stereo aerial image pairs from IGN for 1946, 1979, 2007 and 2011; our analysis is restricted to the modern period where detailed topographic data are available. Subsequently, we generate the coseismic deformation maps by applying the Differential Synthetic Aperture Radar Interferometry (DInSAR) technique to SAR data collected along ascending and descending orbits by the Sentinel-1 (S1) constellation of the European Copernicus Programme. In order to retrieve the seismogenic fault parameters, we jointly invert the so-generated S1 DInSAR measurements by performing a consolidated two-step approach: it consists of a non-linear optimization to constrain the fault geometry with uniform slip, followed by a linear inversion to retrieve the slip distribution on the fault plane.

Finally, our Coulomb stress changes analysis on the fault along the slip direction suggests a clear positive triggering relation between the long-term activity in the Lafarge quarry and the Le Teil earthquake.

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