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Hydraulic and mechanical constraints on the magnitude Ml 5.2 earthquake of 11 November 2019 at Le Teil (France)

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On 11 November 2019, a Ml 5.2 earthquake broke the Rouvière fault in southeast France at Le Teil, close to the Rhone river. This recent seismic event is the strongest earthquake ever felt in France since the Arette (Pyrenees) earthquake in 1967. *A priori,* it is also a historically unprecedented earthquake in the surrounding low strain and stable continental region. By using an updated geological model, we focus this work on the comparison of the effect of hydraulic recharge linked to the infiltration of meteoric water in the period preceding the earthquake and the effect of the exploitation of a large limestone quarry in the vicinity of the epicenter.

At first, we carry out a complete inventory of local seismicity in a rectangular area of 50 km x 25 km around the Teil quarry. We put these seismic events in temporal relation with the rainfall measurements from the weather station at Montélimar. The three most intense rainy events between 2010 and 2019 are all followed by a seismic event in this restricted area, which occurs between 8 and 18 days after these rainy episodes.

Afterward, we describe the different geological configurations from the updated geological model and the boundary conditions, that are used to calculate the pressure variations along the Rouvière fault using two-dimensional (2D) double porosity double permeability models. The BRGM Compass code is used with the surface soil moisture data acquired by the SMOS satellite between 2010 and 2019, as surface boundary conditions and the Rhône river as edge boundary conditions. The main result of these hydrogeological simulations is that at the intersection of the Rouvière fault and a sub-vertical fault, the calculated increase in pore fluid pressure is maximum just before the earthquake of November 11, 2019.

A sensitivity study carried out on the hydraulic parameters and on the configuration of the fault system of the 2D model, allows us to estimate that at about 1000 m depth, the overpressure linked to the hydraulic recharge is between 0.3 and 0.6 MPa. Finally, we compare the variation in normal stress linked to a mechanical discharge from the surface quarry and the hydraulic overpressure linked to a meteoric water recharge, by choosing the same fault geometry. The comparison shows that the overpressure associated with hydraulic recharge has an impact that is an order of magnitude greater than that of the normal mechanical stress due to the decharge of the limestone quarry.