

EGU2020-20740

<https://doi.org/10.5194/egusphere-egu2020-20740>

EGU General Assembly 2020

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Geomorphology of the cumulative deformation since Oligocene age on the Mw 4.9 Le Teil earthquake fault (South of France, 11/11/19)

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The Mw 4.9 earthquake that occurred near Montelimar on November 11, 2019 showed peculiar characteristics: a very shallow hypocenter (1 km depth) with unexpected surface ruptures for such a moderate magnitude, and only few aftershocks showing low magnitudes ($M_L < 2.7$). This event occurred in the industrialized Rhone Valley (including nuclear power plants and chemical industry) where several historical earthquakes with similar intensities and magnitudes took place (e.g. 1773, 1873, 1934).

The earthquake broke a ~5-km-long segment of the northern tip of the Cevennes fault system (La Rouvière Fault Segment). This ~100 km-long fault network has a NE-SW orientation trend and is inherited from the Variscan orogeny (~300 Ma). It first registered an extensive and transtensive tectonic phase ending at the Oligocene age (~30 Ma) before being inverted, as revealed by the reverse focal mechanism of the Le Teil event.

To date, this fault network has been poorly investigated in terms of seismic hazard, likely due to the low Mw expected on such short structures. Therefore, we started a new study to document its paleo-earthquake record in the framework of the new French RGF program (Alps and surrounding basins, BRGM).

Our first target was to map the cumulative trace of the fault. A first airborne LiDAR survey was acquired by helicopter and UAV (unmanned aerial vehicle) just after the earthquake. They allowed the identification of a continuous inherited scarp of 1 – 2 m in height over ~4 km along the preexisting Oligocene fault. In order to characterize the post-Oligocene deformation along this fault, we performed a detailed analysis of geomorphological field observations, as well as a geophysical study by acquisition of seismic, electrical and ground-penetrating radar profiles. These profiles aimed to better understand how the 11/11/19 earthquake surface rupture is connected at depth to the Oligocene structure (La Rouvière Fault).

Each step of the analysis aims at eventually locating sites for further paleoseismological trenches, accounting for fault location, sediment preservation with favorable age determination potential and accessibility. This kind of investigation will provide information on the evolution over time of the seismic activity of this fault network, as well as relevant data on the current hazard they present in the specific context of the French Rhone Valley.