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# Unraveling the Late Quaternary activity of the Petrinja Fault (Croatia), source of the 2020 M 6.4 earthquake

Maxime Henriquet<sup>\*1</sup>, Lucilla Benedetti<sup>2</sup>, Stéphane Baize<sup>3</sup>, Branko Kordić<sup>4</sup>, Daniela Pantosti<sup>5</sup>, Francesca Cinti<sup>5</sup>, Petra Jamšek Rupnik<sup>6</sup>, Marianne Métois<sup>7</sup>, Josipa Maslač<sup>4</sup>, Nikola Belić<sup>4</sup>, Marko Špelić<sup>4</sup>, Stefano Pucci<sup>5</sup>, Alessio Testa<sup>8</sup>, Paolo Boncio<sup>8</sup>, Bruno Pace<sup>8</sup>, Adrien Moulin<sup>9</sup>, and Riccardo Civico<sup>5</sup>

<sup>1</sup>Géoazur – Institut National des Sciences de l’Univers, Observatoire de la Cote d’Azur, Université Côte d’Azur, Centre National de la Recherche Scientifique, Institut de Recherche pour le Développement – France

<sup>2</sup>Centre européen de recherche et d’enseignement des géosciences de l’environnement – Institut de Recherche pour le Développement, Aix Marseille Université, Collège de France, Institut National des Sciences de l’Univers, Centre National de la Recherche Scientifique, Institut National de Recherche pour l’Agriculture, l’Alimentation et l’Environnement, Institut de Recherche pour le Développement :

*UMR<sub>D</sub>161, AixMarseilleUniversité : UM34, Collège de France :*

*UMR7330, CentreNationalde laRechercheScientifique :*

*UMR7330, InstitutNationaldeRecherchepourl’ Agriculture, l’Alimentationetl’ Environnement : UMR1410 – –France*

<sup>3</sup>Laboratoire de mesures nucléaires – Service d’analyses et de métrologie de l’environnement – France

<sup>4</sup>Croatian Geological Survey (HGI-CGS) – Croatie

<sup>5</sup>Istituto Nazionale di Geofisica e Vulcanologia - Sezione di Roma – Italie

<sup>6</sup>Geological Survey of Slovenia – Slovénie

<sup>7</sup>Laboratoire de Géologie de Lyon - Terre, Planètes, Environnement – Ecole Normale Supérieure de Lyon, Université Claude Bernard Lyon 1, Institut National des Sciences de l’Univers, Université Jean Monnet - Saint-Etienne, Centre National de la Recherche Scientifique – France

<sup>8</sup>Università’ degli Studi ”G. d’Annunzio” Chieti-Pescara – Italie

<sup>9</sup>Institut de Physique du Globe de Paris – Institut National des Sciences de l’Univers, Université de la Réunion, Institut de Physique du Globe de Paris, Centre National de la Recherche Scientifique, Université Paris Cité – France

## Résumé

The Mw 6.4 Petrinja earthquake (Croatia, 2020) is one of the strongest intracontinental earthquakes that occurred in Europe in recent decades. Although seismogenic faults were recognized in this low strain and intraplate context, their activity was mainly studied through instrumental and historical seismicity. Shortly after the Petrinja earthquake, our self-organized team of geologists from several European research institutions (so-called ”EU-Team”) performed a survey of coseismic effects and investigated the activity of the causative fault system.

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\*Intervenant

We present a compilation of the results of a multidisciplinary approach to determine the characteristics of the Petrinja fault through from geomorphological and subsurface records. Using field observations and high-resolution topographic data, the morphotectonic analysis revealed the surface geometry of the fault and the associated long-term cumulative along-strike offsets. The fault is highly discontinuous, characterized by short fault sections ( $< 5$  km), and offset geomorphic markers record along-strike cumulative displacements ranging from 4 to 24 m. Based on radiocarbon and cosmogenic dating of fluvial terraces, we assume that their risers, following the terrace abandonment, likely formed during the Late Glacial Maximum or Early Holocene. Combining these results we estimate a total fault slip-rate of 0.7-1.6 mm/yr and 1.6-3.9 mm/yr, with the second estimate being unlikely given the current deformation rate in the region. Additionally, the Quaternary activity of the fault was confirmed by near-surface geophysical profiles collected along the studied section, such as electrical resistivity tomography, ground penetrating radar and radon permeability measurements. Several sites show strong agreement between these datasets and helped to determine suitable sites for paleoseismological investigations. Three sites and six trenches were opened along the ruptured Petrinja fault, making it not only the first case of paleoseismological studies in Croatia. This allows for a robust reconstruction of the recent activity history and, through the correlation of all data, the delineation of the most plausible rupture scenarios. Although the quantification of the Petrinja fault activity is challenging due to moderate and distributed deformations together with vegetation cover or anthropogenic overprint, the combination of different methods shows the potential of a multidisciplinary approach to better assess the seismic hazard of such fault systems.

**Mots-Clés:** Active faults, slip, rate, Quaternary dating, paleoseismological trenches, near, surface geophysics, intraplate deformation