Structure and segmentation of the Ovindoli – Piano di Pezza – Campo Felice fault system (Central Apennines, Italy): Evolution and reactivation of inherited faults

Matthieu Ferry1, Stéphanie Gautier1, Stéphane Mazzotti1, Fabio Villani2, Eric Stell1, Marie Jacottin1, Daniela Pantosti2, Vincenzo Sapia3, Tulio Ricci2, Lucilla Benedetti3, Giuseppe Di Giulio4, and Maurizio Vassallo4

1Géosciences Montpellier, Université de Montpellier - CNRS - Université des Antilles, Montpellier, France
2Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy
3CEREGE, Aix-Marseille University - CNRS, Aix-en-Provence, France
4Istituto Nazionale di Geofisica e Vulcanologia, L’Aquila, Italy

Active deformation in the Central Apennines is mostly accommodated by NW-SE normal faults systems that produce moderate to large earthquakes at shallow depth. Recent examples include the 1915 Mw≈7 Avezzano earthquake (Fucino basin) and the 2009 Mw=6.1 L’Aquila earthquake (Aterno basin) which were both associated with major loss of life and massive damage to buildings and infrastructure. Here, we study the 40-km-long Ovindoli – Piano di Pezza – Campo Felice – Monti d’Ocre (OPCM) fault system, a major NNW-SSE system that potentially links the Fucino and the Aterno fault-systems. The OPCM exhibits linear and arcuate sections with four main segments and borders the eastern margin of the Aterno basin. Paleo-earthquake rupture data on the Piano di Pezza (PPF) and Campo Felice (CFF) faults exhibit remarkable synchronicity with the Fucino fault system, with the most recent surface-rupturing earthquake likely occurring in the XIVth century. In order to better understand the relationships between and earthquake rupture scenarios, we focus on the basin geometry and fault surface expression of the Piano di Pezza fault combining geomorphology and subsurface geophysics. We map the fault trace with unprecedented detail using terrestrial laser scanner surveys and quantify surface deformation affecting alluvial fans as well as glacial moraines. We obtain a mean vertical offset of 2.5 m +/- 0.3 m for the most recent features, well in agreement with paleoseismological data. Furthermore, we document slip distributions at different time scales along strike with a maximum value at the connection between the PPF and the OF. Beneath the scarp, geophysical data reveal a complex faulting geometry with several parallel strands and two minor blind splays. Electrical resistivity tomography images show a cumulative vertical offset of ~ 15 m affecting an interface attributed to the Last Glacial Maximum and confirm the high vertical slip across the fault zone. Gravimetric anomalies across the basin also indicate the sedimentary fill has recorded a maximum finite cumulative throw of 110-140 m. This suggests a maximum vertical slip rate of 0.2-0.3 mm/year since the Pleistocene, which contrasts with the high post-LGM slip rate estimated from trenches. Overall, our observations suggest that the arcuate PPF originally formed
as a reverse fault during the Mio-Pliocene compressive stage and is now reactivated as an extensional horsetail-like feature by ruptures along a major strike-slip fault (OF). This finding points to the PPF as mostly built through ruptures along the OF leaking onto an inherited structure. The time-varying slip rates may also denote an episodic behavior marked by short periods of high seismic activity (a few centuries) and long intervals of seismic quiescence (a few millennia). Furthermore, possible earthquake rupture scenarios along the OPCM may encompass the whole OPCM fault system (cumulative length ca. 40 km) or rupture termination along the PPF (cumulative length ca. 15-20 km) with significantly different impacts over the populated Fucino and Aterno basins.