ESC2016-285, 2016
35th General Assembly of the European Seismological Commission
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35th General Assembly of the European Seismological Commission
4–10 September 2016
Trieste

Active thrusting across the eastern Southern Alps (Italy) inferred from geomorphic analysis: faults geometry, Pleistocene shortening-rates and implications for the 1976 Friuli seismic sequence.

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Geodetic data indicate that slip on SW-NE to WSW-ENE-oriented thrusts of the Southern Alps (NE Italy and W Slovenia) absorbs most of the Adria microplate rotation in this area (Cheloni et al., 2014). The destructive 1976 Friuli seismic sequence (magnitude up to 6.4) ruptured in the eastern part of this belt. While source model for that sequence has been proposed from the analysis of geodetic (including levelling) data (Cheloni et al., 2012), the surface expression and the geometry of the source fault(s) remain poorly constrained, preventing any further paleoseismological investigation that could allow better assessing associated seismic hazard.
Using a 5-m-DEM, (generated from 1:5000 topographical maps) we have identified and mapped Late-Quaternary geomorphic markers that have recorded cumulative tectonic offsets between Tolmezzo and Palmanova, an area encompassing the Friuli earthquake epicentral area. Accurate topographic profiles of fluvial terraces and fans, deposited along the Torre riverbed, show that those surfaces are uplifted and folded by 3 to 10m. We interpret these observations as the surface expression of ongoing folding above the WNW-ESE-oriented Tricesimo and Pozzuolo thrusts. By taking into account geological and sub-surface data (Peruzza et al., 2002) and using a fault-bend-fold model, the identified fold shapes allow constraining the fault shape at depth. It suggests that the two thrusts emerge from a single ramp whose geometry agrees with the source parameters of the 1976 main shock (Aoudia et al., 2000).
Considering the ages of the geomorphic markers (Fontana et al., 2008), we found that about 1.5 mm/yr of slip on that fault is required to reproduce the observed uplift, in agreement with geodetic data. Finally, we found that the 1976 co-seismic uplift, as recorded by levelling data (Cheloni et al., 2012), remarkably mimics the pattern of Late Pleistocene deformation inferred from the identified geomorphic markers. Those levelling data then allowed quantifying that about 40cm would be associated to the co-seismic rupture on the Tricesimo thrust.

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