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Shallow subsurface imaging of the Piano di Pezza active normal fault (central Italy) by high-resolution refraction and electrical resistivity tomography coupled with time domain electromagnetic data

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The Piano di Pezza fault is the north-westernmost segment of the >20 km long Ovindoli-Pezza active normal fault-system (central Italy). Although existing paleoseismic data document high vertical Holocene slip rates (∼1 mm/yr) and a remarkable seismogenic potential of this fault, its subsurface setting and Pleistocene cumulative displacement are still poorly known.
We investigated for the first time by means of high-resolution seismic and electrical resistivity tomography coupled with time domain electromagnetic (TDEM) measurements the shallow subsurface of a key section of the Piano di Pezza fault. Our surveys cross a ∼5 m-high fault scarp that was generated by repeated surface-rupturing earthquakes displacing some Late Holocene alluvial fans.
We provide 2-D Vp and resistivity images which clearly show significant details of the fault structure and the geometry of the shallow basin infill material down to 50 m depth. We can estimate the dip (∼50°) and the Holocene vertical displacement of the master fault (∼10 m). We also recognize in the hangingwall some low-velocity/low-resistivity regions that we relate to packages of colluvial wedges derived from scarp degradation, which may represent the record of several paleo-earthquakes older than the Late Holocene events previously recognized by paleoseismic trenching.
Conversely, due to the limited investigation depth of seismic and electrical tomography, the estimation of the cumulative amount of Pleistocene throw is hampered. Therefore, to increase the depth of investigation, we performed 7 TDEM measurements along the electrical profile using a 50 m loop size both in central and offset configuration. The recovered 1-D resistivity models show a good match with 2-D resistivity images in the near surface. Moreover, TDEM inversion results indicate that in the hangingwall, ∼200 m away from the surface fault trace, the carbonate pre-Quaternary basement may be found at ∼90-100 m depth. The combined approach of electrical and seismic data coupled with TDEM measurements provides a robust constraint to the Piano di Pezza fault cumulative offset. Our data are useful for better reconstructing the deep structural setting of the Piano di Pezza basin and assessing the role played by extensional tectonics in its Quaternary evolution.