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2D-3D GPR signature of shallow faulting in the Castelluccio di Norcia basin (Central Italy).

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Paleoseismology usually provides seismological data through direct analysis, and uses trenching as the principal investigation technique. Over the last years, the use of non-invasive geophysical methods acquired an important role in paleoseismologic studies.

The use of Ground Penetrating Radar (GPR) provided many documented examples of shallow fault zones imaging. In particular, the acquisition of three dimensional GPR data using very dense grids, produces high-resolution data volumes, with high spatial continuity, mandatory for a correct interpretation of the geological features in their actual geometry.

We acquired a 3D GPR volume across a fault zone in Central Apennines (Italy). This fault strand shows both geomorphological and trench-derived evidences of Late-Quaternary activity. The GPR volume covers a 20x20 m area providing an high-resolution imaging of the fault zone and its auxilliary structures .

Using a free open source software to manage the entire 3D dataset, some horizons and fault features were detected and interpreted. Interpretation was improved using attribute analysis, especially based on amplitude, phase and frequency characteristics.

The results of our study provides a detailed 3D geological model of the subsurface extended to more than 4 m below the topographic surface, and a localized area interested by faulting is clearly recognizable. By the use of depth-slices we estimated a width of about 4-2 m, with an average strike of the fault of 170° N. The dip of the W-SW-dipping E-side of the structure was estimated in about 70°, with a total average displacement of about 1 m ± 0.20 m; clinoforms structures, colluvial wedges and sedimentary units showing thickening and rotation close to the fault zone in the hanging-wall were also recognized.

Finally some long 2D GPR profiles were acquired and interpreted to extend the observations over a wider area. We successfully detected the continuity of the fault zone towards North, locating also some possible unknown fault strands that can be potentially mapped and added in the future versions of large scale geological maps. Moreover they can be used as additional constrains for seismological modeling.

Delineating a characteristic radar signature of specific faults, we believe that GPR data represents a valuable source of quantitative data for paleoseismologic studies, not only to optimise the location for future trenches but also to extend the geological information along and across the fault strike.