Title: Modelling the structure of active faults in the southern Apennines mountain belt

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Research program

The study of active faults is of great importance for planning seismic hazard mitigation. In particular, the southern Apennines mountain belt comprises some active faults, which historically destroyed several urbanized centers. This area is one of the most active and hazardous of the central-western Mediterranean region, with earthquake magnitudes up to M_w 7. For example, the Irpinia sector is certainly one of the most dangerous area in Italy, as it was characterized by a lot of disruptive seismic events such as, among others, the 1980 November 23 earthquake (M_w=6.9), which represents nowadays one of the most disruptive earthquakes in Italy. Not less important is the study of active faults associated with low-magnitude seismicity such as those occurring in volcanic areas as the Campi Flegrei or Ischia Island. Although these faults do not release a large amount of seismic energy, they are very shallow and may therefore cause several damages to infrastructures as occurred in the Ischia island in 2017 August 21 with an earthquake of magnitude M_w=4.

Proposal for a PhD position

One of the key issues in the study of active faults is that, although their surficial structure and ground effects can be mapped by means of detailed morphometric analyses of rupture planes (including trenches and levelling) and remote sensing techniques (GPS and InSAR data), their deep structure is often more difficult to be determined. Seismological data can help place constraints on the deep structure and kinematics of active fault zones at depth, however at a resolution which is often not adequate to highlight the degree of fault segmentation which can have an impact on the surficial strain field. 3D seismic reflection data can offer a higher resolution approach, although are often not available for mountainous areas. These issues in determining the deep structure of active faults are well-reflected in the southern Apennines mountain belt. Indeed, in this area, the available data has raised some controversial interpretations. For example, different contrasting models have been proposed for characterizing the faults that generated the 1980's earthquake in Irpinia area at depth. These include a single structure crosscutting the whole upper crust or a highly segmented fault at depth. In this PhD Project, the candidate will investigate the links between the deep structure of selected active fault zones and the associated ground strain field by means of a modeling approach. A library of varieties of 3D fault zone architecture with a realistic degree of segmentation available in the literature and by the research group will be input to a forward modeling approach, by means of which the candidate will reconstruct the observed post-seismic ground effects. The mathematical modeling will shed light on which geometric and kinematic solution fit best the ground deformation patterns. In order to carry out this analysis, post-seismic ground strain patterns will be collated for selected active faults that have produced historical or recent earthquakes in the southern Apennines mountain belt. In areas in which data are not available, new data will be acquired by means of traditional field mapping techniques and drone surveys. Finally, the candidate will compare the results obtained for active faults in the southern Apennines mountain belt with active faults in other, better-exposed, areas, and in particular of some exceptional outcrops in which the segmented nature of faults can be directly observed in the field. The PhD candidate will follow a work schedule articulated as follows:

1st year: bibliographic research on active faults in the southern Apennines and collation of a ground deformation dataset for selected faults including leveling, GPS and InSAR data, complemented by the collection on newly acquired field data.

2nd year: mathematical modeling of the selected faults. Identification of active faults in other tectonic settings and field structural and kinematic surveys. Results presentation at international conferences and in peer-reviewed papers.

3rd year: modeling completion of the studied faults. Results presentation at international conferences and in peer-reviewed papers. Thesis writing.