Multiparametric data analysis for identifying active fault geometries in the Abruzzo and Molise regions (Central-Southern Appennines, Italy)

Germana Gaudiosi, Valeria Paoletti, Rosa Nappi, Paola Luiso, Federico Cella, Giovanni Florio, and Maurizio Fedi

1University of Naples, Federico II, Department of Earth, Environmental and Resources Science, Neaples, Italy
2Istituto Nazionale di Geofisica e Vulcanologia, Section of Naples, Osservatorio Vesuviano, Italy
3Department of Biology and Earth Science, University of Calabria, Rende, Italy
4SOCOTEC Italia Srl, Lainate, Italy

The Central and Southern Apennines are characterized by the occurrence of intense and widely spread historical and recent seismic activity, mostly located along the chain.

In this paper, we present a multi-parametric data analysis in GIS environment (Geographic Information System) with the aim of identifying and constraining the geometry (strike, dip direction and dip angle) of the seismogenic faults in areas of Central-Southern Apennines characterized by outcropping/ buried and/or active/silent faults.

We use an integrated analysis of geo-structural, seismological and gravimetric data, for the identification and geometrical description of faults with density contrast, both at the surface and at depth. At the surface, the gravity lineaments inferred by Multiscale Derivative Analysis (MDA) were compared with the Quaternary faults mapped in the study areas and with the earthquakes’ epicentral distribution. The characterization of faults at depth was instead performed by the combination of the Depth from Extreme Points (DEXP) gravity imaging method with hypocentral sections.

We tested the effectiveness of this multi-method approach at Mt. Vettore-Mt. Bove, L’Aquila basin, Mt. Massico and San Giuliano di Puglia areas (Central and Southern Apennines).

Given the effectiveness of the obtained results, this multiparametric study has been applied to other three areas of the Abruzzo-Molise region: the south-western sector of Mt. Matese, the Fucino basin and the Sulmona basin.

The Matese area was hit by a seismic sequence in 2013-2014 ($M_{\text{wmax}}=5.1$ on December 29, 2013). Our approach showed a correlation between the epicentral distribution of the 2013-2014 Matese seismic sequence ($M_{\text{w}}=5.0$) and the MDA lineaments from gravity data. The hypocentral distribution suggests that the fault rupture does not reach the surface. Therefore, the seismogenic fault responsible of 2013-2014 Matese seismic sequence is likely a buried fault.
The Fucino basin was struck by a $M_w=7.0$ earthquake on January 13, 1915, causing 30,000 causalities within a large area surrounding the basin. At present, the area is characterized by scarce instrumental seismicity with low magnitude. Our analysis highlights a good correlation between NW-SE and NE-SW well-known faults and clear gravimetric MDA maxima bordering the plain. This area can be currently considered silent but, from historical seismological studies, it is one the highest seismic risk areas of Central Apennines.

Moreover, we investigated the area of the Sulmona basin, the southwards extension of the eastern system of Central Apennines developing from Mt. Vettore, Mt. Gorzano and Mt. Gran Sasso. In historical times, the faults of the most external extensional alignment, defined as silent and considered as probable seismic gaps, activated during the 2016 Amatrice–Visso–Norcia seismic sequence. Further to the southeast, two relatively large earthquakes occurred on the eastern flank of Mt. Maiella on November 3, 1706 ($M_w=6.6$) and on September 26, 1933 ($M_w=5.7$). The Sulmona area is presently characterized by poor and low magnitude instrumental seismicity. Our multi-parametric analysis highlighted a strong correlation between MDA maxima and the Mt. Morrone normal fault bordering the western side of Mt. Maiella and the eastern side of the Sulmona basin.