A deep resistivity Full Waver survey unravels the 3D structure of the Castelluccio basin in relation to the source of the 2016 Mw 6.5 Norcia earthquake (central Italy)

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The Castelluccio basin in the central Apennines (Italy) is a ~20-km²-wide intramontane Quaternary depression located in the hangingwall of the NW-trending and SW-dipping Vettore-Bove normal fault system (VBFS). This system is responsible for the 2016-2017 seismic sequence, culminated with the 30 October 2016 Mw 6.5 Norcia earthquake that caused widespread surface faulting affecting also the northern part of the Castelluccio basin. Available borehole and geophysical data are not enough to constrain the basin structure, infill architecture and their relations with the long-term activity of the VBFS. Therefore, we carried out an extensive 3D survey using the innovative Fullwaver (FW) technology, conceived to perform deep electrical resistivity tomography (DERT). We aimed at: a) mapping the geometry of the pre-Quaternary limestone basement and the basin infill thickness down to a depth of ~1 km; b) mapping the subsurface structure of known faults and their extent underneath the alluvial cover; c) mapping possible blind faults splays.

The FW technology allowed us to constrain the geometry of the basin. The infill material is imaged as a wide, N-trending moderately resistive (< 300 Ωm) to conductive (< 100 Ωm) region, likely made of silty sands and gravels, deepening down to 500 m b.g.l. in the southern sector, suggesting the occurrence of two main depocenters. All over the basin, we identify paired high-resistivity (> 500-1000 Ωm) and low-resistivity (< 400 Ωm) belts related to the limestone basement and to the...
basin infill, respectively. They display NNE and NNW dominant trends. We interpret the sharp boundaries of NNE-trending belts as related to early extensional faults promoting the basin inception. The NNW-trending belts suggest the occurrence of faults that locally cross-cut the previous ones, and that we interpret as splays of the VBFS buried under the basin sedimentary cover. The recognition of different systems of extensional faults is coherent with results of high-resolution seismic profiling carried out recently in the basin. A high-resolution 2D transect with 15 m-spaced electrodes across the 2016 surface ruptures shows details of the active VBFS splay down to 300 m depth. Moreover, in the eastern sector of the survey area, low-resistivity round-shaped anomalies in the Mesozoic substratum hints for deep Miocene compressional structures. Therefore, our DERT imaging suggests a complex tectonics in the subsurface of the Norcia earthquake fault. In particular, the currently active NNW-trending faults seem to overprint a pre-existing structural framework, promoting fault segmentation at different spatial scales.