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The 2009 L'Aquila sequence (Central Italy): fault system anatomy by aftershock distribution.

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On April 6 (01:32 UTC) 2009 a destructive MW 6.13 earthquake struck the Abruzzi region in Central Italy, causing nearly 300 deaths, 40.000 homeless people and strong damage to the cultural heritage of the L'Aquila city and its province.
Two strong earthquakes hit the same area in historical times (e.g. the 1461 and 1703 events), but the main fault that drives the extension in this portion of the Apennines was unknown.
Seismic data was recorded at both permanent stations of the Centralised Italian National Seismic Network managed by the INGV and 45 temporary stations installed in the epicentral area together with the LGIT of Grenoble (Fr). The resulting geometry of the dense monitoring network allows us to gain very high resolution earthquake locations that we use to investigate the geometry of the activated fault system and to report on seismicity pattern and kinematics of the whole sequence.
The mainshock was preceded by a foreshock sequence that activated the main fault plane during the three months before, while the largest foreshock (MW 4.08) occurred one week before (30th of March) nucleated on a antithetic (e.g. off-fault) segment.
The distribution of the aftershocks defines a complex, 50 km long, NW-trending normal fault system, with seismicity nucleating within the upper 10-12 km of the crust. There is an exception of an event (MW 5.42) nucleating a couple of kilometers deeper that the 7th of April that activates a high angle normal fault antithetic to the main system. Its role is still unclear.
We reconstruct the geometry of the two major SW-dipping normal faults forming a right lateral en-echelon system. The main fault (L'Aquila fault) is activated by the 6th of April mainshock unluckily located right below the city of L'Aquila. A 50°SW-dipping plane with planar geometry about 16 km long. The related seismicity interests the entire first 12 km of the upper crust from the surface. The ground surveys carried out soon after the occurrence of the earthquake find unclear evidence of surface faulting for a length of about 6 km along the mapped Paganica fault. The ruptures location coincides with the geometry of the main fault imaged by aftershocks distribution. However, in this area, the on-fault seismicity is anti-correlated with the modeled largest slip patches.
To the north, we observe a minor segment (Campotosto fault) defined by seismicity distribution in the 6 to 12 km depth range. This fault slightly overlaps the L'Aquila structure. The larger event occurred on the 9th of April is MW 5.22. Together with other events with magnitudes around 5, they extended the system for another 12-14 km in length. Here we detect a peculiar geometry: the fault dip (40°) decrees with depth mimicking a listric geometry. The main characteristic of this dip variation with depth is that we observe two almost planar segments and the nucleation of the large events exactly where change is detected. Minor sub-parallel segments are active in the main fault footwall, towards the overlapping zone.
We also illustrate some possible examples for inversion tectonics: re-activation of inherited compressional structure.