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The Pollino Seismic Sequence: Activated Graben Structures in a Seismic Gap

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The Mercure Basin (MB) and the Castrovillari Fault (CF) in the Pollino range (Southern Apennines, Italy) represent one of the most prominent seismic gaps in the Italian seismic catalogue, with no M>5.5 earthquakes during the last centuries. In historical times several swarm-like seismic sequences occurred in the area including two intense swarms within the past two decades. The most energetic one started in 2010 and has been still active in 2014. The seismicity culminated in autumn 2012 with a M=5 event on 25 October. The range hosts a number of opposing normal faults forming a graben-like structure. Their rheology and their interactions are unclear. Current debates include the potential of the MB and the CF to host large earthquakes and the style of deformation. Understanding the seismicity and the behaviour of the faults is necessary to assess the tectonics and the seismic hazard.

The GFZ German Research Centre for Geosciences and INGV, Italy, have jointly monitored the ongoing seismicity using a small-aperture seismic array, integrated in a temporary seismic network. Based on this installation, we located more than 16,000 local earthquakes that occurred between November 2012 and September 2014. Here we investigate quantitatively all the phases of the seismic sequence starting from January 2010. Event locations along with moment tensor inversion constrain spatially the structures activated by the swarm and the migration pattern of the seismicity. The seismicity forms clusters concentrated within the southern part of the MB and along the Pollino Fault linking MB and CF. Most earthquakes are confined to the upper 10 km of the crust in an area of $\sim$15x15 km^2. However, sparse seismicity at depths between 15 and 20 km and moderate seismicity further north with deepening hypocenters also exist. In contrast, the CF appears aseismic; only the northern part has experienced micro-seismicity. The spatial distribution is however more complex than the major tectonic structures mapped for the area. Consistent with mapped faults, the seismicity interested both eastwards and westwards dipping normal faults that define the geometry of seismically active graben-like structures. At least one cluster shows an additional spatio-temporal migration with spreading hypocentres similar to other swarm areas with fluid-triggering mechanisms.

The static Coulomb stress change transferred by the largest shock onto the swarm area and on the CF cannot explain the observed high seismicity rate. We study the evolution of the frequency-size distribution of the events and the seismicity rate changes. We find that the majority of the earthquakes cannot be justified as aftershocks (directly related to the tectonics or to earthquake-earthquake interaction) and are best explained by an additional forcing active over the entire sequence. Our findings are consistent with the action of fluids (e.g. pore-pressure diffusion) triggering seismicity on pre-loaded faults. Additional aseismic release of tectonic strain by transient, slow slip is also consistent with our analysis. Analysis of deformation time series may clarify this point in future studies.