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Diffusion processes in minor normal faulting seismic sequences monitored by the Alto Tiberina Near Fault Observatory (Northern Apennines, Italy)

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The analysis of microseismicity has a fundamental role in understanding earthquakes, giving insights on the long- and short-term driving forces and processes preparing and generating the seismicity occurrence and its evolution in space and time.

Recent advances in detection and location algorithms, paired with dense seismic networks, and supported by higher computing capacity, allow dramatic increase in the quality and quantity of low magnitude earthquakes recorded resulting in high resolution earthquakes catalogs in terms of both location attributes and completeness.

Such catalogs enable us to analyze small magnitude (M<4) sequences having the advantage of a high frequency of occurrence, with unprecedented resolution in illuminating minor (few kilometers of extent) fault systems and seismicity patterns.

We present a detailed analysis of two seismic sequences occurred within an extensional sector of the Northern Apennines between 2010 and 2014: the Città di Castello and Pietralunga sequences (maximum magnitude ≤ 3.6). The area is within the Alto Tiberina Near Fault Observatory (TABOO-NFO), a multidisciplinary monitoring infrastructure dedicated to the investigation of the fault slip behavior of this very low angle normal fault.

The very high microseismic activity, the availability of a dense network and a complex tectonic setting involving shallow (H2O) and deep (CO2) fluids circulation, result in an ideal location to apply modern detection and analysis techniques to study microseismicity in detail.

We build the high-resolution catalog starting from the raw waveforms recorded by a seismic network composed of ~60 stations covering an area of 80x80km and applying a deep learning phase picker. The events are located with a probabilistic nonlinear algorithm and finally relocated with the double differences algorithm after undergoing a quality selection based on location parameters. The resulting catalog for these sequences counts 6 times the number of events

documented in previously available standard catalogs.

The spatiotemporal distribution of events shows different characteristics, ranging from foreshock-mainshock-aftershock to more swarm-like patterns but almost all these patterns are compatible with pore-pressure diffusion ($1 - 2m^2s^{-1}$) processes and exhibiting along-strike migration. These are very similar behavior with respect to the ones observed during the larger extensional sequences occurred in the Apennines in recent years.

The case of fluid driven seismicity is coherent with the seismotectonic setting of the area showing large CO_2 degassing phenomena and the presence of geologic formations prone to develop fluids overpressure. The comparison of the spatial distribution of events with a three-dimensional deterministic seismostratigraphic model based on different (non-seismic) geophysical data, highlights in fact a ubiquitous involvement of the Triassic Evaporites as hosting lithology, indicating a strong mechanical control and corroborating their seismogenic role.