Aseismic transient driving the swarm-like sequence in the Pollino range, Southern Italy

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Related to the seismic gap and swarm tendency, anomalies of the crustal parameters

Figure 1. Map of Calabria with the location of the Pollino range, the borders between Calabria Arc and the Southern Apennines to which Pollino range lays at the border between the two tectonic regimes. From the studies of Camassi et al., Quidelleur, 2001, Tellamaliev and Cucci, 2003.

Figure 2. Map of Southern Italy with National seismicity, research and instrumentation intensity, color-coded circles, From 1981 to 2012. No earthquakes with M<4 are recorded in the Pollino region in the period. From Totaro et al. 2014 Geophys. J. Int.

Figure 3. Aseismic transient driving the swarm-like sequence belongs to. From Tansi et al. 2007, Calabrian Arc and the Southern Apennines to which features. Pollino range lays at the border between the two tectonic regimes. Fabio Corbi, Francesco Maccarelli, Simone Cesca, Francesco Maccarelli, Marco Mucciarelli, Dirk Roessler, Fabio Corbi, Torsten Dahm and Elephant Rivalta.

Figure 4. Cyclical map of the Calabrian Arc. From Totaro et al. 2014, the area interested by the swarm activity is highlighted with a high pressure of faults and high seismic activity.

Figure 5. Map of Calabria with seismicity from 1981 to 2012.主sequence and aftershocks. The seismic gap and swarm tendency is highlighted with a high pressure of faults and high seismicity. From the studies of Camassi et al., Quidelleur, 2001, Tellamaliev and Cucci, 2003.

Figure 6. Coulomb stress changes calculated for each phase of the seismic sequence; texts report the Mw=6.3 event, Coulomb map refers to 5 km depth. d) same as in panel c) but at 10 km depth. Gray shaded curve are expected events related to the transient background rate. No earthquakes with M>5.6 are recorded in the Pollino region in the period. From Totaro et al. (2014) and Dini working group (2013), BkC, FkC, GkC, used for Mercator basic fault. Constraints basic fault and frictional model are discussed elsewhere.

Figure 7. Time dependent probability for occurrence of another earthquake, (a) Shows the daily rate of events from 2006, superposed values are calculated for each phase of the seismic sequence, superposed values are calculated as in Fig. 6. Frequency-magnitude plots in panel (a) and the relative b-values (panel (b)) are reported together with the number of data above the catalogue completeness. Fault traces are reported in the map. The line at the failure of magnitude is a power law distribution with mean equal to six minute, while solid line is exponential distribution with mean of 2 min. In the inset same as the main plot but IETs of each sequence are calculated, markers are placed in the middle point of the time window.

Coulomb stress changes

Figure 8. Observed and modeled background. Time relative to mainshock [days]. Cumulative number of events. The observed events are the black circles, the gray shaded curve are expected events related to the transient background rate. Time dependent probability for occurrence of another earthquake, (a) Shows the daily rate of events from 2006, superposed values are calculated for each phase of the seismic sequence, superposed values are calculated as in Fig. 6. Frequency-magnitude plots in panel (a) and the relative b-values (panel (b)) are reported together with the number of data above the catalogue completeness. Fault traces are reported in the map. The line at the failure of magnitude is a power law distribution with mean equal to six minute, while solid line is exponential distribution with mean of 2 min. In the inset same as the main plot but IETs of each sequence are calculated, markers are placed in the middle point of the time window.

Conclusions:

In the present work we have examined the geometrical, mechanical and statistical characteristics of the seismic swarm unlike the Pollino range region. Fault mechanisms show primarily NNW-SSE normal faulting with some events having a right-lateral component of slip. We interpret this as the result of the transitional stress field acting in the southern part of the Mercator Basin. Due to a lack of resolution on the hypocentre of the events, we cannot definitively discriminate the tectonic structures hosting the sequence but we discuss two possible alternative scenarios. One single curved structure or a system of subparallel faults. It is difficult to explain the spatial and temporal evolution of the sequence only in terms of static stress transfer due to the larger earthquakes within the sequence, so we argue for an external forcing as a driving mechanism of the swarm.

The external forcing is confirmed by analysis of the sequence using the ETAS model. Results indicate 75% of the earthquakes in the sequence may be attributed to a transient forcing and the rest is normal aftershock activity. Changes of b-values in time throughout the sequence also support the external forcing hypothesis since low b-values correlate with the period of highest seismicity rate and with the occurrence of the largest shock. Yet, whether the external forcing is due to transient and aseismic slip episodes can only be resolved by linking high precision earthquake locations and high resolution geodetic monitoring. The swarmy propensity, as also backed by new analysis of the historical activity, can be a manifestation of “passive” energy release of small fault patches failing on a largely locked fault or part of “active” and largely aseismic release of energy by transient slip.

Reference: