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Analysis of microseismicity associated with the 2017 seismic swarm near the Aegean coast of NW Turkey

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A seismic crisis with three moderate earthquakes (M=5.1, 5.1, 5.0) took place near the Aegean coast of NW Turkey, 5 km from the active geothermal area of Tuzla, during the first three months of 2017 (January - March). A thorough spatiotemporal analysis of the intense seismic activity was conducted aiming to identify its causative relation to the regional seismotectonic properties.
First, all the available P and S phases from Greek and Turkish seismological networks (GD AUTh, NOA, KOERI) along with daily recordings were gathered in order to relocate the earthquakes and compile a high accurate catalog. In this respect, absolute and relative locations were combined and a catalog consisting of 2,485 events was compiled. Relative locations were determined with high accuracy using the double difference technique and differential times both from phase pick data and cross correlation measurements. The absolute locations were obtained using HYPOINVERSE software, an 1D velocity model, a Vp/Vs ratio and station corrections. The spatial distribution of the relocated events revealed a south dipping causative fault along with small antithetic segments. Spatially, the seismicity started on the westernmost part and migrated with time to the easternmost part of the activated area.
The temporal evolution of the seismic activity showed the existence of two distinctive periods (A and B). Period A lasted one month with small magnitude earthquakes (M<4.0), whereas period B lasted two months and included the three largest events in the sequence. The two periods were further divided in shorter subperiods based on the changes in the seismicity rate. The interevent time distribution, examined after testing several statistical distributions (i.e Lognormal, Weibul, Gamma, Exponential), was best fitted by the Lognormal distribution for each subperiod, revealing a triggering mechanism. The possibility of fluid driven seismicity was investigated by applying the epidemic aftershock-type aftershock sequence (ETAS) model in the different subperiods. Parameter α, which describes the ability of an earthquake Mi to trigger another event, showed a complex temporal evolution consisting of subsequences with swarm-like behavior as well as of Mainshock – Aftershock type. Additionally, parameter μ, which is the background rate, fluctuated with time and had values ranging from 3 to 9. This provided evidence for the existence of a strong external force, most probably related to the nearby geothermal field.

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