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A DETAILED STUDY OF THE 12TH JUNE 2017 MW=6.3 LESVOS EARTHQUAKE

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Lesvos Island is part of an old volcanic center in the east Aegean Sea that was active 15-19 My ago, located west of the coast of NW Asia Minor (Turkey). Geological, seismological and geodesy data indicate that the region’s deformation is driven by transtensional tectonics, including E-W normal and NE-SW strike-slip faulting. The abovementioned complex deformation has been associated with intense seismicity in the past, documented in catalogues of historical and instrumental seismicity.

On 12 June 2017, a shallow strong earthquake with magnitude Mw=6.3 occurred offshore, south of Lesvos (12:28 GMT), causing one fatality, severe structural damage and several secondary effects in the SE part of the island (Papadimitriou et al., 2018). This event was one of the largest that have occurred in the vicinity of Lesvos Island since the antiquity, as well as during the 20th century. It was strongly felt in the north Aegean islands and the neighboring Turkish coasts, while it was also felt in the Greek mainland.

In this work we attempt to highlight the nature and dynamics of the earthquake sequence, the driving forces that acted during its evolution and potential consequences of its occurrence on the regional hazard. To this aim, a comprehensive dataset of recordings from the Hellenic Unified Seismological Network (HUSN), a local temporary network deployed by the Geodynamic Institute – National Observatory of Athens and the Kandilli Observatory and Earthquake Research Institute (KOERI) was compiled and the following tasks were carried out: (a) determination of precise hypocentral locations employing a custom velocity model, followed by double-difference relocation, (b) spatiotemporal analysis of the sequence, (c) regional moment tensor inversion for the determination of the source parameters of the mainshock and the larger events, (d) inversion of focal mechanisms to investigate the local stress-field distribution and (e) computation of Coulomb stress transfer to identify regions that were loaded with additional stress.

After the manual determination of P- and S-wave phase arrivals, a dataset of 900 earthquakes, between 12 and 30 June 2017, was compiled and a local velocity model was calculated. Locations were following recalculated with the new model and relocated with the use of a double-difference algorithm. The spatial distribution of epicenters revealed seven clusters that are in general agreement with the geometry of known mapped faults and compatible with the strike of Quaternary faults along the southern coast of Lesvos. Seismicity gradually migrated towards the NW and SE, away from the main rupture. Additionally, on 17 June, the largest aftershock (Mw=5.2) triggered a secondary sequence on a separate fault segment, oriented NW-SE.

Regional moment tensor inversion revealed a focal mechanism with a strike of N122°E, a dip of 40° and a rake of -83°, indicating SW dipping normal faulting. Most of the determined focal mechanisms of the sequence followed this trend. Nevertheless, the largest aftershock displayed strike-slip characteristics. In addition, 82 focal mechanisms, including events of past activity (Kassaras et al., 2016), were inverted (Hardebeck and Michael, 2006). A complex stress field south of Lesvos, related both to normal and strike-slip faulting was revealed.

Results from the Coulomb stress transfer procedure indicate placement of all aftershocks outside the main rupture within positive lobes of static stress transfer. Furthermore, the occurrence of the Mw=5.2 aftershock to the SE of the island and the seismicity that accompanied it, can be attributed to stress loading on optimal faults under a strike-slip regime.

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