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The 2014 Kefalonia seismic sequence and continuous microseismicity monitoring

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On January 26, 2014 a strong (Mw6.1) strike slip earthquake ruptured the western part of Kefalonia Island, the area with the highest moment rate in the entire Mediterranean, at the southern part of Palliki peninsula. The sequence continued with numerous aftershocks that in the first few hours covered an area extended over 35 km, much longer than expected from the causative fault segment. Intense seismicity encompassing a major aftershock (Mw 5.5) in less than 6 hours after and several M>4.0 earthquakes mostly during the first three days, continued along the entire activated area, evidencing a less densely covered part where the second main shock (Mw6.0) on 3 February occurred, associated with the adjacent fault segment, located to the north of the firstly failed segment and evidently encouraged by stress transfer of the first main shock. The aftershock distribution evidenced two adjacent fault segments striking almost N–S and dipping to the east, in full agreement with the centroid moment tensor solutions, constituting segments of the Kefalonia Transform Fault (KTF). Intense aftershock activity lasted for several weeks whereas continued seismicity afterwards is mainly located off fault with minor and fewer on fault aftershocks. The seismic network was intensified in the area (Institute of Geodynamics portable network, seismic stations installed in the frame of OTRIONS project, CEN–ION network) after the main ruptures, providing improvement both in detectability and accurate locations. Since network coverage was not previously adequate for revealing detailed features of the activated area, the improved monitoring and location is of paramount importance for this scope. More recent seismicity, forming distinctive clusters, occurred along the edges of the double rupture indicating activation of adjacent fault segments. To the north several aftershocks forming an east–northeast striking seismicity band suggest a transfer zone linking KTF with its northward continuation, the Lefkada Fault. The south cluster, with the larger earthquake of M_w5.1, reveals again an almost E–W striking fault segment, placed obliquely to the regional stress field that is characterized by ENE–WSW almost horizontal compression and NNW–SSE almost horizontal tension. The off fault clusters may well be interpreted as triggered by stress transfer of the main ruptures, whereas they shed more light on the regional seismotectonic properties, an indispensable component for the seismic hazard assessment in this notably high seismicity area.

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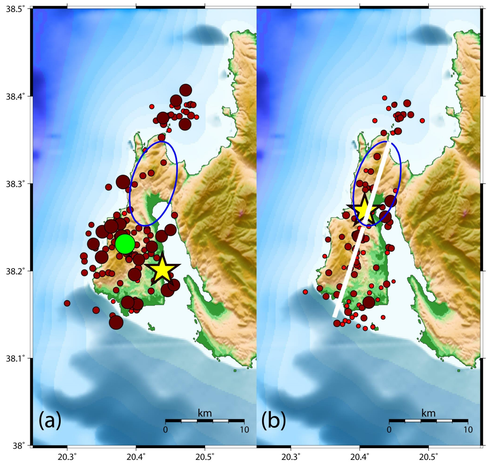
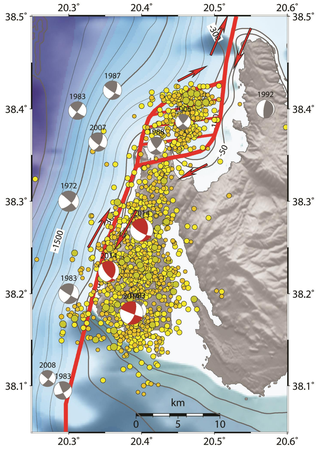
Introduction

On January 26, 2014 a strong (Mw6.1) strike slip earthquake ruptured the western part of Kefalonia Island, the area with the highest moment rate in the entire Mediterranean, at the southern part of the peninsula. The sequence continued with numerous aftershocks that in the first few hours covered an area extended over 35 km, much longer than expected from the causative fault segment. Intense seismicity encompassing a major aftershock (Mw 5.5) in less than 6 hours after and several M>4.0 earthquakes mostly during the first three days, continued along the entire activated area, evidencing a less densely covered part where the second main shock (Mw6.0) on 3 February occurred, associated with the adjacent fault segment, located to the north of the firstly failed segment and evidently encouraged by stress transfer of the first main shock.



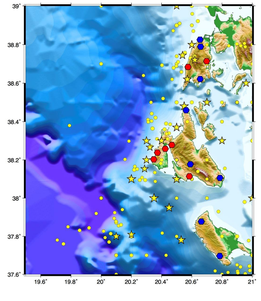
The aftershock distribution evidenced two adjacent fault segments striking almost N–S and dipping to the east, in full agreement with the centroid moment tensor solutions, constituting segments of the Kefalonia Transform Fault (KTF). Intense aftershock activity lasted for several weeks whereas continued seismicity afterwards is mainly located off fault with minor and fewer on fault aftershocks (Karakostas et al., 2014).

Continuous monitoring of seismic activity



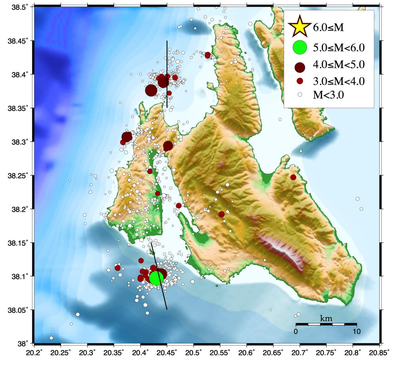
Aftershock activity (circles) along with inferred fault traces and strong earthquakes fault plane solutions shown as equal area lower hemisphere projections. The compressions quadrants of the stronger earthquakes of the sequence are shown in red. The off fault aftershock activity forms a transfer zone of extensional step overs that connect the Kefalonia Transform Fault to the south with the Lefkada Transform Fault to the north (Karakostas et al., 2014).

The seismic network was intensified in the area (Institute of Geodynamics portable network, seismic stations installed in the frame of OTRIONS project, CEN–ION network) after the main ruptures, providing improvement both in detectability and accurate locations. Since network coverage was not previously adequate for revealing detailed features of the activated area, the improved monitoring and location is of paramount importance for this scope.

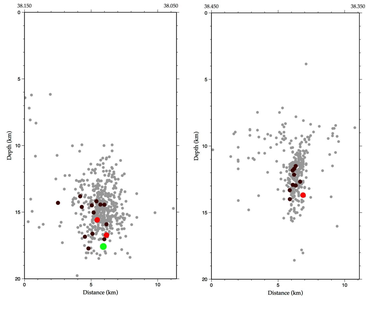


Seismological stations that were linked to Hellenic Unified Seismological Network (HUSN) before (blue dots) and after (red dots) the occurrence of the 2014 seismic sequence.

Recent Seismicity



More recent seismicity (01 November 2014 – 31 January 2015), forming distinctive clusters, occurred along the edges of the double rupture indicating activation of adjacent fault segments. To the north several aftershocks forming an east–northeast striking seismicity band suggest a transfer zone linking KTF with its northward continuation, the Lefkada Fault. The south cluster, with the larger earthquake of M_w5.1, reveals again an almost E–W striking fault segment, placed obliquely to the regional stress field that is characterized by ENE–WSW almost horizontal compression and NNW–SSE almost horizontal tension.



Cross section normal to the orientation of the aftershock activity of the southern and the northern cluster. The symbols are the same as in the map view of the above figure.

Results – Conclusions

- The 2014 Kefalonia doublet (M_w6.1 and M_w6.0) with the two main events being separated by seven days in time and about 10 km in space, are associated with two adjacent fault segments that are compatible with dextral shearing along the Kefalonia fault branch.
- The cluster to the north of the two main fault segments can be decomposed in a branch of WSW–ENE striking parallel lineaments, forming bends and stepped strike slip secondary faults
- The area of Myrtos gulf exhibited high seismicity continuously, which along with the absence of any known strong earthquake in the area is an evidence of aseismic movement in the area, an observation demanding more investigation with more data.
- The most recent seismicity forms distinctive clusters that may well be interpreted as triggered by stress transfer of the main ruptures, whereas they shed more light on the regional seismotectonic properties, an indispensable component for the seismic hazard assessment in this notably high seismicity area.

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