Geophysical Research Abstracts
Vol. 18, EGU2016-7018-1, 2016
EGU General Assembly 2016

The 2015, Mw 6.5, Leucas (Ionian Sea, Greece) earthquake: Seismological and Geodetic Modelling

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A cluster of earthquakes (6<M_s <7) characterized by strike slip faulting have occurred along the NW edge of the Aegean Arc in the Ionian Sea, the most seismically active region in Greece, in the last 30 years. The most recent earthquake was the 2015 (M_w 6.5) Leucas (Lefkada) earthquake. The modelling of these earthquakes, some of which are double events (2003 Leucas; 2014 Cephalonia) is a challenge for two main reasons. First, the geography of the area limits the distribution of the available seismological and GNSS stations and the correlations of INSAR data. Second, the structural pattern of the area indicates distributed thrusting but recent earthquakes are confined to the west margin of the Aegean Arc, usually assigned to the Cephalonia Transform Fault (CTF), and are dominated by strike slip faulting.

In order to contribute to the understanding active tectonics along this critical region, our study was based on the independent analysis of the seismological and geodetic signature of the 2015 earthquake and the on the joint evaluation of the inferred models on the basis of the fault pattern of the area and of previous earthquakes.

First, based on teleseismic long-period P- and SH- and broad-band P-waveforms a point-source solution at the SW part of Leucas yielded dominantly right-lateral strike-slip faulting mechanisms (strike: 23^o, dip: 68^o, rake: -170^o) with a shallow focal depth (h: 9 km) and with seismic moment of M_o: $10.4x10^{18}$ Nm. Furthermore, the rupture history of the earthquake was obtained by applying a new back-projection method that uses teleseismic P-waveforms to integrate the direct P-phase with reflected phases from structural discontinuities near the source. In the slip inversion the faulting occurs on a single fault plane (strike and dip are obtained from the best fitting point-source solution) and slip (rake) angle varied during the whole rupture process.

Second, co-seismic displacements were derived from eight permanent and one campaign GPS stations spread in the near and far field of the meizoseismal area. Significant horizontal slip was recognized, with a maximum dislocation of 36 cm in the SW part of Leucas island. Inversion of GPS-derived displacements using the new TOPological INVersion (TOPINV) algorithm permitted to model a nearly vertical strike slip fault (strike: 15^o, dip: 78^o, rake: -175^o and M_o: $11.4x10^{18}$ Nm), fully controlled by a variance co-variance matrix, and subsequently a variable-slip model. An alternative low-angle strike slip fault was also computed. Both models were obtained assuming all nine variables defining a fault variable fully constrained, simply each one taking possible values independent of each other in a broad space.

The matching of the independently computed seismological and geodetic fault-models indicate that the 2015 earthquake was associated with a nearly strike-slip fault just offshore SW Leucas, and along with the events in the last 30 years, it indicates gradual, piece-wise rupture of the west edge of a shear zone which is superimposed on the regional compressional margin of the Aegean Arc.