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The October 25, 2018 M6.7 Zakynthos earthquake sequence (Ionian Sea, Greece): fault modelling from seismic and GNSS data and implications for seismic strain release along the western Hellenic Arc

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Extended abstract

We present preliminary analysis of the fault model and the shallow earthquake sequence offshore Zakynthos (Ionian Sea, Greece; Fig. 1) that was initiated by the October 25, 2018 $M_{w(NOA)}$=6.7 earthquake (event no 15 in Fig. 1). We use geodetic and seismological data (phase data and moment tensor solutions from NOA) to identify the geometry and kinematics of the fault plane using linear inversion techniques in elastic half-space. First, we analysed the time series of fourteen (14) permanent GNSS stations located around the epicentre, two of them (ZAKU, ZAKY) being located on the island of Zakynthos and one (STRF) on the small island of Strofades. The stations are equipped with dual-frequency geodetic receivers and belong to several networks such as NOANET (Ganas et al., 2008; 2013), HxGN SmartNet Greece, Uranus (Greece) and RING (INGV). The GNSS data are processed using the GIPSY 6.4 software. This software uses a Precise Point Positioning processing strategy (Zumberge et al., 1997). We found that cm-size co-seismic horizontal offsets were recorded by the continuous GPS stations operating at both Zakynthos and Strofades islands. Secondly, for the broader region of Zakynthos, 2335 earthquakes were relocated using phases from the NOA online catalogue for the period 23 October 2018 - 17 January 2019, applying the nonlinear location algorithm NonLinLoc (Lomax et al., 2000). Thirdly, we processed Sentinel-1 SAR (C-band) data. Despite the large magnitude of the mainshock (M6.7), the surface deformation in Zakynthos is not clearly visible with differential InSAR because of the offshore occurrence of the earthquake. In various co-seismic interferograms we see small co-seismic displacements within 1 fringe (28 mm). This small visible signal is not consistent with the slip-model predictions, based on the GPS inversion models (Fig. 2). We attribute the "reduced" InSAR signal in tropospheric effects that mask most of onshore deformation. We then modelled the co-seismic displacements by assuming that the earthquake corresponds to a homogenous slip on a rectangular fault buried in an elastic half space, and we use the formalisms of Okada (1992). The best fitting fault has a centroid at 6.5 km depth which is shallower than most seismological estimates (for example, the 12-15 km of GEOSCOPE). The GPS inversion product indicates that the 25 October 2018 earthquake was due to the activation of one reverse fault with a total length of about 30 km (see green rectangle in Fig. 1), at depths 5-15 km. The fault-dip direction is also retrievable from GNSS data inversion with a low-angle (25°), eastern-dip. Therefore, we propose that the M6.7 event occurred along a N-S striking seismic fault which is located on the African-Aegean plate interface (i.e. along the megathrust).

As the October 25, 2018 event occurred along the Hellenic megathrust it signifies the high degree of seismic coupling in this region of the Hellenic Arc (i.e. Laigle et al., 2002). It also highlights the "strong" nature of the subducting slab with the occurrence of "locked" patches under the Ionian seafloor that fail during large, reverse-slip earthquakes (see Fig. 1 where 6 such events are shown near Zakynthos). In addition, the data from the recent, strong seismic events of the western Hellenic arc (1976 Zakynthos, 1997 Strofades, 2018 Zakynthos; events 7, 10 and 15 in Fig. 1) point to a sequence of a low-angle events along the plate interface with most of co-seismic deformation taken up by the upper (Aegean) plate (plate transport and uplift).

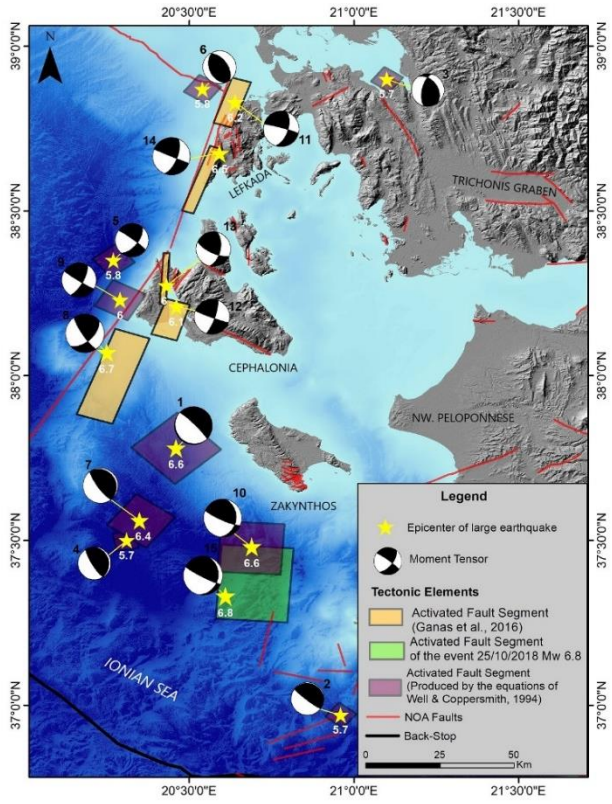

Figure 1. Overview relief map of western Greece showing the location of the offshore strong seismic events since 1959 (shaded rectangles).

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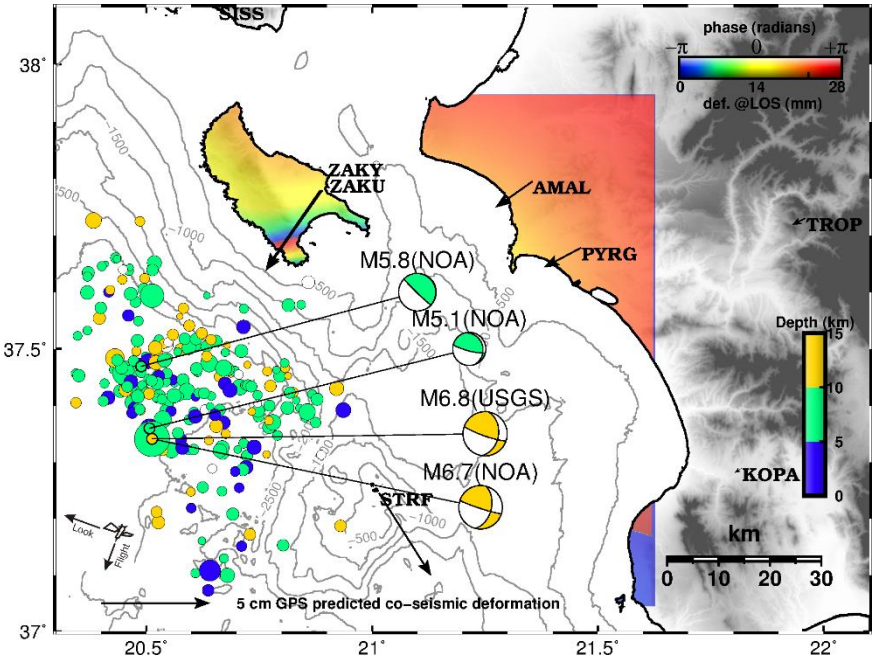

Figure 2. Modelled co-seismic S1 interferogram. Descending orbit.

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