The 2018 Mw 6.8 Zakynthos, Greece, earthquake Strike-slip and thrust faulting in shallow subduction

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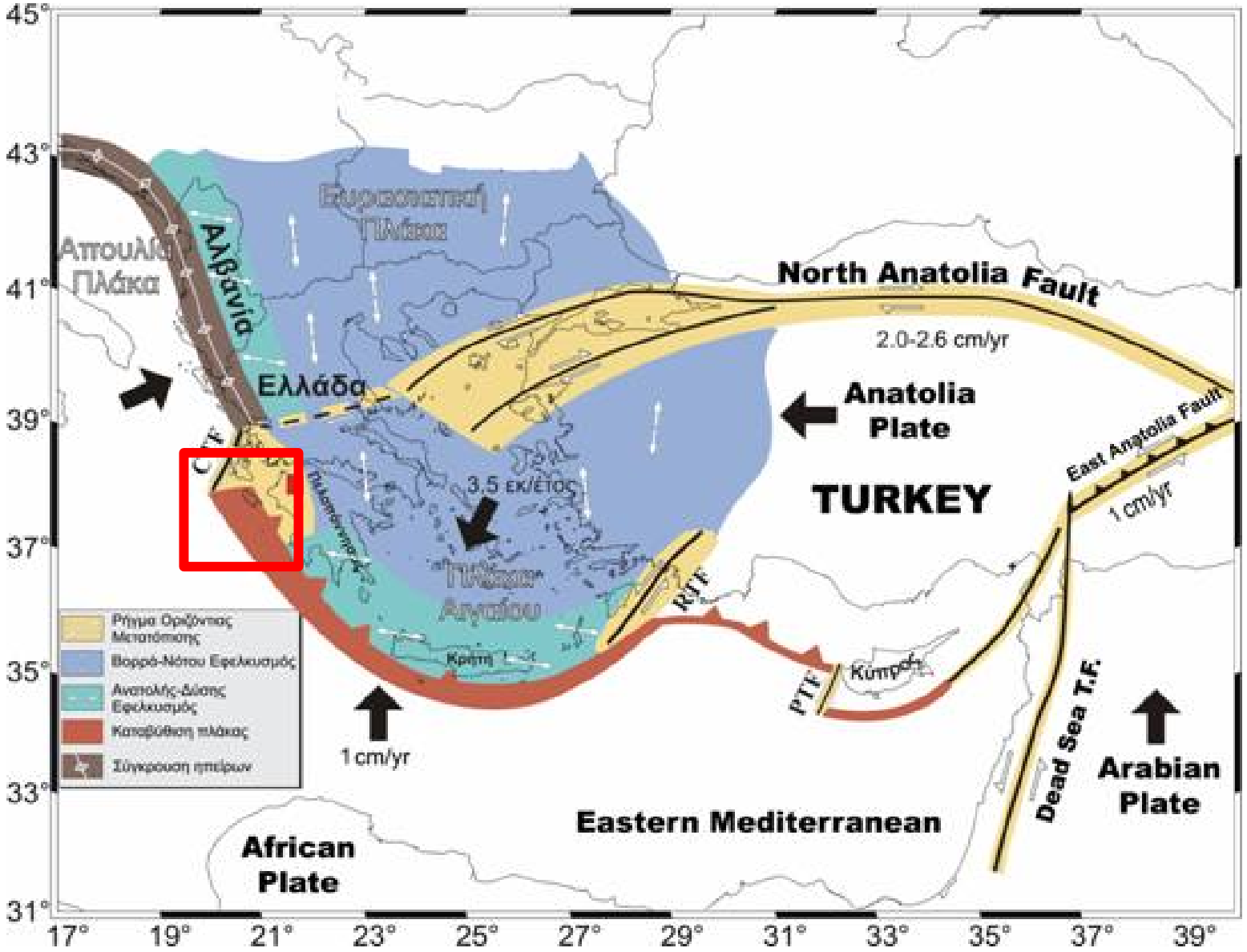
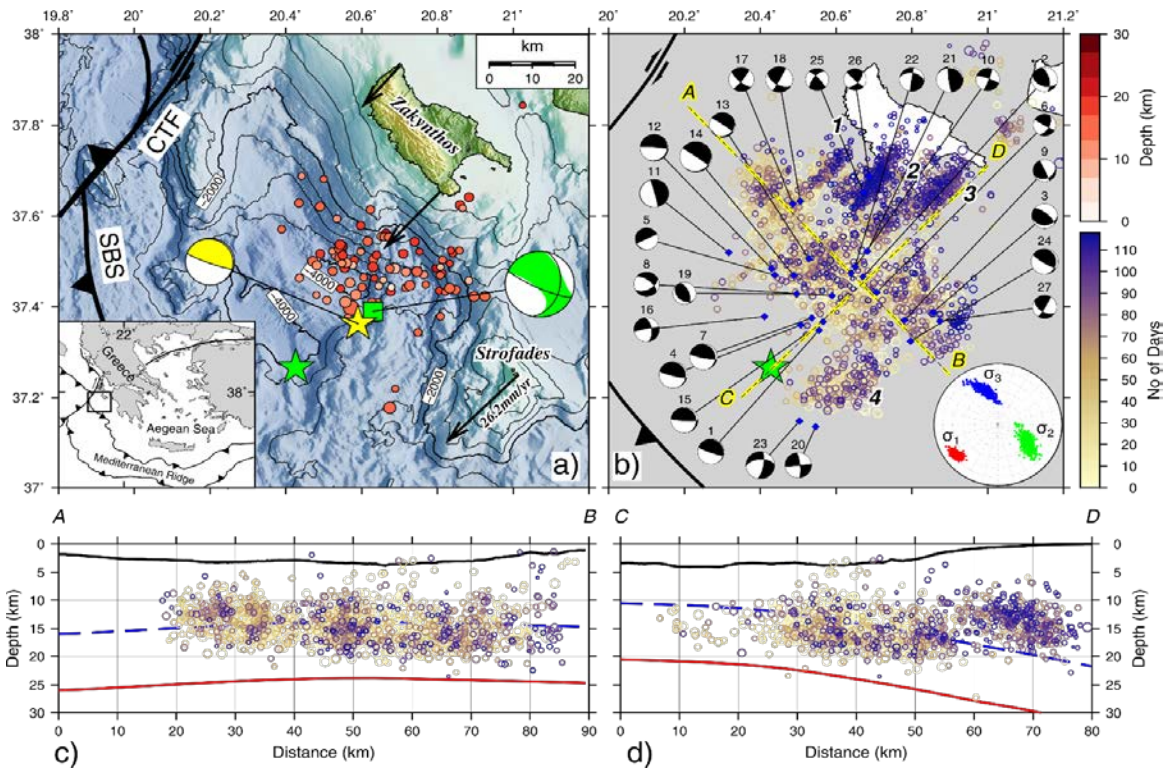
Seismotectonic context



Papazachos et al., 2000

The 2018 Zakynthos earthquake sequence

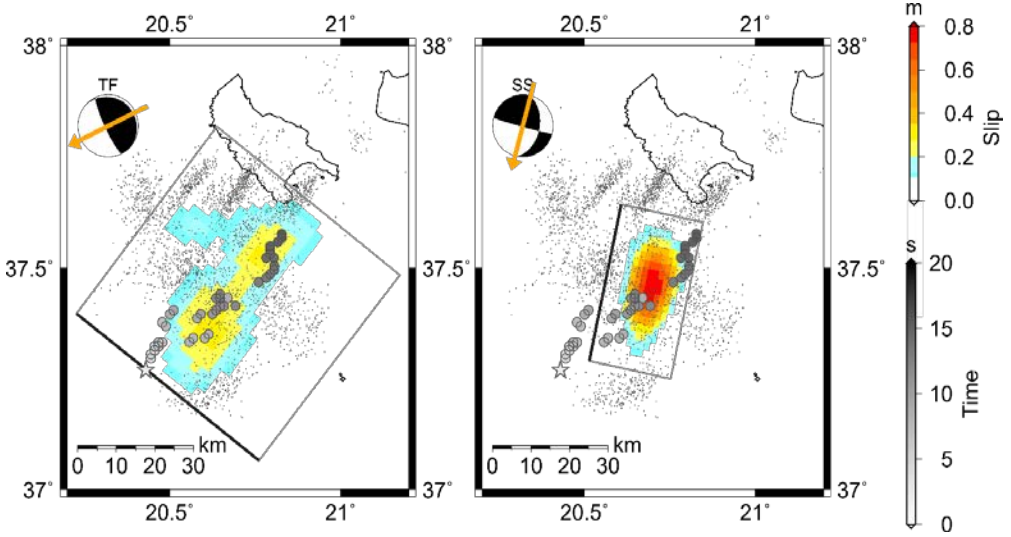
- Event (6.8Mw) occurred on October 25, 2018, at 22:54 UTC, southwest of Zakynthos island, western Greece
- Limited damage on the island, event connected with Hellenic subduction
- Mixed strike-slip and thrust faulting. MT solutions provided by international agencies suggested large CLVD component
- This study analyzes the source process of the 2018 mainshock and aftershocks using regional broadband, accelerometric and GNSS data
- We interpret the mainshock in terms of a segmented source model, possibly related to trench-orthogonal fractures in the subducting plate and reactivated faults in the upper plate.



a) Foreshock (yellow star and beachball), mainshock epicenter (green star), centroid-moment-tensor (green square and beachball), and activity in the first 24 hours b) Activity in the first 120 days with focal mechanisms. Principal stress axes are shown in the inset. c, d) Vertical cross sections along profiles AB and CD shown in panel b, and their vicinity +/- 10 km, with surface topography (black), schematic slab top (blue line), and Moho (red line;

Segmented Fault model

- Study of segmented rupture started with multiple point source (MPS) modelling of local strong motion waveforms, results indicated that the largest subevent had a strike slip mechanism (SS), smaller subevents were of thrust type (TF)
- Furthermore, the linear slip inversion (LSI) method was used for detailed modelling of the source process
- We tested several combined SS+TF models, as suggested by the MPS modeling
- The final source model consists of two fault segments (SS+TF), representing a reasonable compromise between very good fit of waveforms, large non-DC part, and an overall consistency with aftershocks.
- Importantly, if summing the DC-constrained MTs of the TF and SS faults, we obtain a significant CLVD value (-56 %), thus explaining the observed non-DC mechanism. Obviously, even more complex models cannot be ruled out.

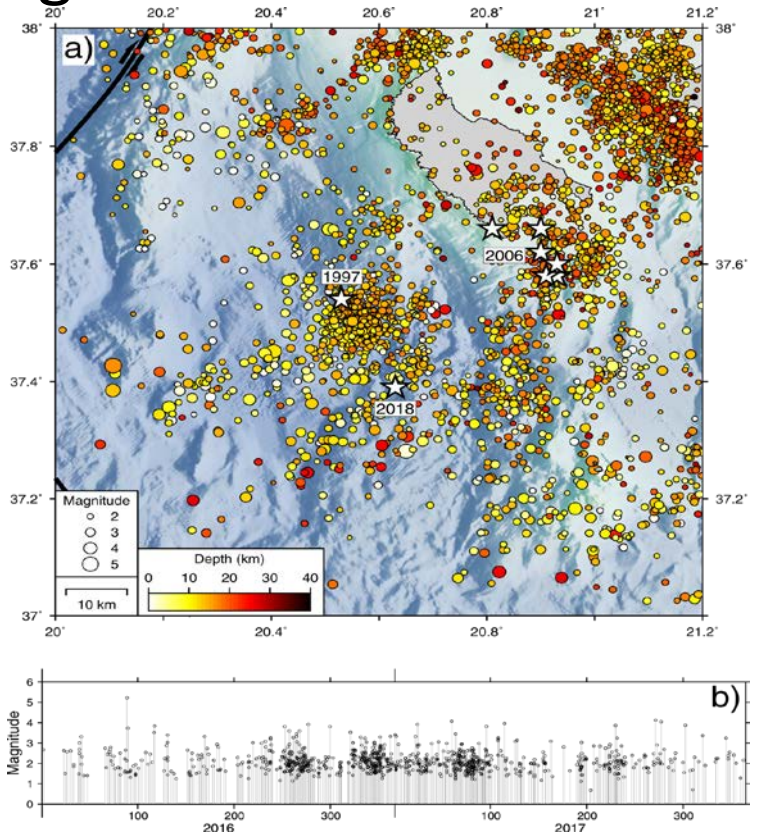


Segmented fault model. Map view of the slip distribution on the modest thrust (left) and dominant strike-slip (right) faults is shown by color. Overprinted are aftershocks (dots) and space-time high frequency energy release from backprojection (small circles, shade-coded according to time; time 0 corresponds to origin time). Star marks the epicenter; rectangles correspond to the respective fault segments. Slip vectors are shown by arrows at the beachballs.

- The moment release started on the TF segment near the shallow hypocenter, and propagated to northeast along both faults. The SS fault ruptured a single compact patch, with peak-slip of 0.8 m, situated between the two TF episodes. The entire thrust process developed on or near the slab top, but due to limited data and location inaccuracies we cannot be more specific.

Discussion – Source model and regional tectonics

- The low-dip TF part of the source process is clearly acceptable in the shallow subduction environment, but the dominant SS fault slip of the 2018 earthquake is a significant finding deserving more discussion.
- Possible explanations of SS faulting near the trench include e.g. transpressional strain partitioning due to oblique plate convergence. (This process has been documented in the area)
- Other explanations include a) the SS fault is part of a restraining bend or a part of a strike-slip duplex, (possibly connecting one of the aftershock stripes near Zakynthos with the southern stripe) and b) that the 10°-striking right-lateral SS occurred on a ~N-S oriented reverse- or normal-fault that was reactivated as SS fault and bounds a relay ramp
- Seismicity in the are is continuous, one cluster was repeatedly activated three times (twice in 2016 and once in 2017) very near the 1997 and 2018 events. This activity was of swarm type. To explain the spatial correlation of the swarms with the significant earthquakes we can speculate that the region is affected by fluids of deep origin



Seismicity 2011-2018. a) Space distribution of earthquakes 2011-2018 (until the 2018 mainshock). The centroids of significant earthquakes southwest of Zakynthos, in 1997 (Kiratzi & Louvari, 2003), 2006 (Serpetsidaki et al., 2010) and 2018 (this paper), occurred near two localized clusters**. b)** Magnitude-time distribution in 2016-2017, demonstrating the swarm character of the clusters near the 1997 and 2018 Mw > 6 earthquakes.

Conclusions

- The Zakynthos Mw 6.8, 2018 event, had a **complex rupture** (two main segments)
- Segments had **different geometry** (strike slip and thrust type) both are compatible with regional stress and tectonics
- The **dominant strike slip segment** can be explained by e.g. strain partitioning, strike slip duplex, reactivation of older structure
- Results have significant tectonic and hazard implications

More info at : Sokos, E., F. Gallovič, C. P. Evangelidis, A. Serpetsidaki, V. Plicka, J. Kostelecký, and J. Zahradník (2020). The 2018 Mw 6.8 Zakynthos, Greece, Earthquake: Dominant Strike-Slip Faulting near Subducting Slab, *Seismol. Res. Lett.* **91**, no. 2A, 721–732, doi: 10.1785/0220190169.