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FAULT CREEP AND PERSISTENT ASPERITIES ON THE WESTERN SECTION OF THE NORTH ANATOLIAN FAULT, TURKEY

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Abstract
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Seismic segmentation of the NAF

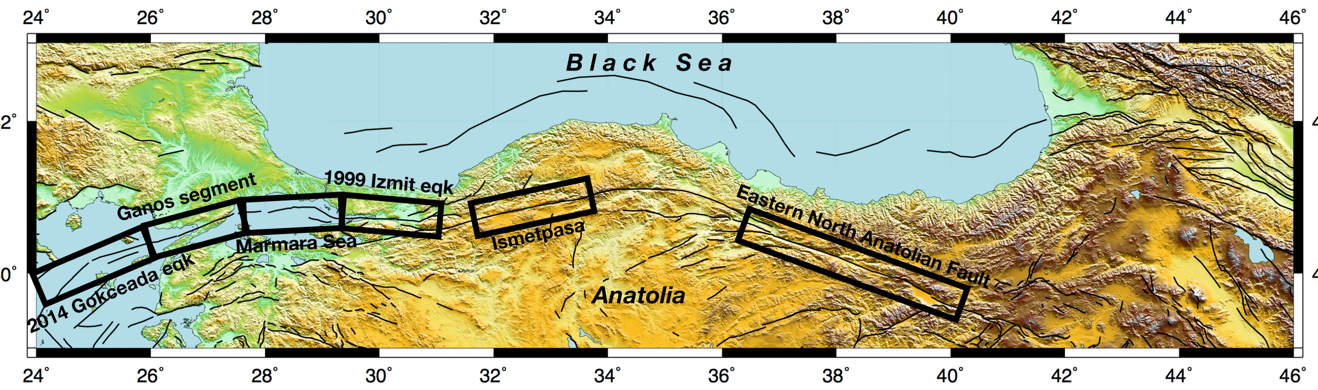

Figure 1 Overview of significant sections of the North Anatolian Fault, with historical observations showing varying behaviors over the seismic cycle. Here we synthesize geodetic and seismic observations from the four westernmost segments.

1. 2014 Gokceada earthquake (Konca et al., 2018)

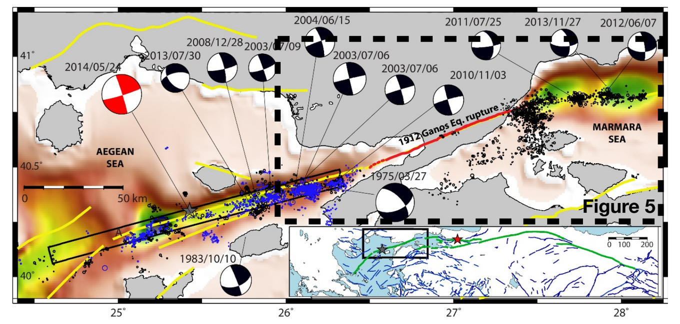

Figure 2 Yellow lines are active faults. Red trace the estimated surface break of the 1912 Earthquake. Seismic activity before the 2014 North Aegean Earthquake are black circles and aftershocks blue circles. The focal mechanisms of significant earthquakes (M>4.7) since 1975 – red the 2014 event.

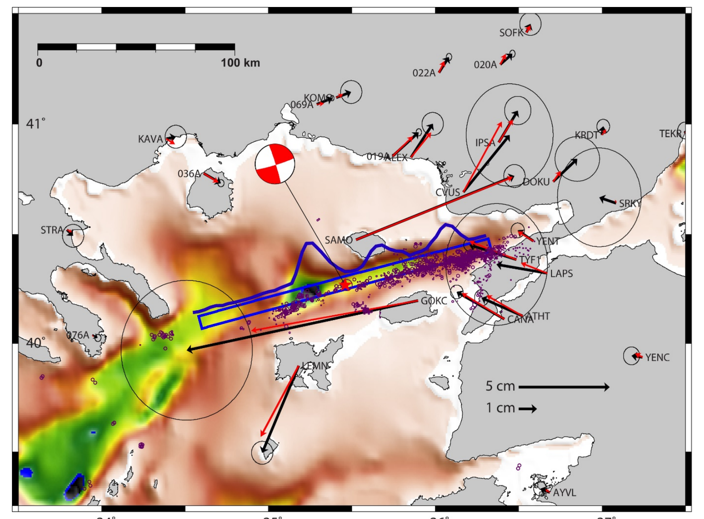

Figure 3 Coseismic offsets (black vectors) with 1-σ error ellipses. Red vectors horizontal deformations predicted from the joint slip model shown below. The map view of depth-averaged slip is shown by the blue curve. The blue rectangle shows the surface projection of the finite-fault model.

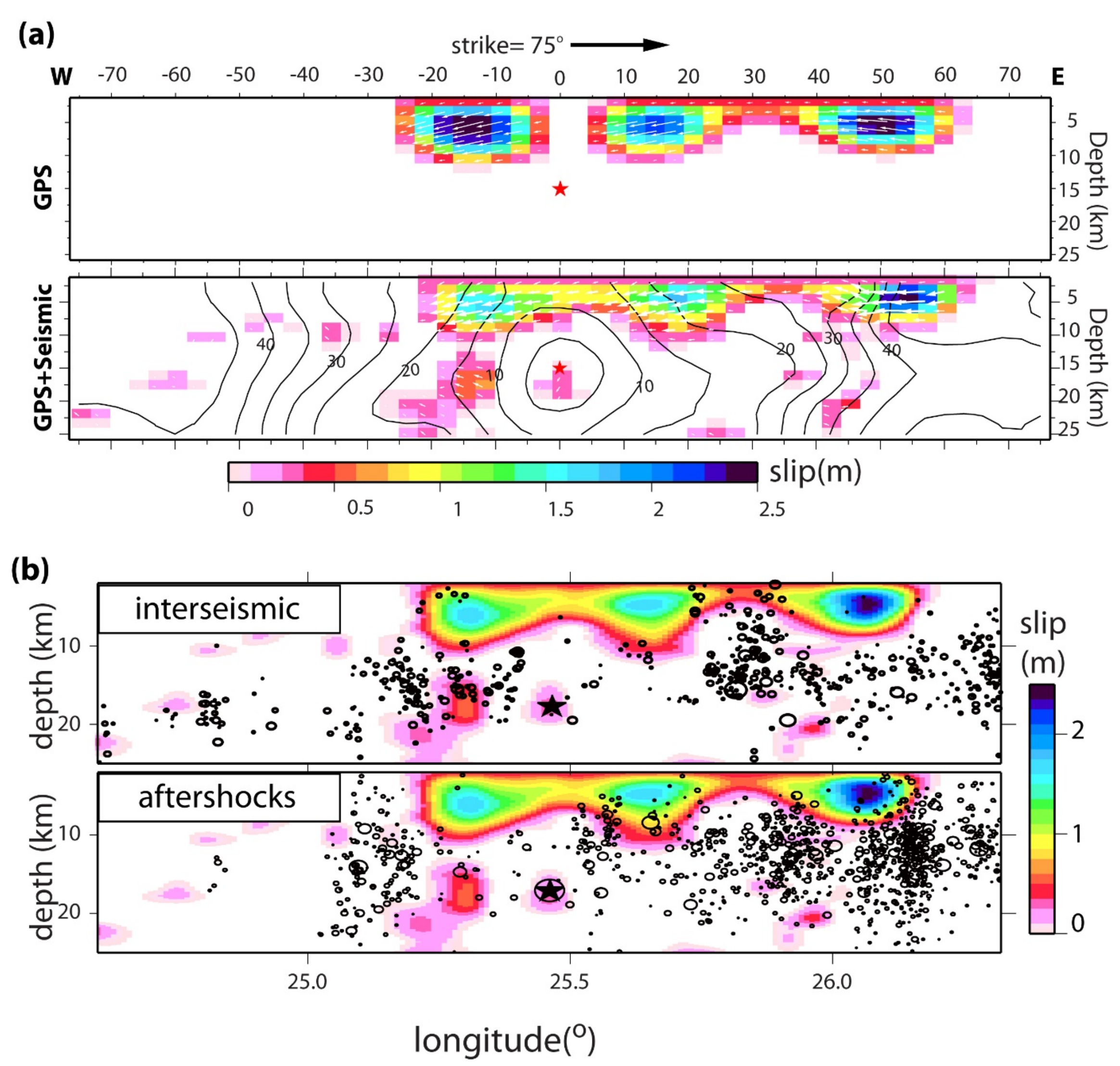

Figure 4 (a) Slip distribution obtained from modeling of GPS data. (Bottom) Slip distribution obtained from GPS and seismic data. (b) (Top) Coseismic slip distribution and the seismicity before the main shock (projected onto the fault. (Bottom) Same for aftershocks. Seismicity and aftershocks lie outside coseismic slip patches.

2. 1912 Ganos *M*7.4 earthquake segment

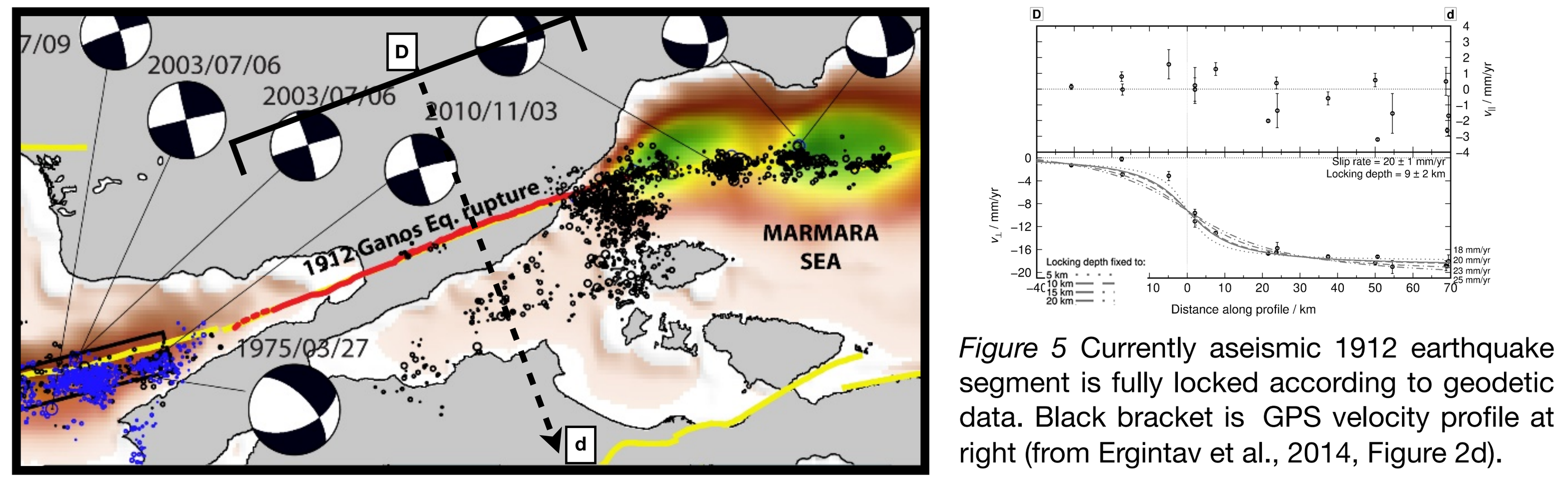

Figure 5 Currently aseismic 1912 earthquake segment is fully locked according to geodetic data. Black bracket is GPS velocity profile at right (from Ergintav et al., 2014, Figure 2d).

3. Marmara Sea segments

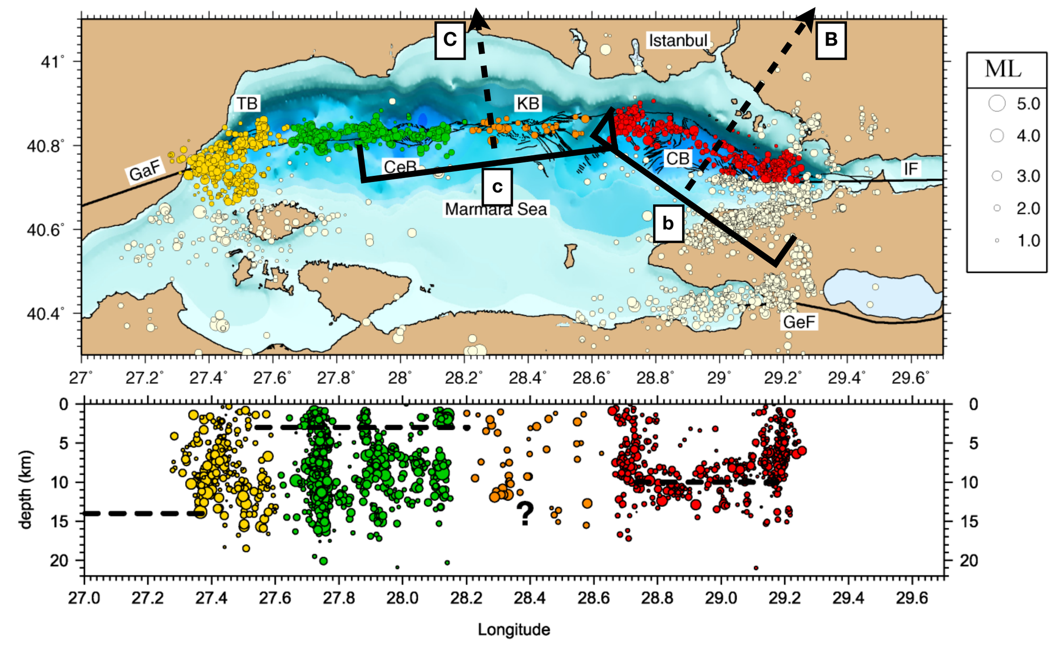

Figure 6 (Top) Marmara Sea seismicity. Black brackets are GPS profiles to right using the velocity solution of Ergintav et al. (2014). (Bottom) Seismicity projected on Main Marmara Fault (Schmittbuhl et al., 2016, Figure 2).

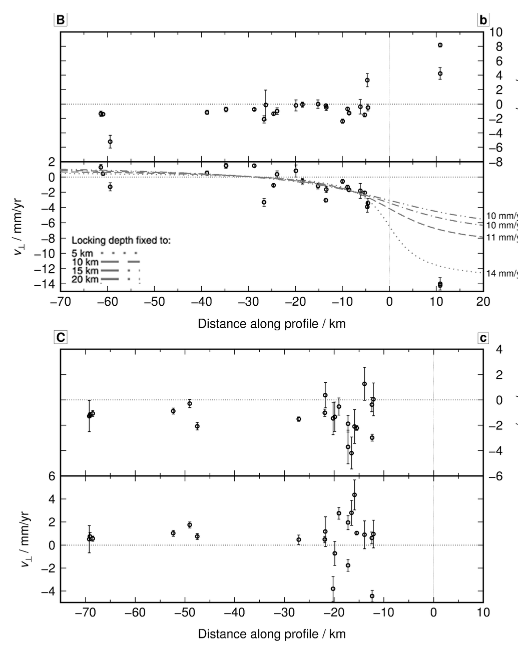

Figure 7 GPS fault-xing profiles (Top) Princes Islands segment shows strain accumulation. (Bottom) Kumburgaz Basin segment unclear, note different scales (Ergintav et al., 2014, Figures 2b and 2c).

4. 1999, M7.6 Izmit/M7.2 Duzce sequence

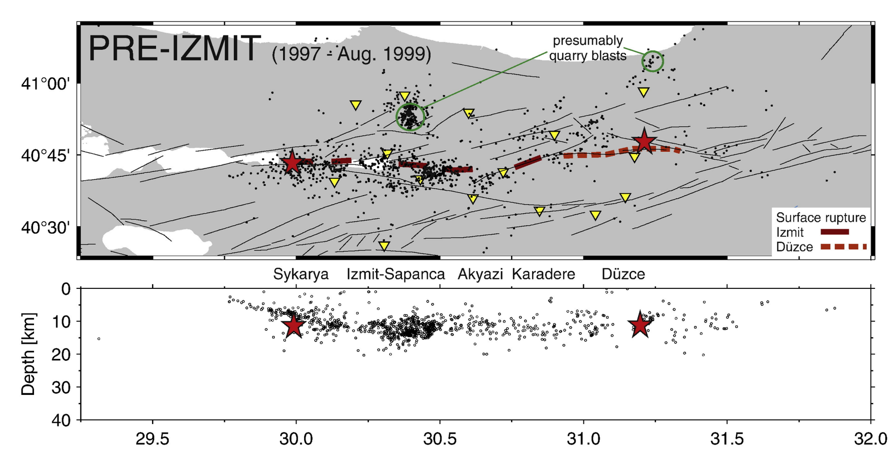

Figure 8 Pre-Izmit earthquake seismicity on fault plane; aseismic mid-crust? (Bohnhoff et al., 2016, Figure 5)

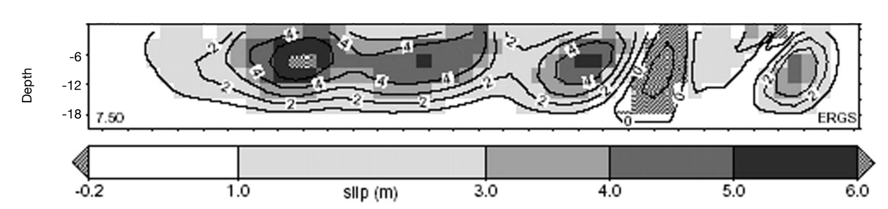

Figure 9 Izmit coseismic right-lateral slip from inversion of GPS, InSAR (ERS and RADARSAT), and SPOT correlation map. Maximum coseismic slip between 2-12 km depth.

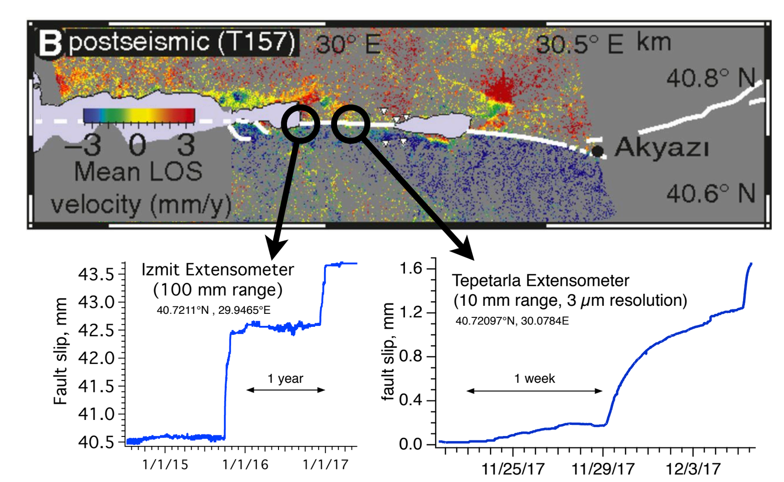

Figure 10 Fault creep continues on the section of the North Anatolian Fault that ruptured during the 1999 Izmit earthquake. Top: InSAR observations (2002–2009) of Izmit post-earthquake surface creep from Cakir et al. (2012, Figure 3). Circle shows creepmeter location (time series below). Bottom: 2015 (left) and 2017 surface creep events recorded at 2 locations on the Izmit coseismic fault attest to ongoing surface creep.

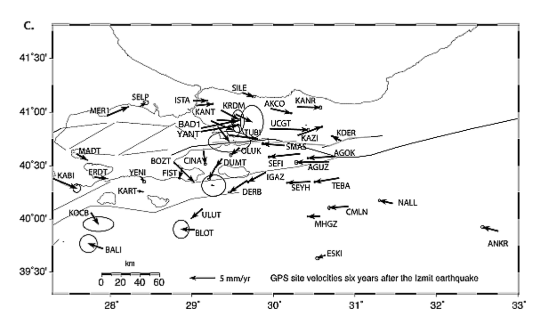

Figure 11 Postseismic GPS velocities at 6 years following the eq corrected for interseismic deformation attest to broad deformation, suggesting deep active fault creep (from Ergintav et al., 2009, Figure 6c).

3-layer elastic model for Izmit earthquake cycle

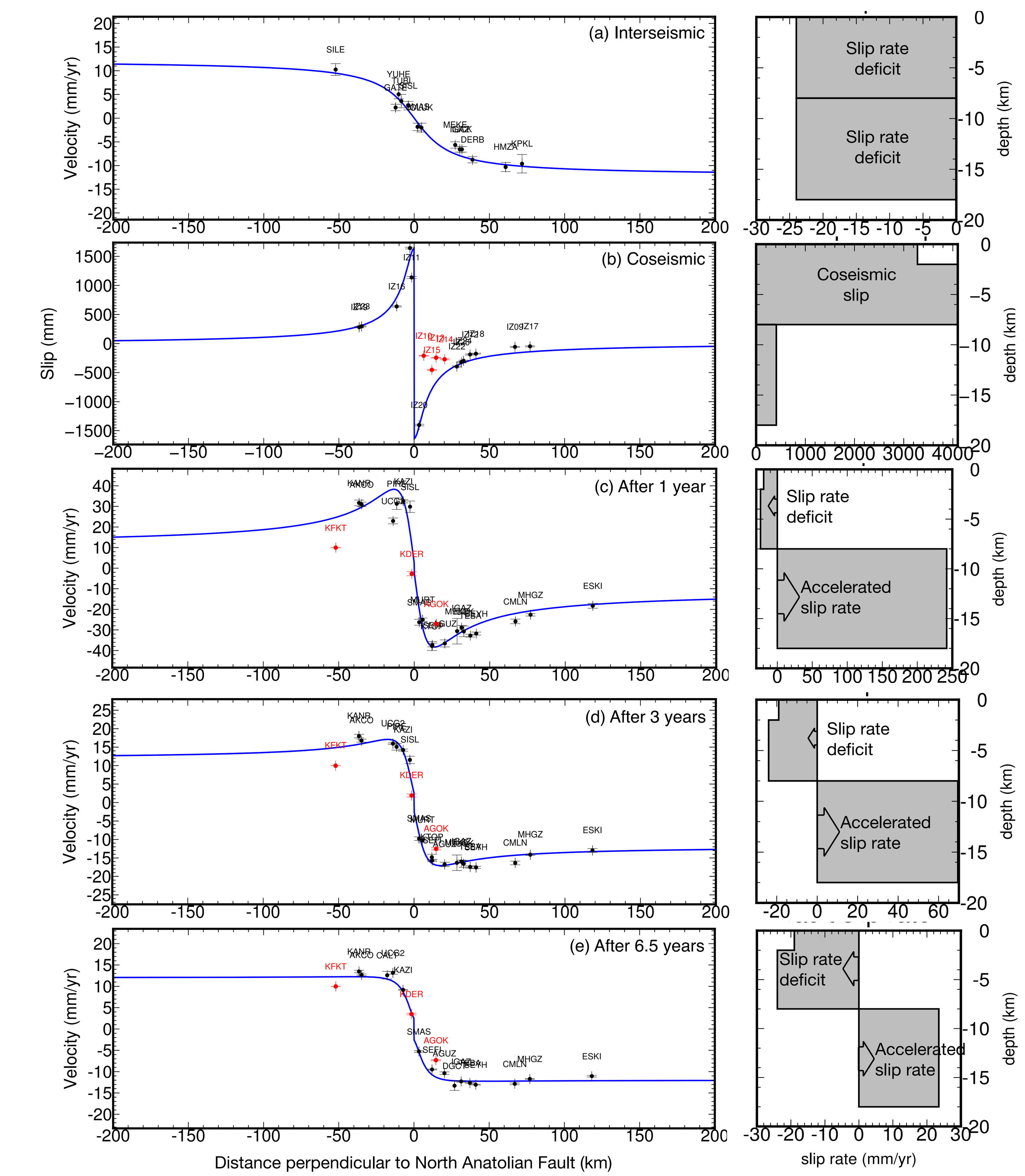

Figure 12 Left column: GPS velocity profiles across the North Anatolian Fault around the Izmit earthquake rupture for (a) pre-earthquake velocities, (b) coseismic displacements, (c) velocities 1 year after the earthquake, (d) velocities 3 years after the earthquake and (e) velocities 6.5 years after the earthquake. Blue line represents the model shown in the panel to the right. Right column: Slip rate models to fit velocity profiles consist of a middle layer (2–8 km depth) fully locked interseismically and upper and lower layers allowed to creep at a rate estimated from the data (Vernant et al., in prep.).

SUMMARY AND CONCLUSIONS

—New, precise geodetic and seismological observations allow mapping variations in coupling on the western North Anatolian Fault.
—Variations in fault coupling have a first-order effect on the earthquake cycle.
—Seismicity appears to be directly associated with areas of low coseismic slip that we infer reflect areas of interseismic fault creep.
—Models with rapid, post-earthquake fault healing in mid-layer and post-earthquake creep in top and bottom layers can account for eq-cycle deformation for the western North Anatolian Fault.
—Long-term, deep post-earthquake fault slip may contribute to earthquake interaction/propagation on the North Anatolian Fault, including deep afterslip from Izmit triggering the Duzce earthquake (Reilinger et al., 2000; Burgmann et al., 2002).

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