



The slip deficit along the North Anatolian Fault (Turkey) in the Marmara Sea: Insights from paleoseismicity, seismicity and geodetic data

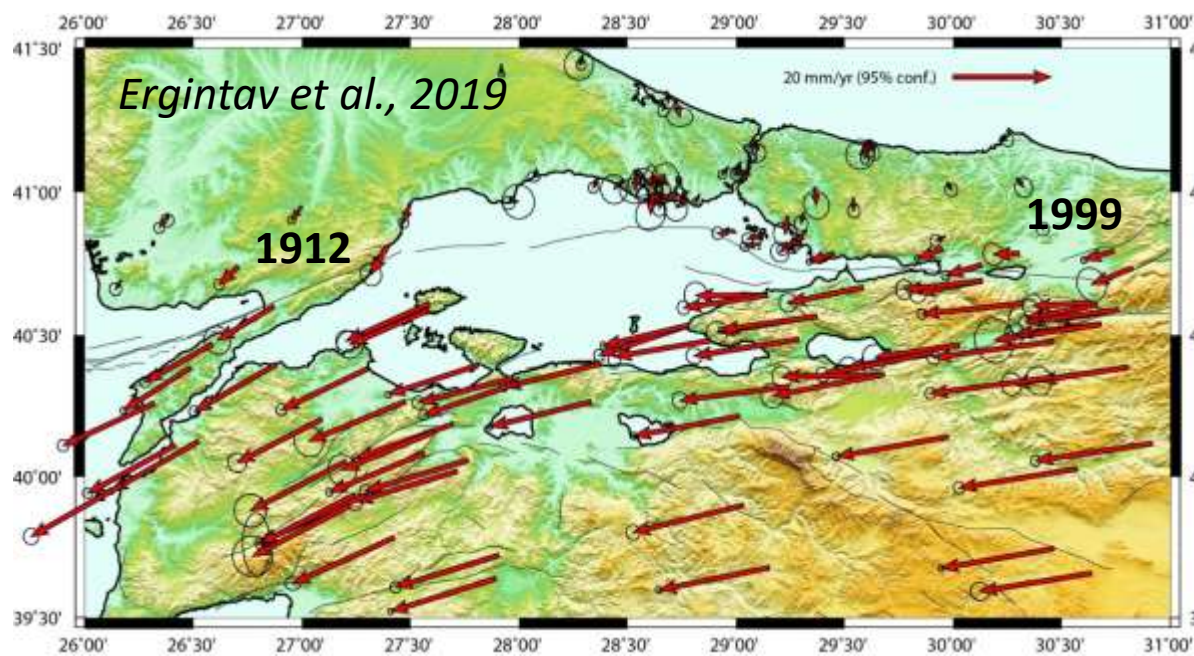
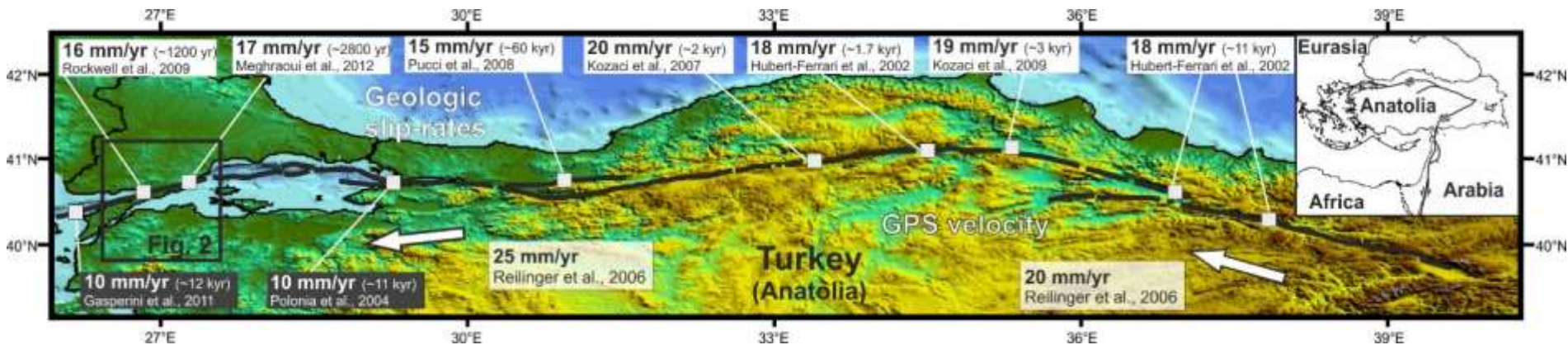
Mustapha Meghraoui & Renaud Toussaint
Institut de Physique du Globe, UMR-7516, Strasbourg University, France

M. Ersen Aksoy
Mugla S.K. University, Turkey



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Geologic slip rate and Geodetic deformation rate along the NAF

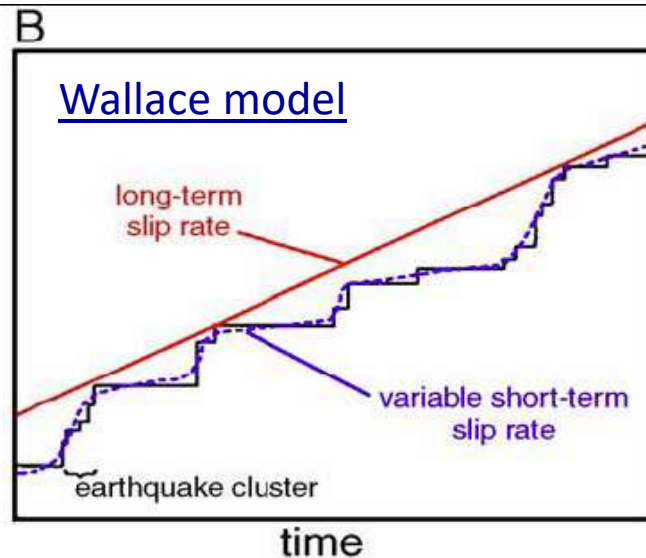
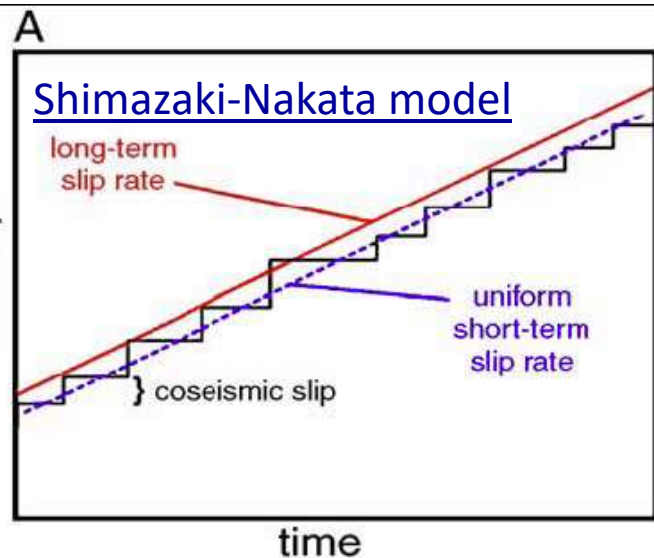


The North Anatolian Fault (NAF) is a major east-west trending, continental right-lateral strike-slip fault that limits Anatolia from Eurasia.

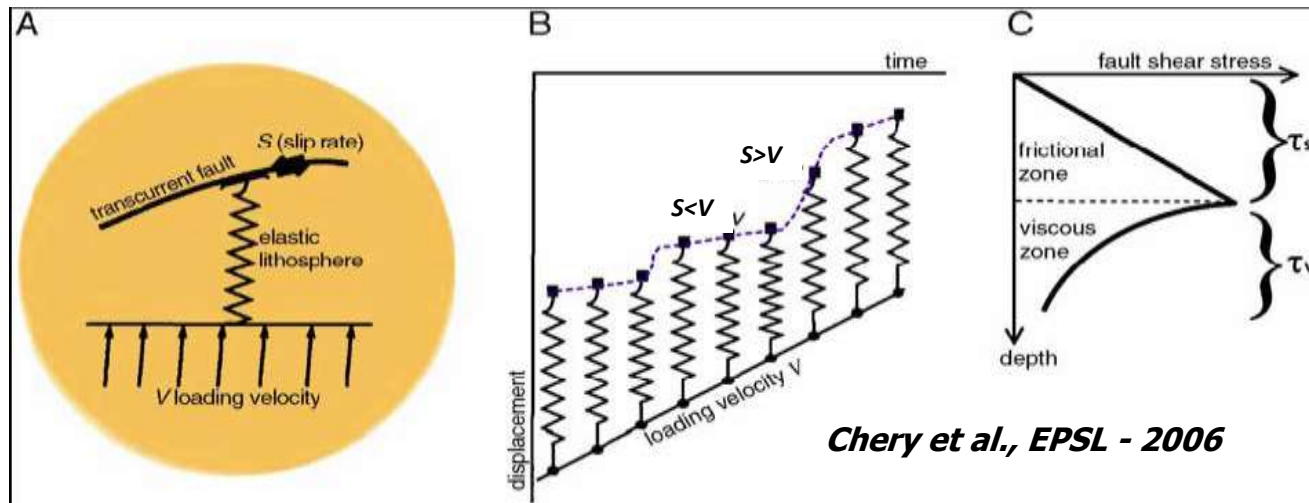
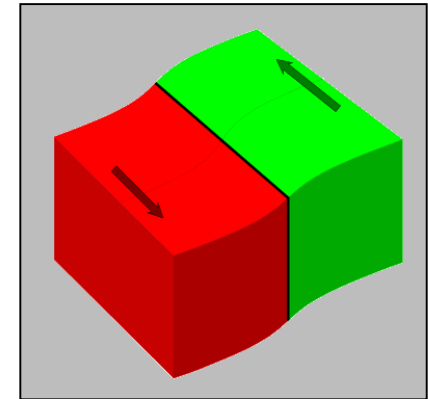
The Sea of Marmara is a major transtensional step-over. The most recent earthquakes occurred West and East of the Sea of Marmara (1912 Ganos ($M_w = 7.4$), 1999 Izmit ($M_w = 7.4$), respectively) and define the limits of a seismic gap.

The gap is related to the seismic slip deficit. We use a completed seismic catalogue, paleoseismic slip-rates and GPS velocities to constrain the characteristics of the seismic gap.

Driving mechanism, seismic cycle and strain-stress pattern



Uniform/Episodic



S = fault slip-rate
 V = plate velocity

$S > V$

« Fault strengthening »

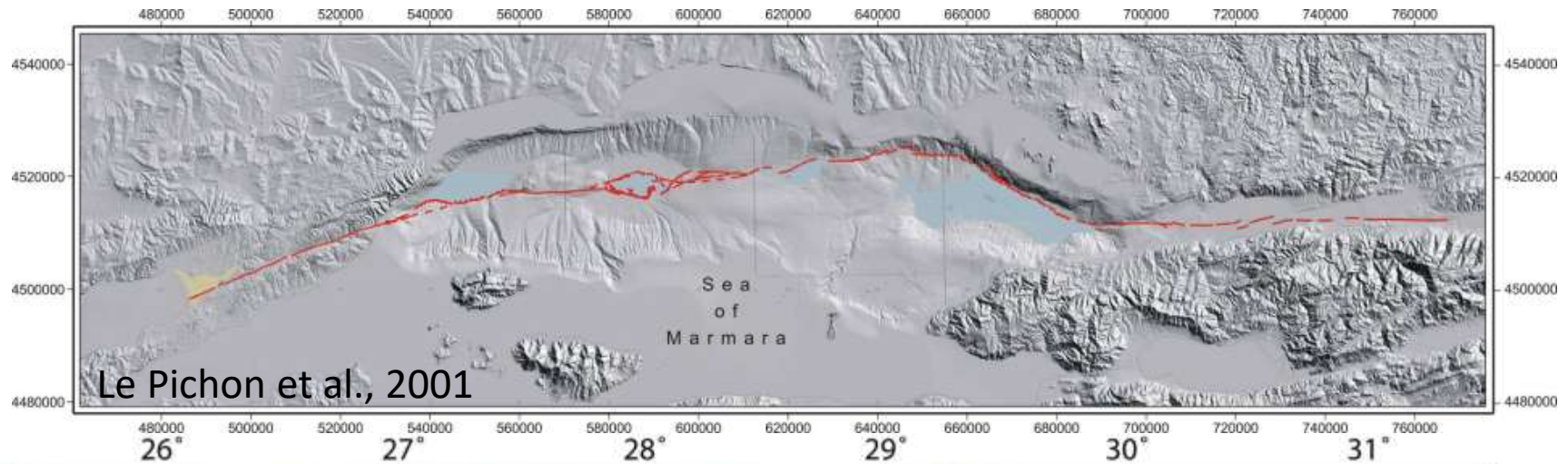
$S < V$

« Fault weakening »

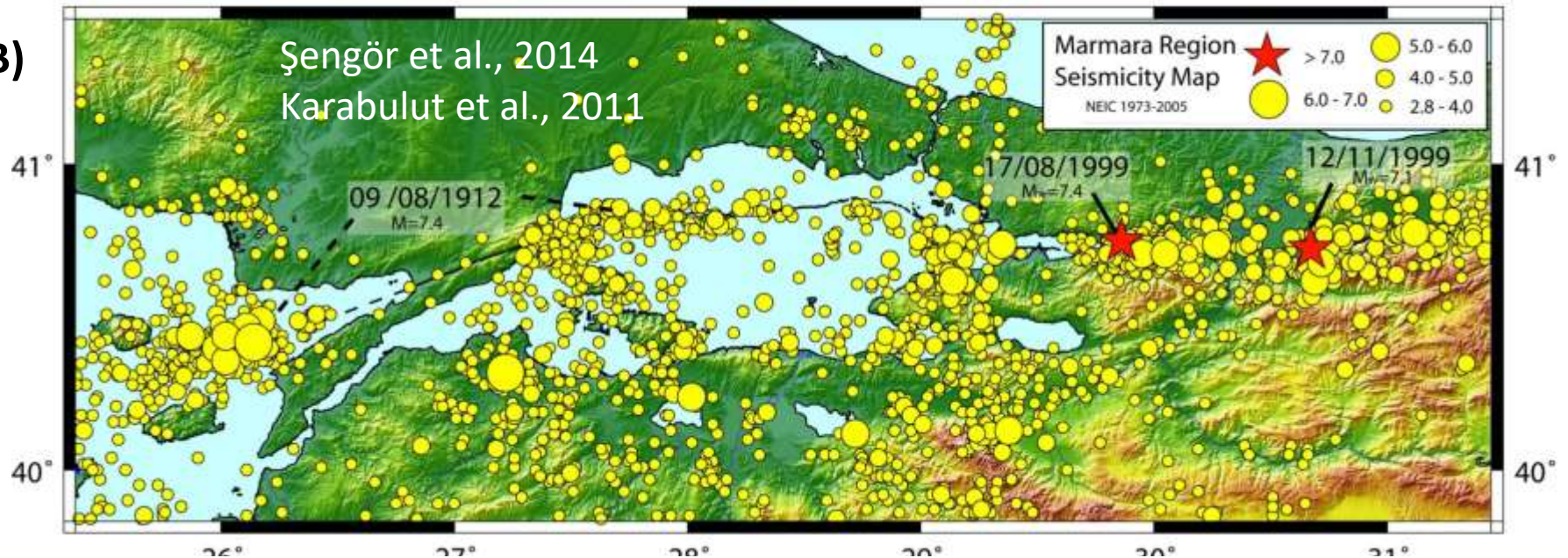
Stresses deriving from plate movements are concentrated on faults. In a state where $S < V$ requires additional slip (earthquakes) to counterbalance the accumulated strain.

Fault Geometry, Surface Faulting and Seismicity: The 1999 legacy

(A)



(B)



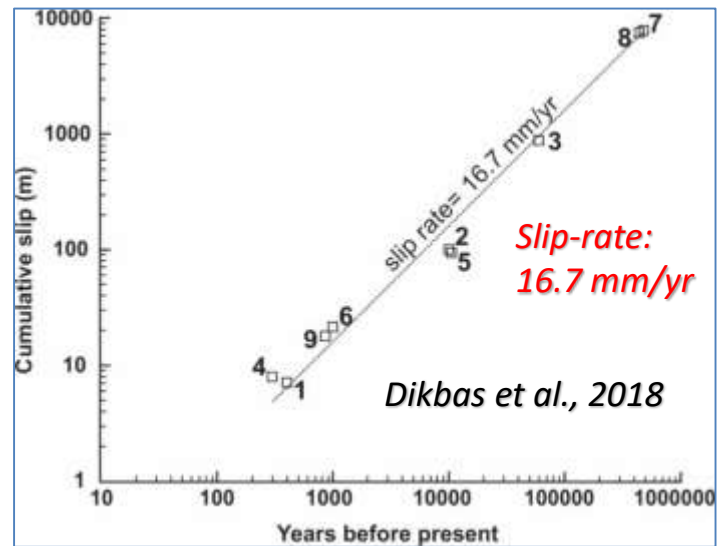
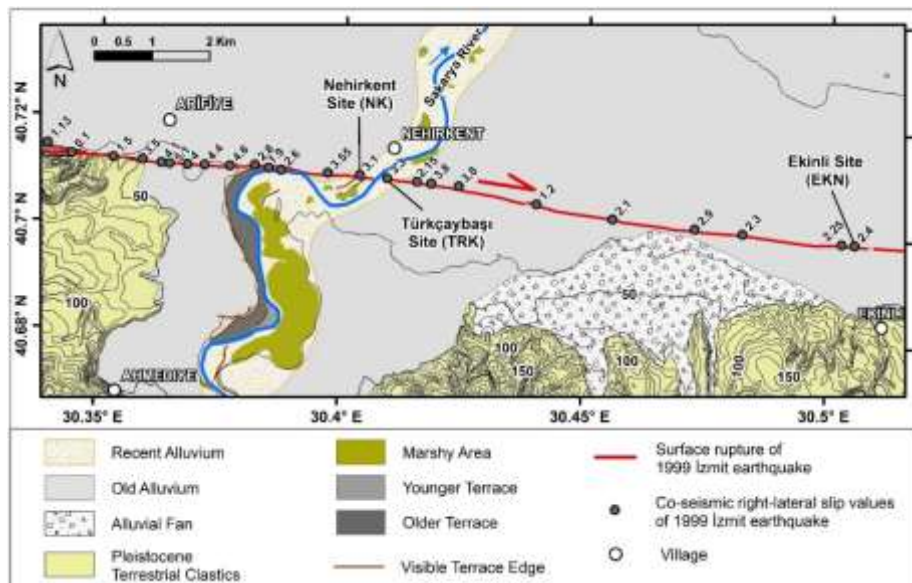
The NAF forms an extensional step-over geometry within the Sea of Marmara. The offshore fault geometry is illustrated in (A). The 1912 and 1999 earthquakes occurred at the Western and Eastern sections of the NAF. The section in between forms the seismic gap for the next large earthquake in the Marmara region.

1999 coseismic slip & slip-rate on the Eastern segment



Up to 5.5 m co-seismic slip during the Izmit 17 August 1999 Mw 7.4

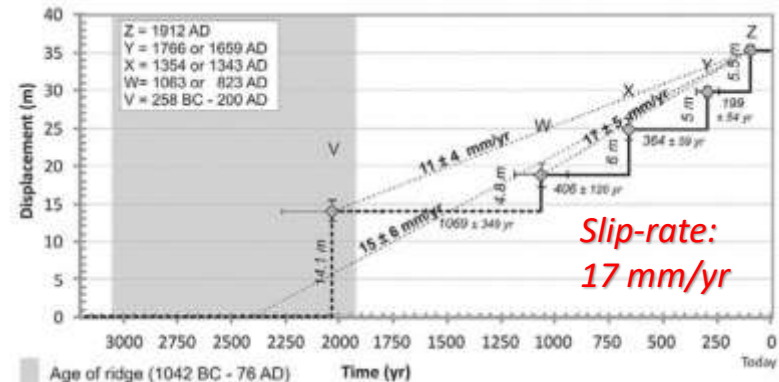
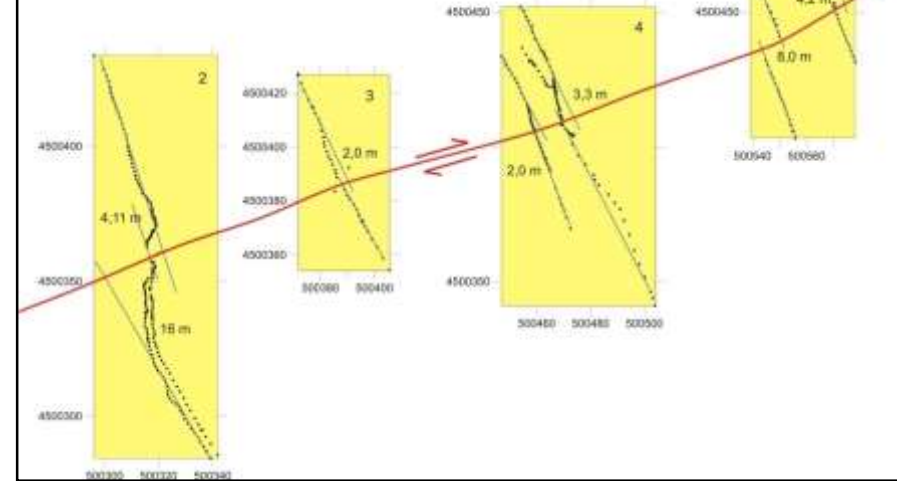
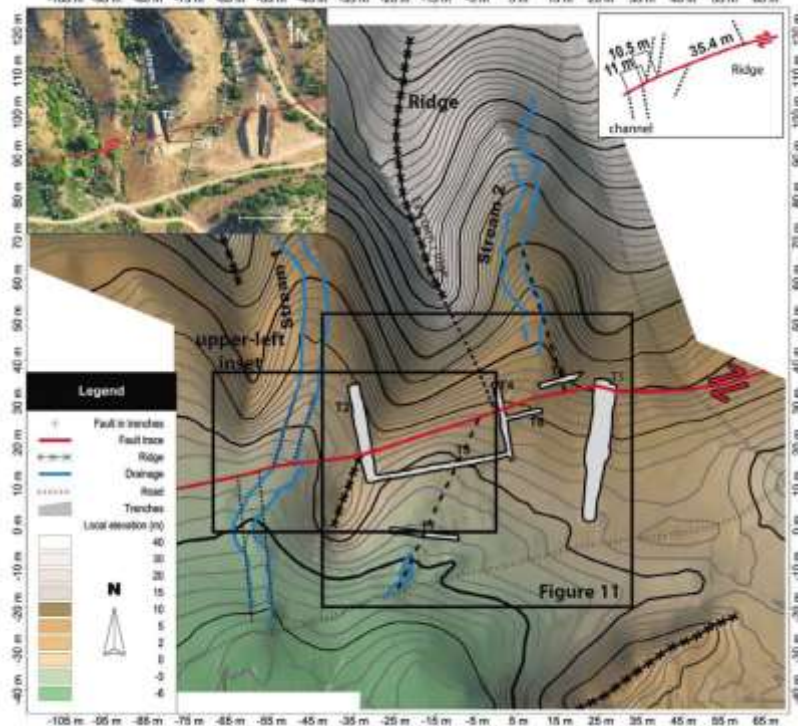
Barka et al., 2002



1912 co-seismic slip & slip-rate on the Western segment



Up to 5.5 co-seismic offset during the 1912 Ganos earthquake (Mw 7.4) (Altnel et al., 2004; Aksoy et al., 2010; Meghraoui et al., 2012)



Paleoseismic events and the seismic cycle



1912 segment

[Rockwell et al., 2001, 2009; Aksoy et al., 2010
Meghraoui et al., 2012]

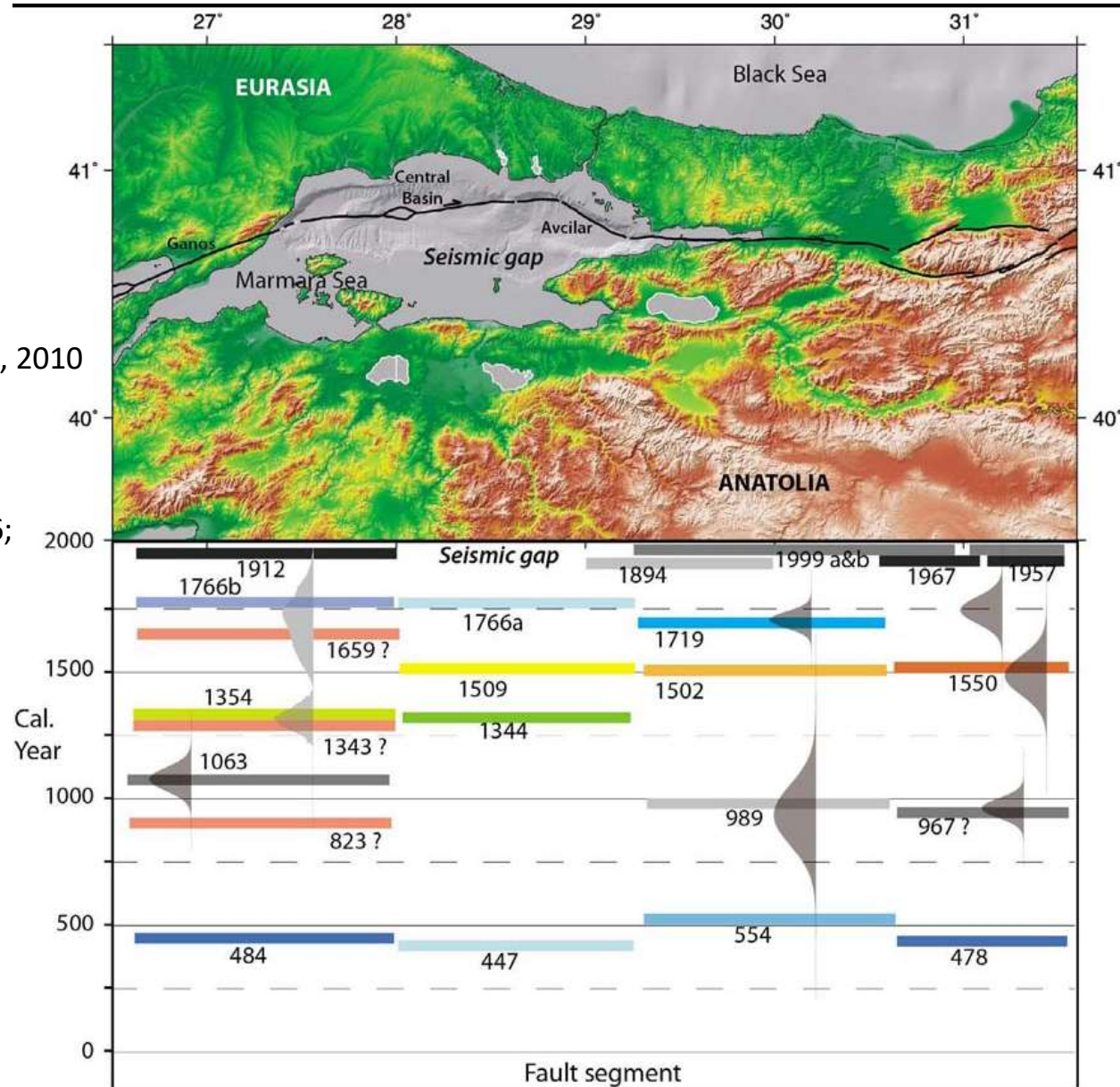
1999 İzmit segment

[Klinger et al., 2003; Pavlides et al., 2006;
Dikbaş and Akyüz, 2011]

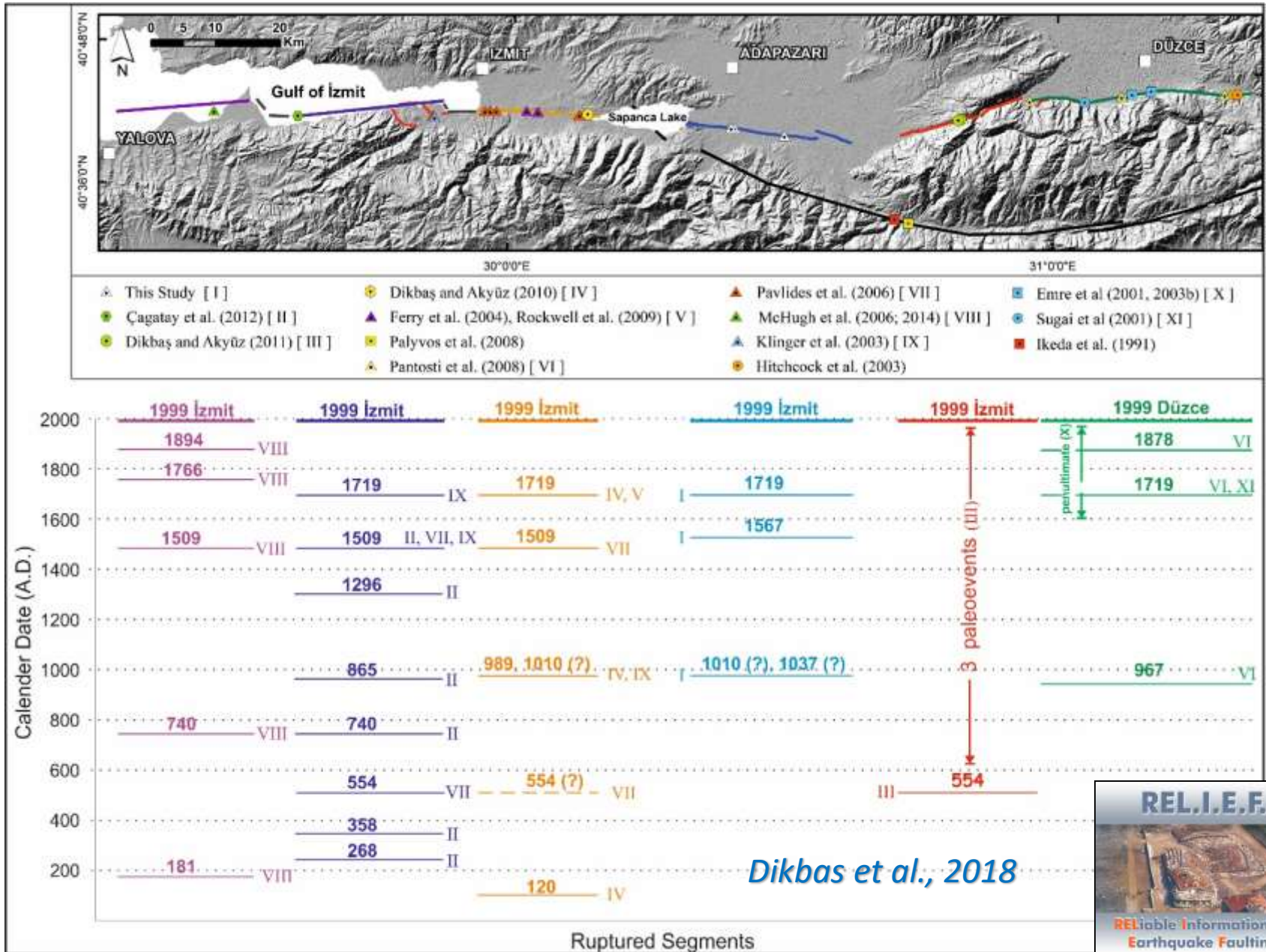
1999 Düzce segment

[Pantosti et al., 2008]

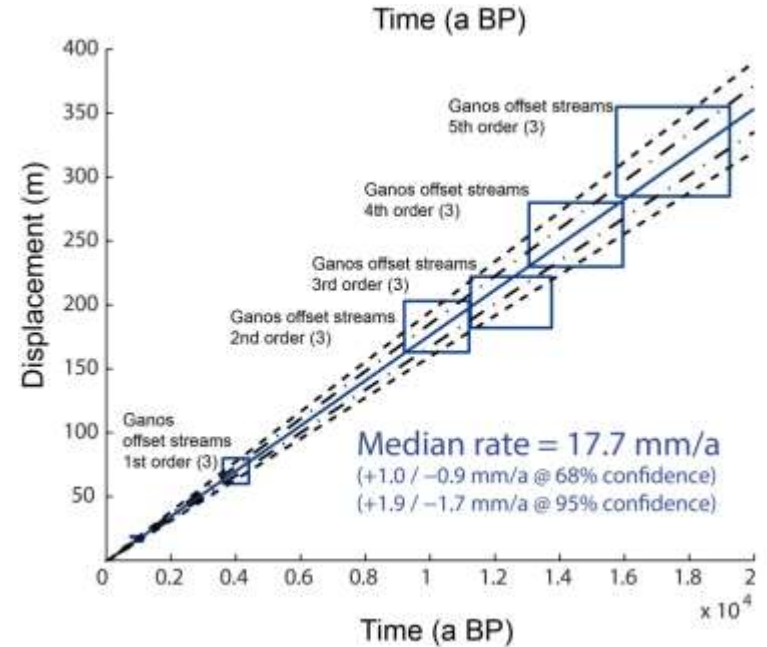
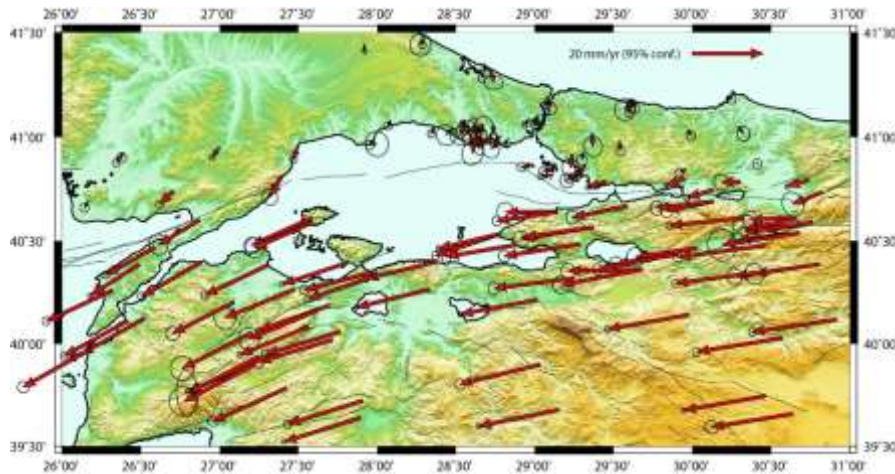
1967 segment [Palyvos et al., 2007]).



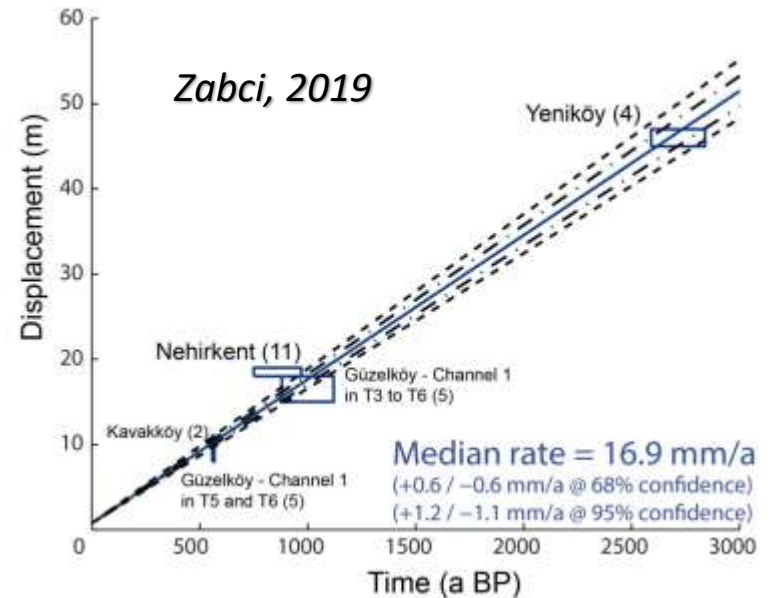
Paleoseismic events and the seismic cycle



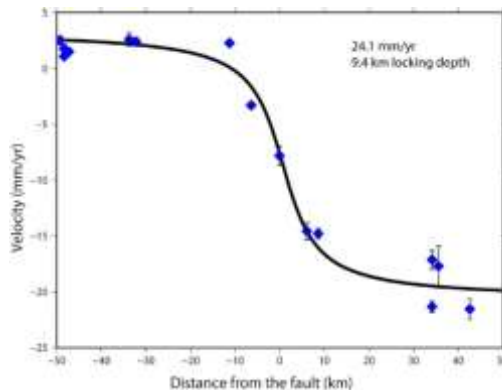
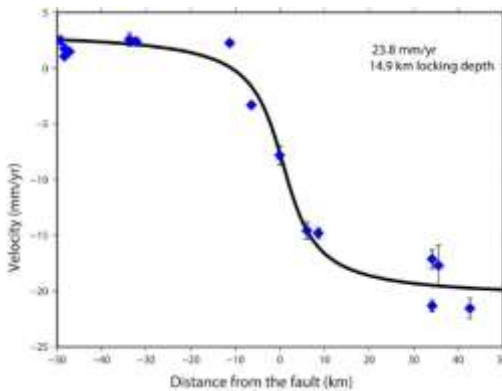
Fault slip and deformation rate



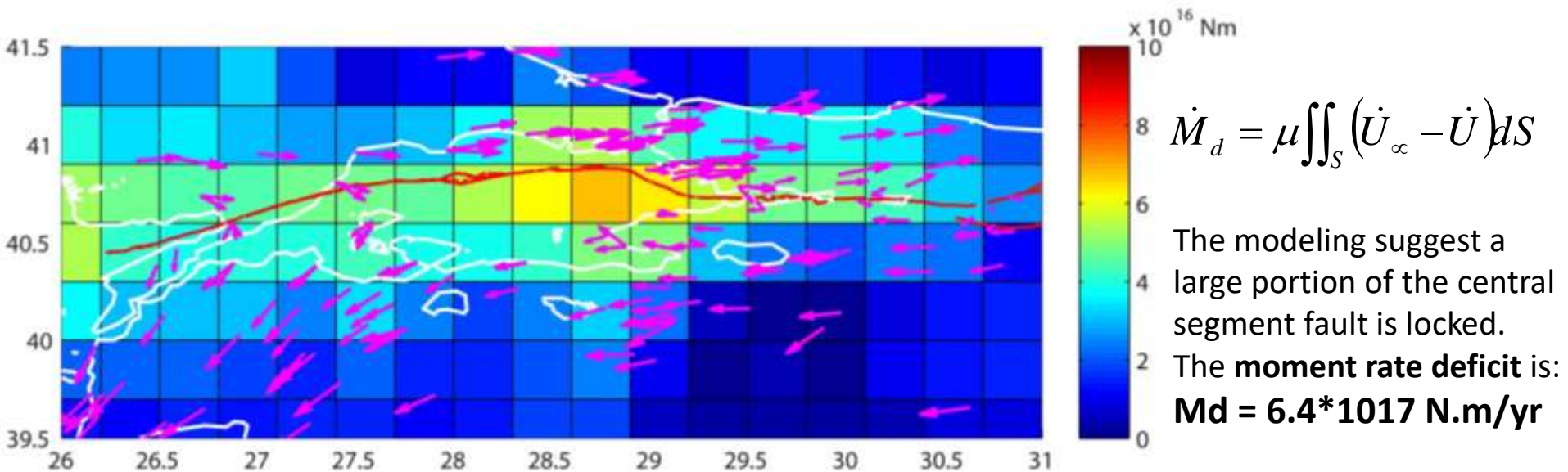
The slip history solutions for both segments of the NAF show **no significant change** in the slip history paths for the last 20 ka (Zabci, 2019; Fig. right).



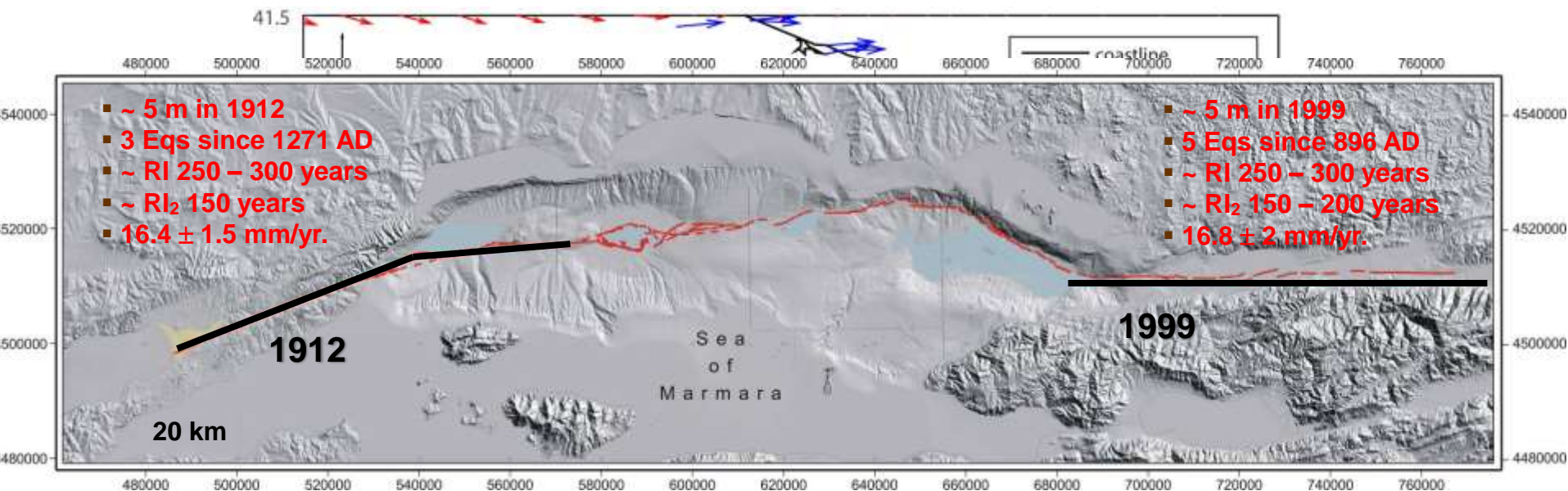
15 km locking depth is assumed for the NAF in the Marmara region (Fig. left).



The Seismic Moment deficit



Meghraoui et al., submitted 2020



CONCLUSION

Database in Marmara region

- Late Holocene earthquake catalogue – Paleoseismology
- Pleistocene right-lateral offset
- Historical seismicity
- Instrumental seismicity
- GPS data
- Sea bottom geodesy

Moment deficit

- 6 to 7 10^{16} N.m/yr.
- Cumulative seismic strain in the central fault segment since 1766 = 1.5 to 2 10^{19} N.m ($M_w \sim 7.2$)