Shear zones developed between extensional and compressional tectonic regimes: recent deformation of the Burdur-Fethiye Shear Zone as a case study

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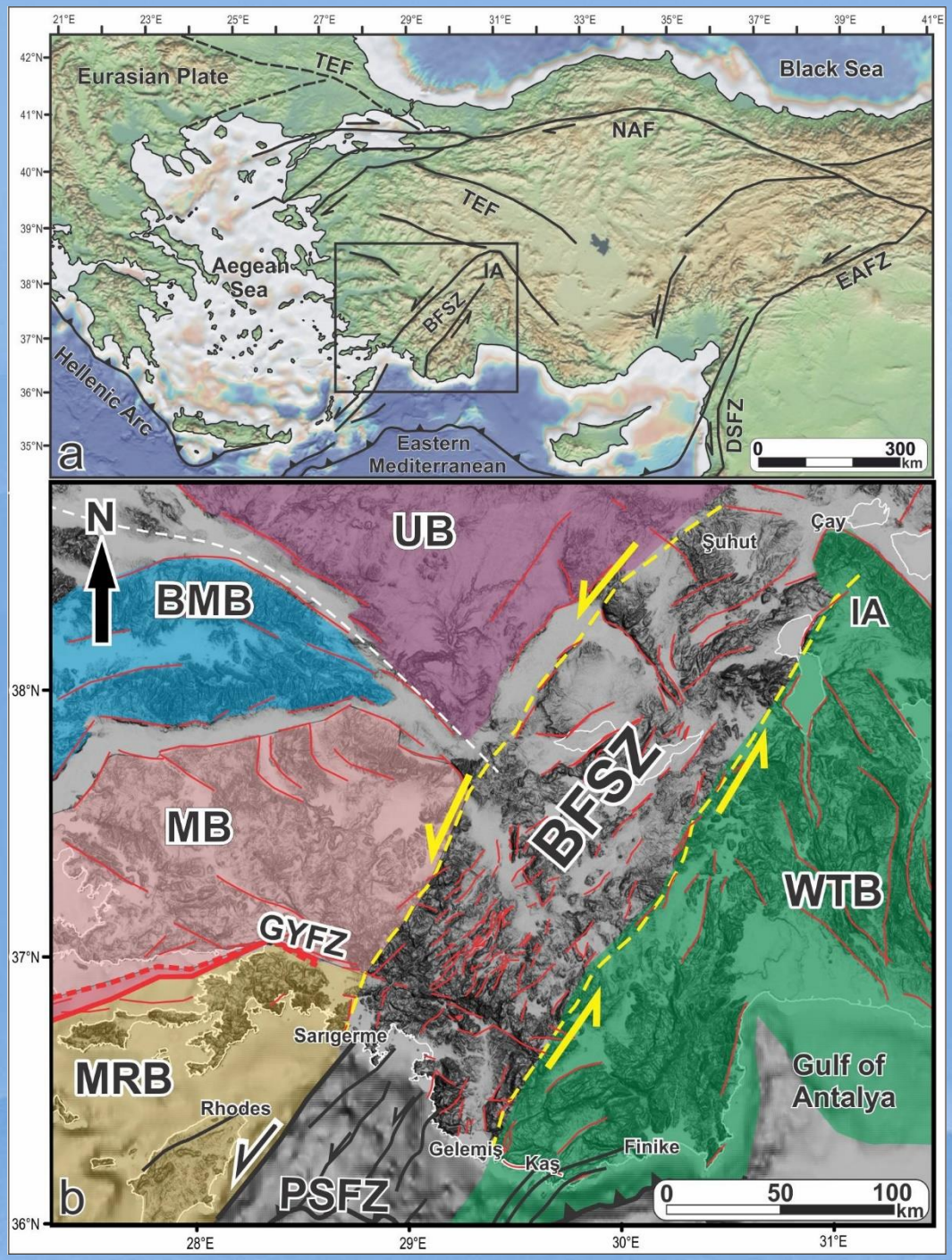
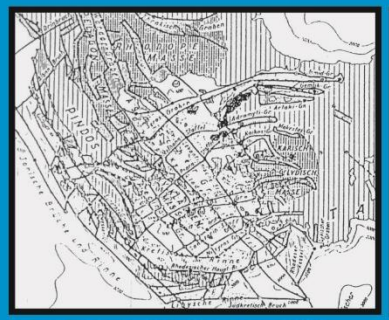
Simplified Tectonic Map of Turkey and Study Area

TEF: Thrace-Eskişehir Fault
NAF: North Anatolian Transform Fault
EAFZ: East Anatolian Fault Zone
DSFZ: Dead Sea Fault Zone,
IA: Isparta Angle
BFSZ: Burdur-Fethiye Shear Zone
PSFZ: Pliny-Strabo Fault Zone
GYFZ: Gökova-Yeşilüzümlü Fault Zone
MRB: Marmaris-Rhodes Block
WTB: Western Taurides Block
MB: Menderes Block
BMB: Büyük Menderes Block
UB: Uşak Block

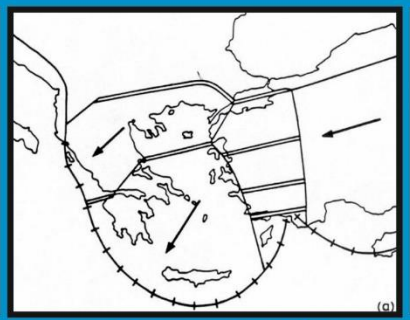


Different colors show different zones and blocks.

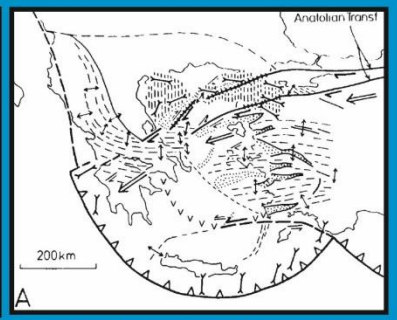
Previous Tectonic Models of the Region



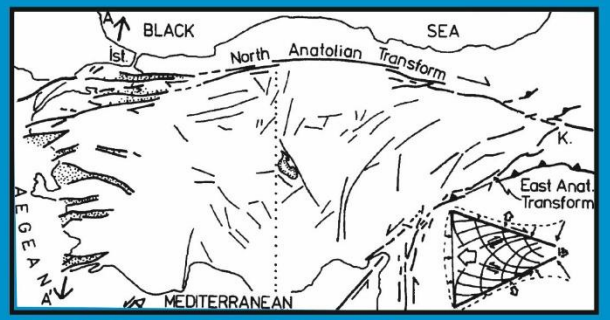
Cross Graben and Horsts: Sieberg, 1932



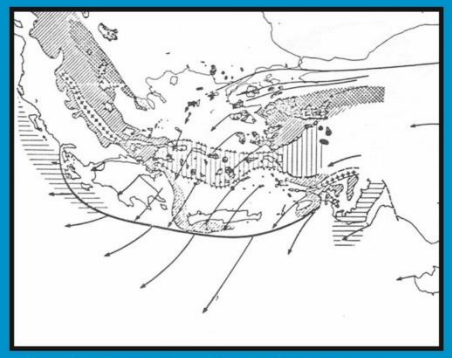
Back Arc Extension and grabens. Mc Kenzie, 1972,1978



Back Arc extension with strike slip faults: Dewey & Şengör, 1979

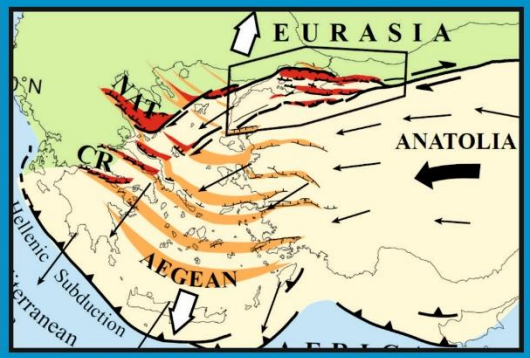


Tectonic Escape and N-S extension: Şengör, 1979

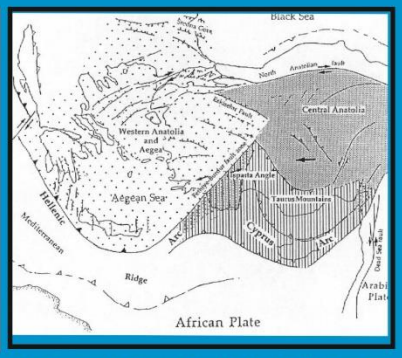


Back Arc Extension Le Pichon &Anglier, 1979

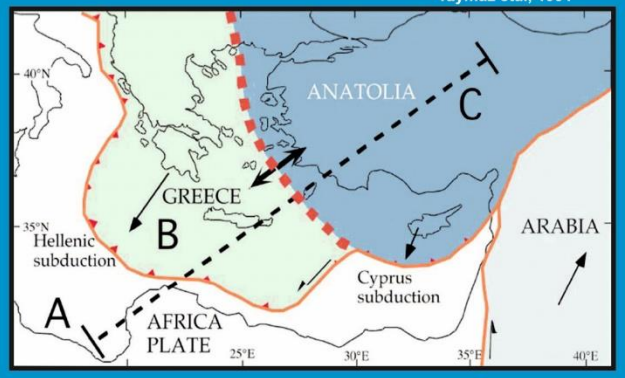
Back arc extension with broken slat normal and strike slip faults Taymaz etal, 1991



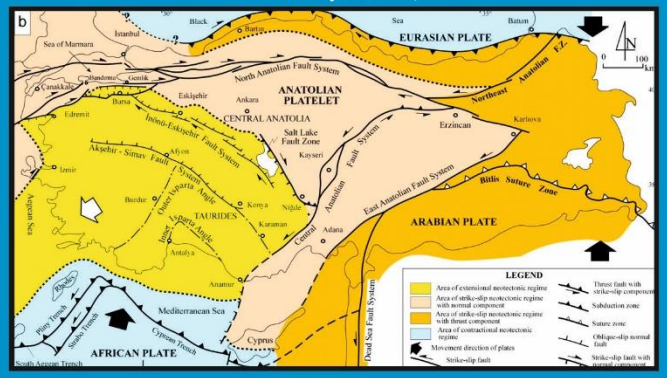
Back Arc Extension with strike slip northern boundary Armijo etal1996;1999



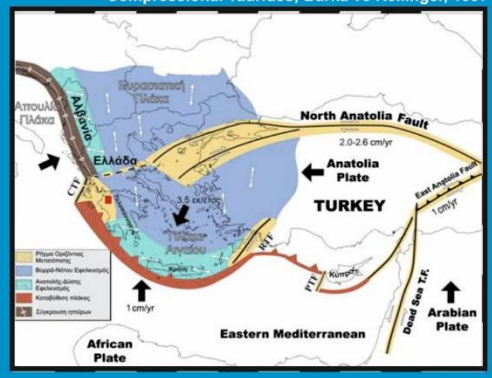
Back arc extensional Aegean, Anatoilian Escape and Compressional Taurides; Barka ve Reilinger, 1997



No Escape - Back Arc extension: Doglioni etal, 2002

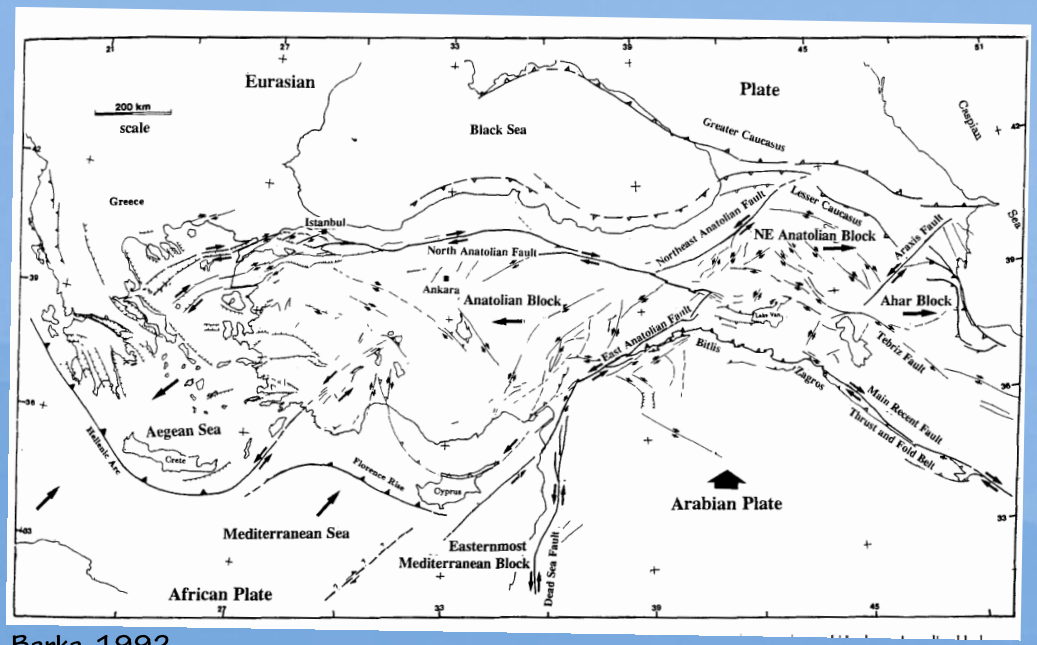


Back arc extensional Aegean, Anatoilian Escape, Koçyiğit and Özacar, 2003

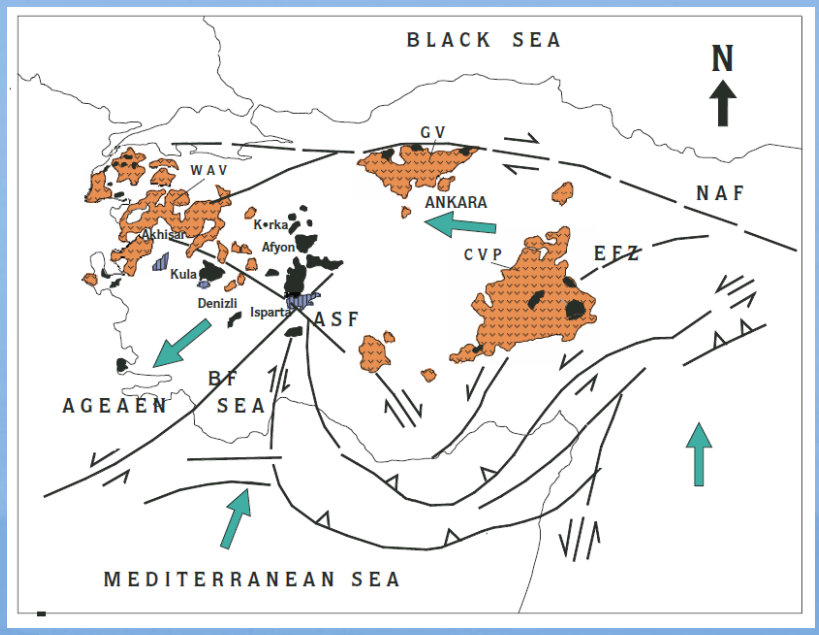


Back arc extension with strike slip rotation: Papazachos & Papazachou, 2003

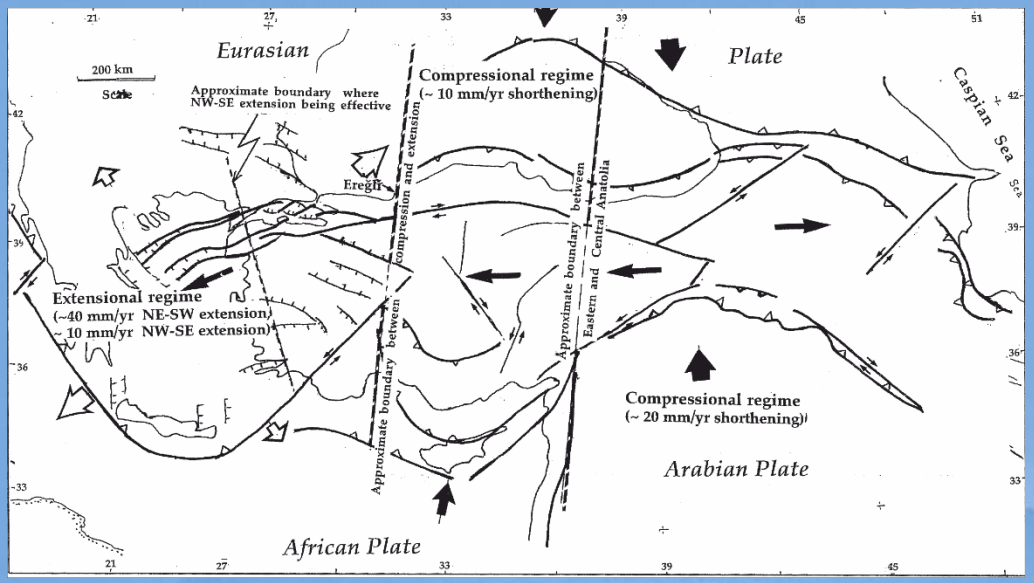
Previous Tectonic Models of the Region



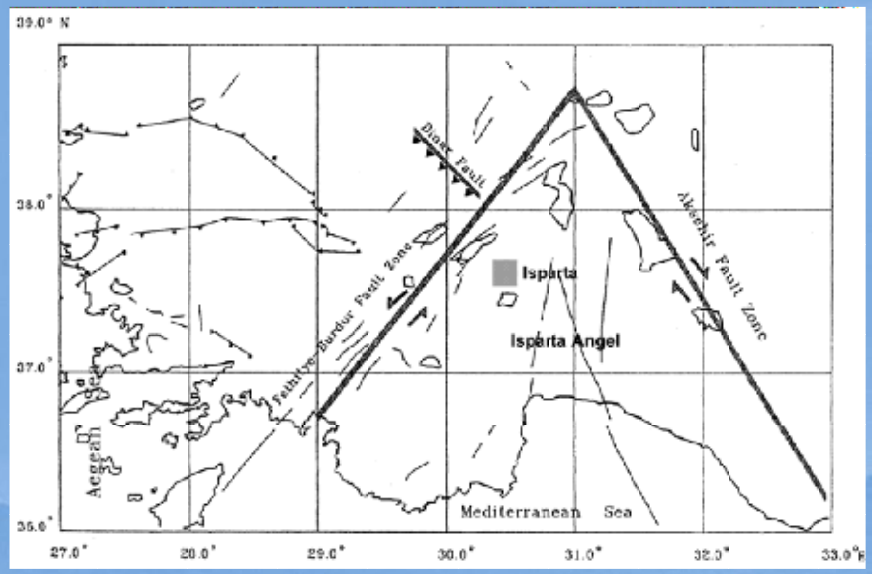
Barka, 1992.



Savaşçın and Oyman 1998

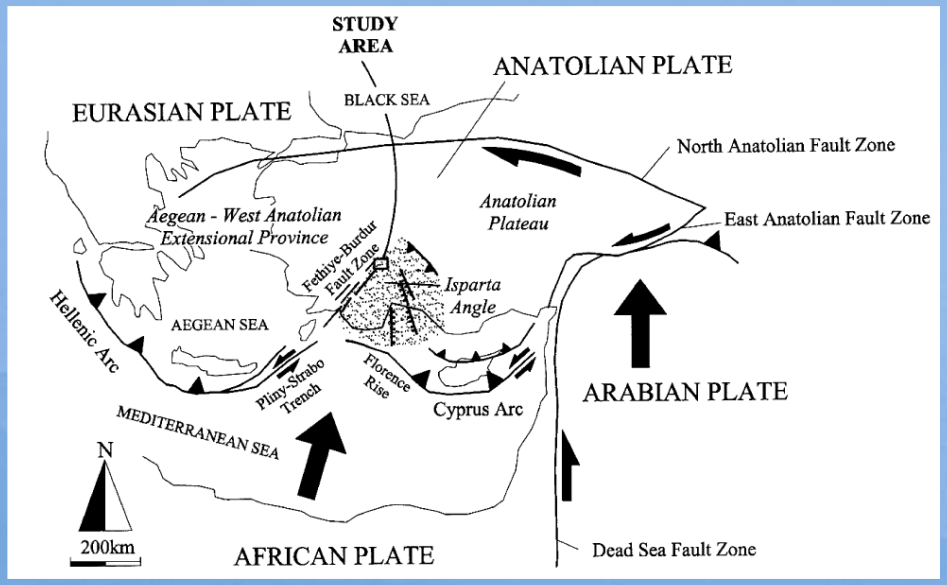


Barka and Reilinger, 1997.

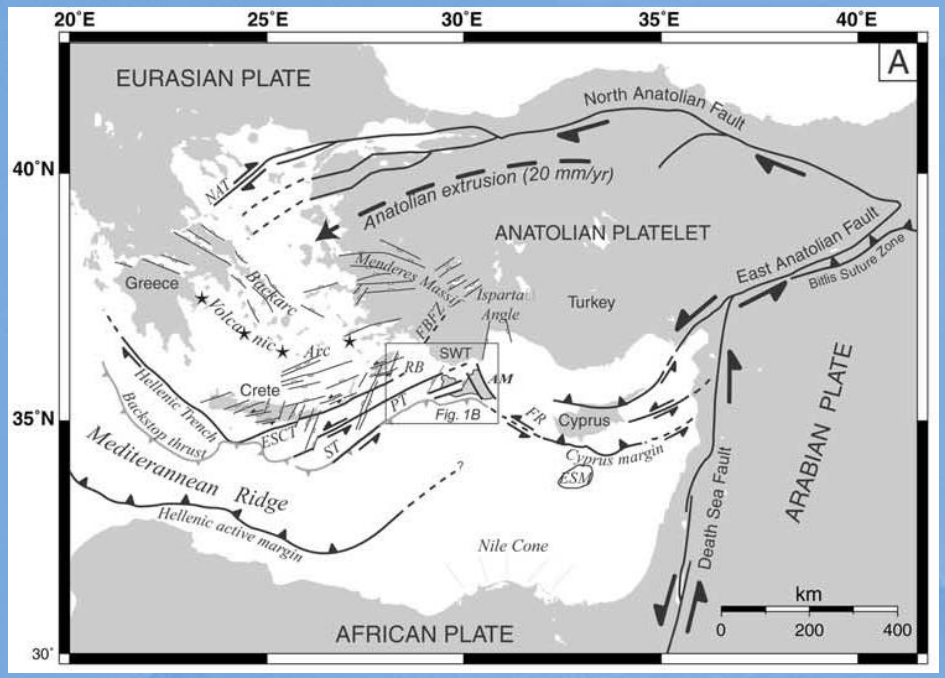


Kalyoncuoğlu and Özer, 2003

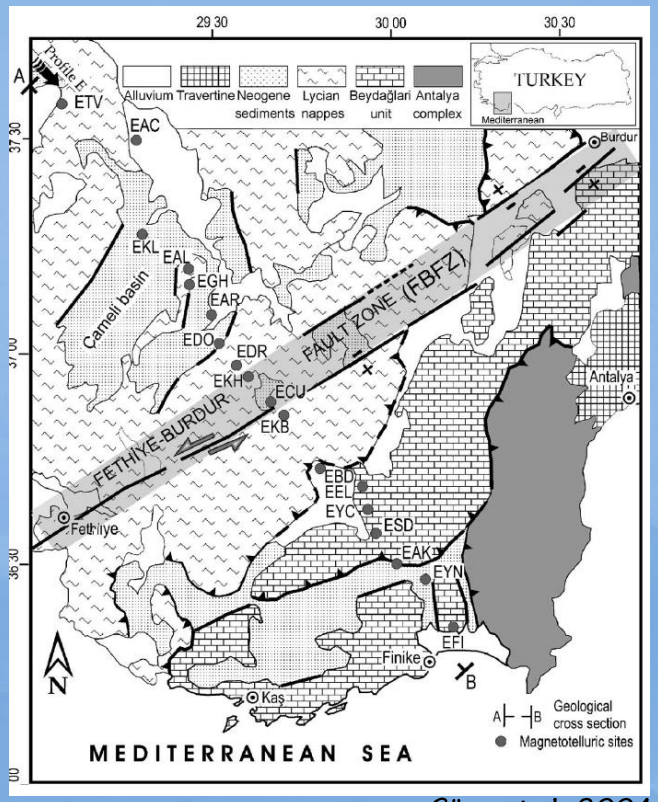
Previous Tectonic Models of the Region



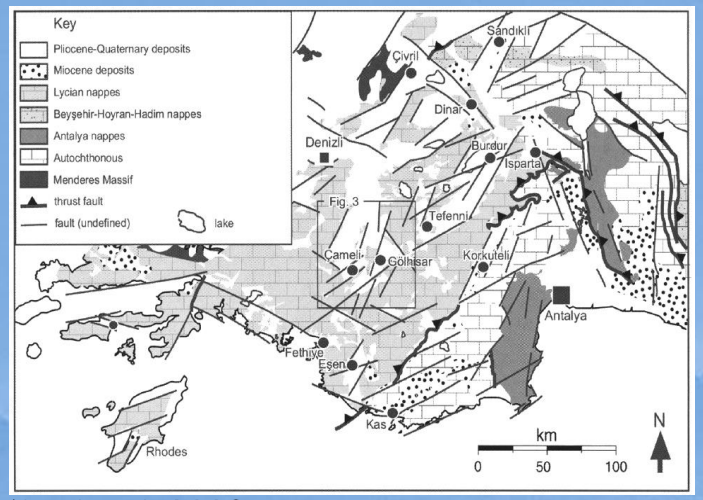
Sintubin et al., 2003



ten Veen, 2004

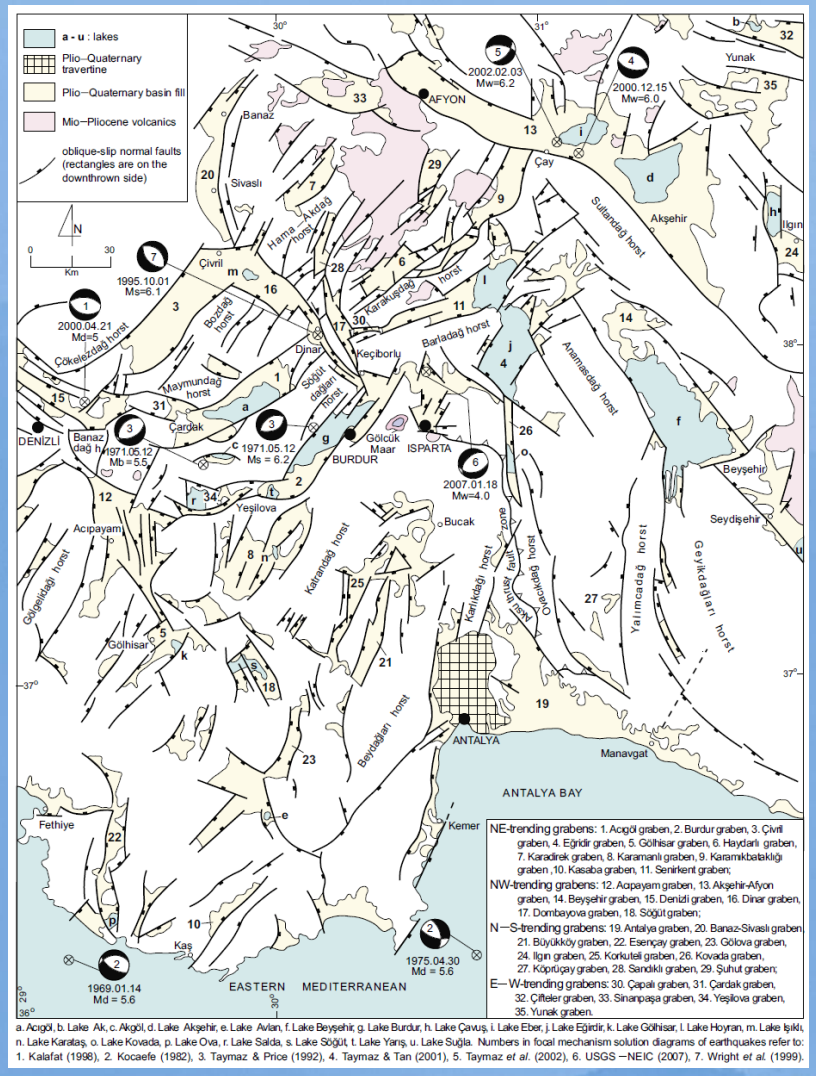


Gürer et al., 2004



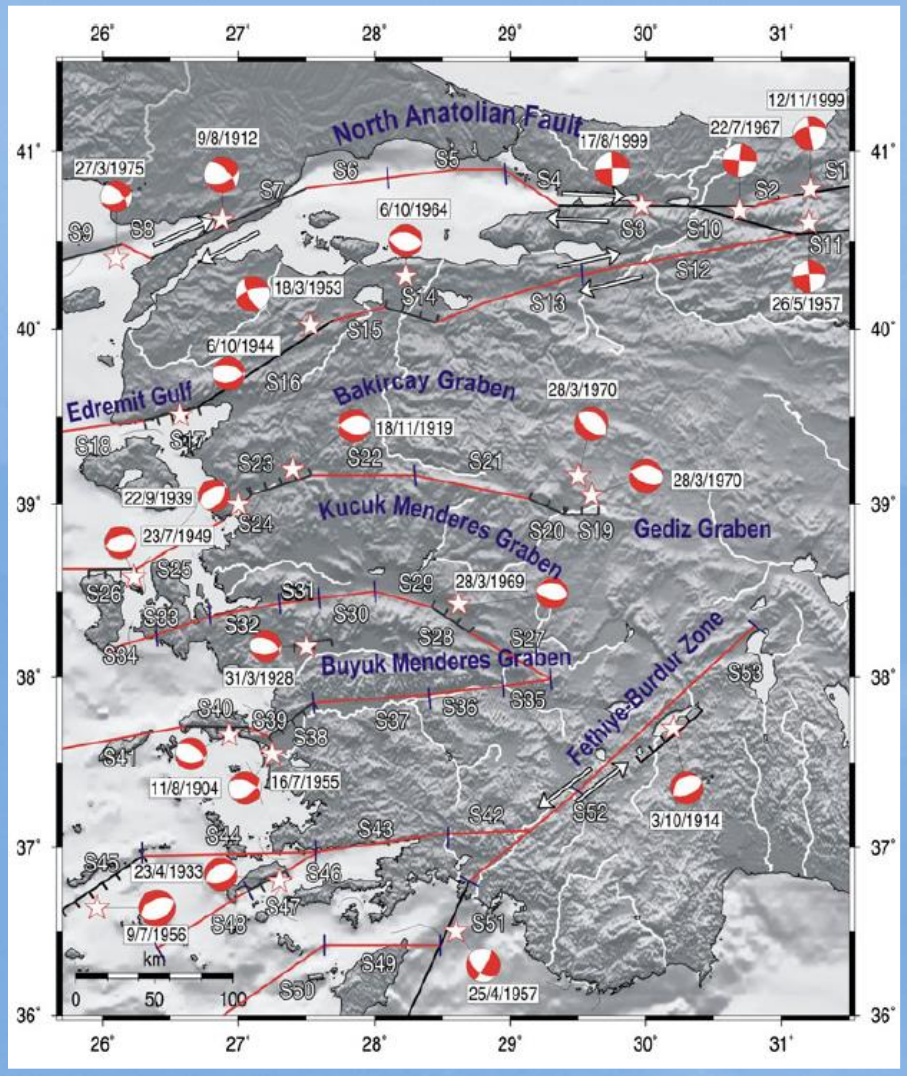
Alçiçek et al., 2006

Previous Tectonic Models of the Region

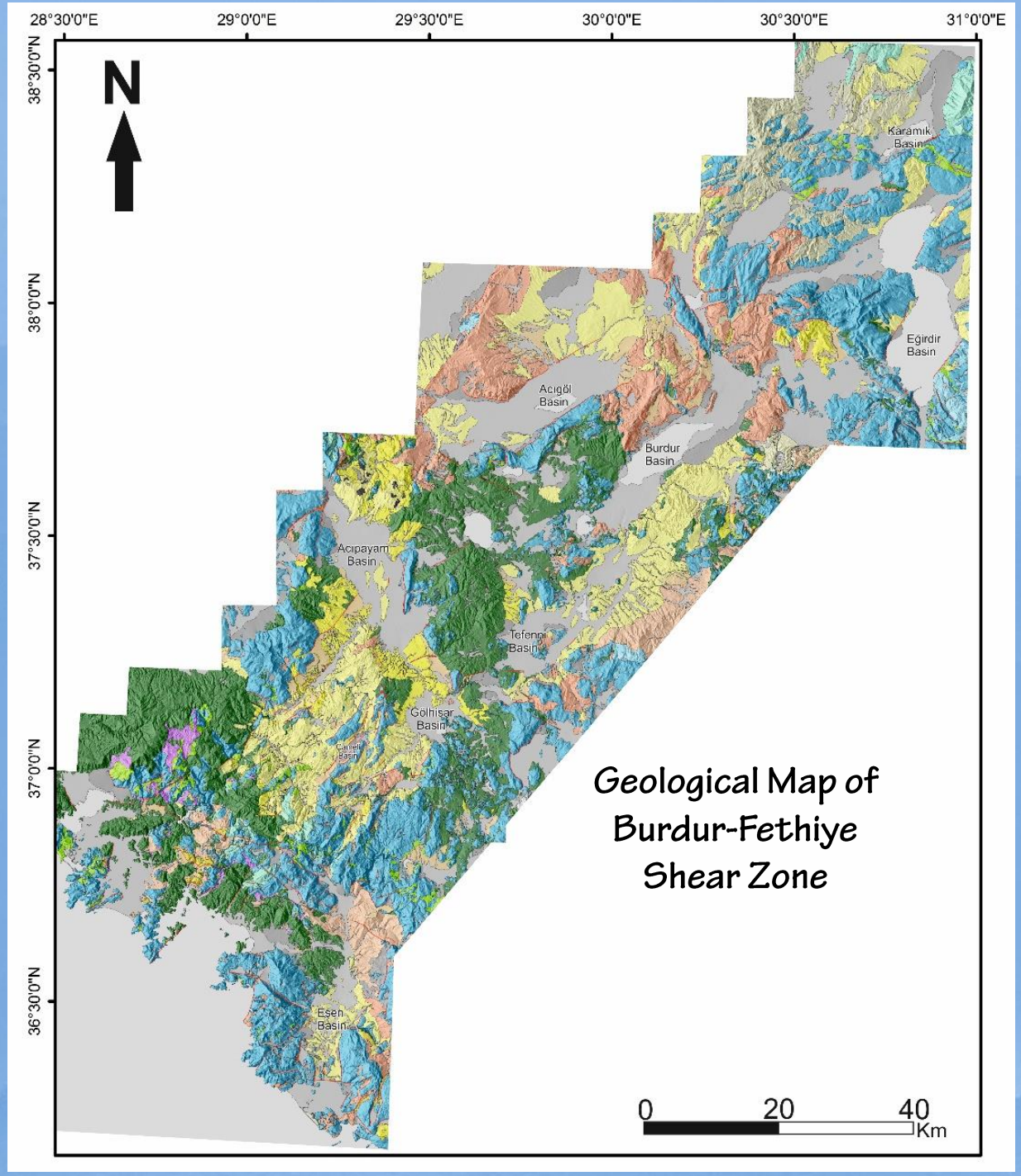


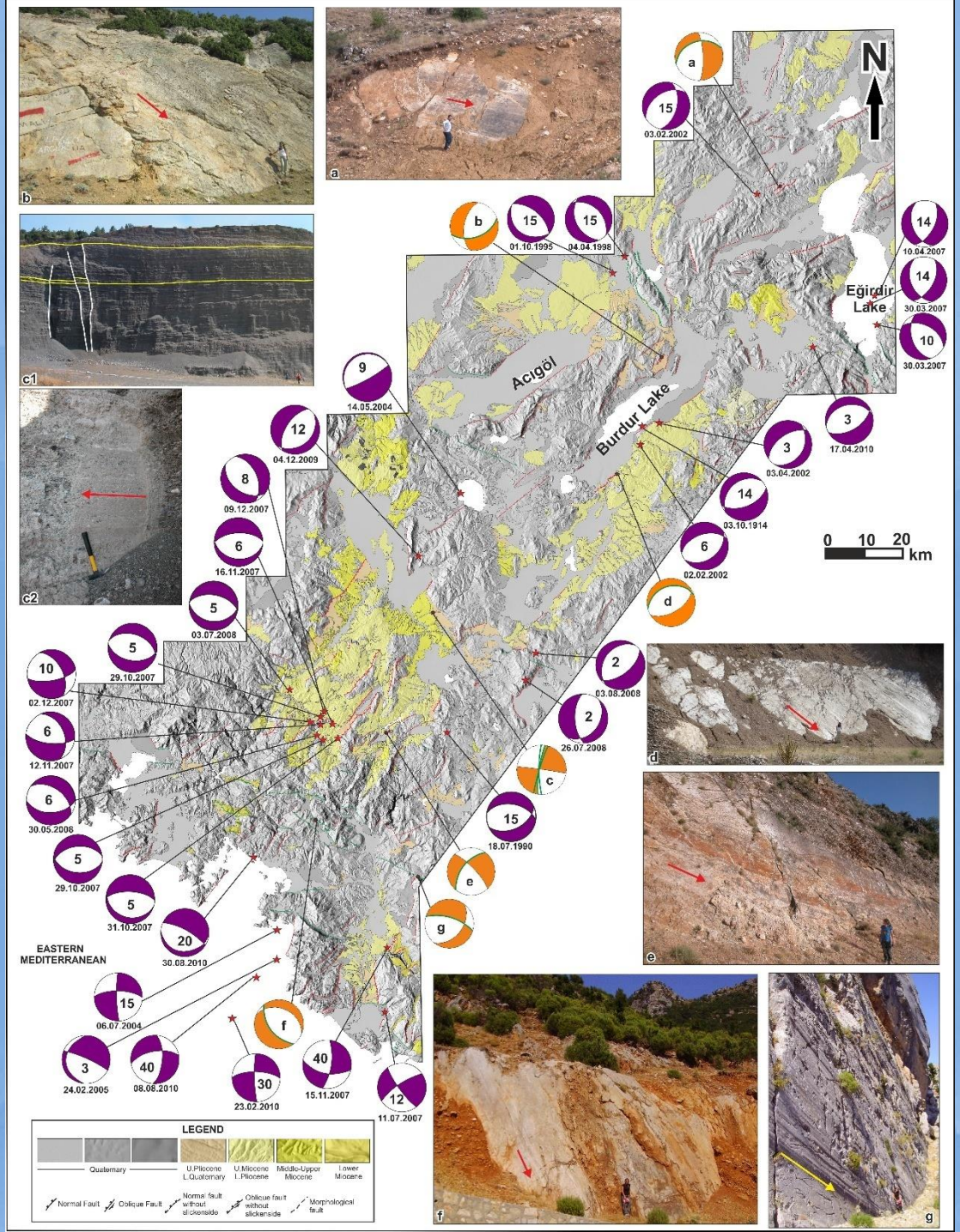
a. Acıgöl, b. Lake Ak, c. Akgöl, d. Lake Akşehir, e. Lake Avlan, f. Lake Beyşehir, g. Lake Burdur, h. Lake Çavuş, i. Lake Eber, j. Lake Eğirdir, k. Lake Gölhisar, l. Lake Hoyran, m. Lake Işıklı, n. Lake Karataş, o. Lake Kovada, p. Lake Ova, r. Lake Salda, s. Lake Söğüt, t. Lake Yarış, u. Lake Suğla. Numbers in focal mechanism solution diagrams of earthquakes refer to: 1. Kalafat (1998), 2. Kocaefe (1982), 3. Taymaz & Price (1992), 4. Taymaz & Tan (2001), 5. Taymaz *et al.* (2002), 6. USGS –NEIC (2007), 7. Wright *et al.* (1999).

Kocyigit and Deveci, 2007



Paradisopoulou et al., 2010


28°30'0"E
29°0'0"E
29°30'0"E
30°0'0"E
30°30'0"E
31°0'0"E
38°30'0"N
38°0'0"N
37°30'0"N
37°0'0"N
36°30'0"N
N
Karamık Basın
Eğirdir Basın
Acıgöl Basın
Burdur Basın
Acıpayam Basın
Tefenni Basın
Gölhisar Basın
Eşen Basın
Geological Map of Burdur-Fethiye Shear Zone
0
20
40
Km


N
Acigöl
Burdur Lake
Eğirdir Lake
0 10 20 km
EASTERN MEDITERRANEAN
LEGEND
Quaternary
U.Pliocene L.Quaternary
U.Miocene L.Pliocene
Middle-Upper Miocene
Lower Miocene
Normal Fault
Oblique Fault
Normal fault without slickenside
Oblique fault without slickenside
Morphological fault
a
b
c1
c2
d
e
f
g
15 03.02.2002
15 01.10.1995
15 04.04.1998
14 10.04.2007
14 30.03.2007
10 30.03.2007
9 14.05.2004
12 04.12.2009
8 09.12.2007
6 16.11.2007
5 03.07.2008
3 17.04.2010
3 03.04.2002
14 03.10.1914
6 02.02.2002
5 29.10.2007
10 02.12.2007
6 12.11.2007
6 30.05.2008
5 29.10.2007
5 31.10.2007
20 30.08.2010
2 03.08.2008
2 26.07.2008
15 18.07.1990
15 06.07.2004
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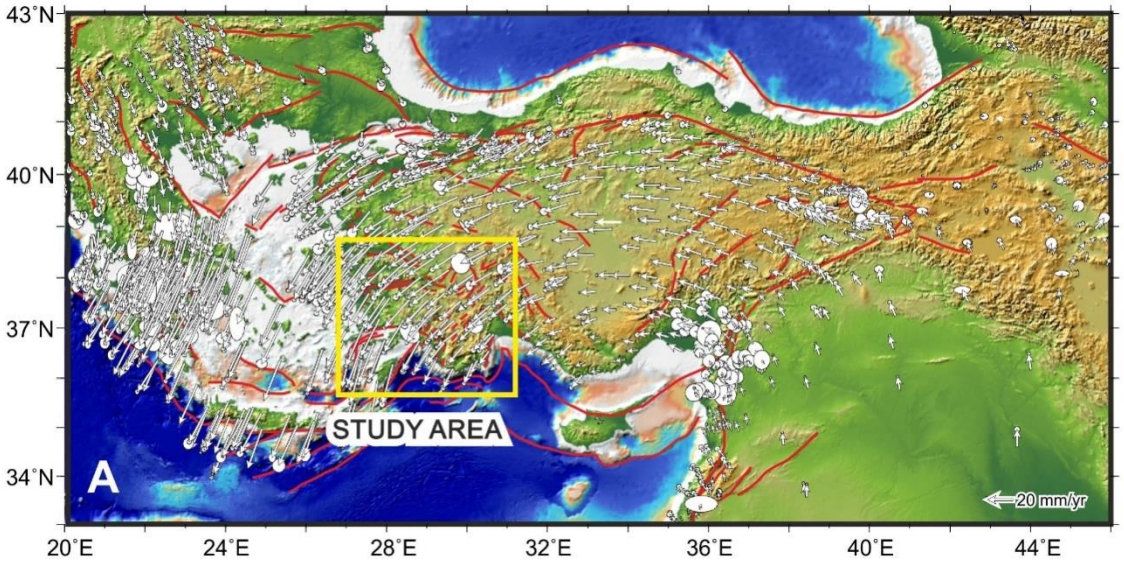
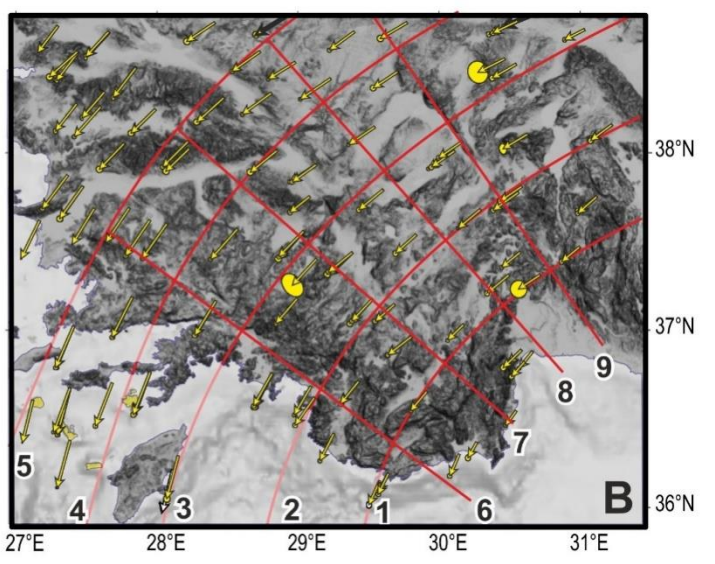
40 08.08.2010
30 23.02.2010
40 15.11.2007
12 11.07.2007

Recent Deformation of Anatolia and Southwestern Turkey



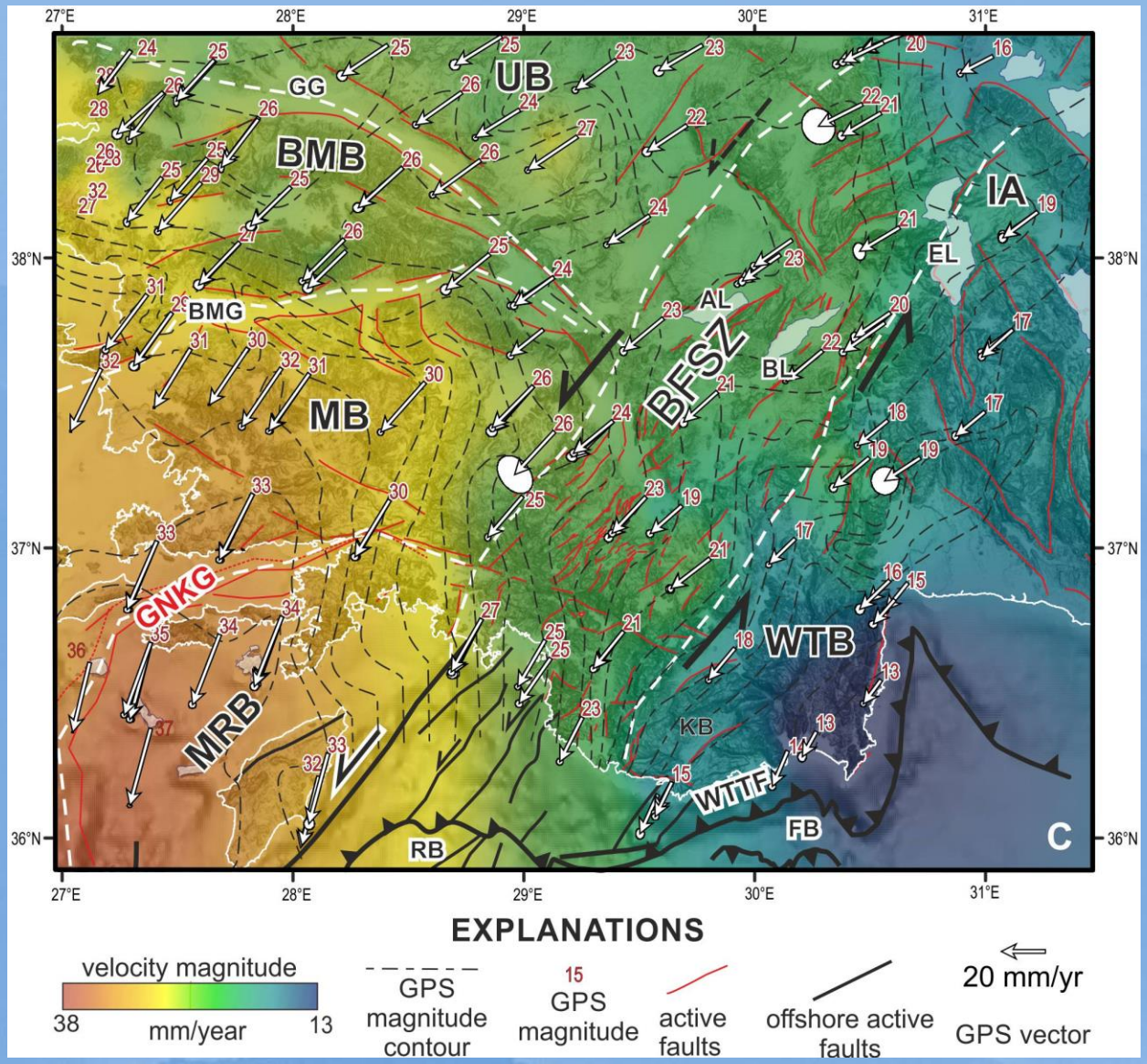
GPS vectors relative to the fixed Eurasian Plate showing the counterclockwise rotation of the Anatolian Block (Kreemer et al., 2014).



GPS velocity and topographic profiles perpendicular or parallel to the GPS vectors.

Eurasia-fixed GPS Velocities and Colour Magnitude Contour Map

GPS velocities increase from north to south

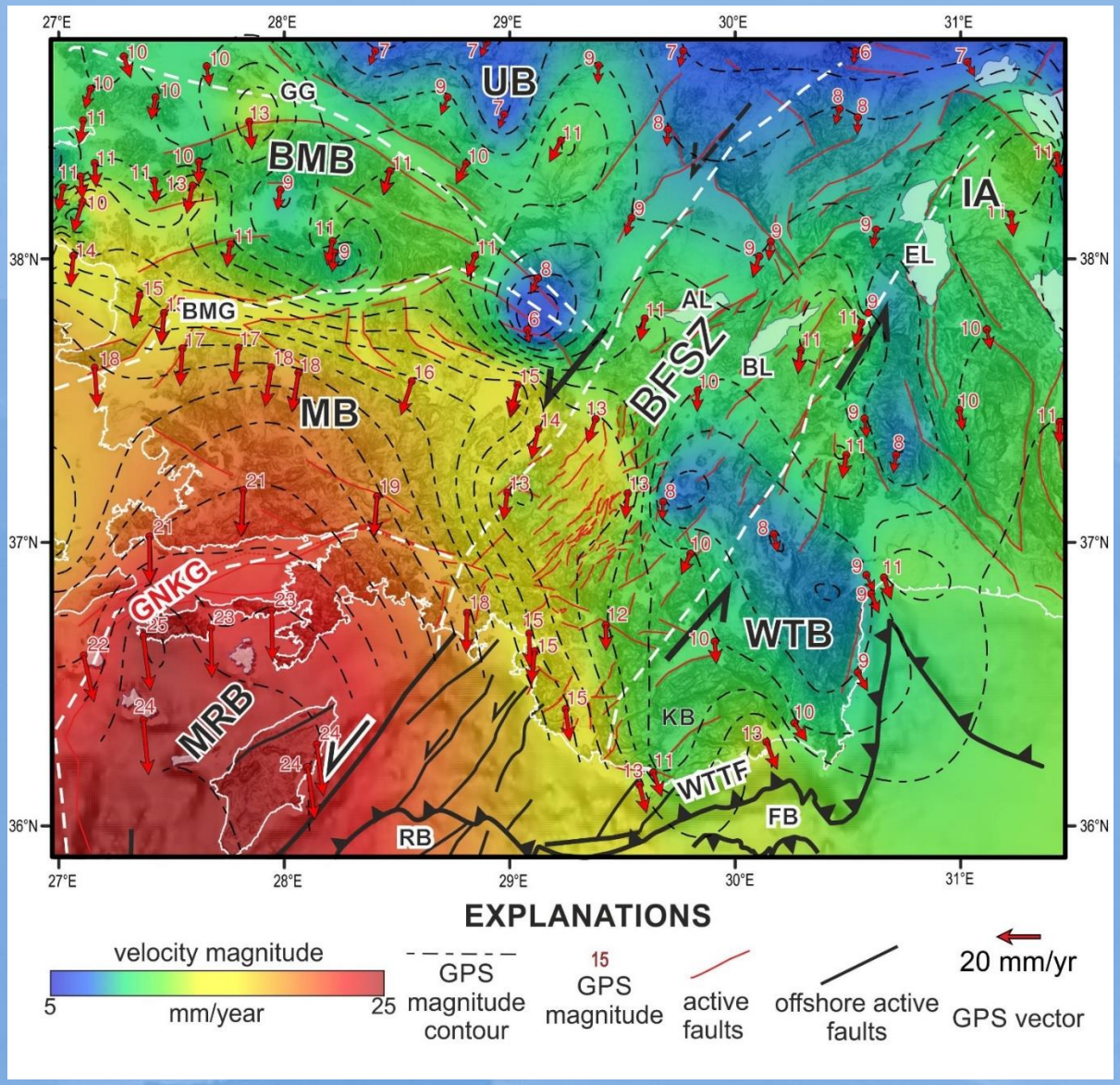


GPS velocities decrease from north to south

IA: Isparta Angle BFSZ: Burdur-Fethiye Shear Zone GNKG: Gökova-Nisyros-Karpatos Graben UB: Uşak Block
MRB: Marmaris-Rhodes Block WTB: Western Taurides Block MB: Menderes Block BMB: Büyük Menderes Block
BMG:Büyük Menderes Graben GG:Gediz Graben WTTF:Western Taur,des Thrust Fault RB:Rhodes Basin FB:Finike Basin
AL:Acıgöl Lake BL:Burdur Lake EL:Eğirdir Lake

Anatolia-fixed GPS Velocities and Colour Magnitude Contour Map

GPS velocities increase from north to south



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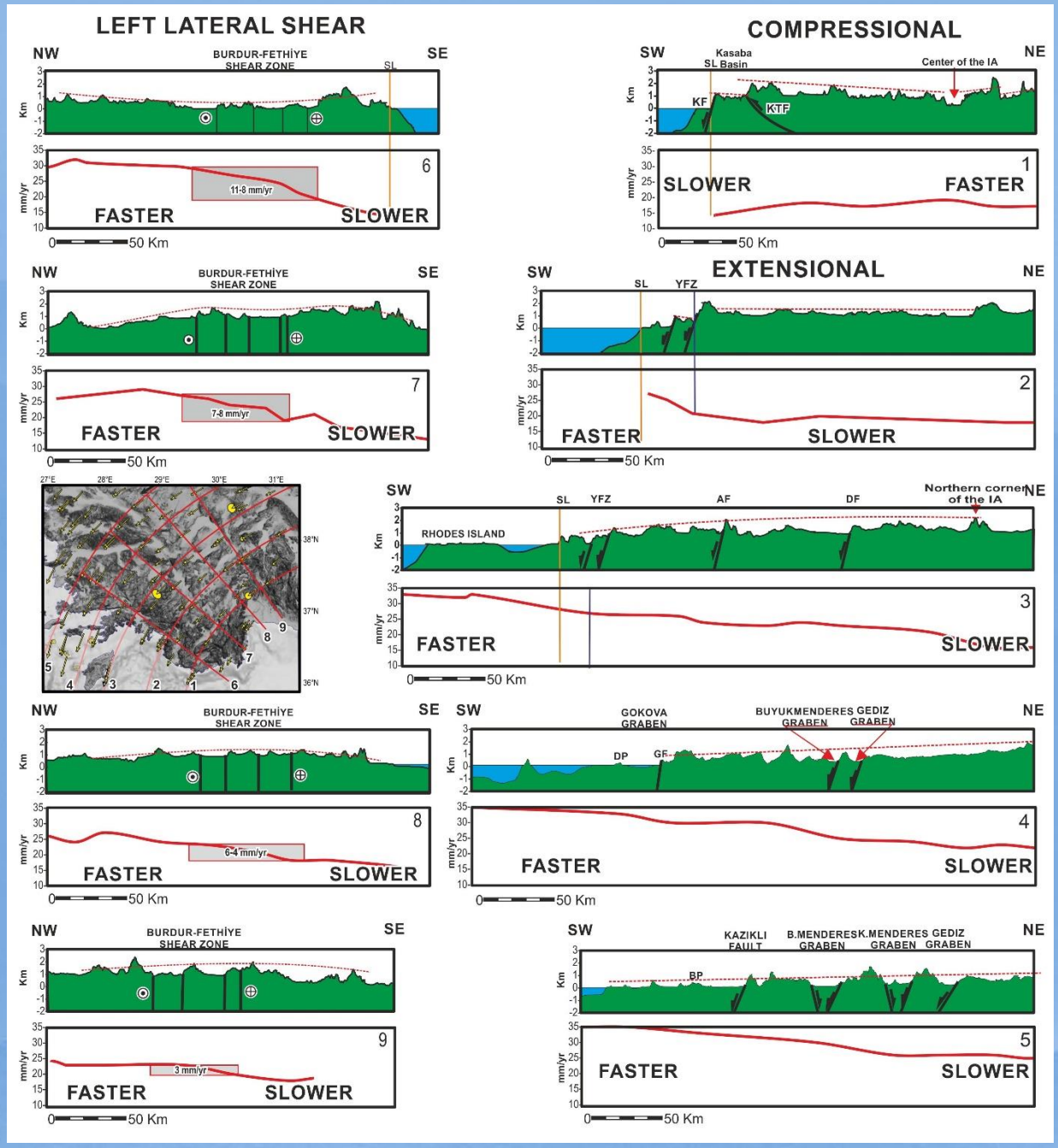
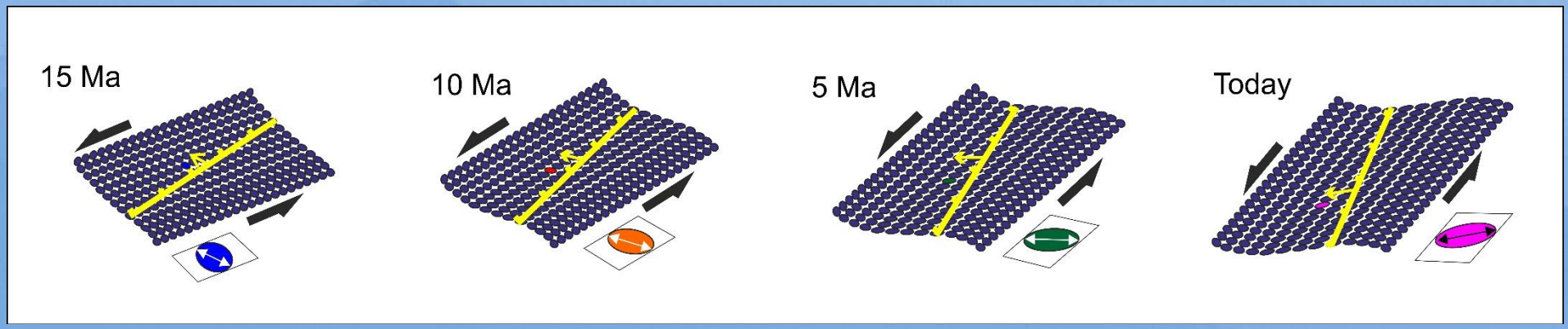
GPS Velocity and Topographic Profiles



IS IT REALLY A SHEAR ZONE?

According to the shear zone model of Ramsay and Huber (1983), the strain elipses display different extension directions across the zone and more deformation in the center.



Rotation and strain evolution of an extensional left lateral shear zone during last 15 Ma. Deformed circular markers modified from Ramsay and Huber (1983). Strain ellipses show the structural features.

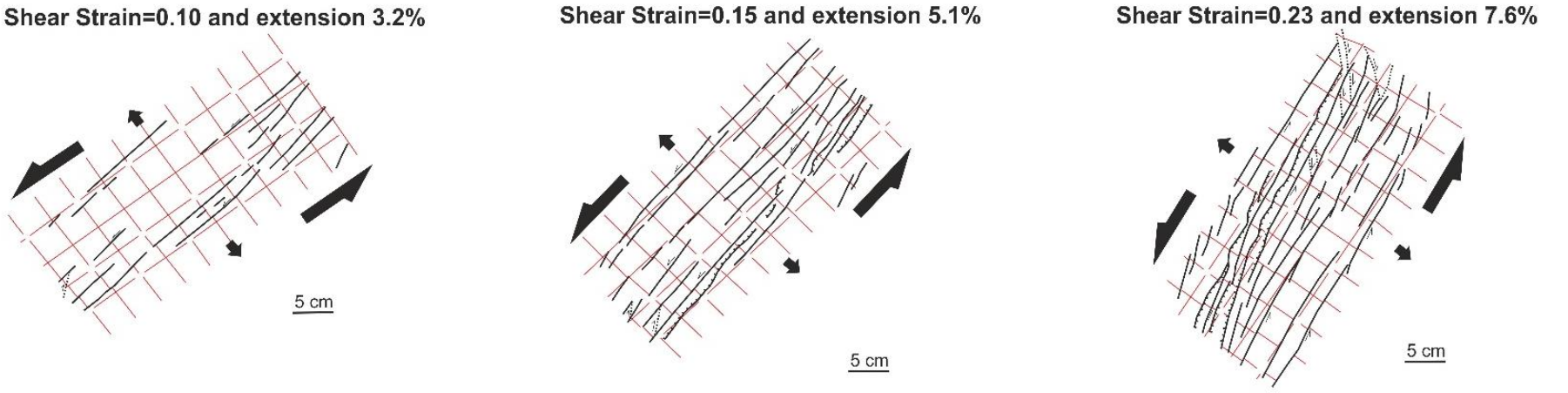
Schreurs and Colletta (1998):

-Normal faults develop between earlier formed major strike-slip faults with increasing deformation

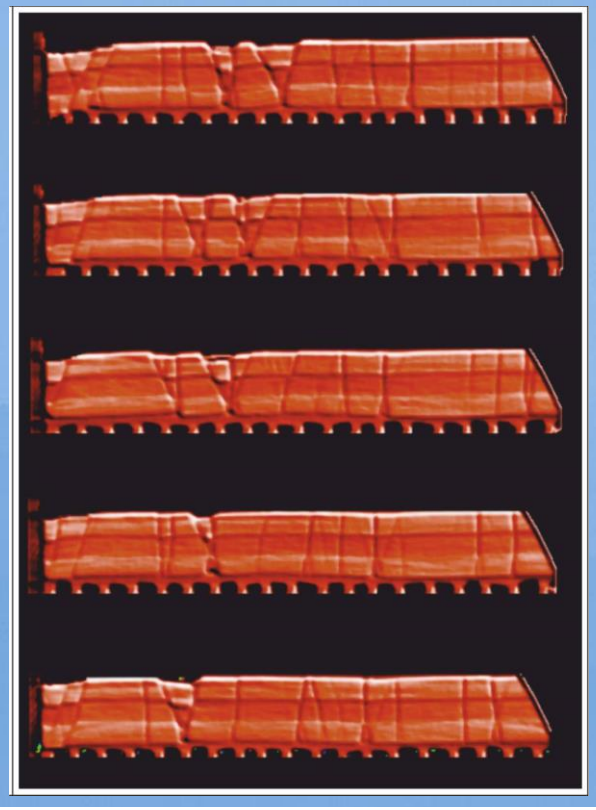
-Some of the faults display oblique slips in time

-High angles of the faults begin to decrease during deformation

-Small transtensional basins develop

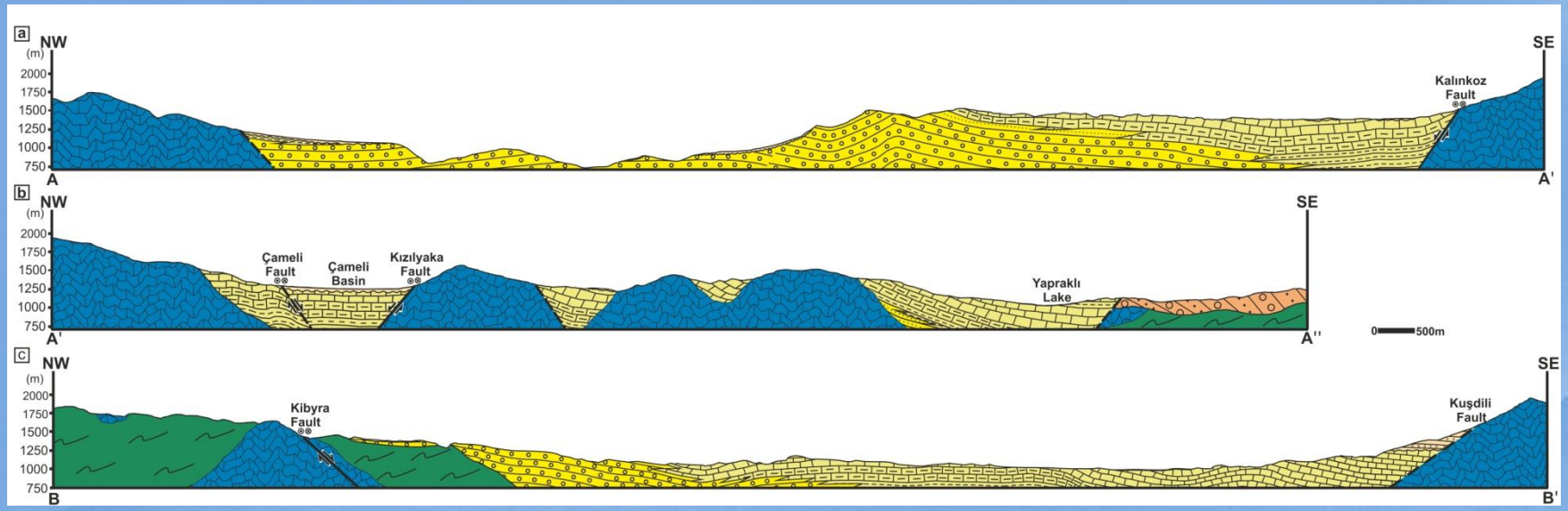


Fault evolution of the extensional left lateral shear zone. Left-lateral transtensional model modified from Schreurs and Colletta (1998).



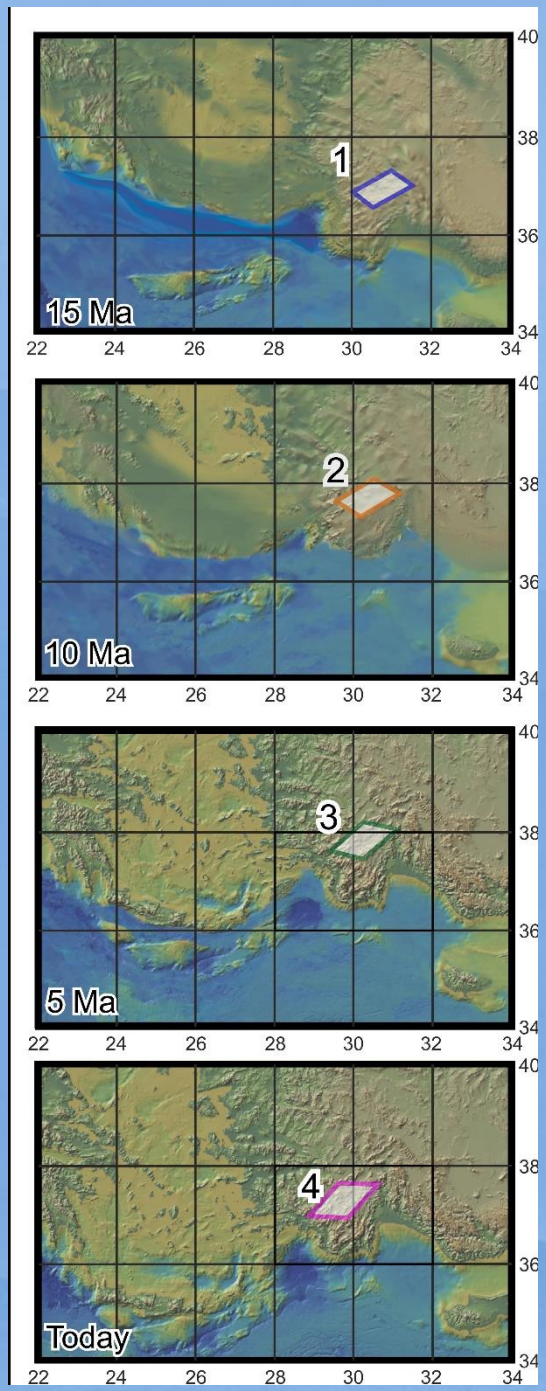
Basins developed in the experiment of Schreurs and Colletta (1998)

Basins developed in the middle part of Burdur-Fethiye Shear Zone

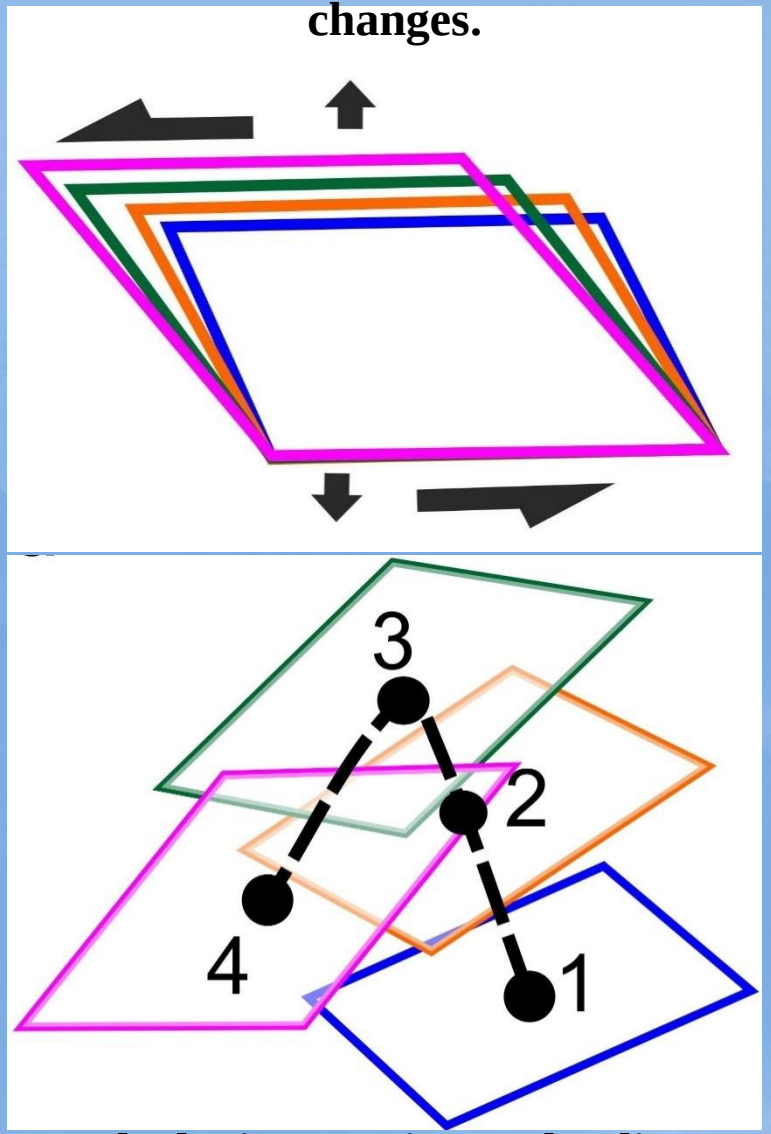


Addditionally, the heterogeneous systems show increase of the strain intensity from the margins to the center of the shear zone (Vitale and Mazzoli, 2008) and can widen with time (Type I; Means, 1984, 1995; Hull, 1988).

Palinspastic tectonic evolution of Western Anatolia, Aegean Region and Burdur-Fethiye Shear Zone.

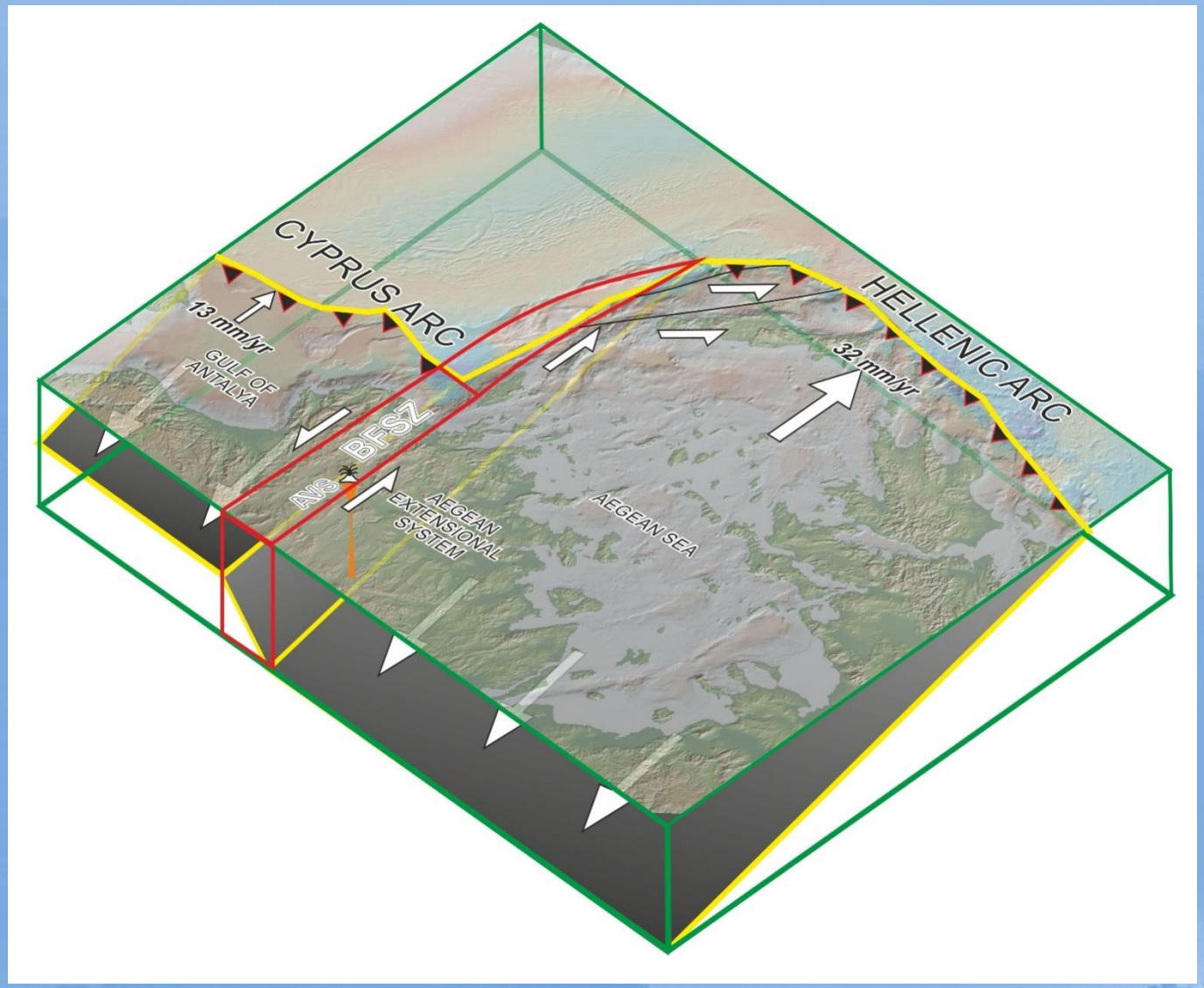


Time-dependent transtensional left lateral simple shearing model and dimensional changes.



Counterclockwise rotation and palinspastic migration. Parallelograms show the positions in different time-intervals.

3D tectonic block model of the southwestern Turkey and Aegean Sea



Red lines show the Burdur Fethiye Shear Zone on land, the offshore parts of either Pliny-Strabo Fault System or southeastern Aegean STEP fault.
AVS: Acıpayam Volcanic Source,
BFSZ: Burdur Fethiye Shear Zone.

Conclusions

- Burdur-Fethiye Shear Zone (BFSZ) is a left-lateral transtensional shear zone, rather than an individual fault system, which is under the progressive influence of the counterclockwise rotation of the southwestern Turkey, Aegean graben system and the Cyprus and Hellenic arcs.
- The evolution of the Burdur-Fethiye Shear Zone continues progressively since the middle Miocene and represents dominantly 1-10 km-long NE-SW-striking oblique-left lateral faults and NE-SW basins.
- The basins along the Burdur-Fethiye Shear Zone are generated as a result of transtensional sytem.
- The regional compression regime and left-lateral shear deformation along the Burdur-Fethiye Shear Zone that are related to plate motions occur since Middle Miocene.
- There is a progressive deformation along the Burdur-Fethiye Shear Zone. The tectonic structures develop related to rotation, shearing and/or extension regime.
- Two subducting plate with different angles and velocities cause tearing and a shear zone is observed in the brittle crust.
- The Burdur-Fethiye Shear Zone is a left-lateral deformation transition zone driven by the relative velocity differences due to the roll-back effect of the Hellenic Trench and the compressional region of Western Taurides, but mostly due to the westward escape of Anatolia.

THANK YOU