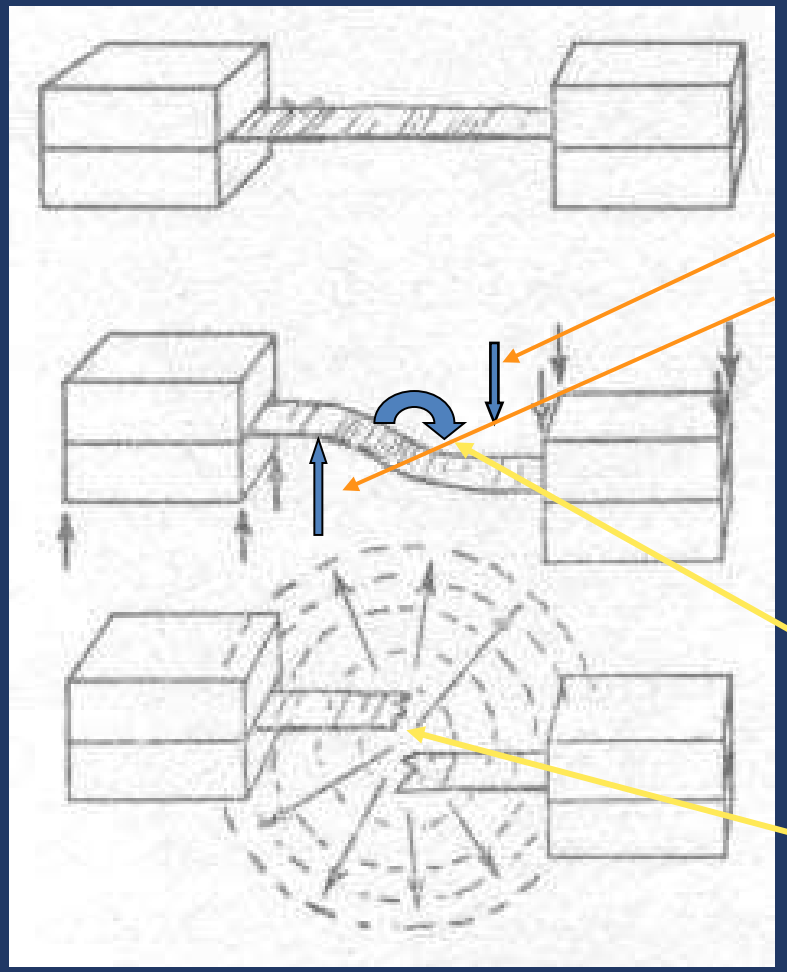
İSTANBUL VE KAHRAMANMARAŞ-MALATYA DEPREMLERİ: NEDENLERİ, TABİATLARI VE GELECEKLERİ VE KAYSERİ!

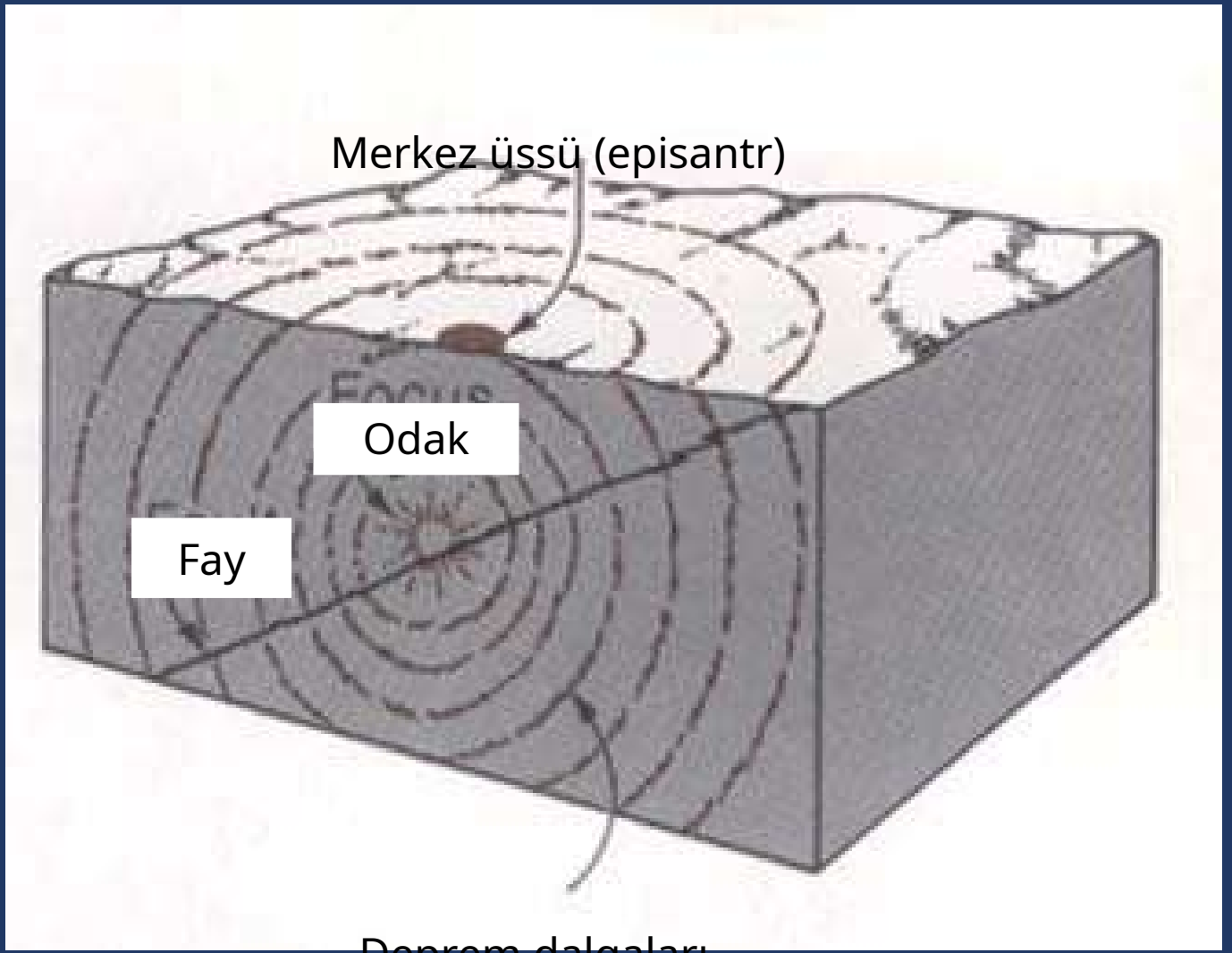
A. M. Celâl Şengör

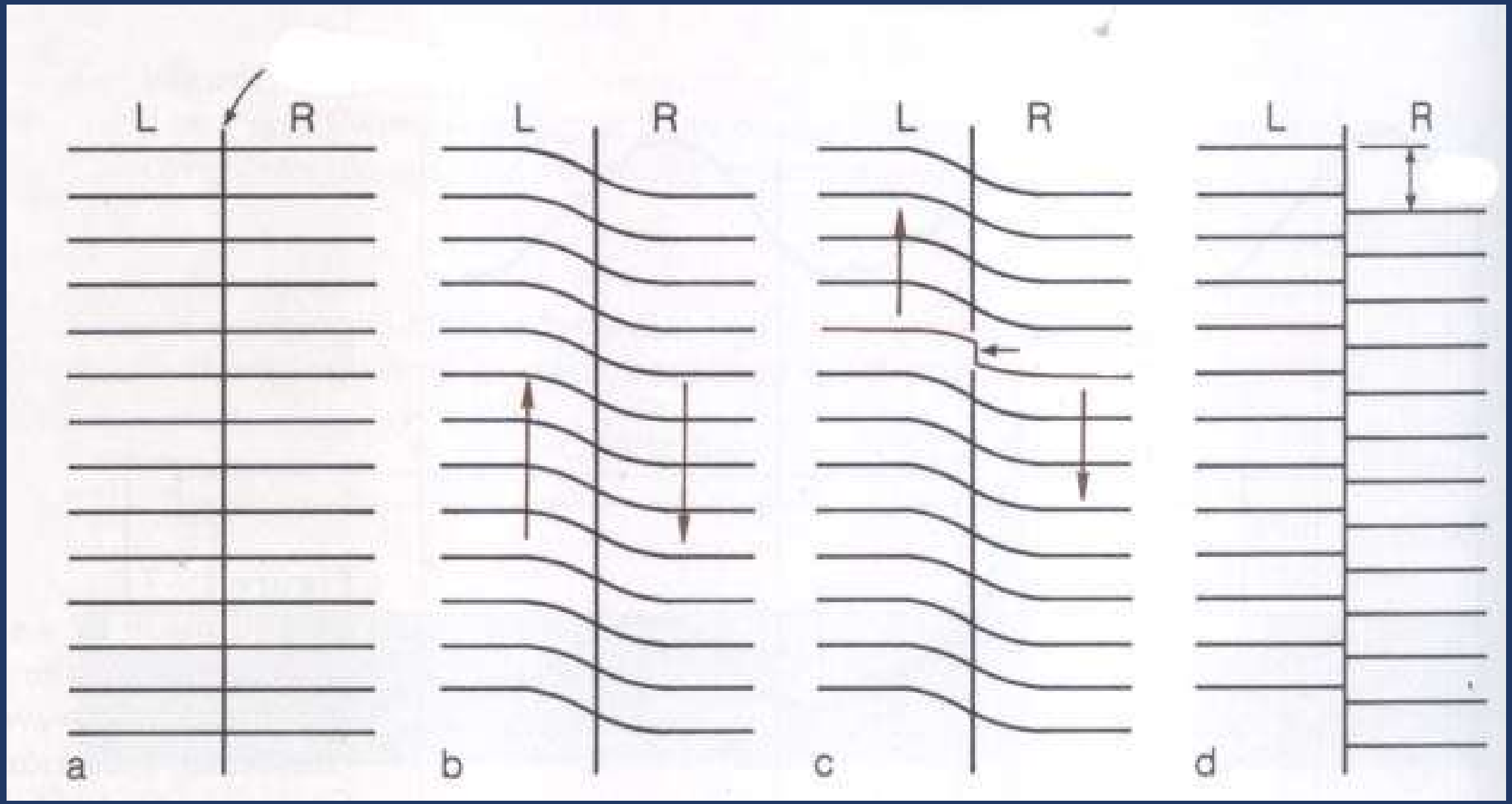
İTÜ Maden Fakültesi, Jeoloji Bölümü ve Avrasya

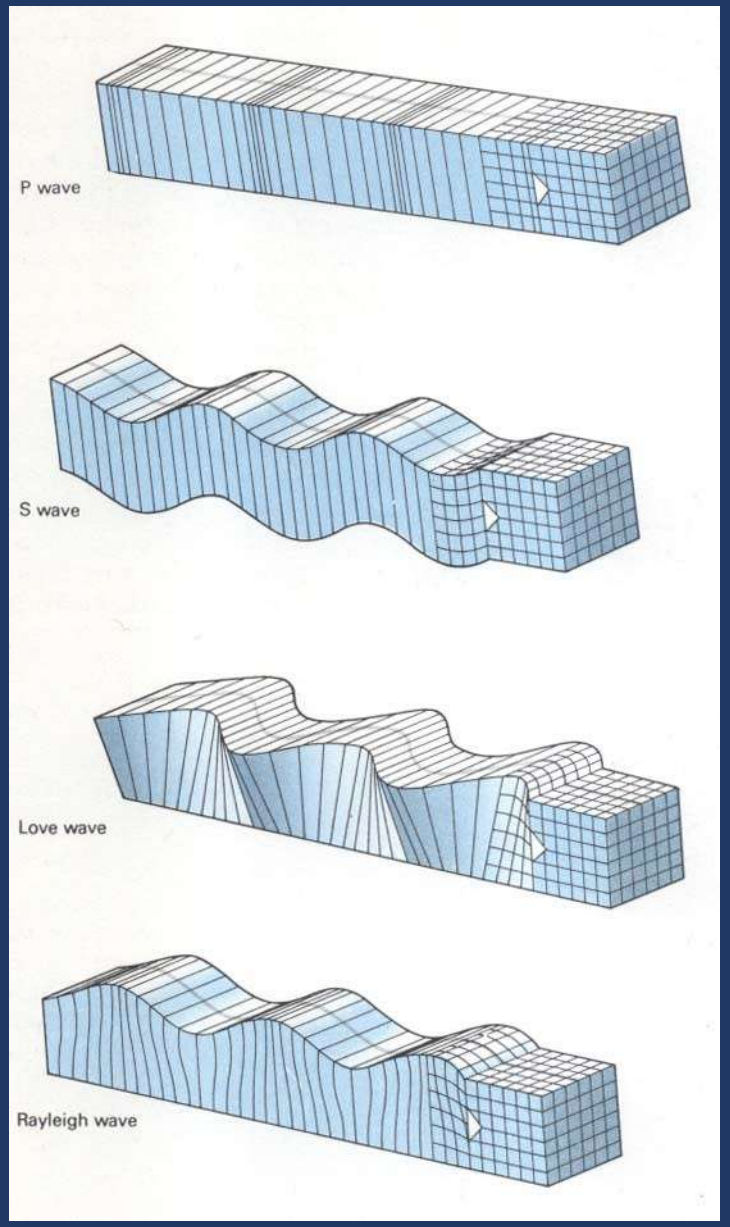
Deprem nedir?

Deprem, taşkürenin bir kısmının elastik yamulmasının direnç sınırına ulaşarak kırılması sonucu elastik yamulmanın yamulma öncesi haline dönerken yarattığı titreşimlerin elastik dalgalar halinde yayılmasıdır.




Merkez üssü (episantr)
Odak
Fay
Deprem dalgaları


L
R
a
L
R
b
L
R
c
L
R
d



KÜTLE DALGALARI

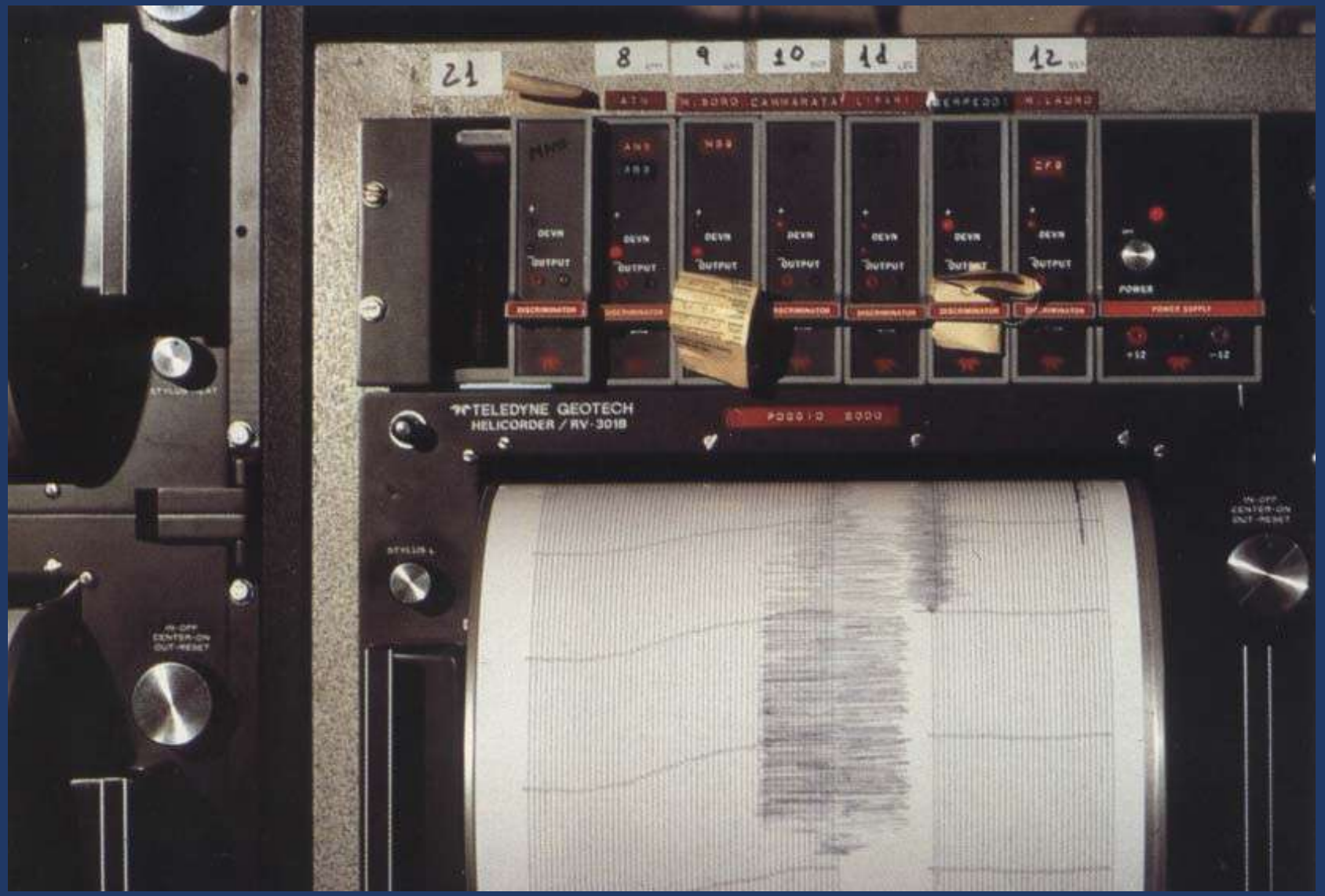
Boyuna dalgalar (P dalgaları)

Enine dalgalar (S dalgaları)

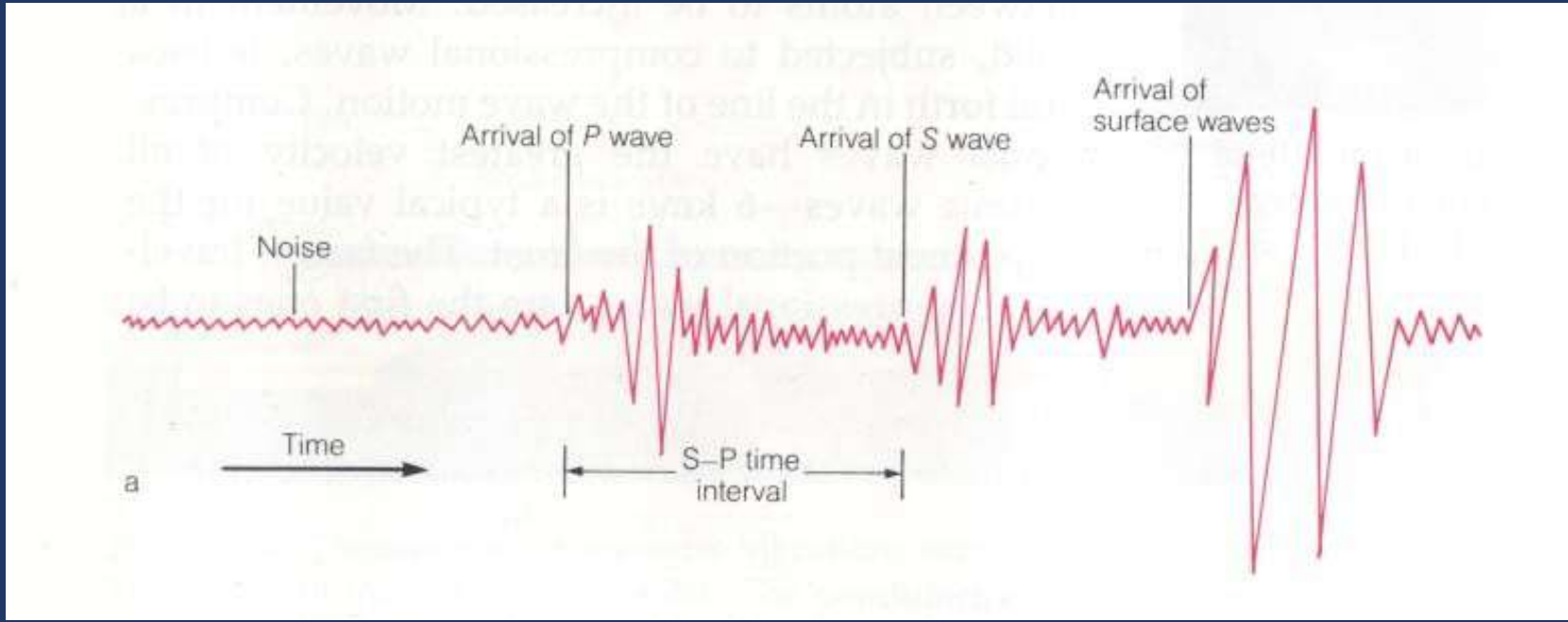
YÜZEYDALGALARI

Love dalgaları (enine)

Rayleigh dalgaları (boyuna)

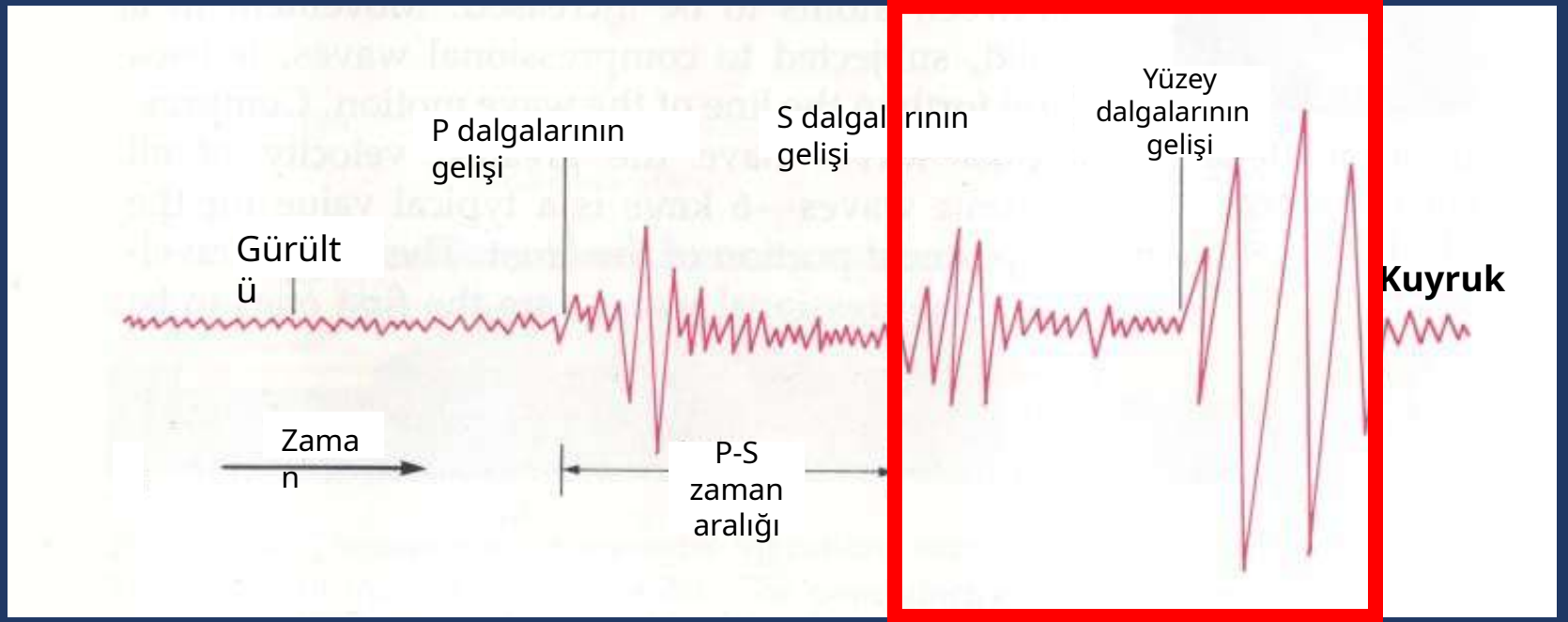


Modern bir sismografta kaydedilen bir deprem

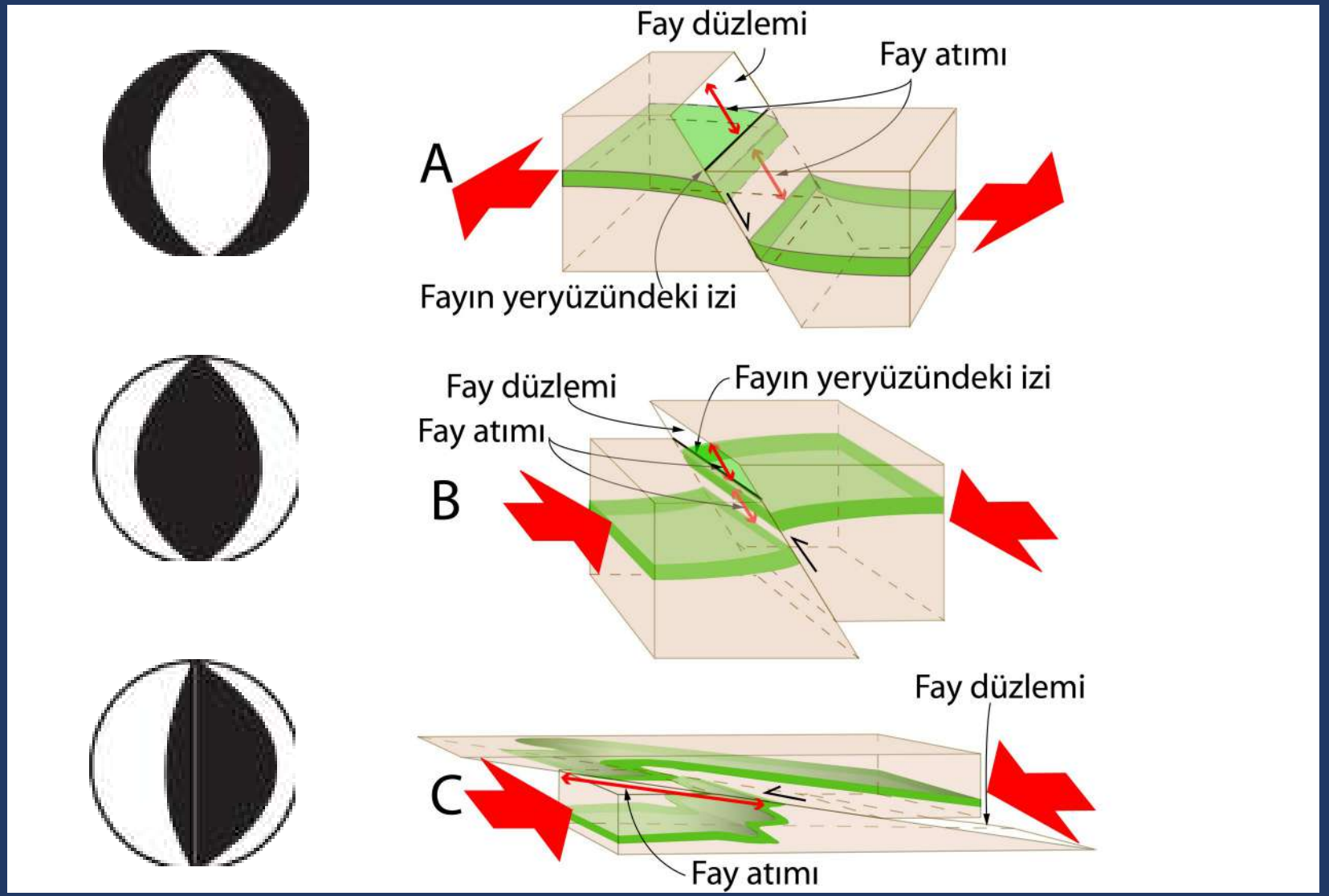


Bir sismogramın parçaları

YIKIM SÜRECİ



Bir sismogramın parçaları

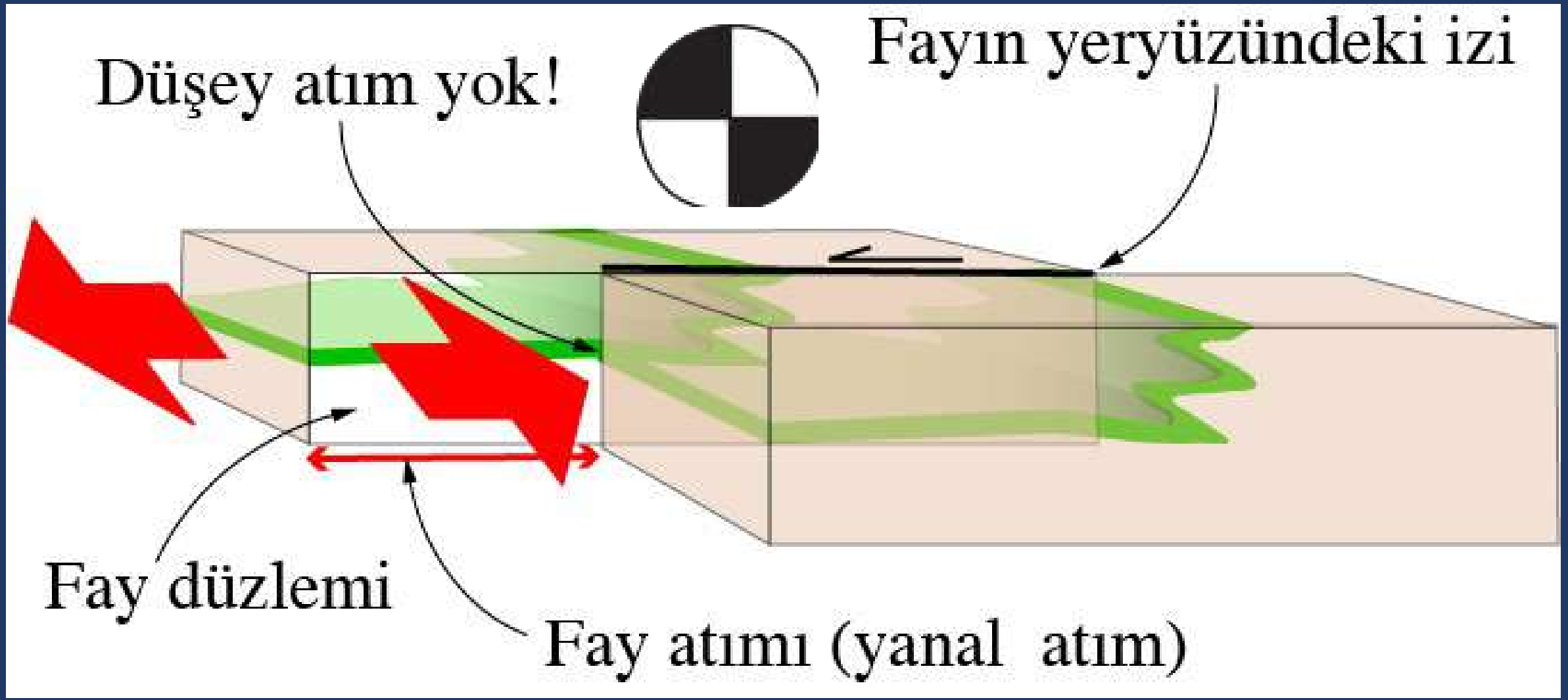

Fay düzlemi
Fay atımı
A
Fayın yeryüzündeki izi
Fay düzlemi
Fayın yeryüzündeki izi
Fay atımı
B
Fay düzlemi
C
Fay atımı

TETON SİLSİLESİ, BATI ABD

Apeninlerde 2016 normal fay depremi olan Amatrice-Norcia zelzelesinde oluşmuş fay basamağı, İtalya

Efes normal fayının fay düzlemi, batı Türkiye

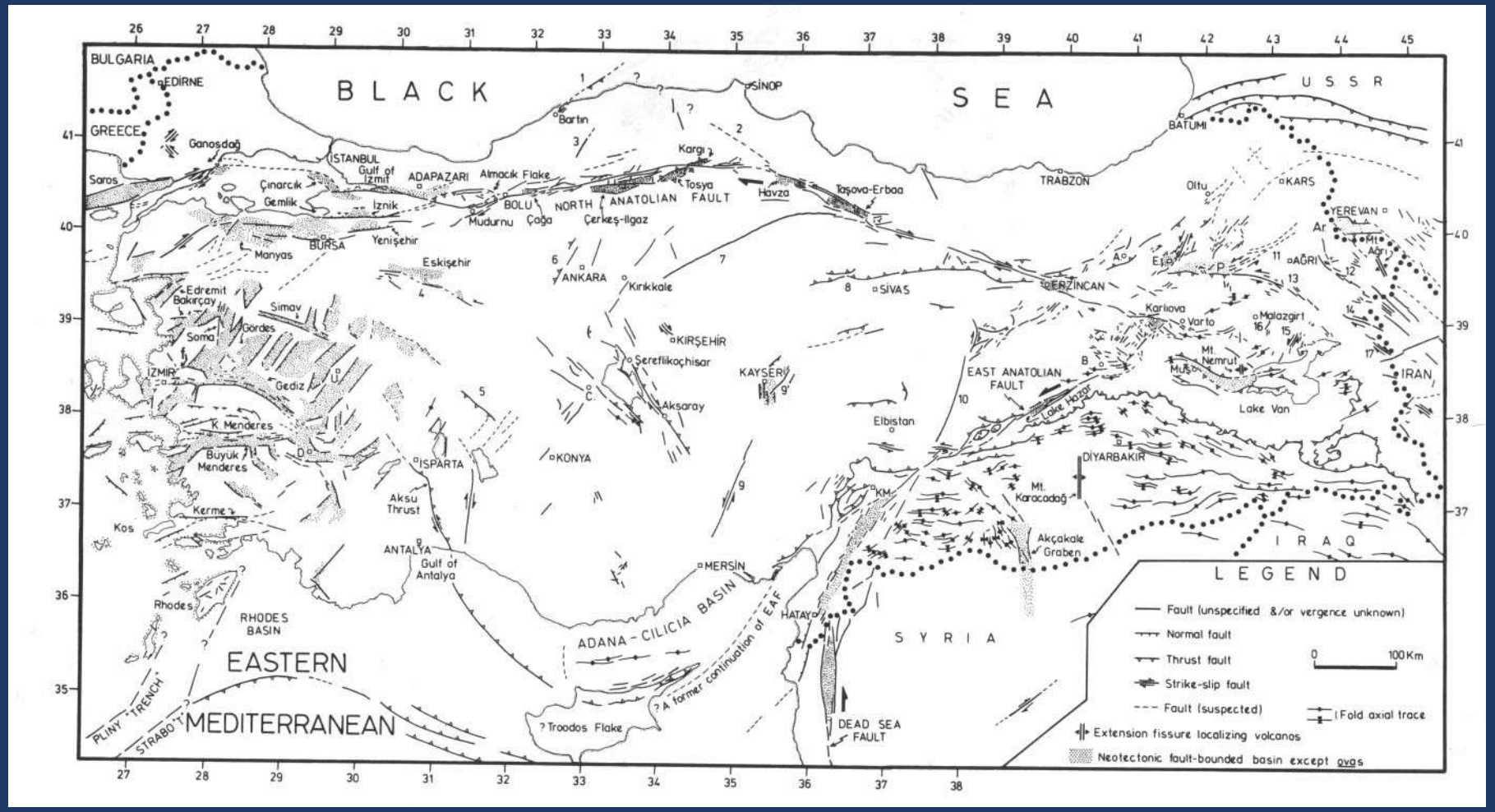
Güney Kaliforniye'da 1992 Landers bindirme fayı depreminde oluşmuş fay yüzeyi



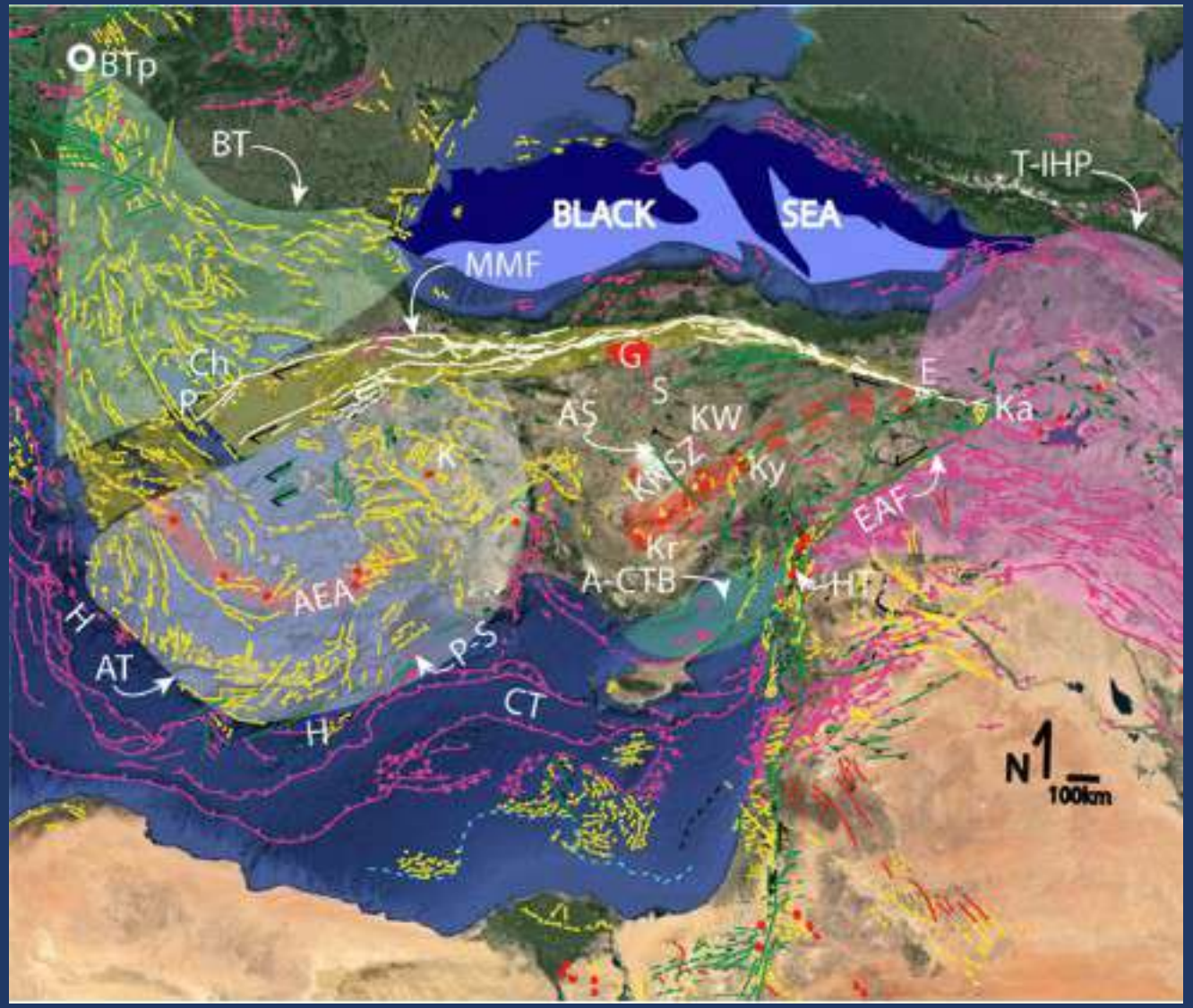
Yanal atımlı fay

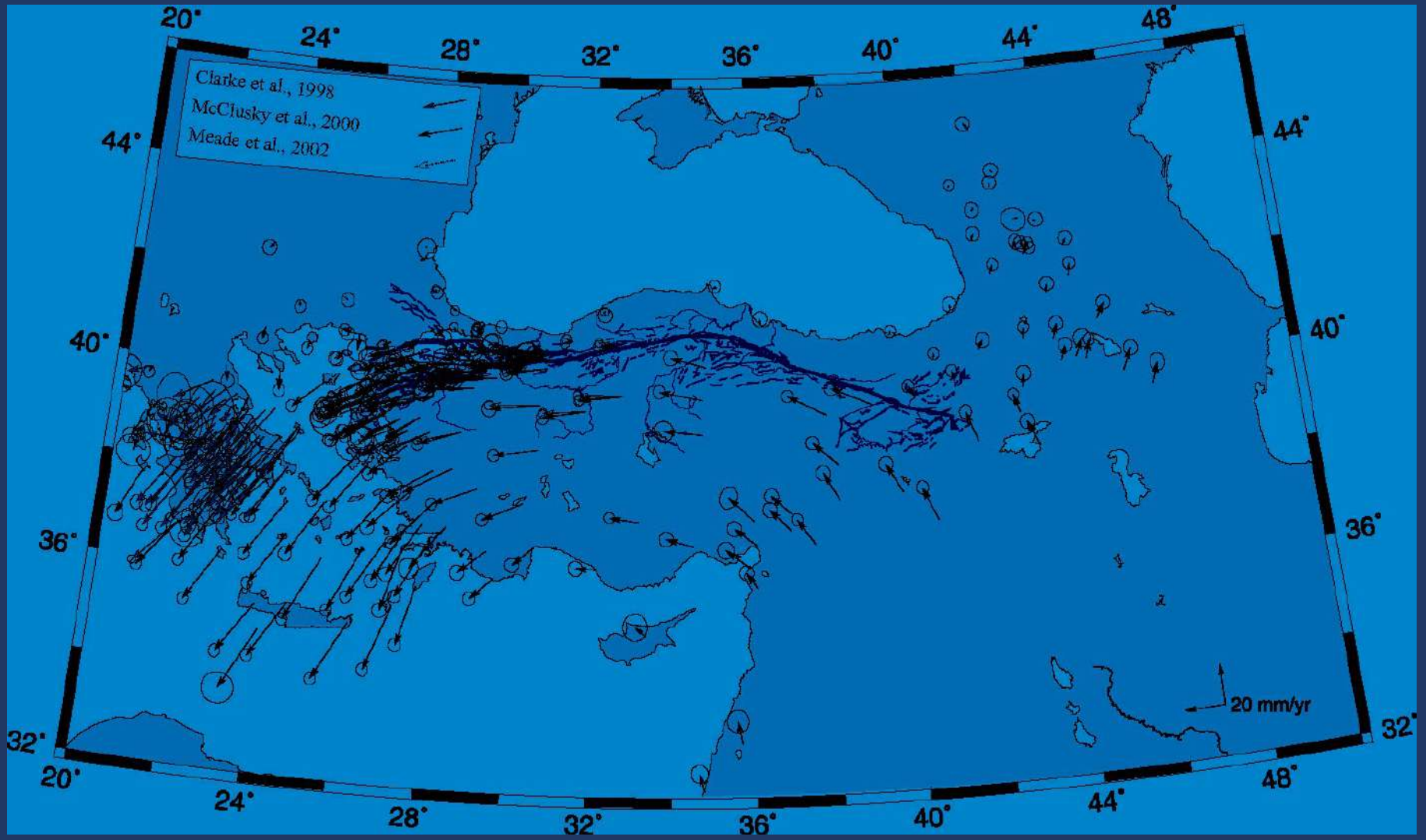
YANAL ATIMLI BİR FAY: SAN ANDREAS FAYI, KALİFORNİYA, ABD

TÜRKİYE'NİN YÜZEY ŞEKİLLERİ

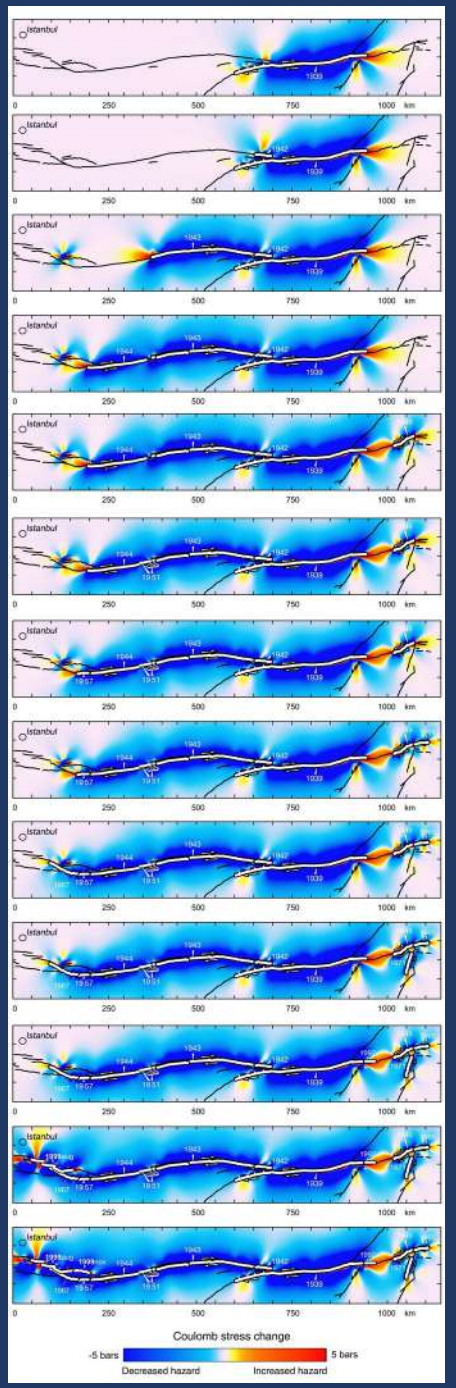


TÜRKEYİ'NİN FAAL JEOLOJİK YAPILARI


BTp
BT
BLACK
SEA
T-IHP
MMF
Ch
P
G
S
E
Ka
AŞ
KW
KMSZ
Ky
K
EAF
Kr
A-CTB
HT
AEA
H
AT
P-S
CT
N
100km

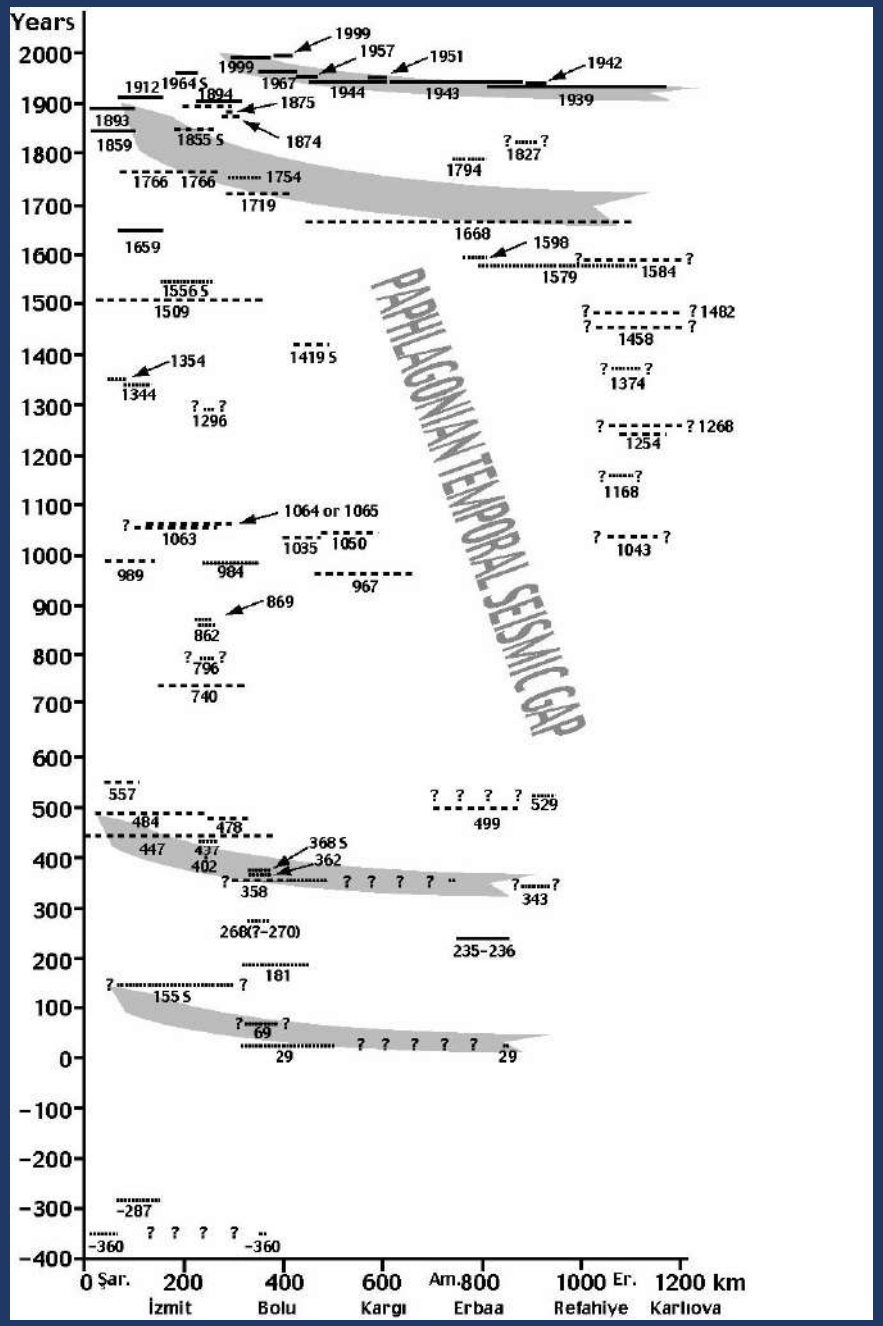


Türkiye ve cıvarında güncel yüzey hareketleri

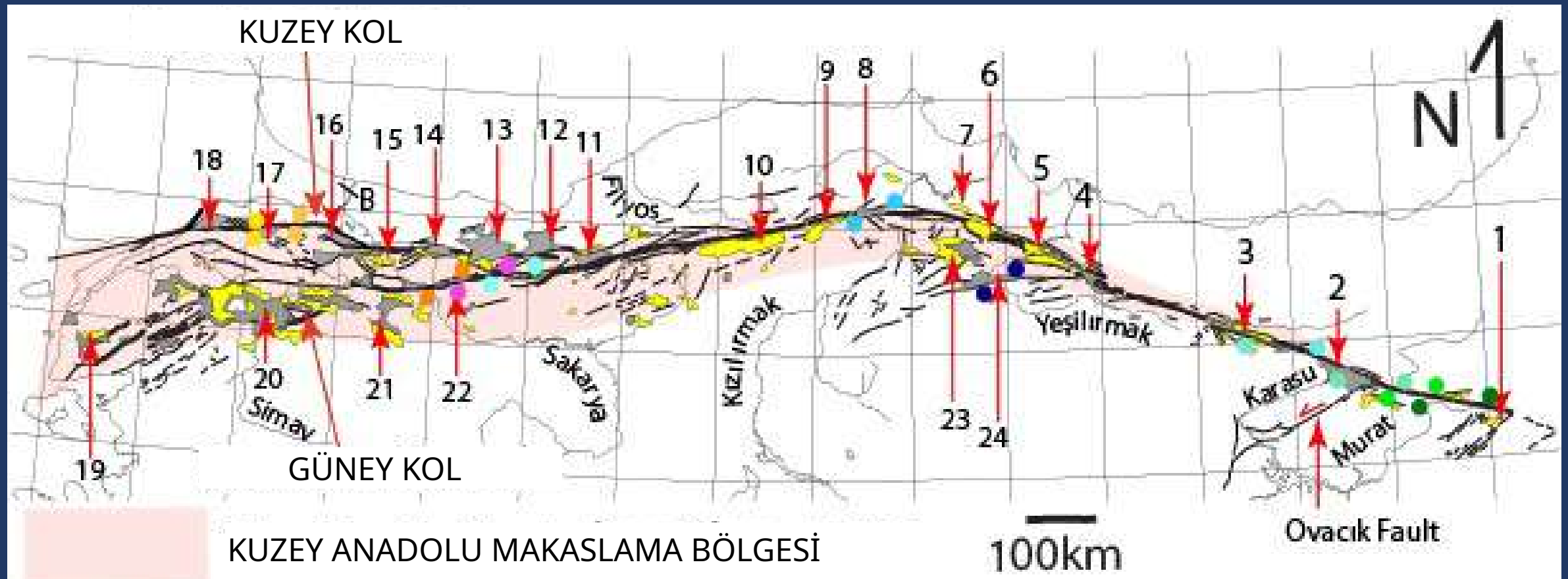


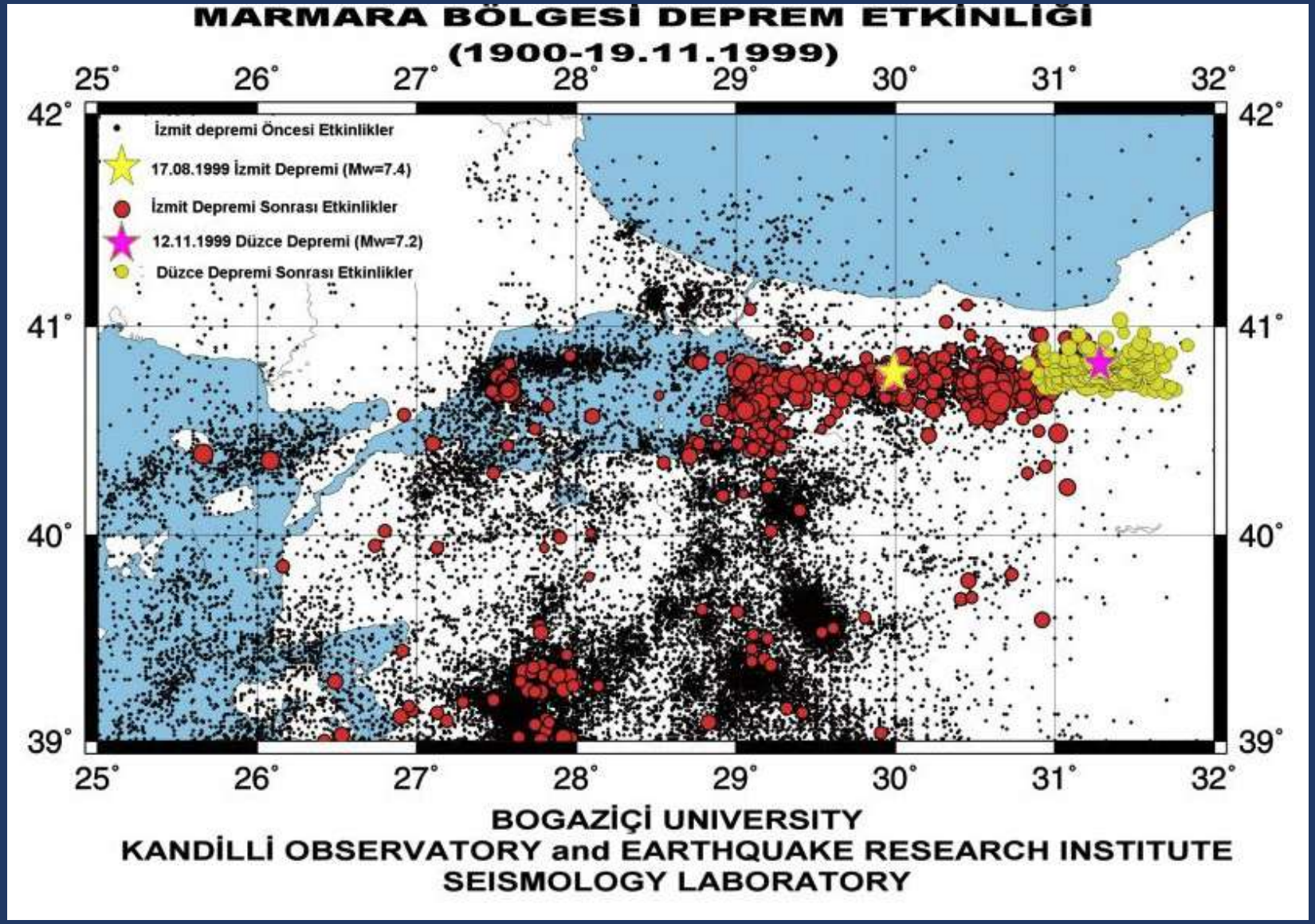
KUZEYANADOLU FAYI BOYUNCA DEPREM GÖÇÜ (1939-1999)

BOB STERN VE SERHAN BOZKURT



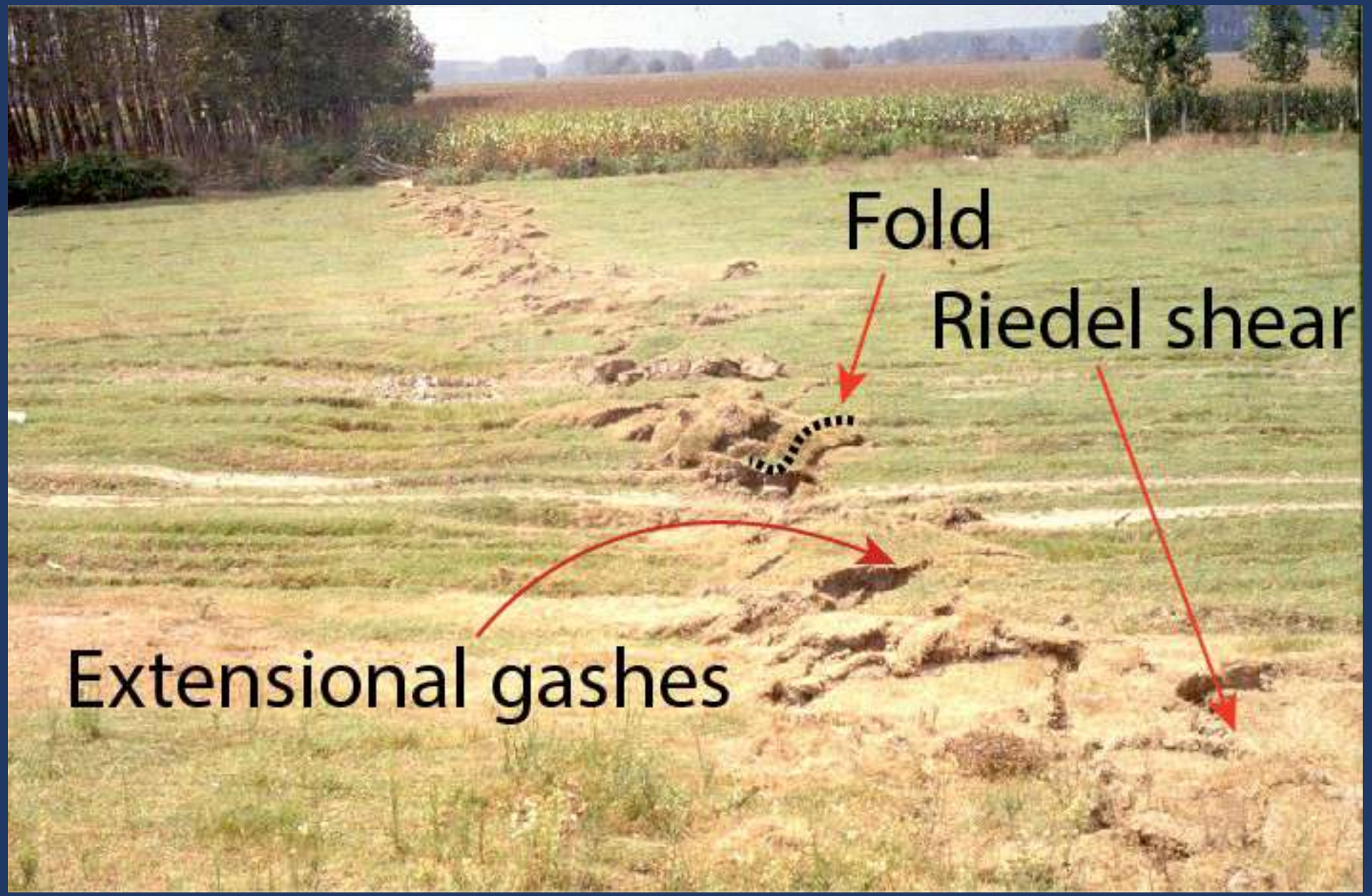
KUZEY ANADOLU FAYI TARİHSEL DEPREMSELLİK

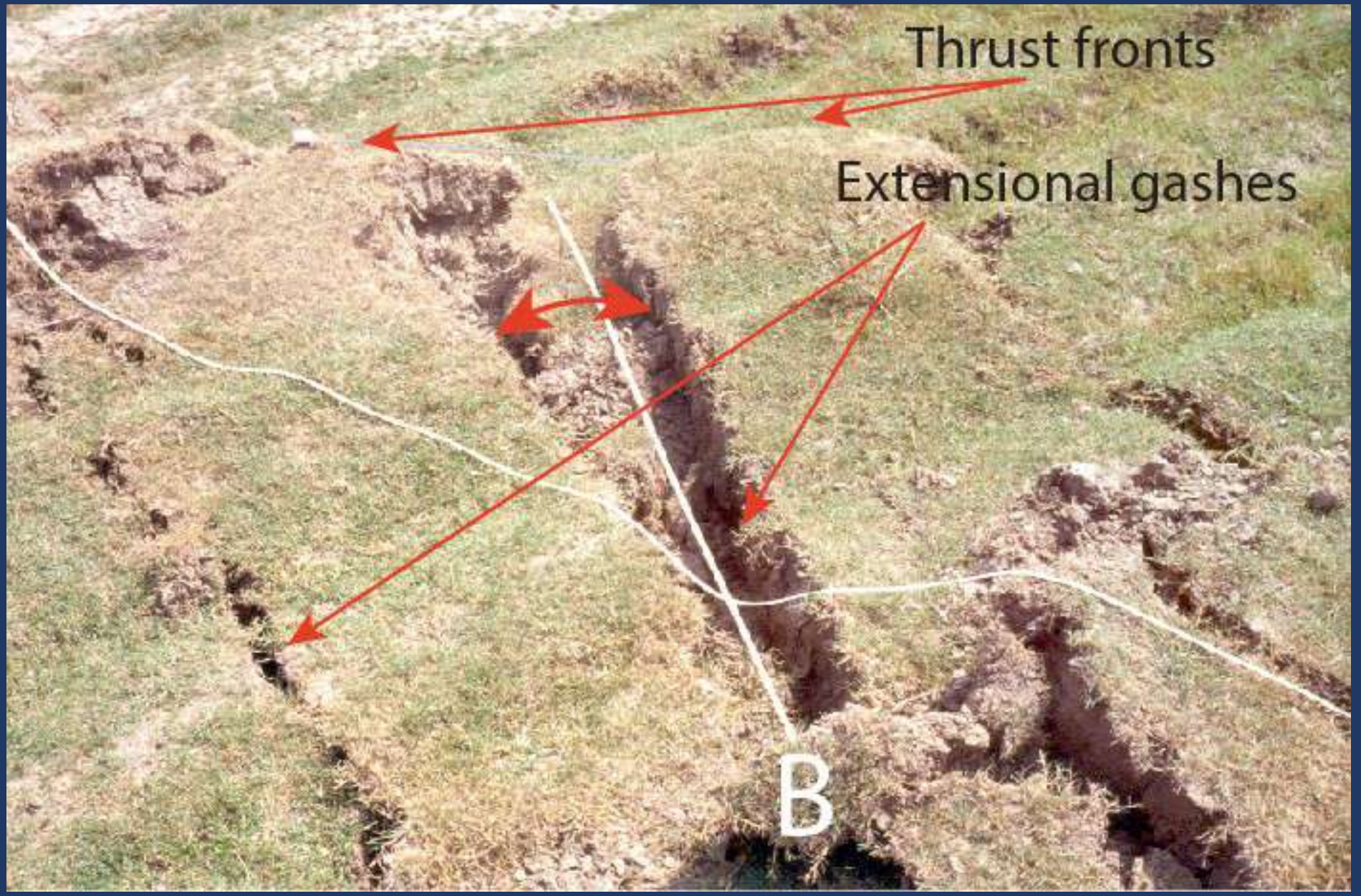

KUZEY KOL
GÜNEY KOL
N
18
17
16
B
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
19
20
Simav
21
22
Sakarya
Kızılırmak
Yeşilırmak
23
24
Karasu
Murat
Ovacık Fault
Pliyos
100km
KUZEY ANADOLU MAKASLAMA BÖLGESİ
Geç Miyosen-Pliyosen havzaları
Kuaterner havzaları
1
2
3
4
5
6
7
8
9
10
11

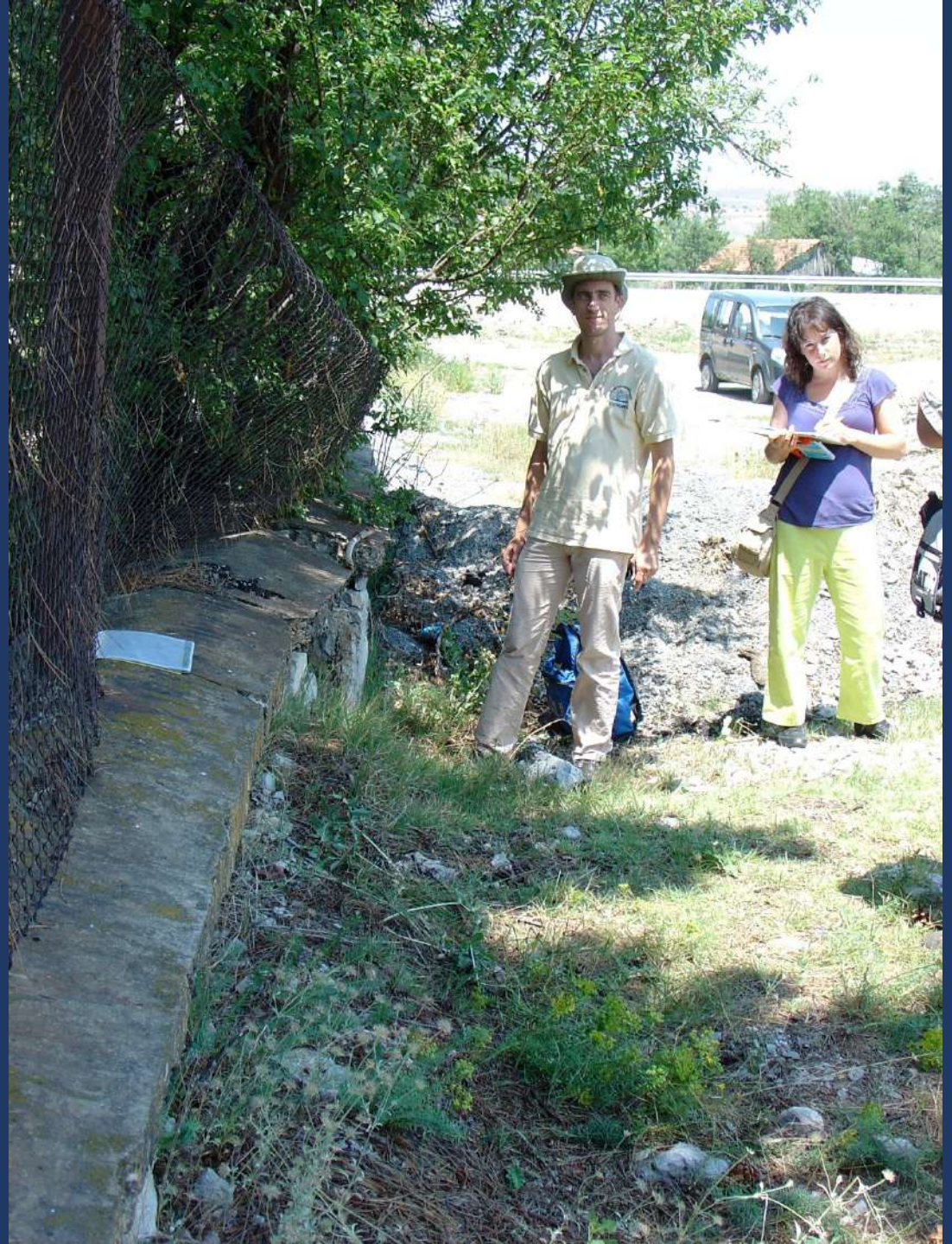

MARMARA BÖLGESİ DEPREM ETKİNLİĞİ
(1900-19.11.1999)
İzmit depremi Öncesi Etkinlikler
17.08.1999 İzmit Depremi (Mw=7.4)
İzmit Depremi Sonrası Etkinlikler
12.11.1999 Düzce Depremi (Mw=7.2)
Düzce Depremi Sonrası Etkinlikler
25° 26° 27° 28° 29° 30° 31° 32°
42° 41° 40° 39°
BOGAZİÇİ UNIVERSITY
KANDİLLİ OBSERVATORY and EARTHQUAKE RESEARCH INSTITUTE
SEISMOLOGY LABORATORY

17 AĞUSTOS 1999 DEPREMİ YÜZEY KIRIĞI, SAPANCA GÖLÜ KUZEYDOĞUSU

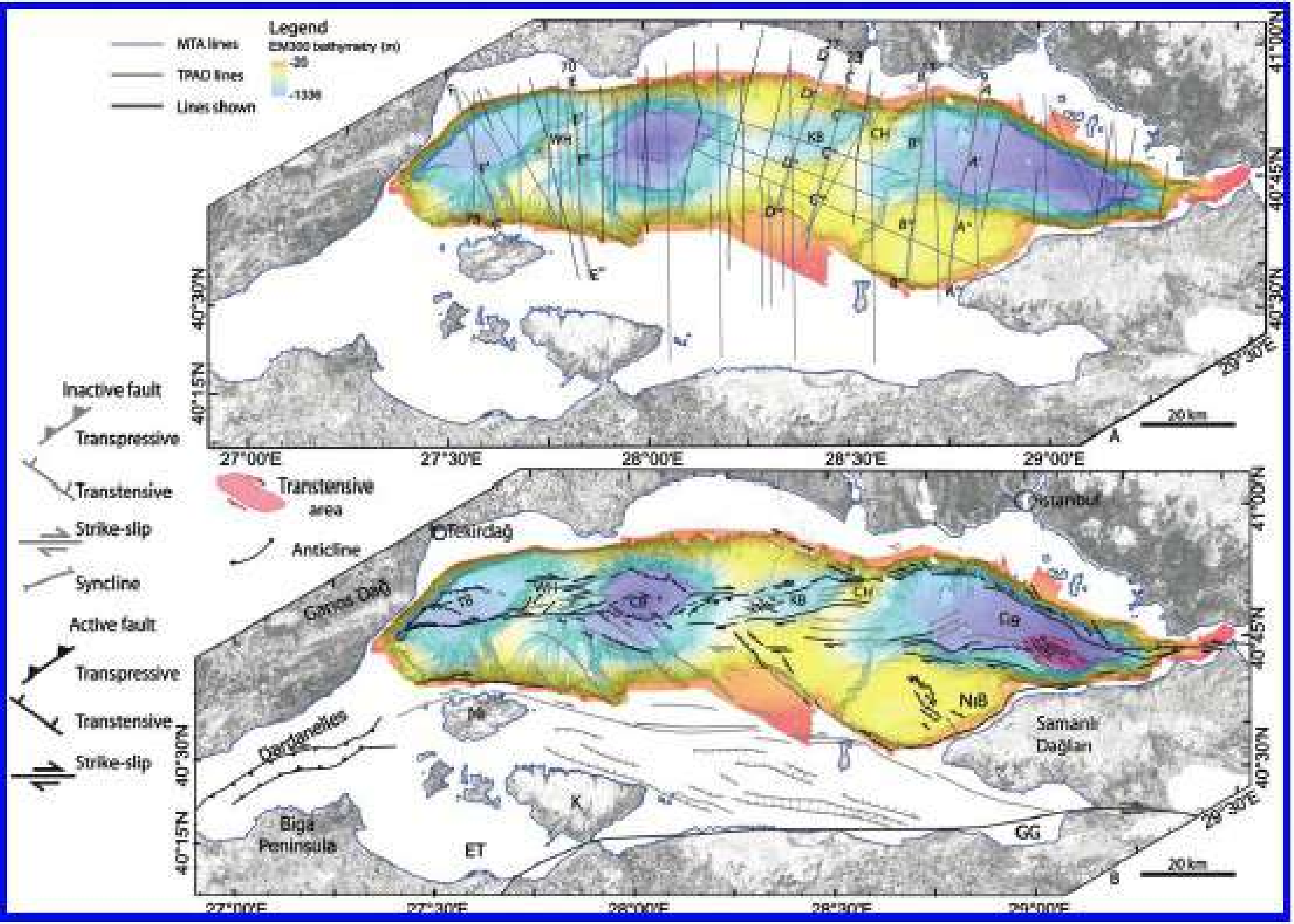
ARİFİYE’DE ELGAZ BENZİN İSTASYONUNDA ÖLÇÜLEN 5 METRELİK YANAL ATIM

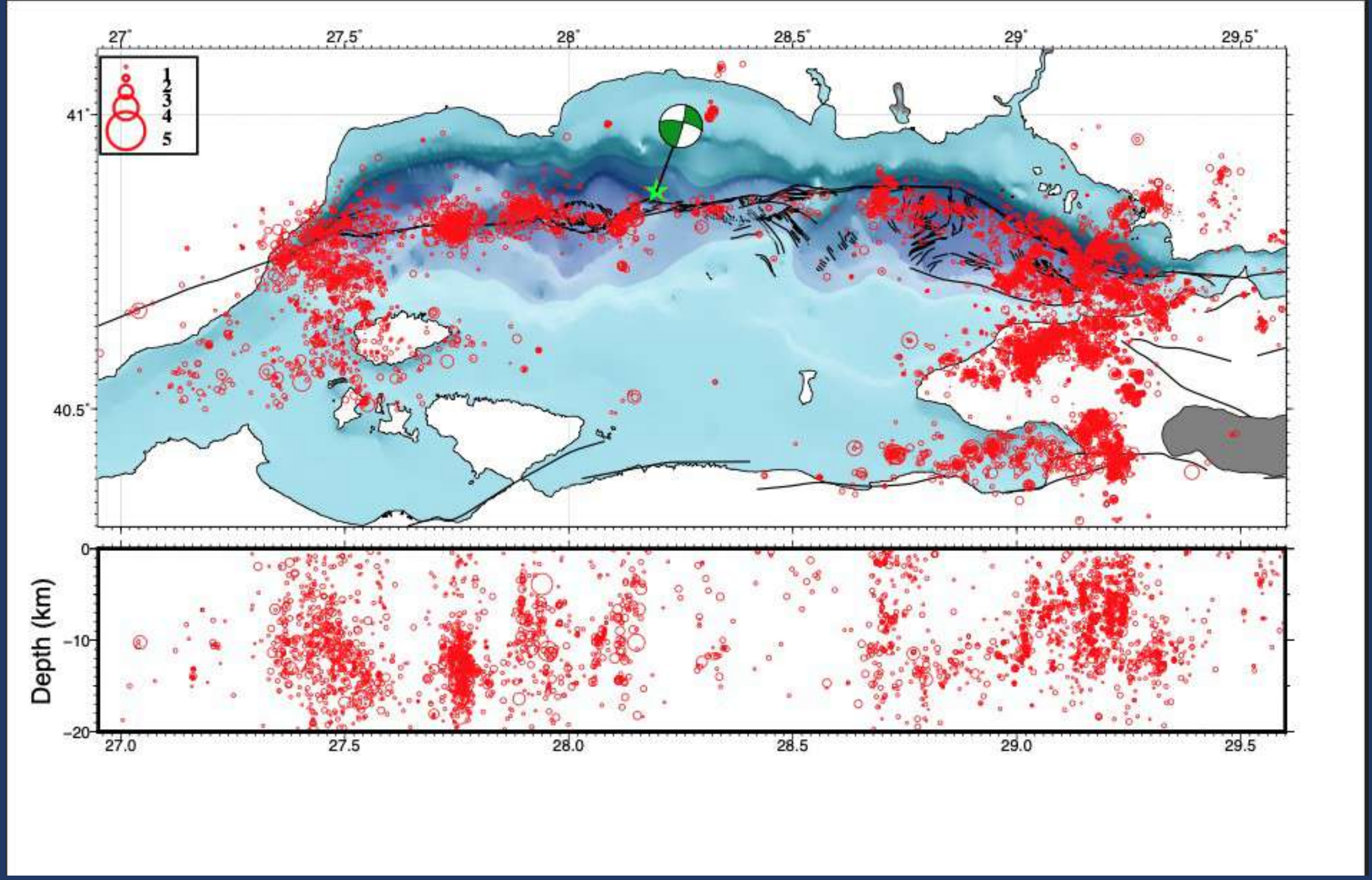

Fold
Riedel shear
Extensional gashes

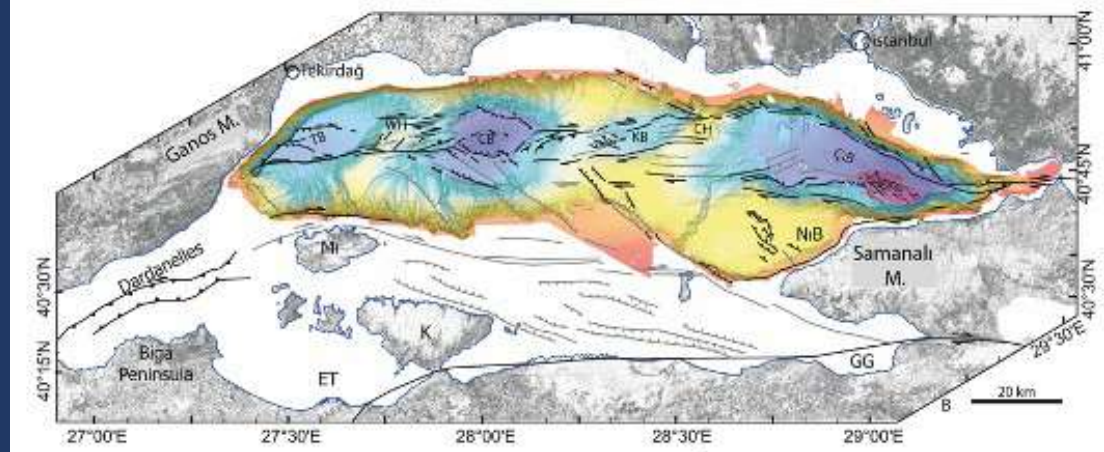

Thrust fronts
Extensional gashes
B

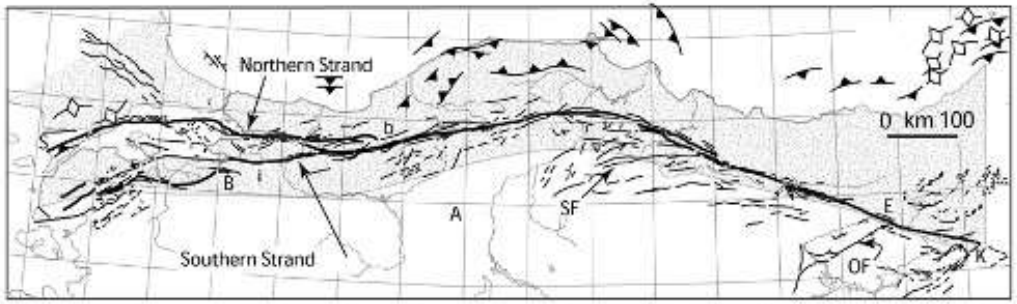


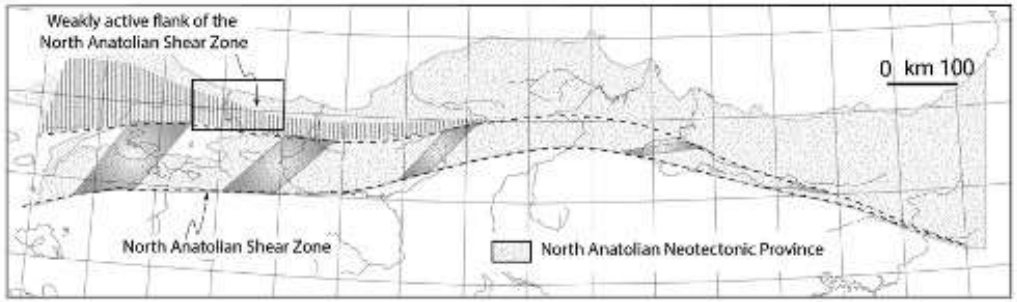
Gerede’de İsmet Paaşa Karayolları bakım istasyonunda gözlenen sürüklenme olayı (creep)

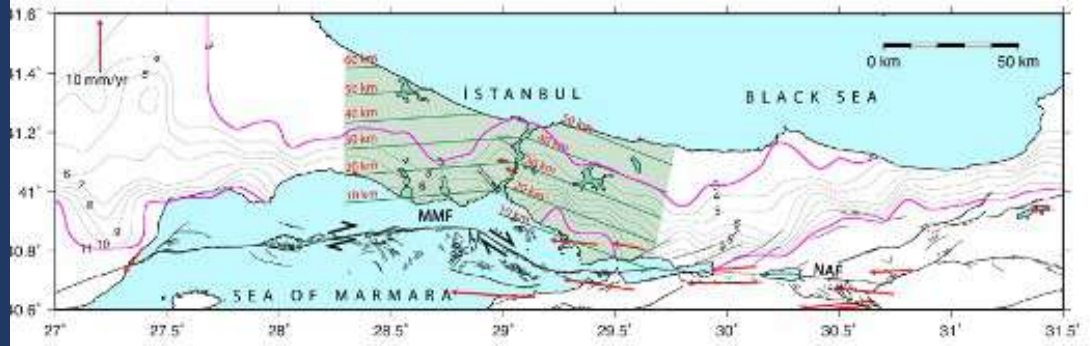

Legend
EM300 bathymetry (m)
MTA lines
TPAO lines
Lines shown
Inactive fault
Transpressive
Transtensive
Strike-slip
Syncline
Active fault
Transpressive
Transtensive
Strike-slip
Transtensive area
Anticline
İstanbul
Tekirdağ
Ganos Dağ
Dardanelles
Biga Peninsula
ET
K
GG
Samanlı Dağları
NiB
CB
KB
CH
WH
TB
20 km
A
B
27°00'E
27°30'E
28°00'E
28°30'E
29°00'E
29°30'E
41°00'N
40°45'N
40°30'N
40°15'N

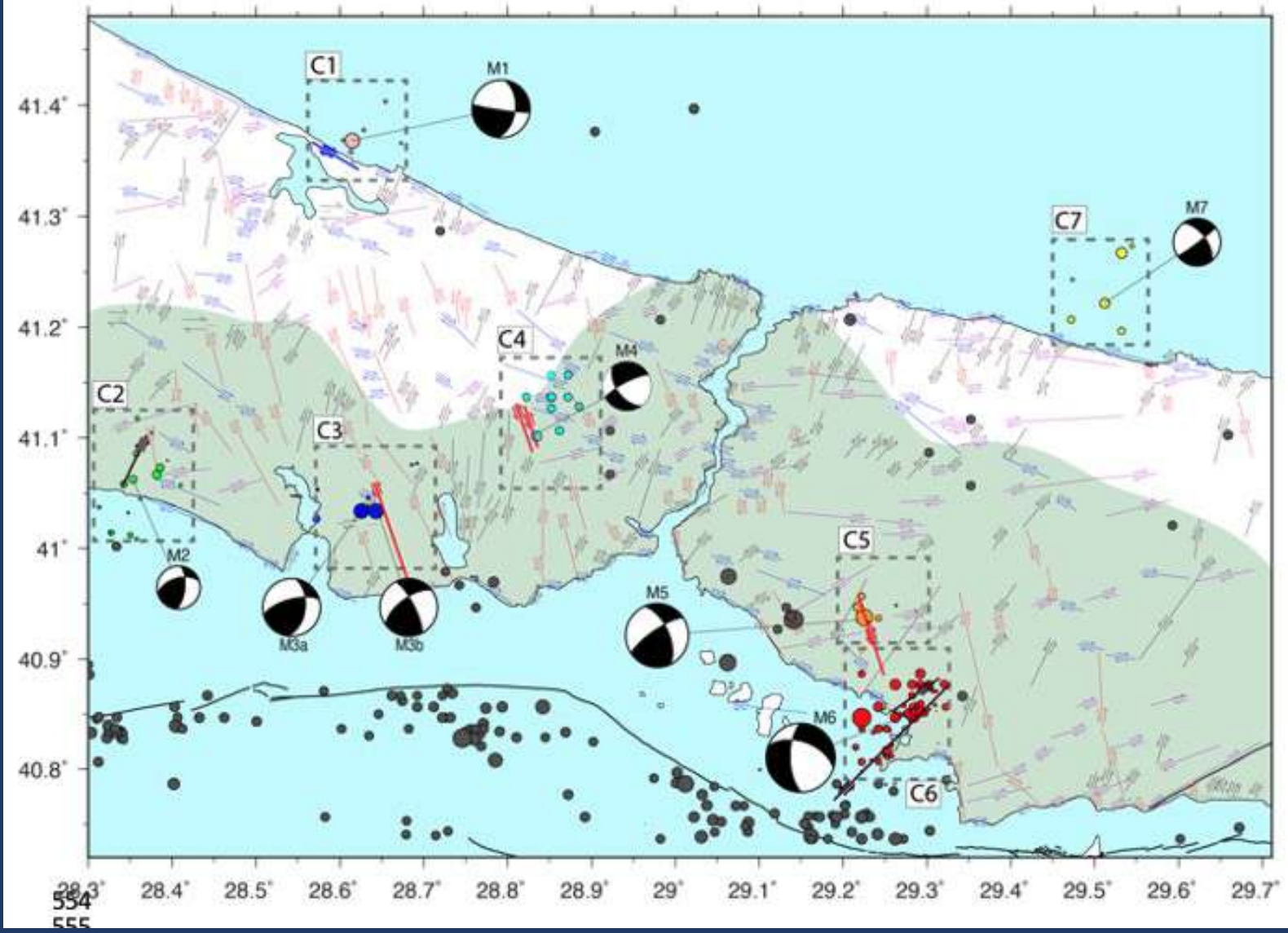

27°
27.5°
28°
28.5°
29°
29.5°
41°
40.5°
1
2
3
4
5
0
−10
−20
Depth (km)
27.0
27.5
28.0
28.5
29.0
29.5


Istanbul
Tekirdag
Ganos M.
TB
WT
CB
KB
CH
NiB
Samanalı M.
MI
Dardanelles
K
Biga Peninsula
ET
GG
B
20 km
40°45'N
40°30'N
40°15'N
27°00'E
27°30'E
28°00'E
28°30'E
29°00'E


Northern Strand
Southern Strand
B
A
SF
OF
E
K
0 km 100

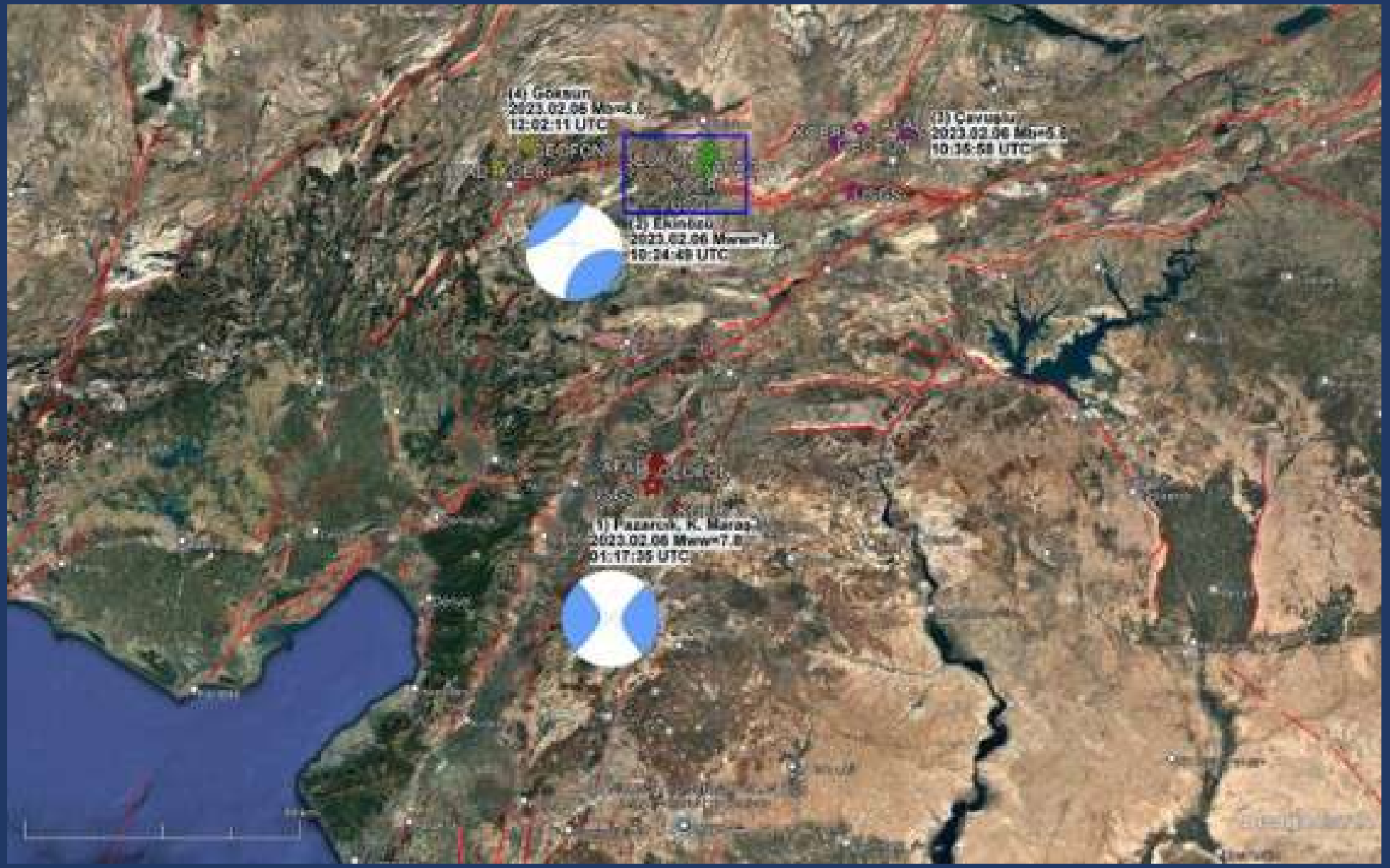

Weakly active flank of the North Anatolian Shear Zone
North Anatolian Shear Zone
North Anatolian Neotectonic Province
0 km 100


10 mm/yr
ISTANBUL
BLACK SEA
SEA OF MARMARA
MMF
NAF
0 km
50 km
27°
27.5°
28°
28.5°
29°
29.5°
30°
30.5°
31°
31.5°

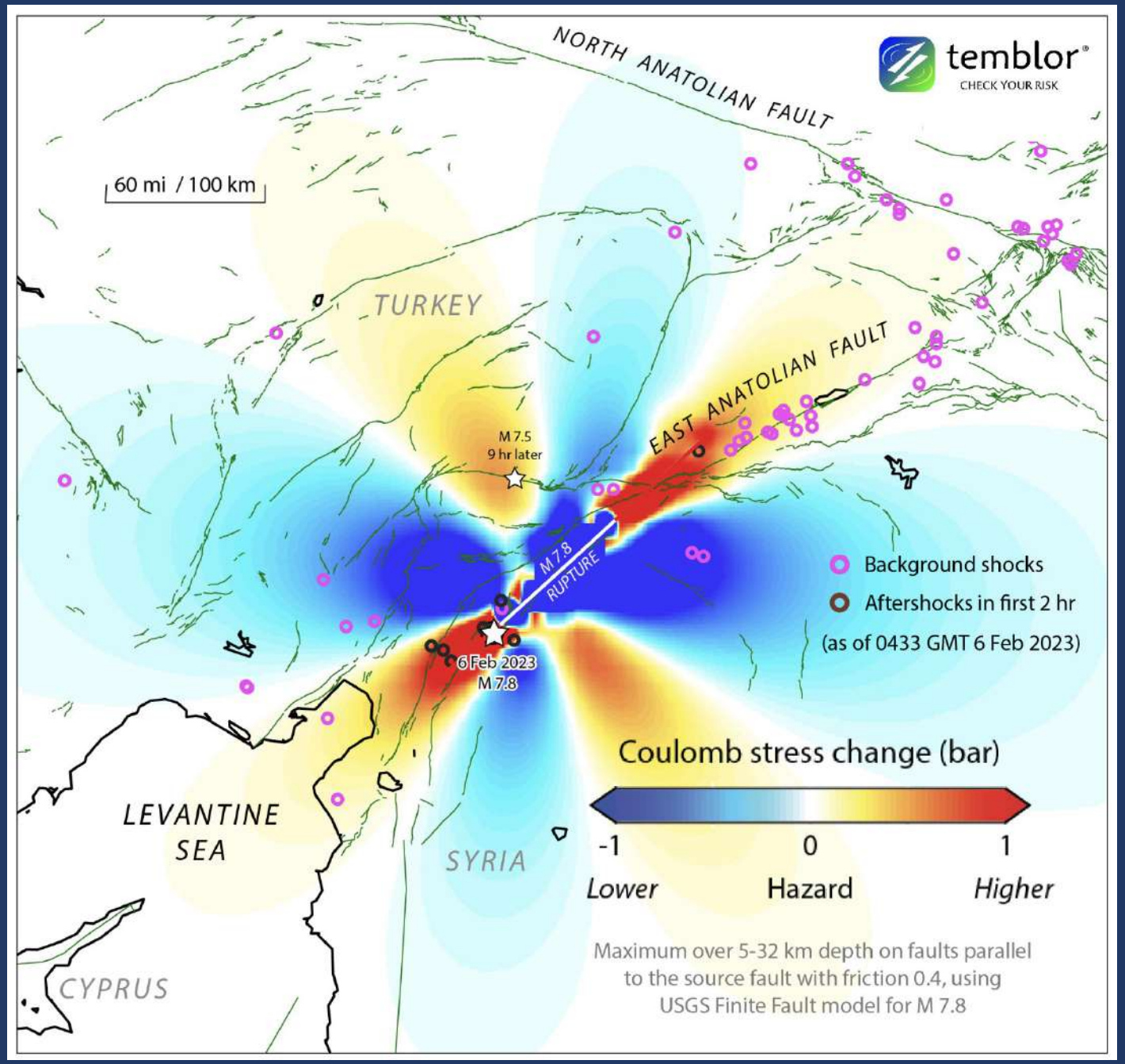


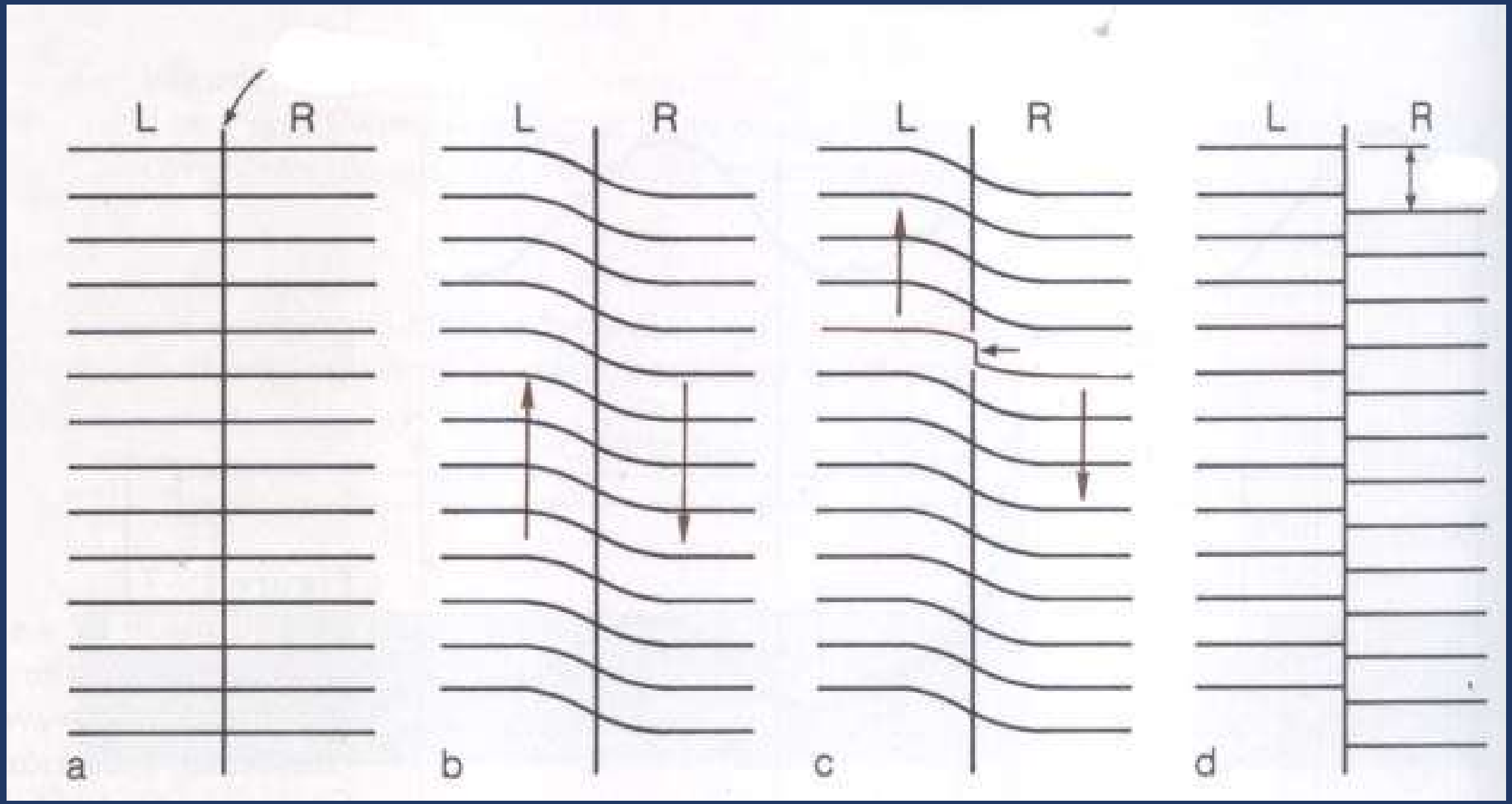
İstanbul şehir içi deprem ve potansiyel fay dağılımı

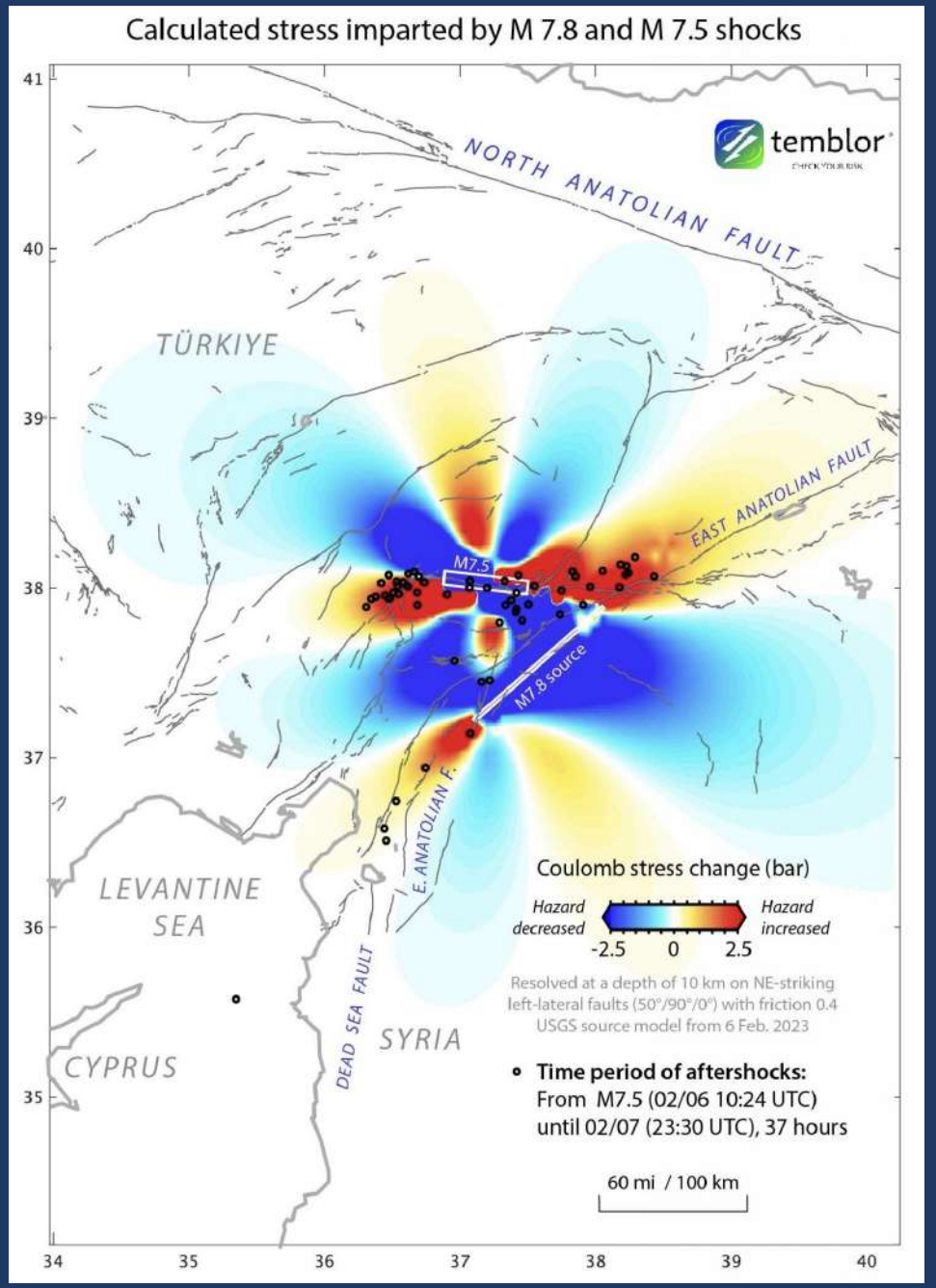
2023 KAHRAMANMARAŞ VE MALATYA DEPREMLERİ VE ARDCILARI

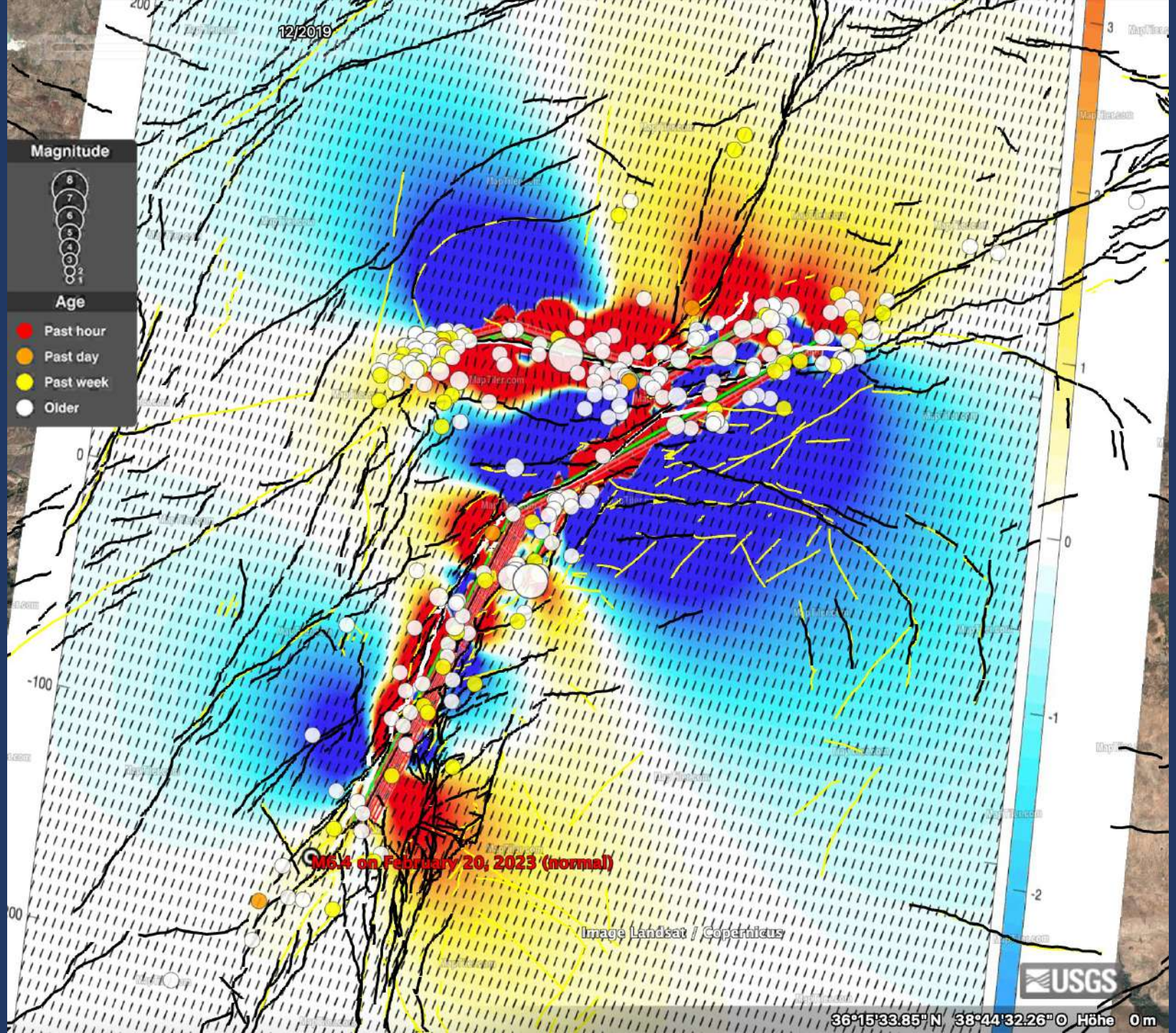


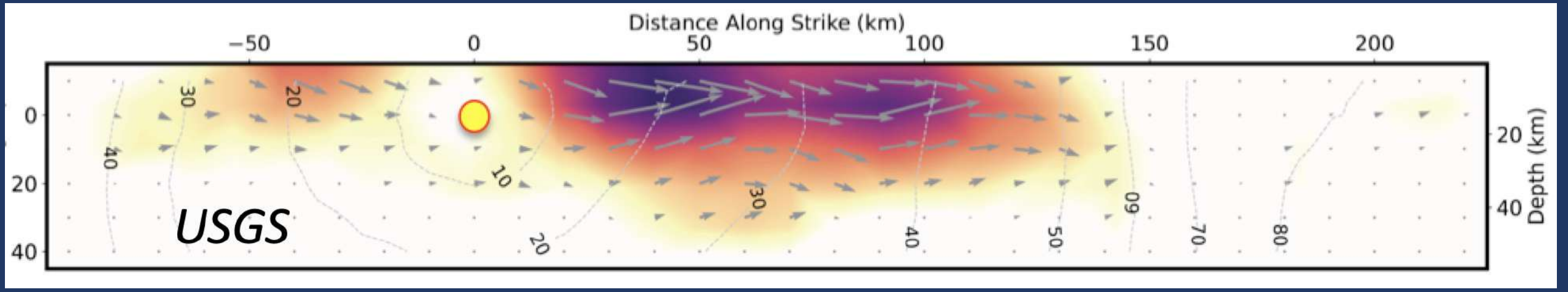
Kahramanmaraş ve Malatya depremlerinin vuku bulduğu
böylgenin faal fay haritası (Prof. Gürol Seyitoğlu, yazılı görüşme)

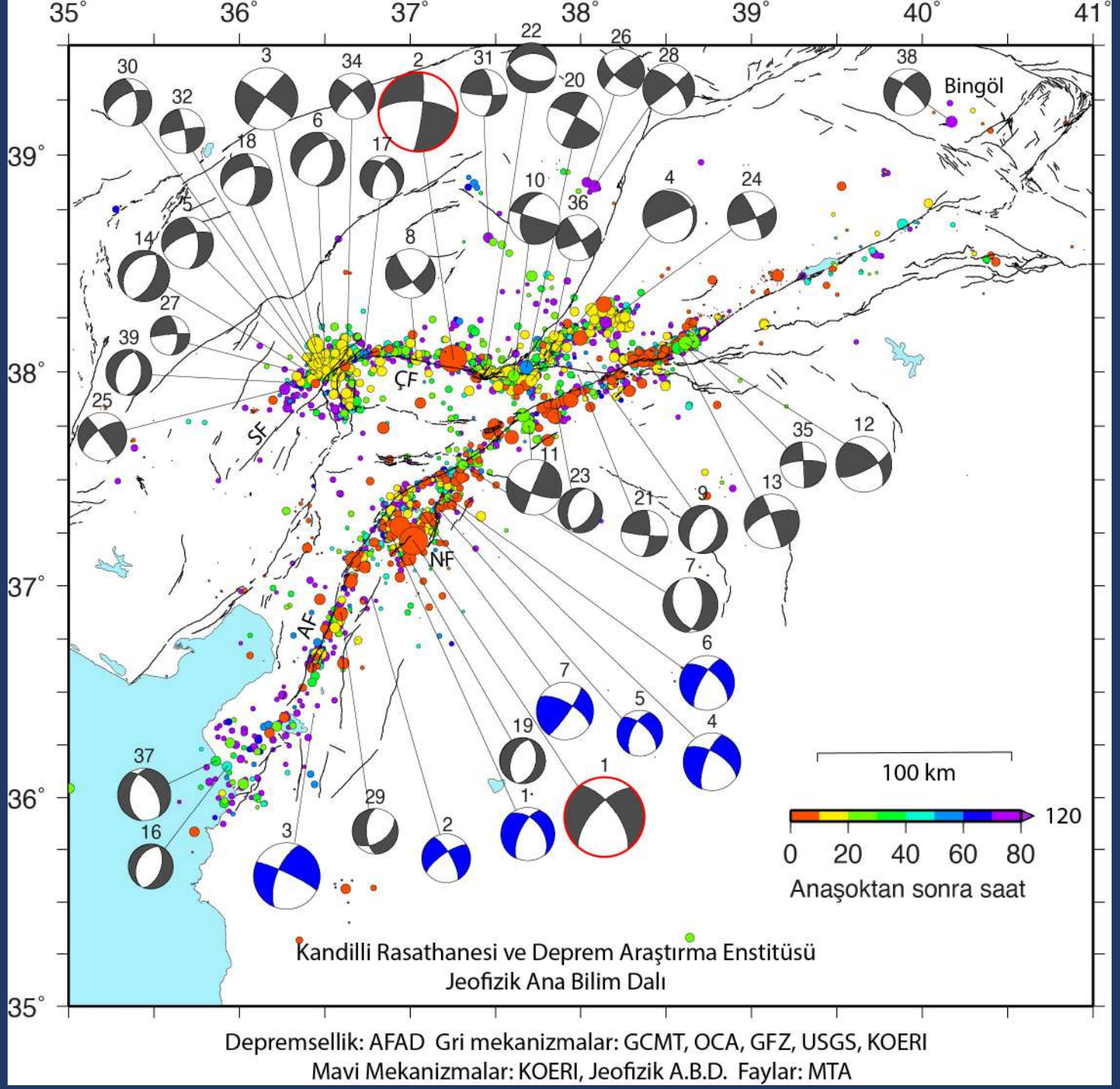

temblor
CHECK YOUR RISK
NORTH ANATOLIAN FAULT
60 mi / 100 km
TURKEY
EAST ANATOLIAN FAULT
M 7.5
9 hr later
M 7.8
RUPTURE
6 Feb 2023
M 7.8
Background shocks
Aftershocks in first 2 hr
(as of 0433 GMT 6 Feb 2023)
LEVANTINE
SEA
SYRIA
CYPRUS
Coulomb stress change (bar)
-1
0
1
Lower
Hazard
Higher
Maximum over 5-32 km depth on faults parallel
to the source fault with friction 0.4, using
USGS Finite Fault model for M 7.8


L
R
a
L
R
b
L
R
c
L
R
d

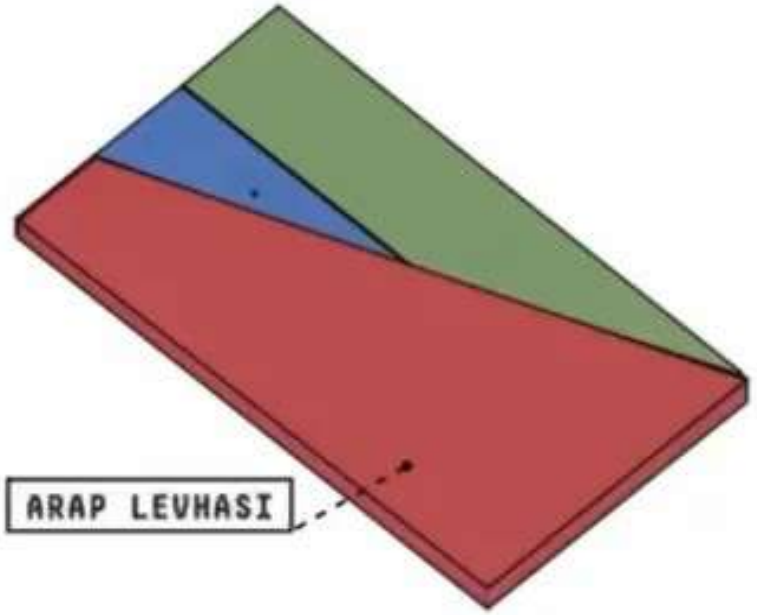

Calculated stress imparted by M 7.8 and M 7.5 shocks
temblor
NORTH ANATOLIAN FAULT
TÜRKIYE
EAST ANATOLIAN FAULT
M7.5
M7.8 source
E. ANATOLIAN F.
LEVANTINE SEA
DEAD SEA FAULT
SYRIA
CYPRUS
Coulomb stress change (bar)
Hazard decreased
Hazard increased
-2.5
0
2.5
Resolved at a depth of 10 km on NE-striking left-lateral faults (50°/90°/0°) with friction 0.4
USGS source model from 6 Feb. 2023
Time period of aftershocks:
From M7.5 (02/06 10:24 UTC)
until 02/07 (23:30 UTC), 37 hours
60 mi / 100 km
41
40
39
38
37
36
35
34
35
36
37
38
39
40

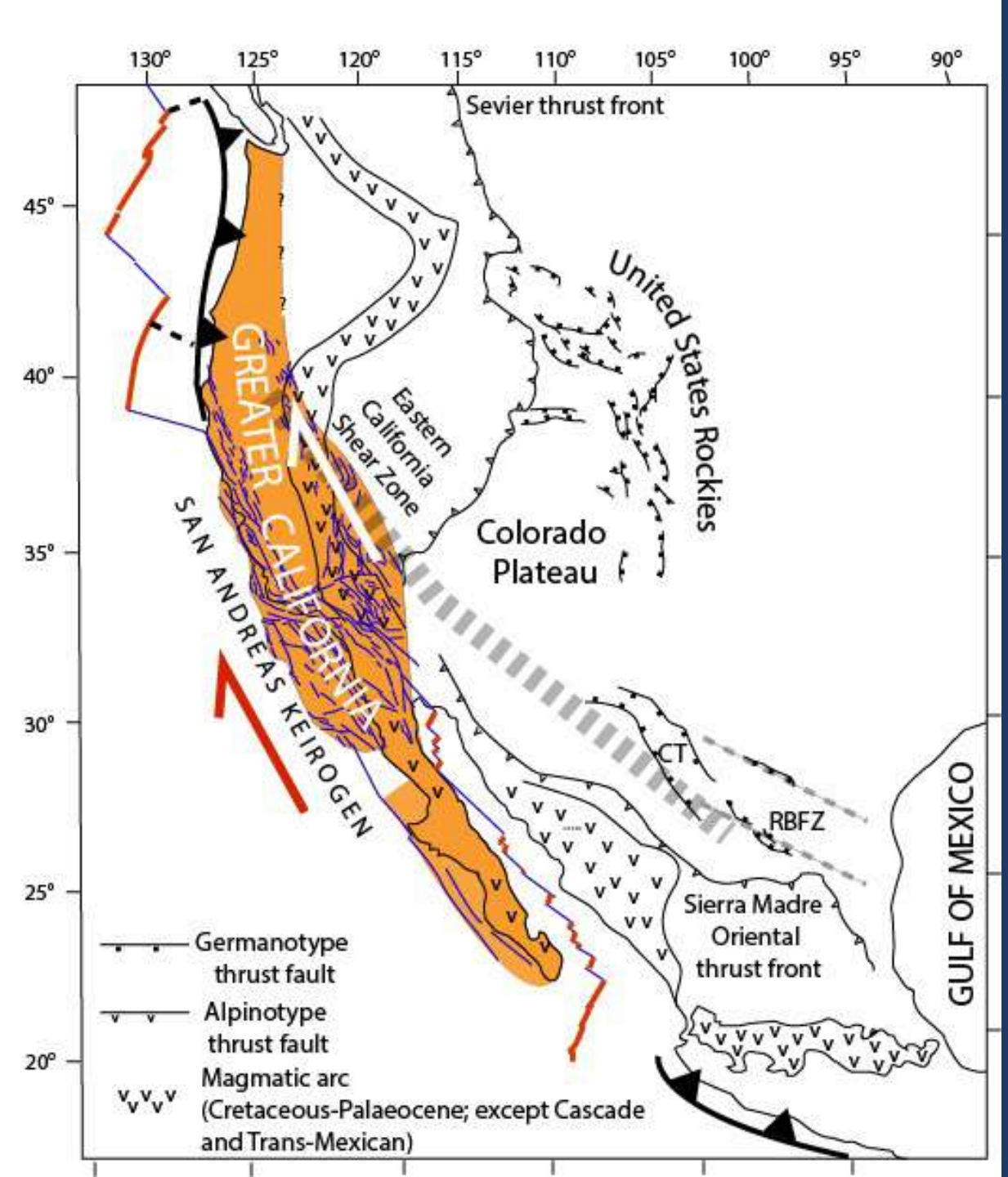

12/2019
Magnitude
8
7
6
5
4
3
2
1
Age
Past hour
Past day
Past week
Older
200
0
-100
M6.4 on February 20, 2023 (normal)
Image Landsat / Copernicus
USGS
36°15'33.85" N 38°44'32.26" O Höhe 0 m

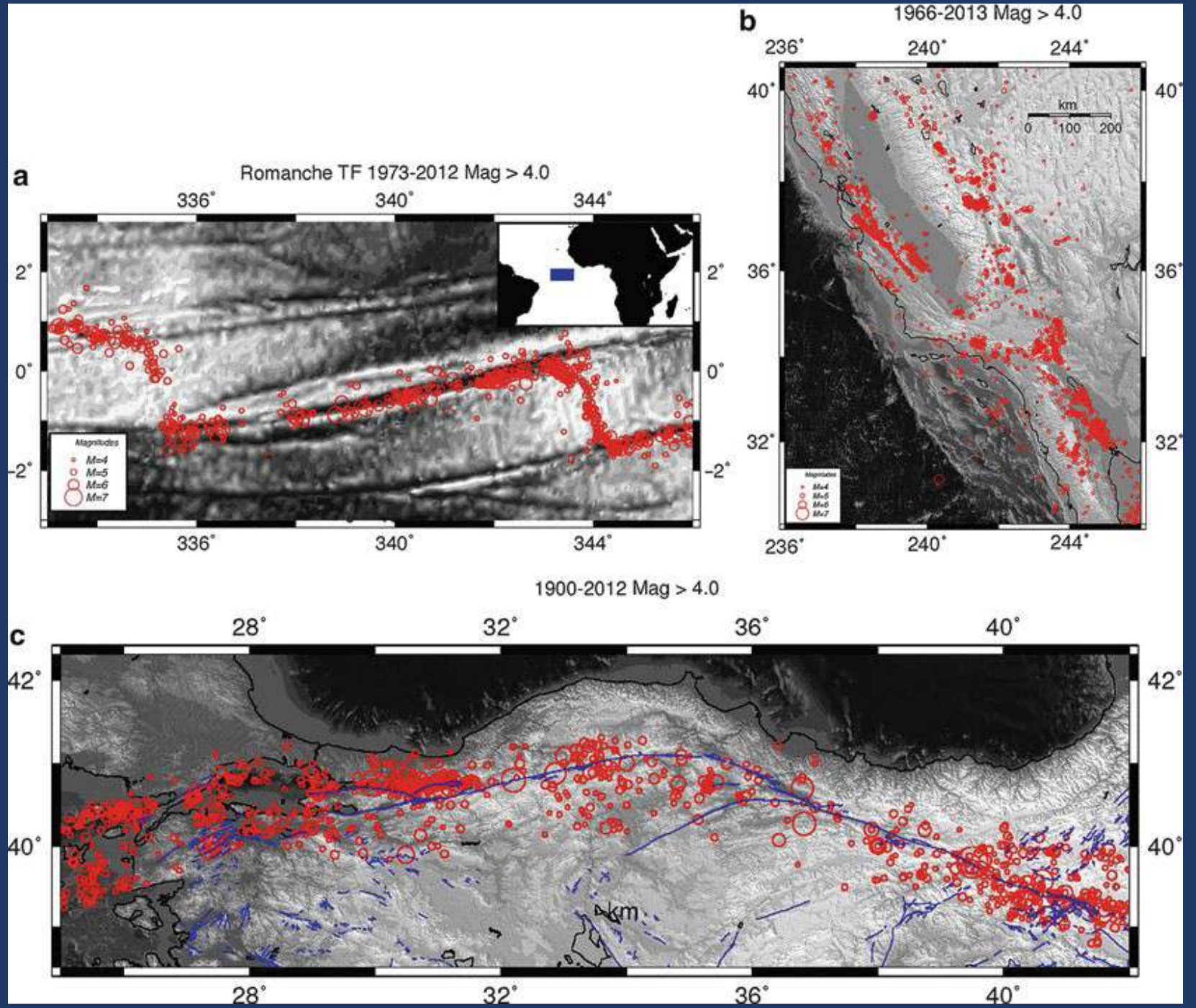

Distance Along Strike (km)
−50
0
50
100
150
200
0
20
40
Depth (km)
20
40
30
20
10
20
30
40
50
60
70
80
USGS

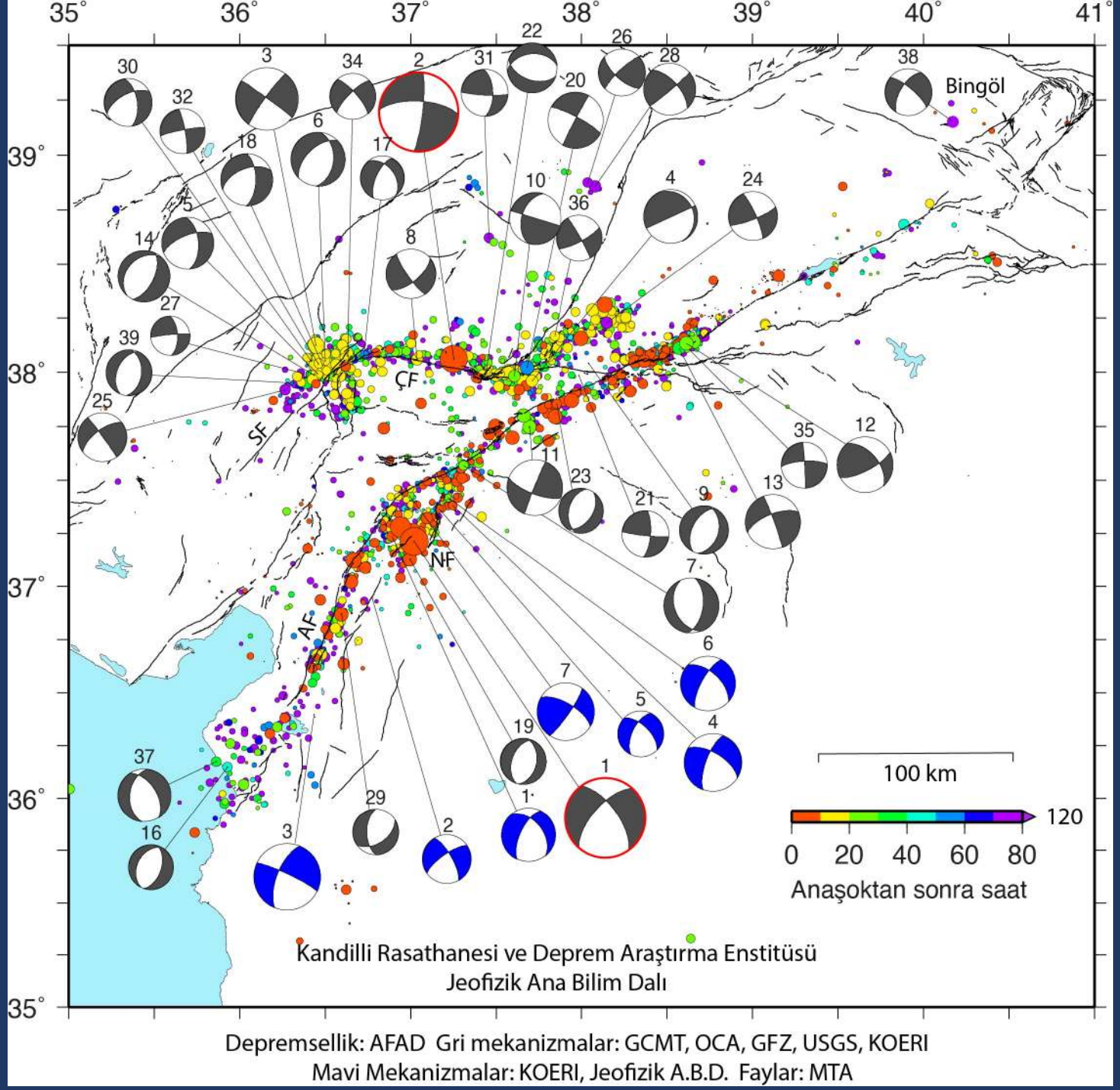


Depremsellik: AFAD Gri mekanizmalar: GCMT, OCA, GFZ, USGS, KOERI
Mavi Mekanizmalar: KOERI, Jeofizik A.B.D. Faylar: MTA


ARAP LEVHASI

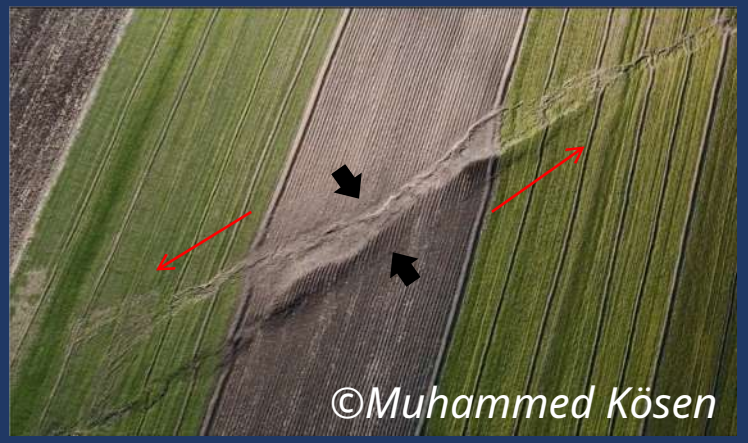

130°
125°
120°
115°
110°
105°
100°
95°
90°
45°
40°
35°
30°
25°
20°
Sevier thrust front
United States Rockies
GREATER CALIFORNIA
Eastern California Shear Zone
SAN ANDREAS KEIROGEN
Colorado Plateau
CT
RBFZ
Sierra Madre Oriental thrust front
GULF OF MEXICO
Germanotype thrust fault
Alpinotype thrust fault
Magmatic arc (Cretaceous-Palaeocene; except Cascade and Trans-Mexican)

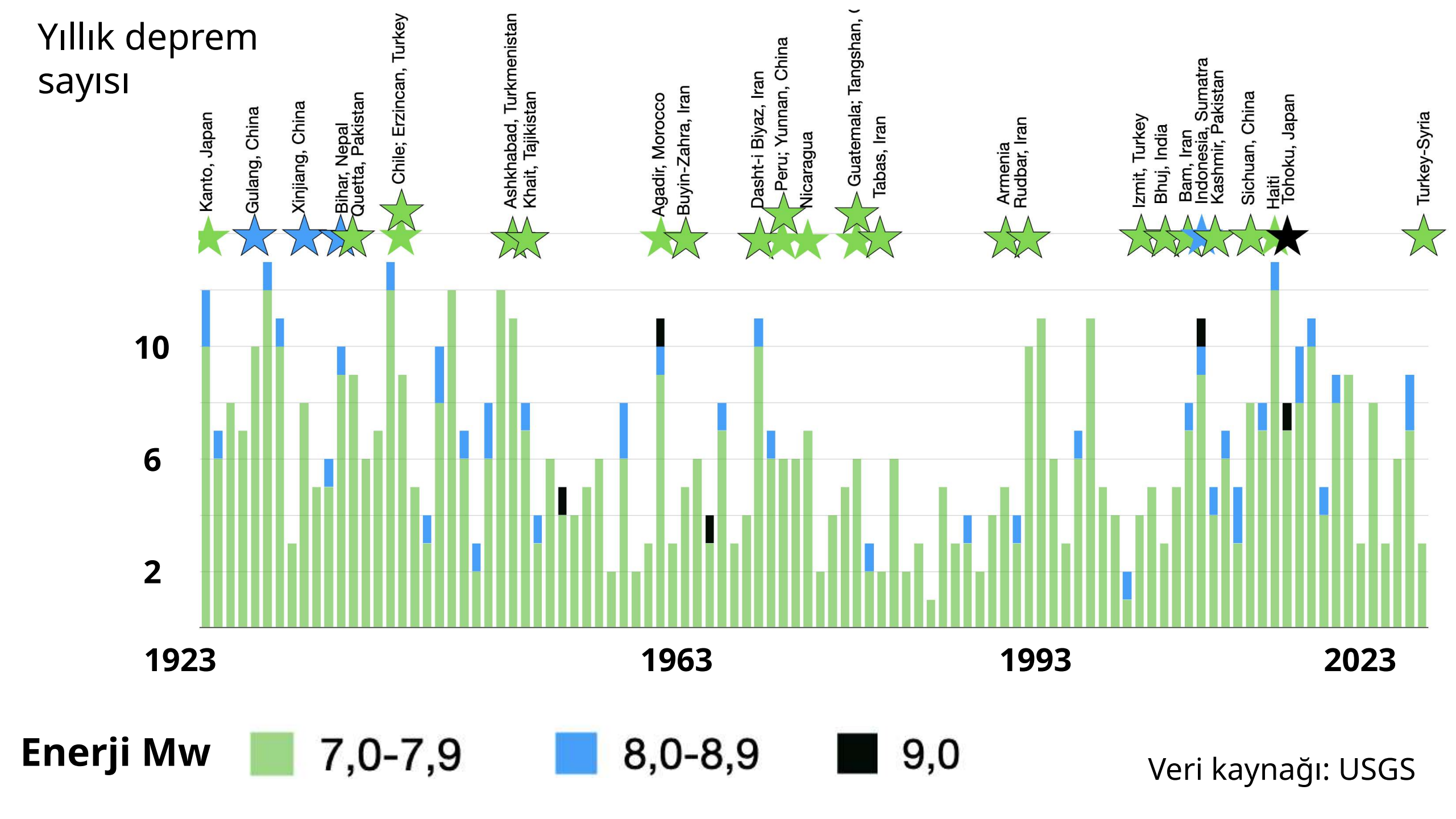

a
Romanche TF 1973-2012 Mag > 4.0
336°
340°
344°
2°
0°
-2°
Magnitudes
M=4
M=5
M=6
M=7
b
1966-2013 Mag > 4.0
236°
240°
244°
40°
36°
32°
km
0
100
200
c
1900-2012 Mag > 4.0
28°
32°
36°
40°
42°
km

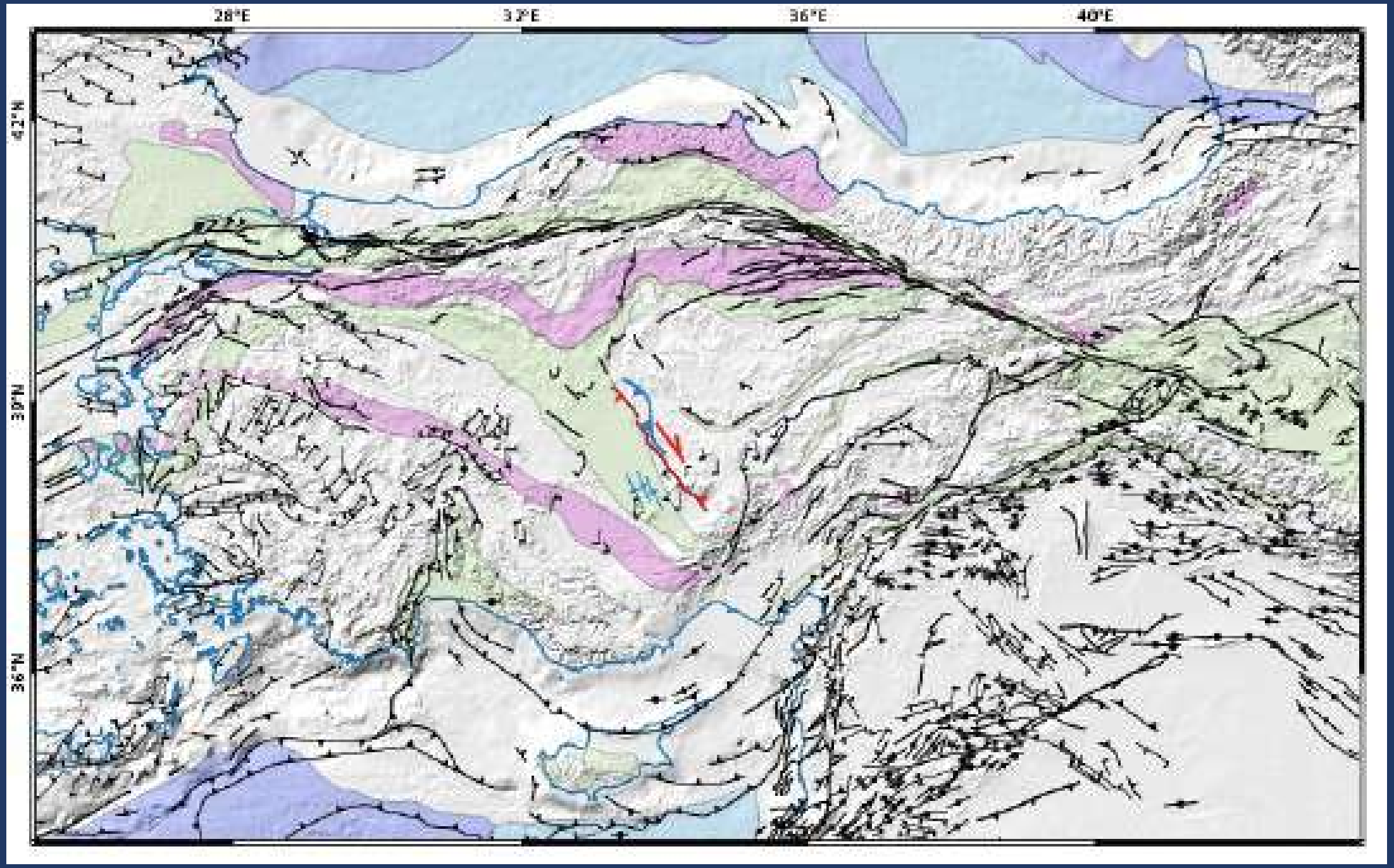


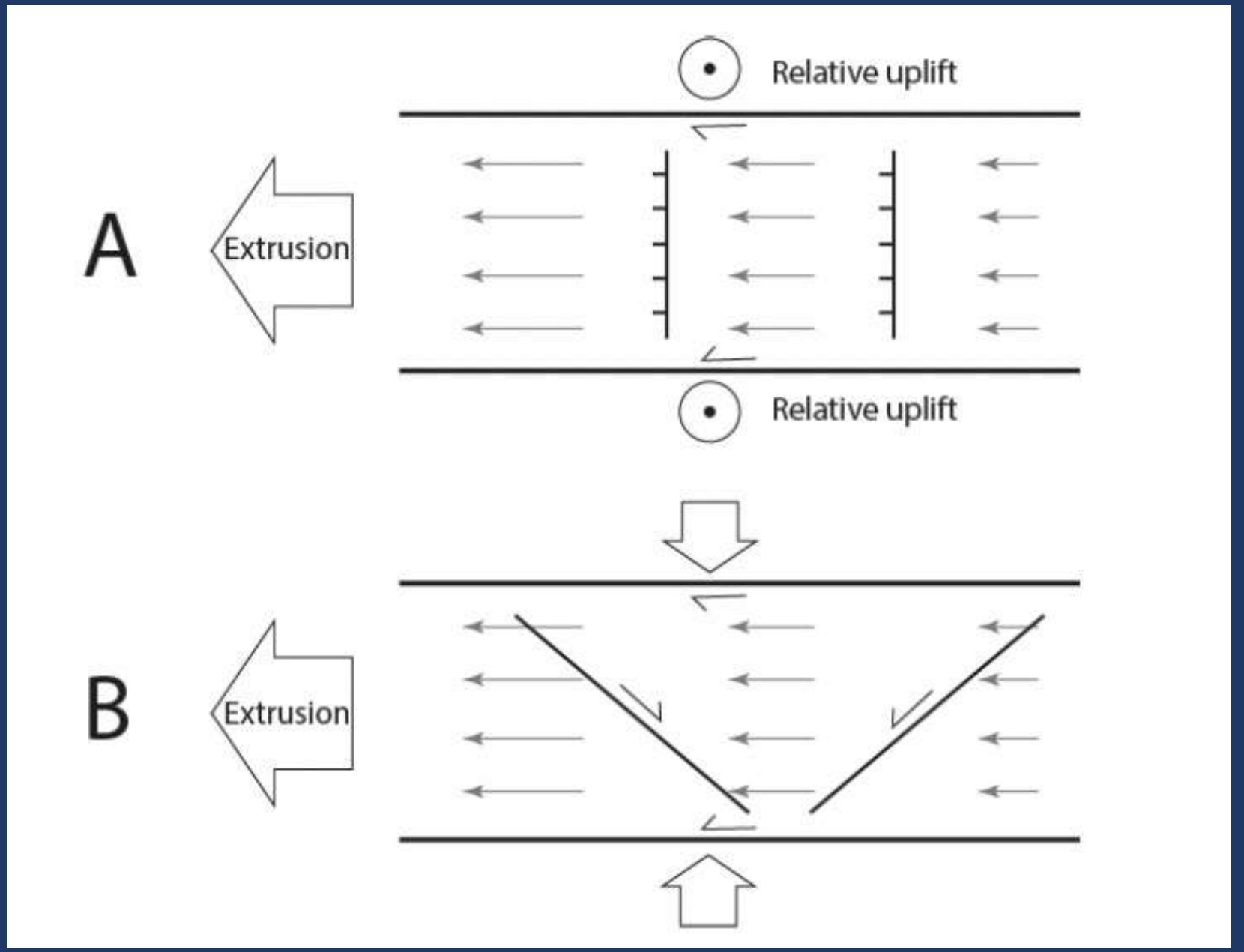
Depremsellik: AFAD Gri mekanizmalar: GCMT, OCA, GFZ, USGS, KOERI
Mavi Mekanizmalar: KOERI, Jeofizik A.B.D. Faylar: MTA

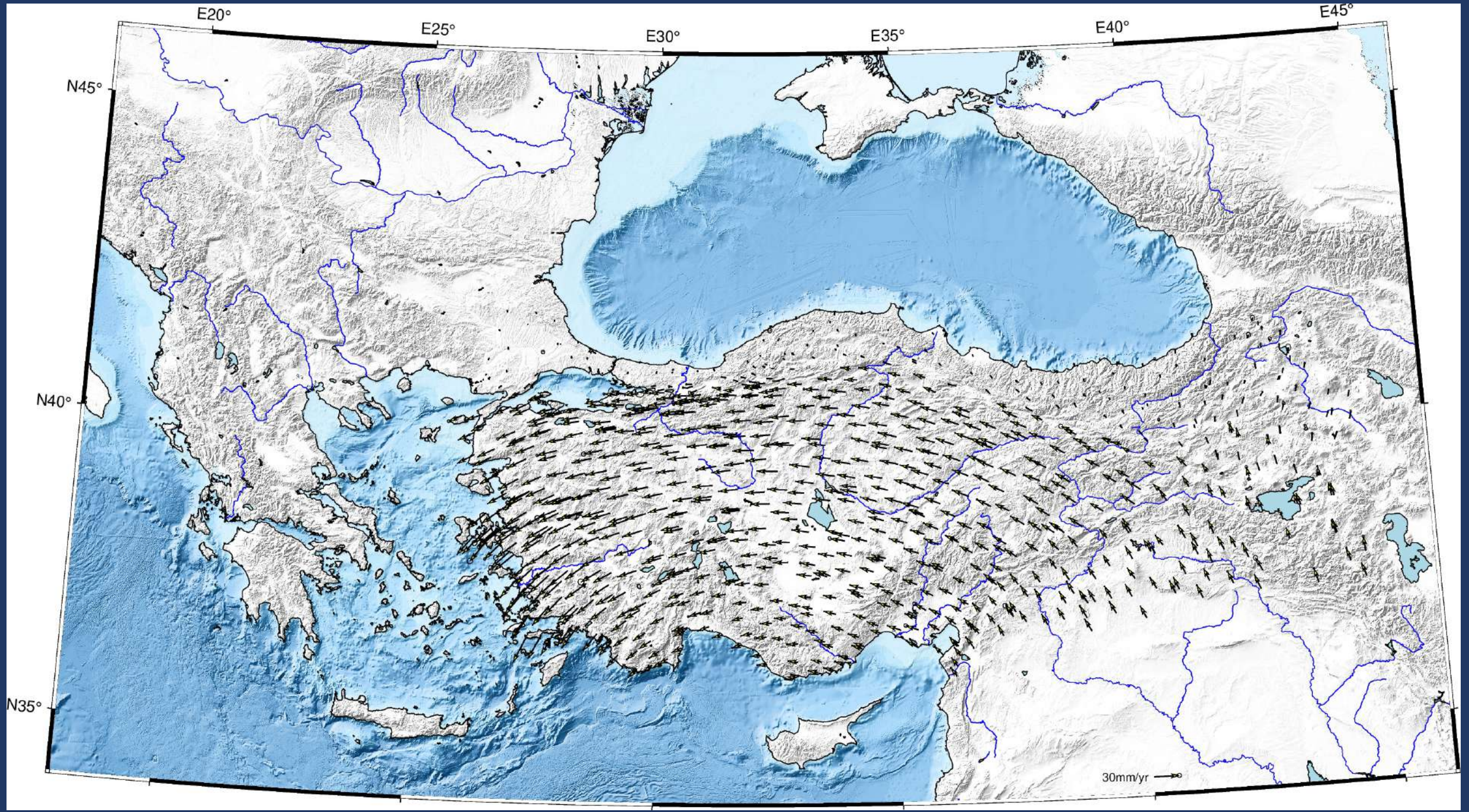
Fayın yeryüzündeki ifadesi

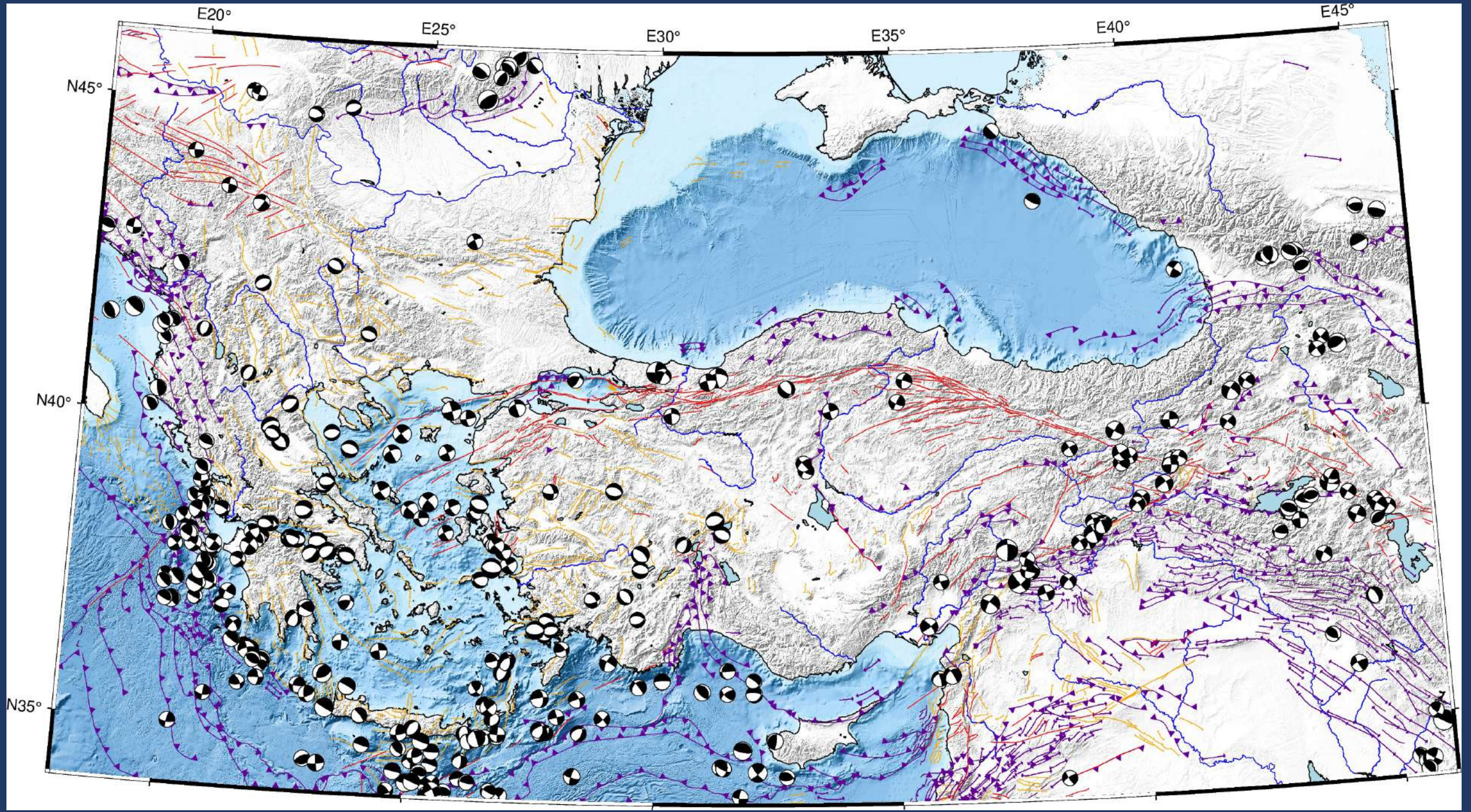


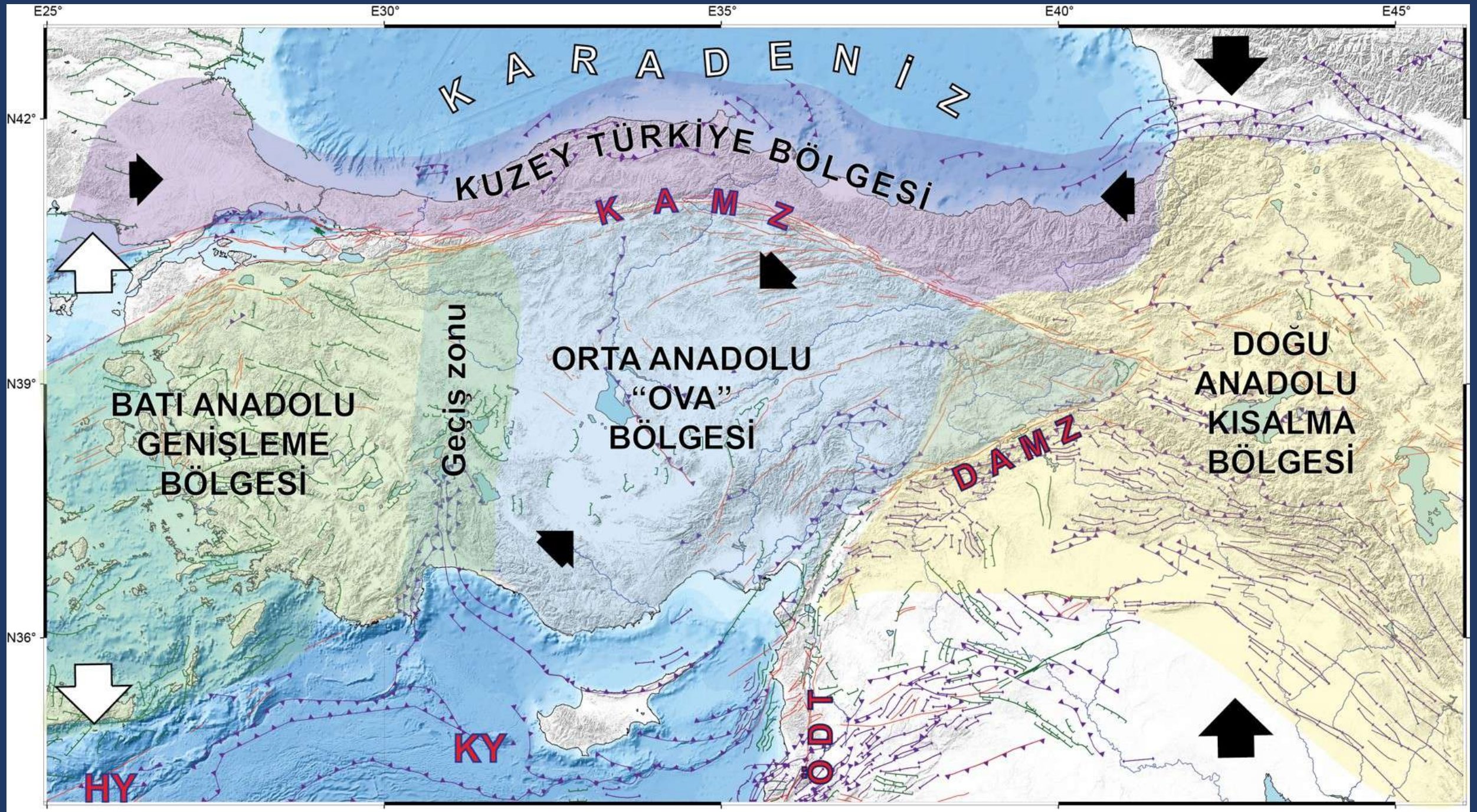

Yıllık deprem sayısı
Kanto, Japan
Gulang, China
Xinjiang, China
Bihar, Nepal
Quetta, Pakistan
Chile; Erzincan, Turkey
Ashkhabad, Turkmenistan
Khait, Tajikistan
Agadir, Morocco
Buyin-Zahra, Iran
Dasht-i Biyaz, Iran
Peru; Yunnan, China
Nicaragua
Guatemala; Tangshan,
Tabas, Iran
Armenia
Rudbar, Iran
Izmit, Turkey
Bhuj, India
Bam, Iran
Indonesia, Sumatra
Kashmir, Pakistan
Sichuan, China
Haiti
Tohoku, Japan
Turkey-Syria
10
6
2
1923
1963
1993
2023
Enerji Mw
7,0-7,9
8,0-8,9
9,0
Veri kaynağı: USGS

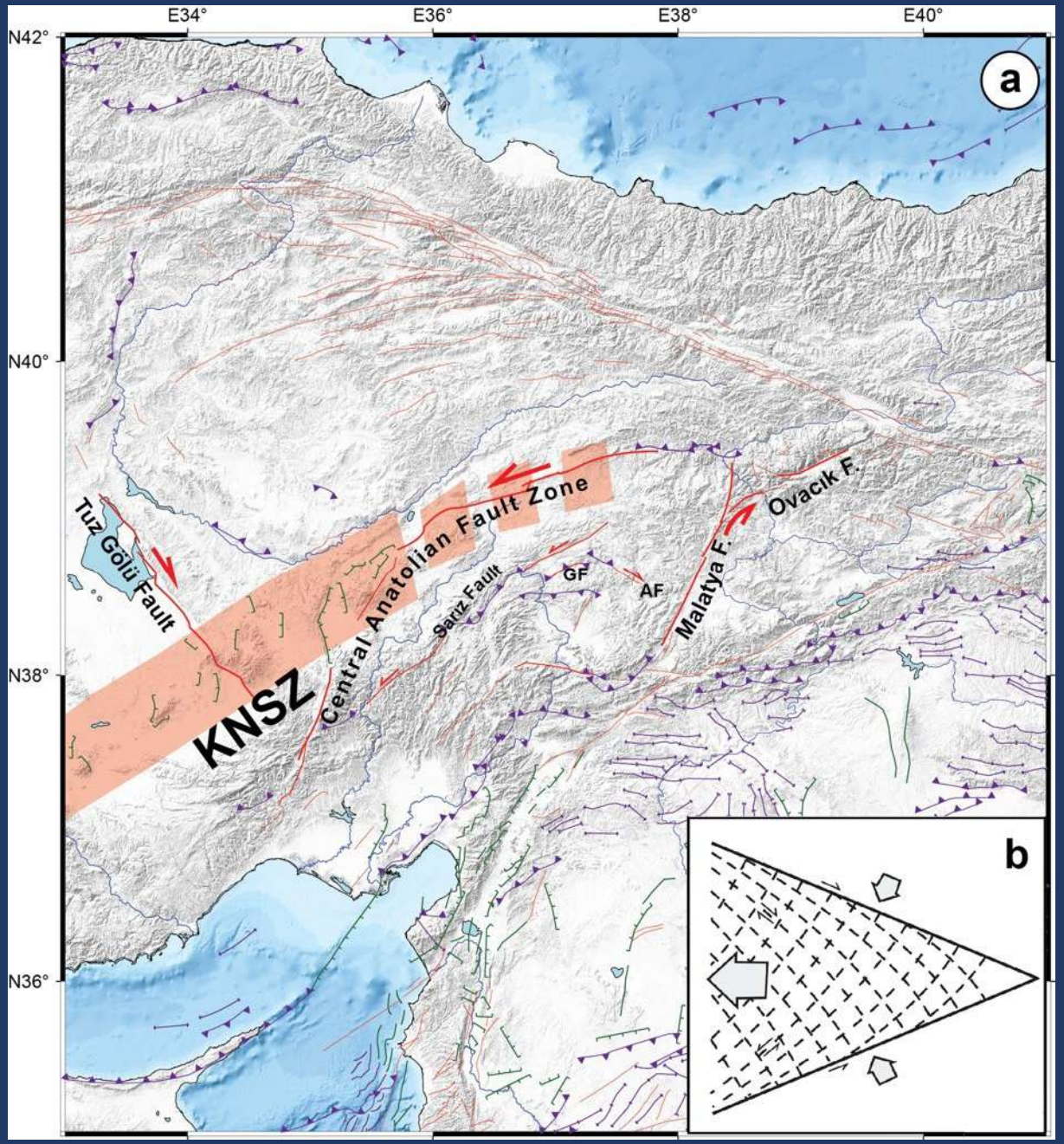

28°E
32°E
36°E
40°E
42°N
39°N
36°N

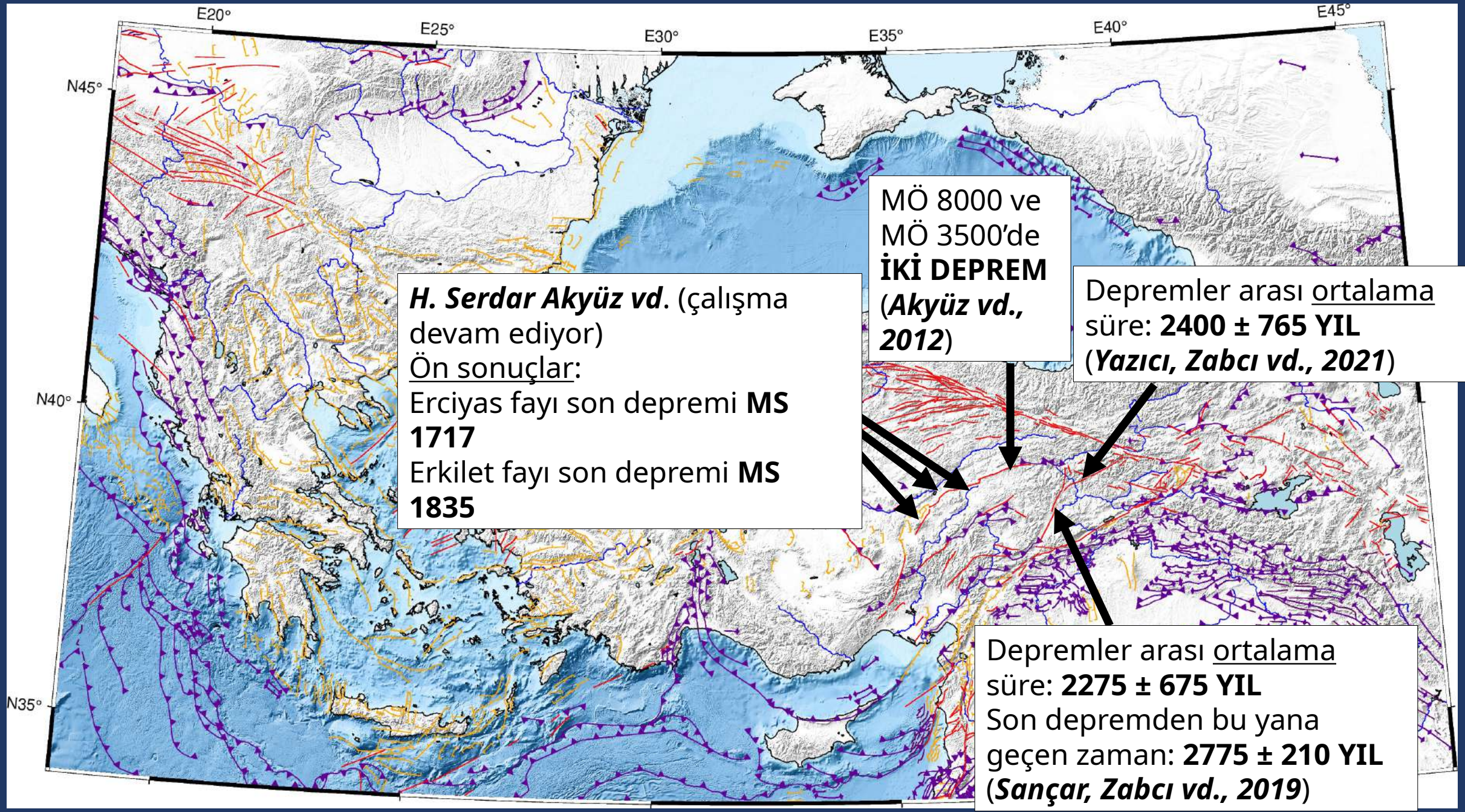

A
Extrusion
Relative uplift
Relative uplift
B
Extrusion


E20°
E25°
E30°
E35°
E40°
E45°
N45°
N40°
N35°
30mm/yr


E20°
E25°
E30°
E35°
E40°
E45°
N45°
N40°
N35°


E25°
E30°
E35°
E40°
E45°
N42°
N39°
N36°
KARADENİZ
KUZEY TÜRKİYE BÖLGESİ
KAMZ
Geçiş zonu
ORTA ANADOLU
"OVA"
BÖLGESİ
BATI ANADOLU
GENİŞLEME
BÖLGESİ
DAMZ
DOĞU
ANADOLU
KISALMA
BÖLGESİ
DT
KY
HY


E34°
E36°
E38°
E40°
N42°
N40°
N38°
N36°
a
b
KNSZ
Central Anatolian Fault Zone
Tuz Gölü Fault
Sariz Fault
GF
AF
Malatya F.
Ovacık F.



H. Serdar Akyüz vd. (çalışma devam ediyor)
<u>Ön sonuçlar</u>:
Erciyas fayı son depremi **MS 1717**
Erkilet fayı son depremi **MS 1835**

MÖ 8000 ve MÖ 3500'de **İKİ DEPREM** (***Akyüz vd., 2012***)

Depremler arası <u>ortalama</u> süre: **2400 ± 765 YIL** (***Yazıcı, Zabcı vd., 2021***)

Depremler arası <u>ortalama</u> süre: **2275 ± 675 YIL**
Son depremden bu yana geçen zaman: **2775 ± 210 YIL** (***Sançar, Zabcı vd., 2019***)

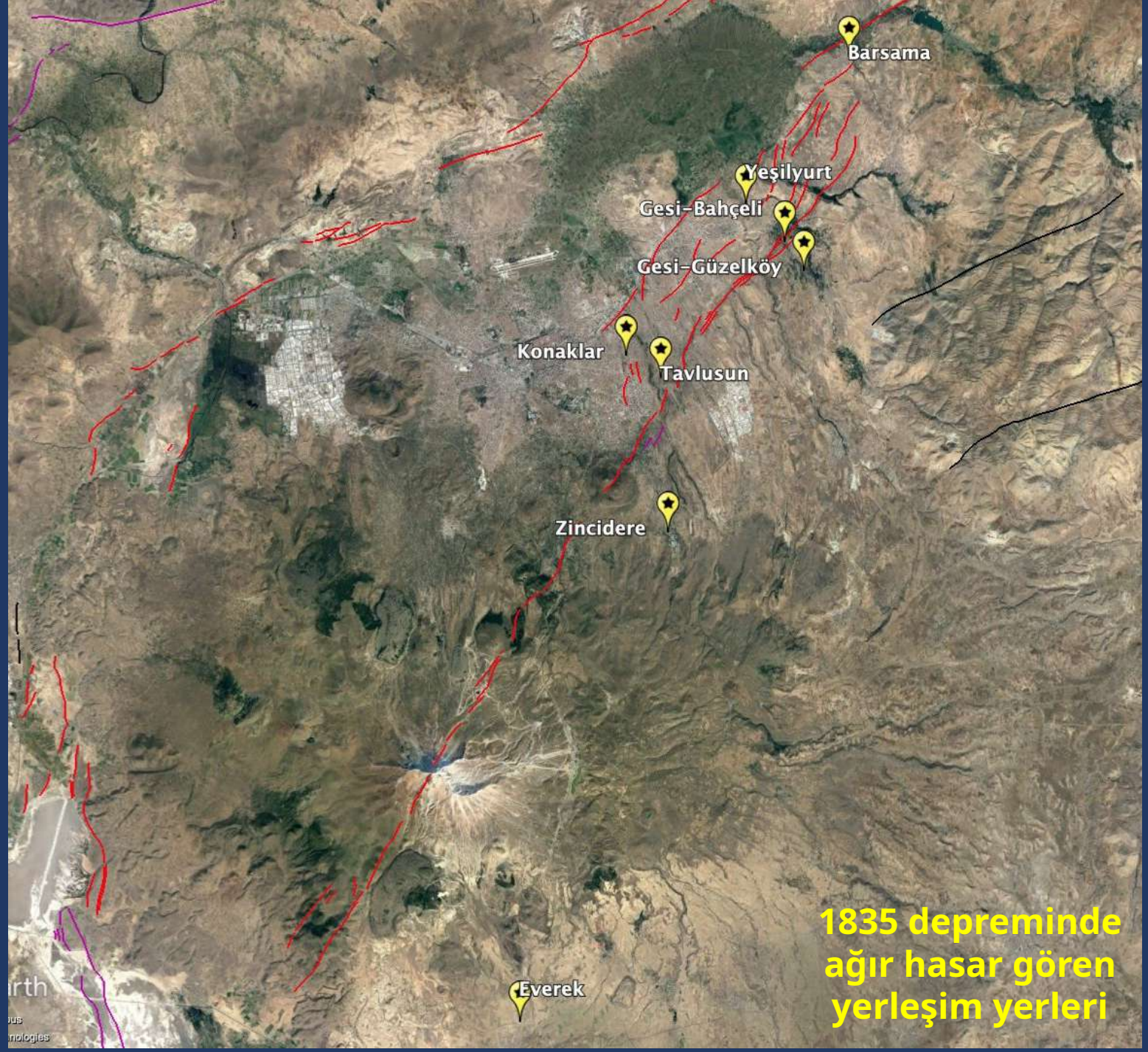
9 Mayıs 1717 Depremi

Kaynaklar:

Taher, 1974
Palamutoğlu, 1987
Resm-i Kayseriyye

Can kaybı 5600 ila 8000 arasınd

13 Ağustos 1835 Depremi



Kaynaklar:

Texier, 1835
Brant, 1836
Poujoulat, 1840
Ainsworth, 1841
Levidis, 1899
Palamutoğlu, 1987

Can kaybı 1600 ila 4000 arasında