

# The 2 earthquakes of February 6<sup>th</sup> 2023 in Turkey

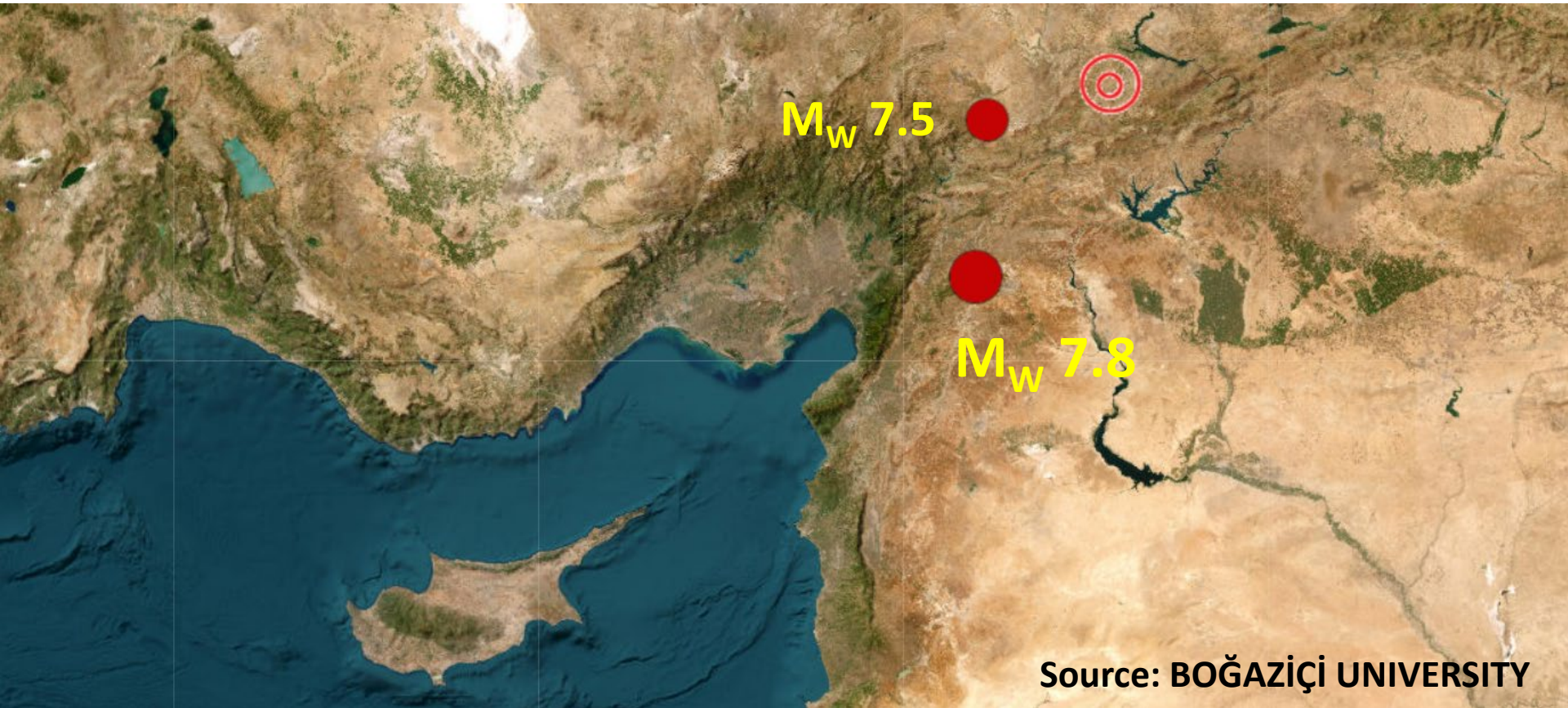


Source: CNBC

## Preliminary Report

by **Evangelia GARINI** and **George GAZETAS**

NTUA, Greece



Source: BOĞAZIÇI UNIVERSITY

➔ Magnitude **Mw 7.8**  
➔ Region **CENTRAL TURKEY**  
➔ Date time **2023-02-06 01:17:36.1 UTC**  
➔ Location **37.17 N ; 37.08 E**  
➔ Depth **20 km**

➔ Magnitude **Mw 7.5**  
➔ Region **CENTRAL TURKEY**  
➔ Date time **2023-02-06 10:24:49.6 UTC**  
➔ Location **38.11 N ; 37.24 E**  
➔ Depth **10 km**



# Map of seismic epicenters



Source: <https://www.emsc-csem.org/Earthquake/Map/gmap.php>



# Map of seismic epicenters



Source: <https://www.emsc-csem.org/Earthquake/Map/gmap.php>



The **M 7.8** earthquake resulted from **strike-slip faulting** at shallow depth.

The event ruptured either a **near-vertical left-lateral fault** striking northeast-southwest, or a **right-lateral fault striking** southeast-northwest.

The preliminary location of the earthquake places it within the vicinity of a triple-junction between the Anatolia, Africa and Arabian tectonic plates. **A magnitude 7.8 strike slip earthquake is associated with a rectangular fault rupture of ~240 km long and ~20 km wide.**

**Nine hours after the first earthquake of M 7.8**

**a second earthquake of M 7.5 occurred**

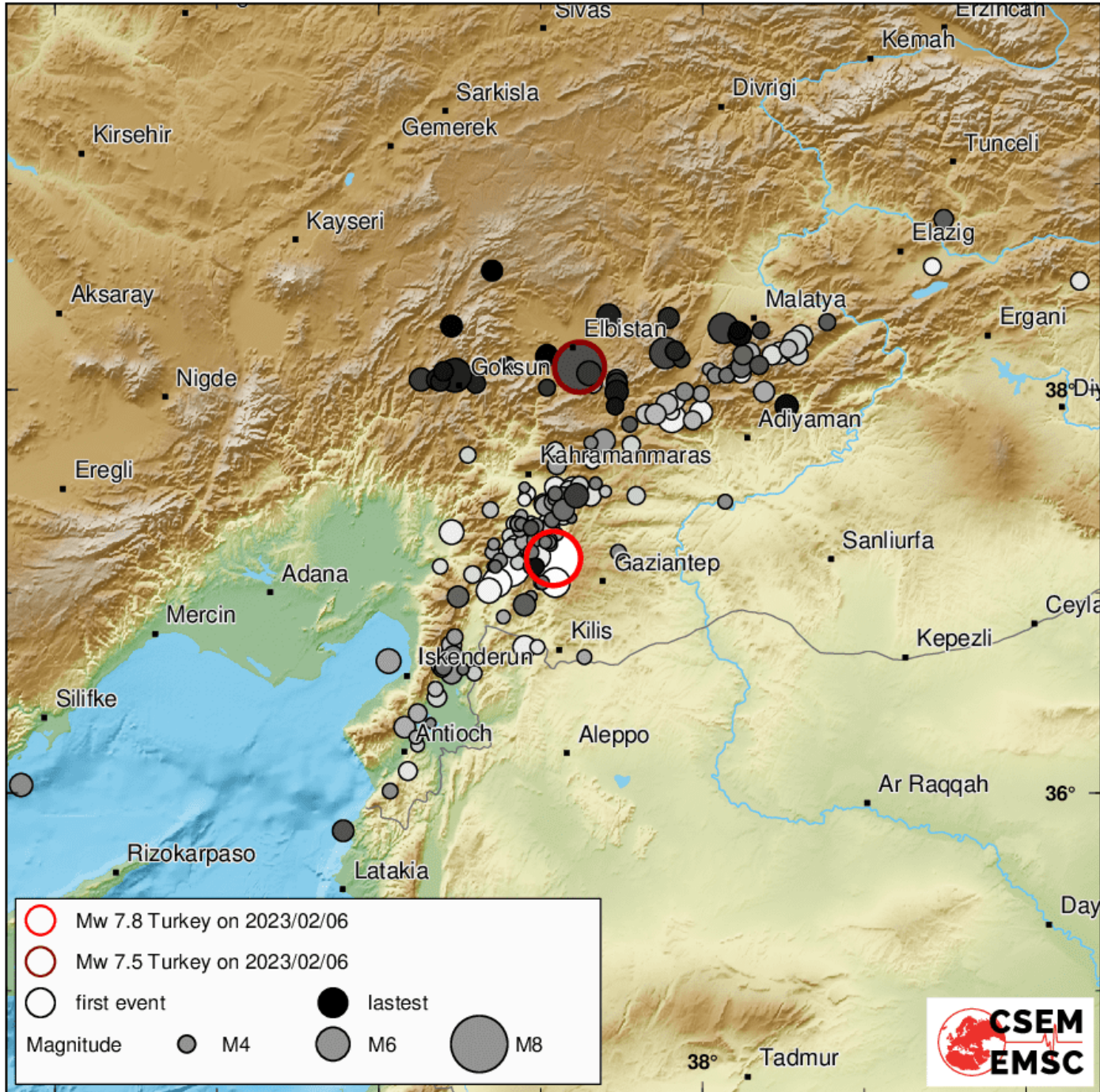
**100 km to the north**





Source: INGV





178 earthquakes on this map

100 km

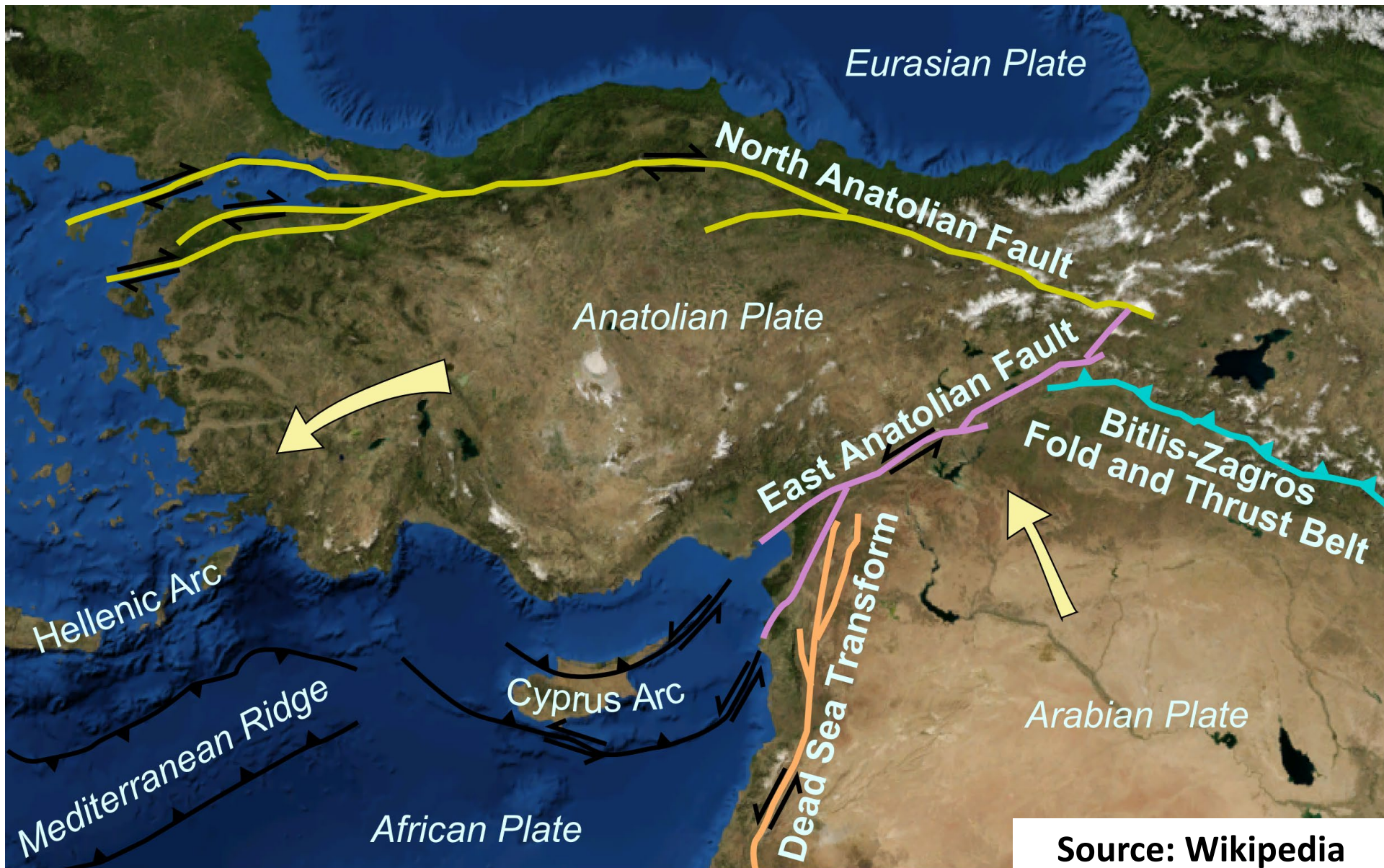
Updated on 06/02/2023 at 13:15 UTC



# **SEISMOLOGICAL INFO**

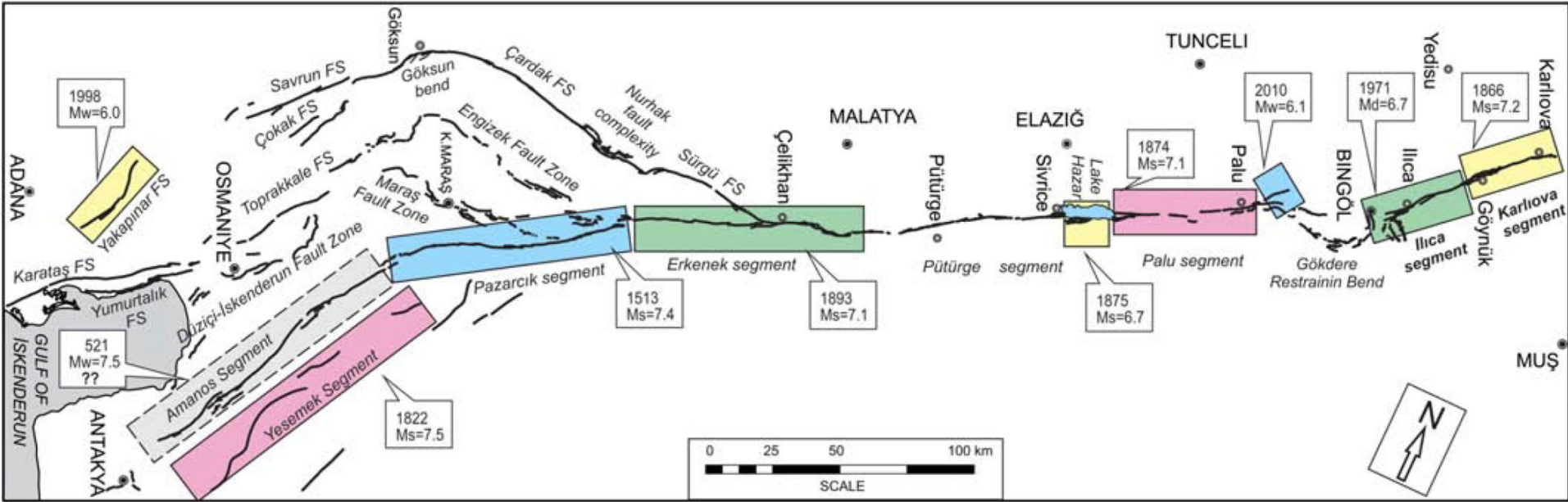


Map showing main tectonic structures around the Anatolian Plate.  
The arrows show displacement vectors of the Anatolian and Arabian Plates  
relative to the Eurasian Plate



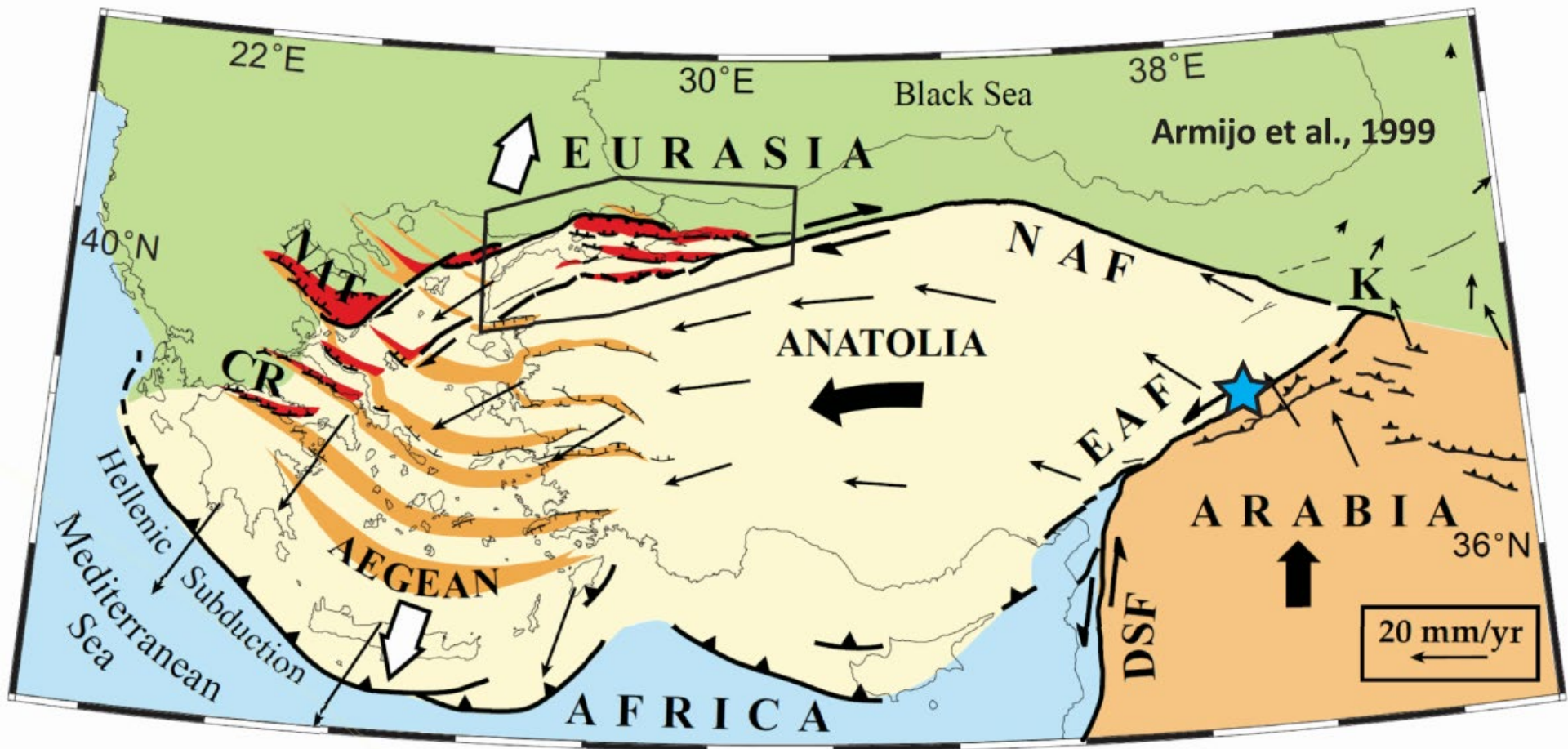
Source: Wikipedia

# Tectonics and fault system Map of the East Anatolian Fault



Source: Duman and Emre (2013)



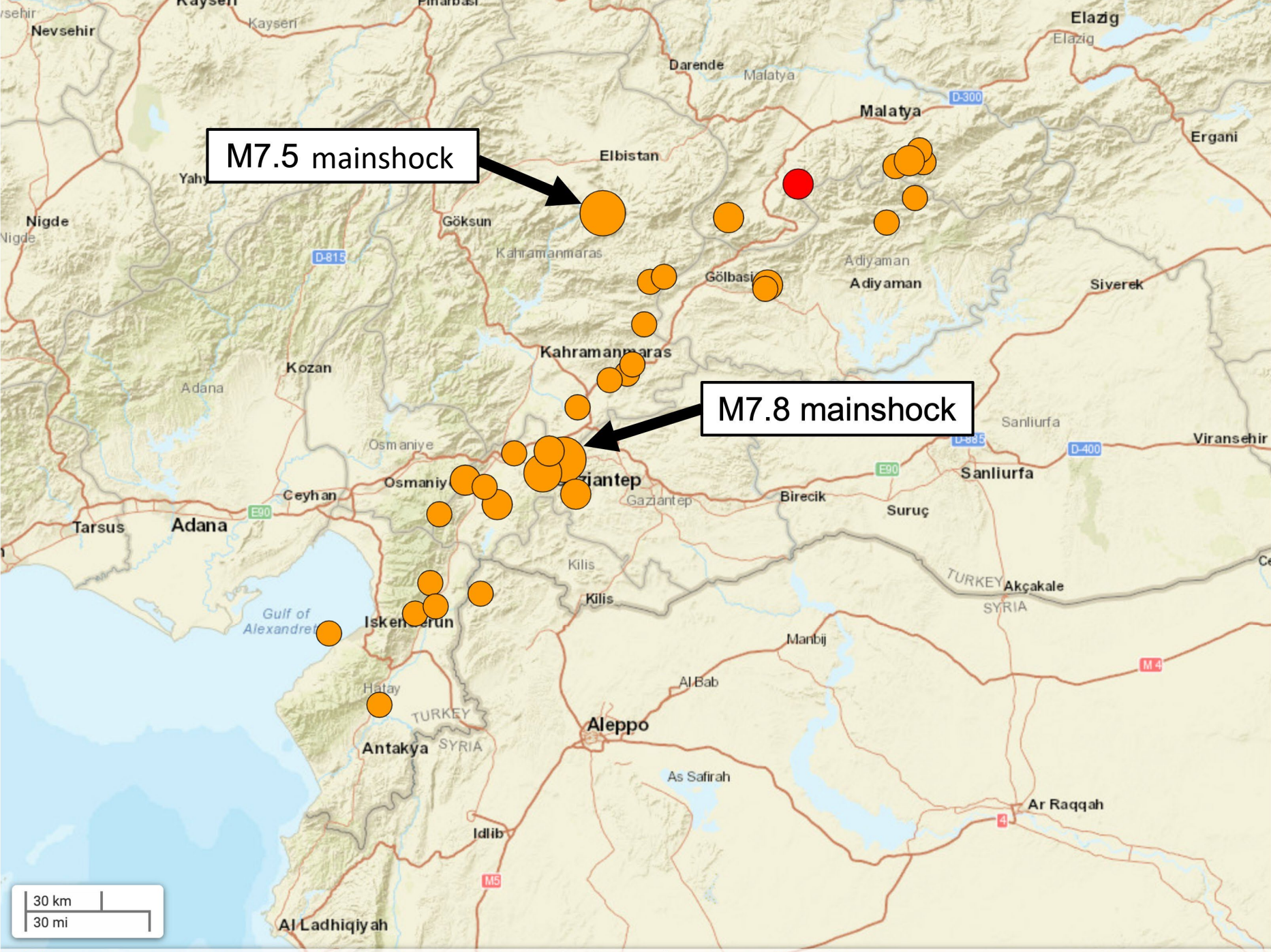


Source: CSEM-EMSC + GEM + USGS + Jason R. Patton

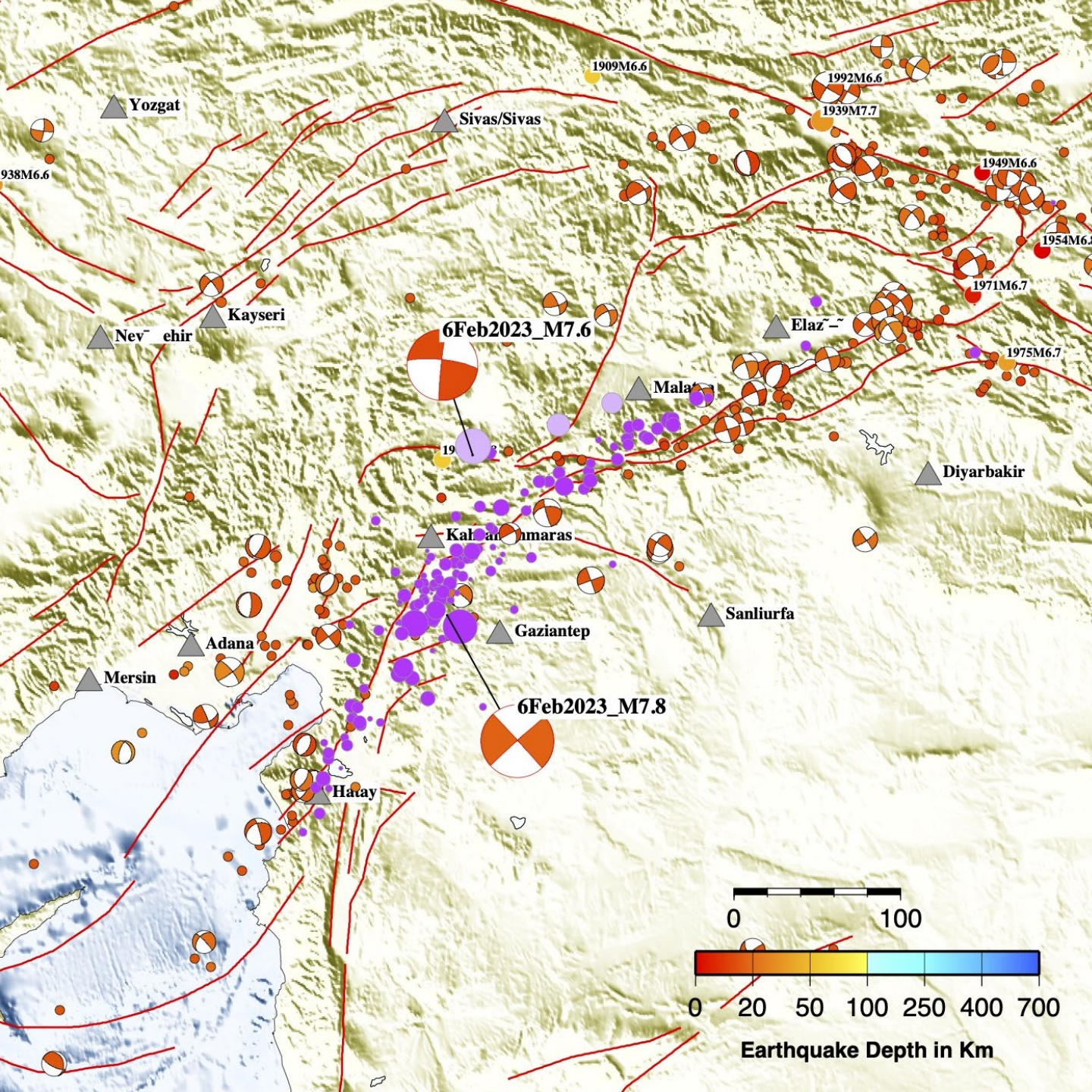


M7.5 mainshock

M7.8 mainshock



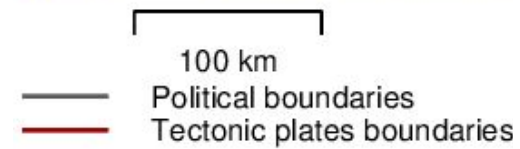
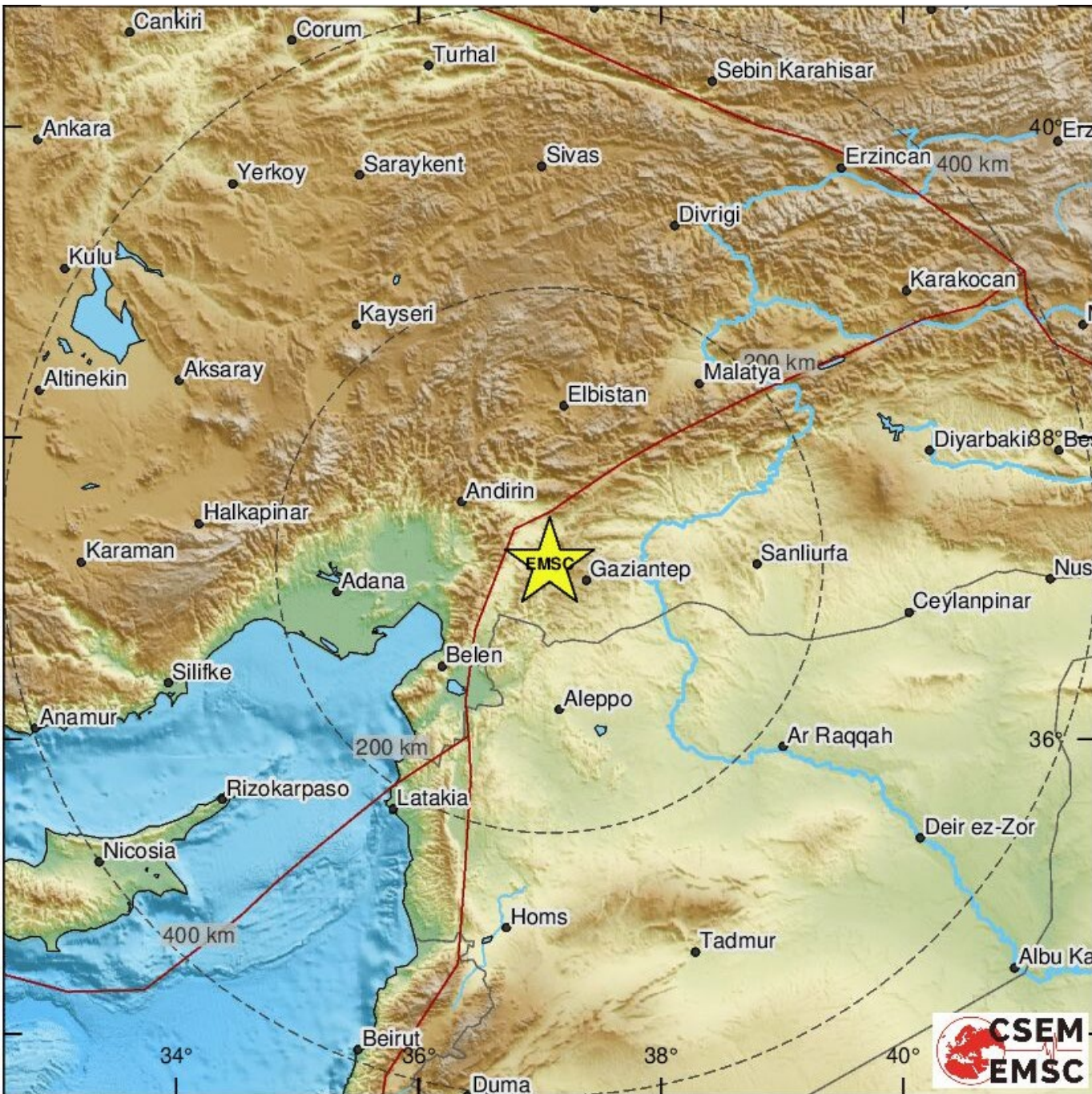




Source: Jascha Polet



# The 1<sup>st</sup> mainshock of M7.8



## Depth

- ★ 0 - 40 km
- ★ 40 - 80 km
- ★ 80 - 150 km
- ★ 150 - 300 km
- ★ > 300 km





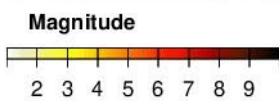
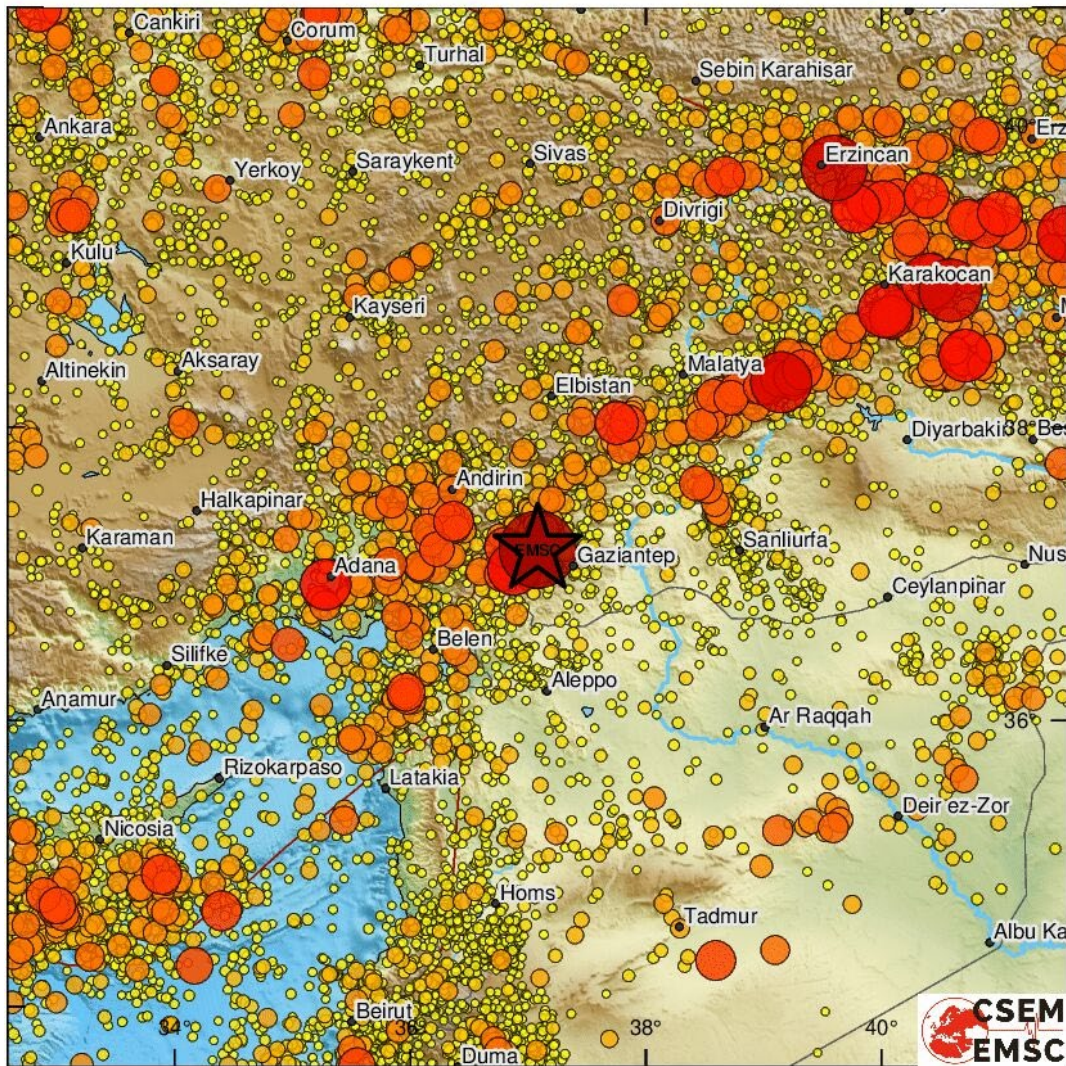
# EMSC manual location

M:7.8 2023/02/06 - 01:17:36 UTC

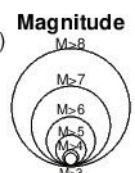
Lat: 37.17 Lon: 37.08 Depth: 20 km

Background data: ISC + EMSC catalogues from 1960 to 06/02/2023 01:00

(Total number of events with M>3: 18778)



Last updated: 2023-02-06 at 08:21 UTC



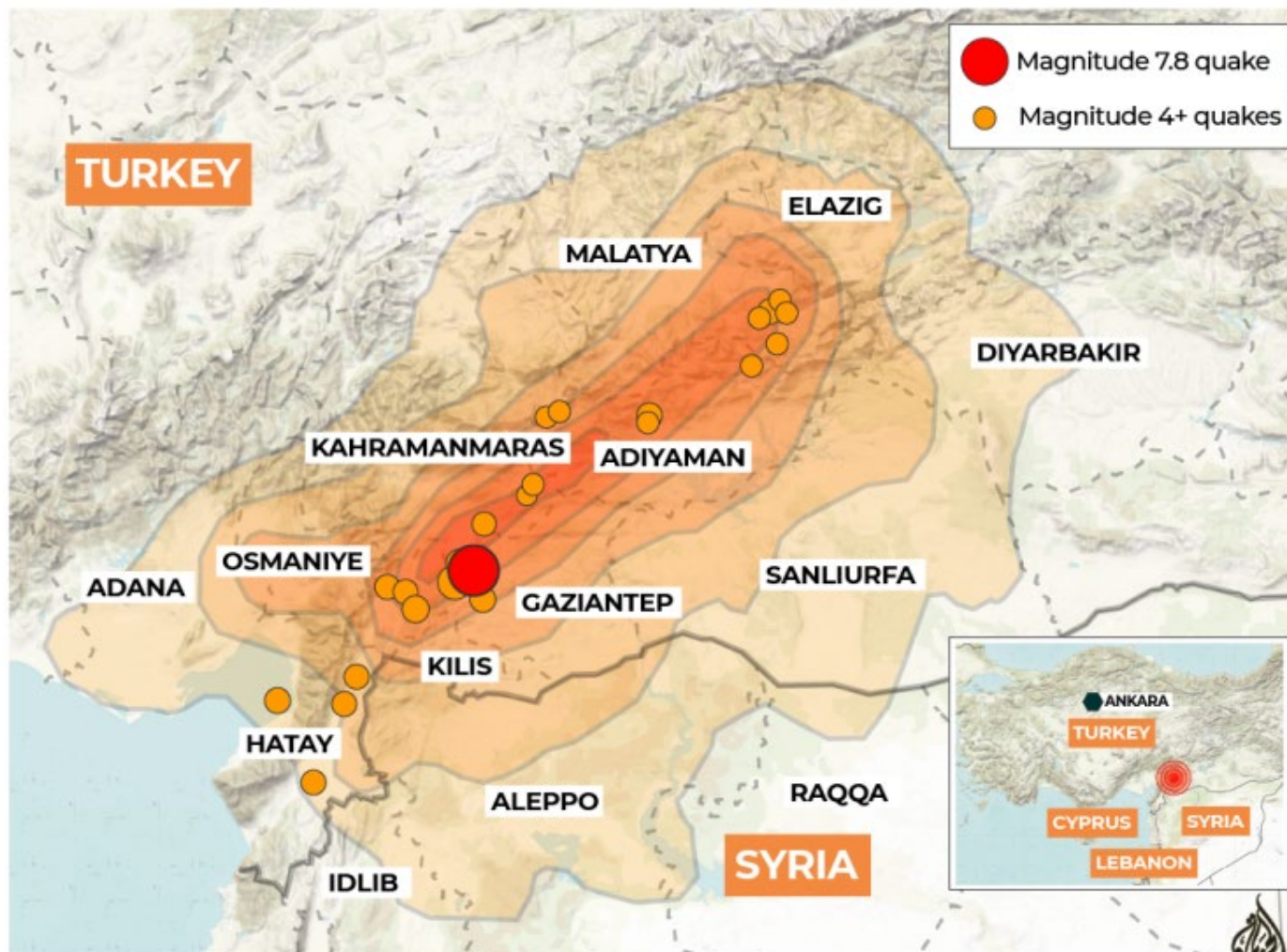




## EARTHQUAKE

# Hundreds dead in Turkey, Syria earthquake

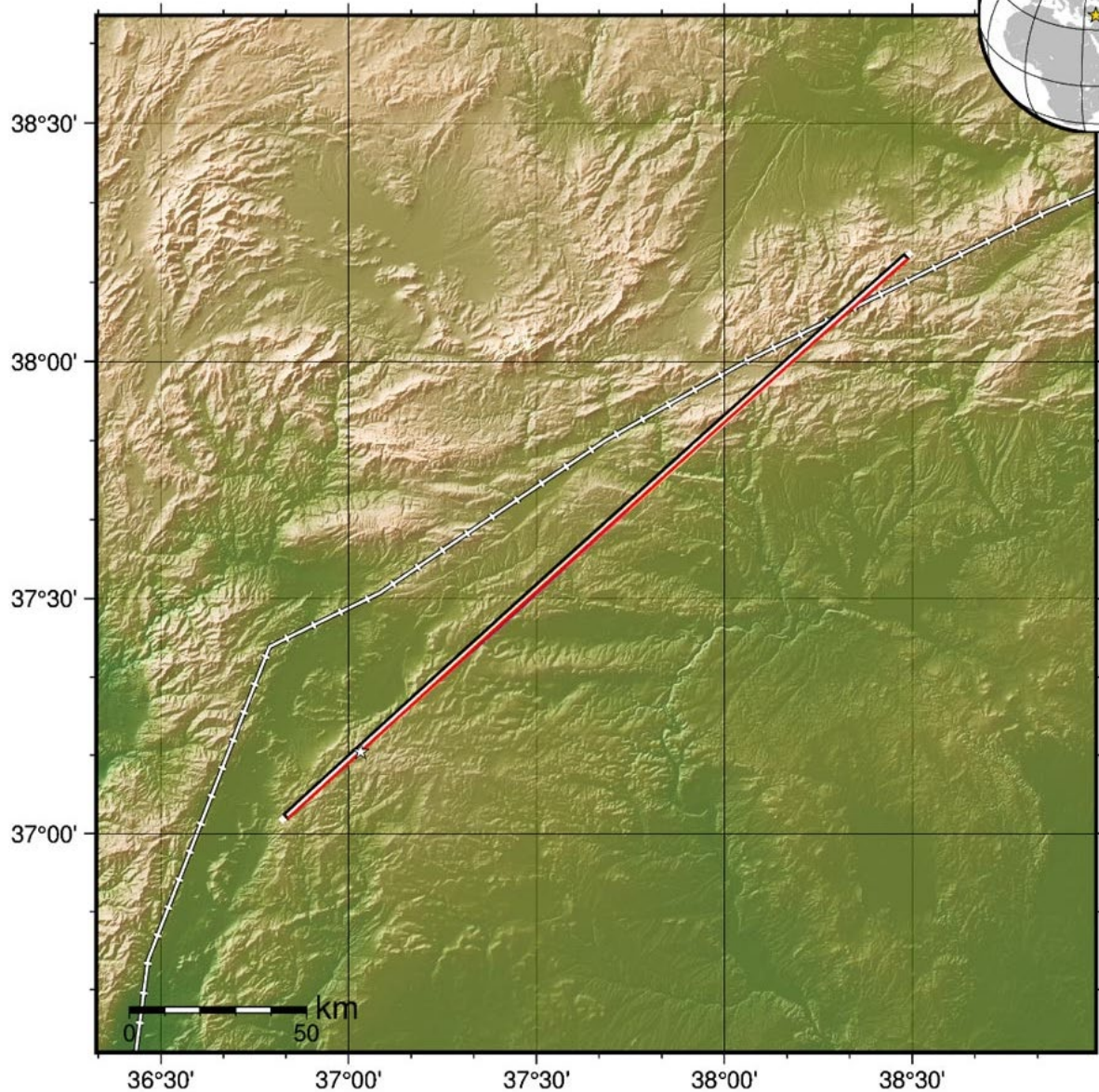
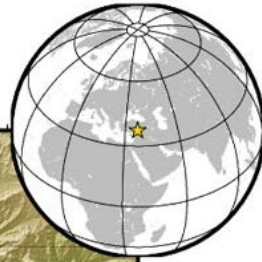
Hundreds of people are dead and more than 1,700 buildings have collapsed after a magnitude 7.8 earthquake struck the southeastern region of Turkey along the border with Syria. Tremors were also felt across Lebanon and Cyprus.



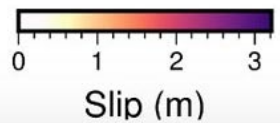
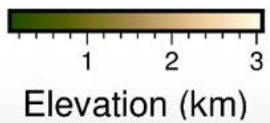
©Mapbox, ©OpenStreetMap

Source: Al Jazeera | Updated: February 6, 2023

©AJLabs ALJAZEERA



**Surface projection of the fault that ruptured** during the 6 Feb 2023 morning magnitude 7.8 quake in southern Turkey; white line is the plate boundary between Anatolia (north) and Arabia.  
**Source: USGS**

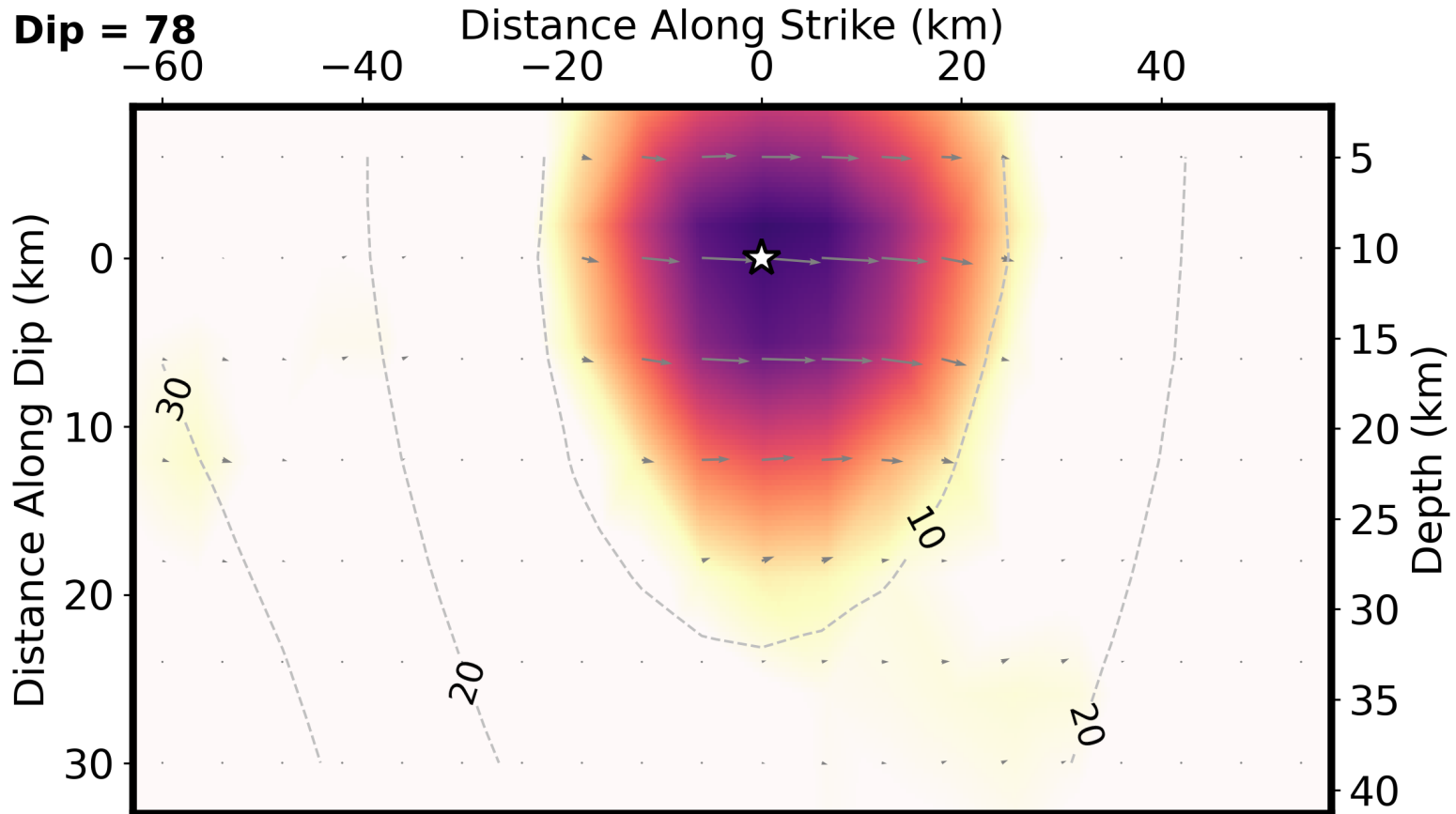




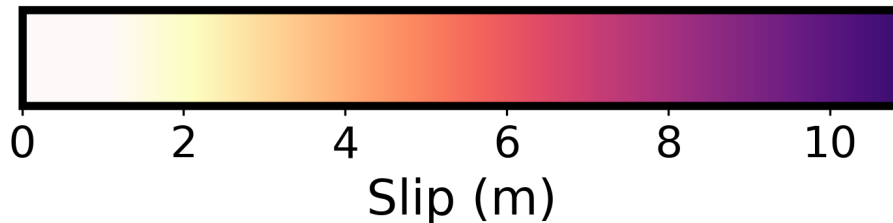
# Slip distribution Cross-section of 2<sup>nd</sup> shock $M_w$ 7.5

**Strike = 277**

**Dip = 78**



**Rupture Front Contours Plotted Every 10 s**



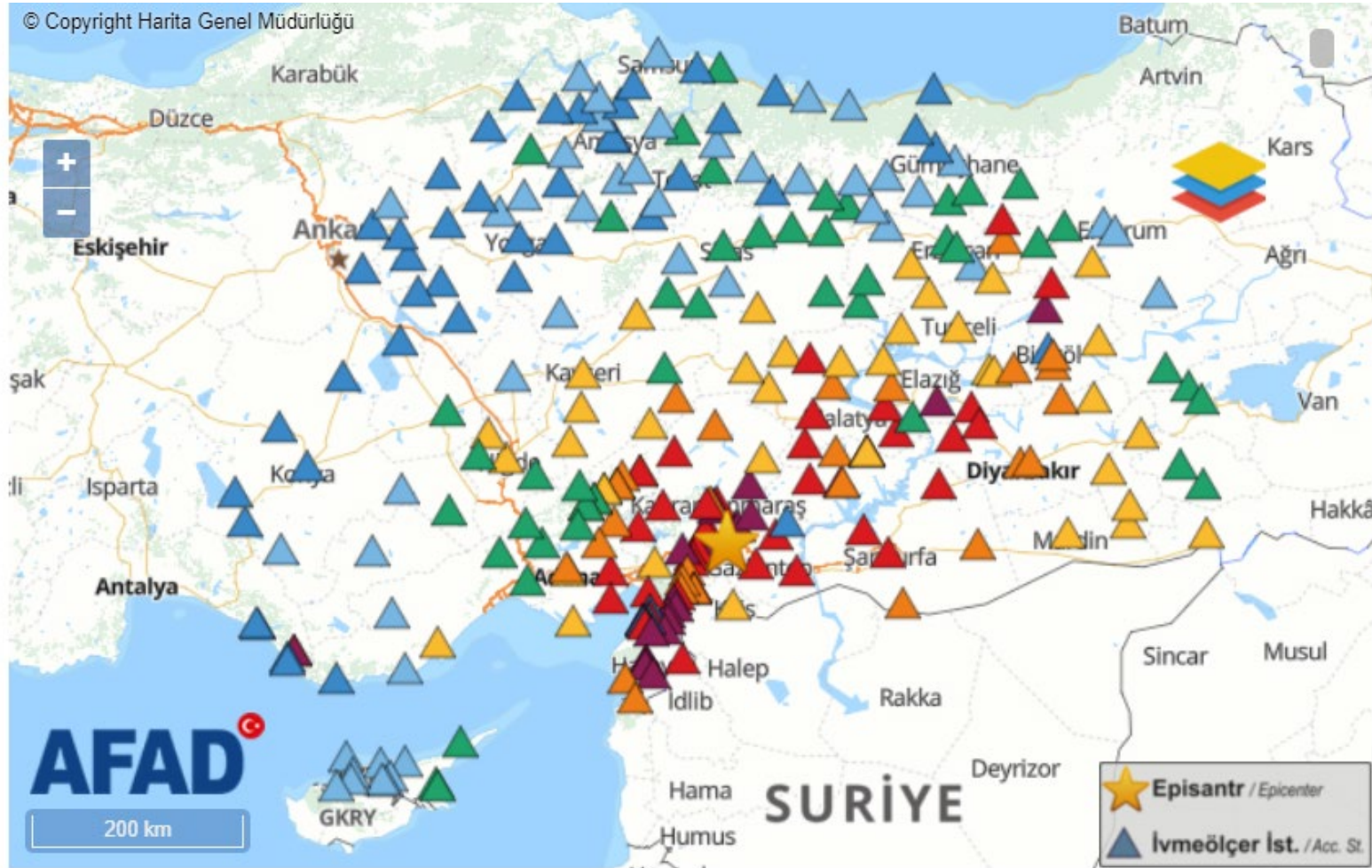
**Source: USGS**

**Strong Motions Recordings:**

**ACCELEROGRAMS**



# 1<sup>st</sup> Mainshock: $M_w$ 7.8 (6 February 2023 at 01:17)



Distribution by:  PGA (cm/s<sup>2</sup>)  PGV (cm/s)  PGD (cm)

Legend

▲ <1

▲ 1-5

▲ 5-10

▲ 10-20

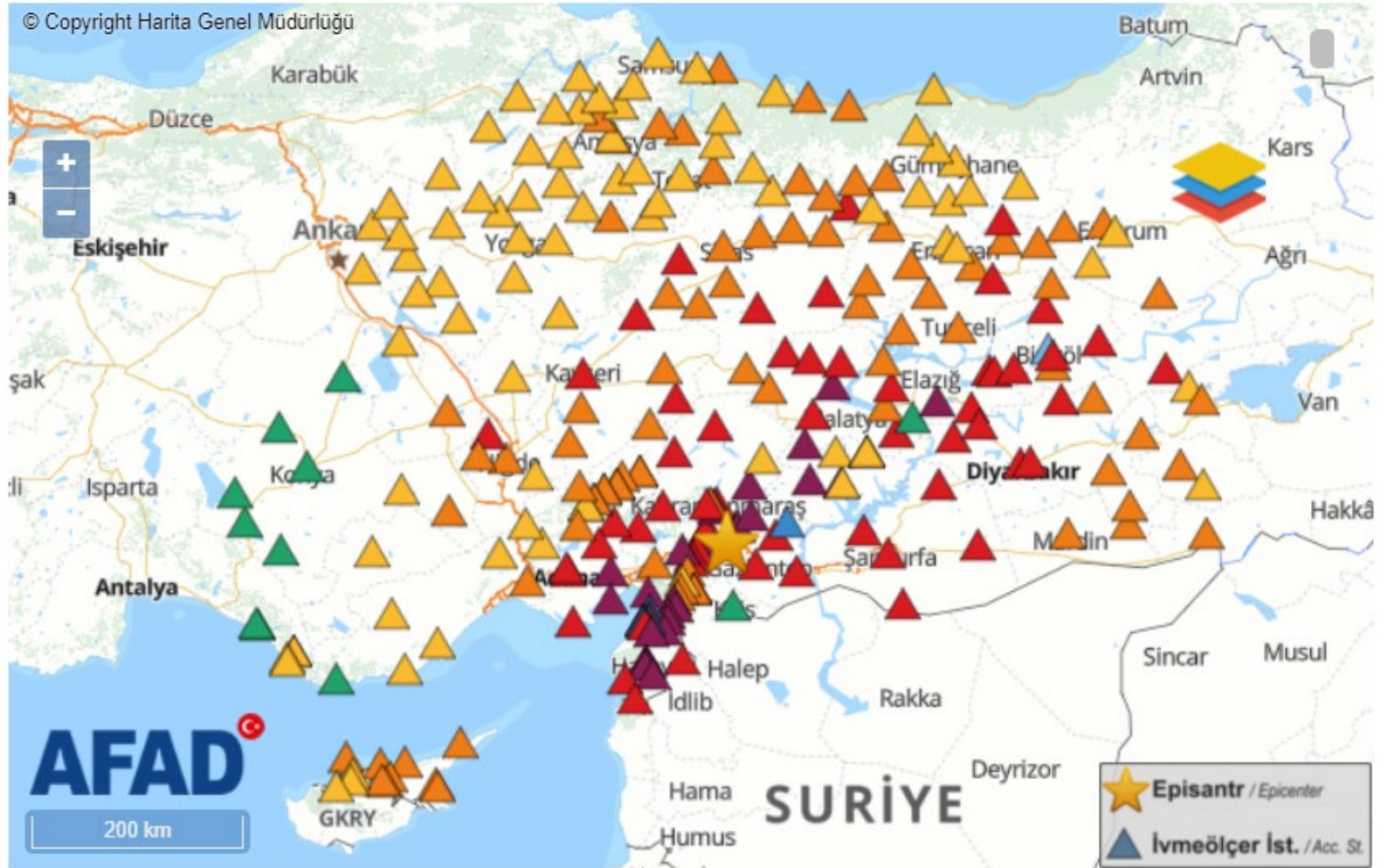
▲ 20-50

▲ 50-100

▲ 100-300

▲ >300

# 1<sup>st</sup> Mainshock: $M_w$ 7.8 (6 February 2023 at 01:17)



Distribution by:  PGA (cm/s<sup>2</sup>)  PGV (cm/s)  PGD (cm)

Legend



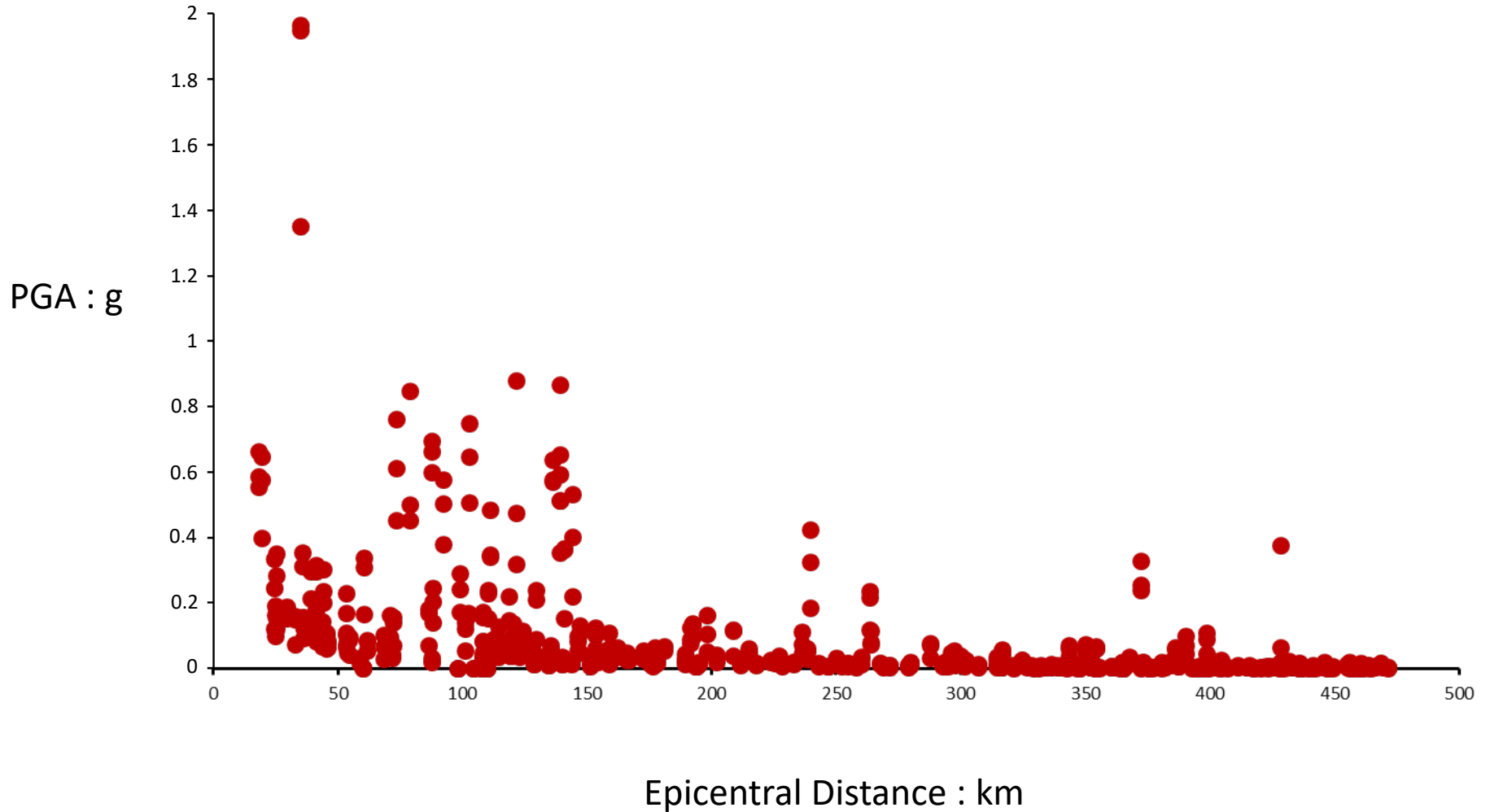


# 1<sup>st</sup> Shock: $M_w$ 7.8

Accelerograms recorded by AFAD with  $PGA > 0.30$  g

Station Code	$R_{epi}$ : km	$PGA_{NS}$ : g	$PGA_{EW}$ : g	$PGA_{UD}$ : g
4614	35	1.949	1.967	1.353
3123	139	0.655	0.594	0.868
3142	103	0.647	0.750	0.506
NAR	19	0.647	0.579	0.399
3144	74	0.611	0.763	0.452
3145	88	0.600	0.696	0.663
4615	18	0.588	0.556	0.665
3139	92	0.577	0.505	0.379
3124	136	0.572	0.638	0.578
3136	144	0.534	0.402	0.220
3132	139	0.515	0.515	0.354
3146	111	0.484	0.347	0.341
201	122	0.474	0.880	0.319
3137	79	0.453	0.848	0.502
3131	141	0.363	0.366	0.154
4624	36	0.354	0.313	0.156
4632	25	0.353	0.286	0.188
4611	60	0.339	0.311	0.165
4629	24	0.337	0.247	0.122

# Peak recorded ground acceleration VS epicentral Distance for the 1<sup>st</sup> Mainshock of $M_w$ 7.8



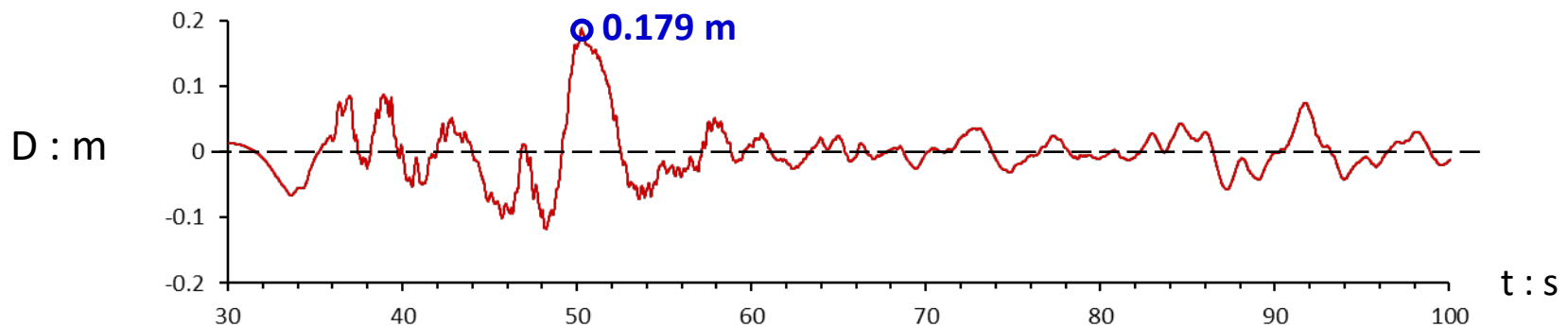
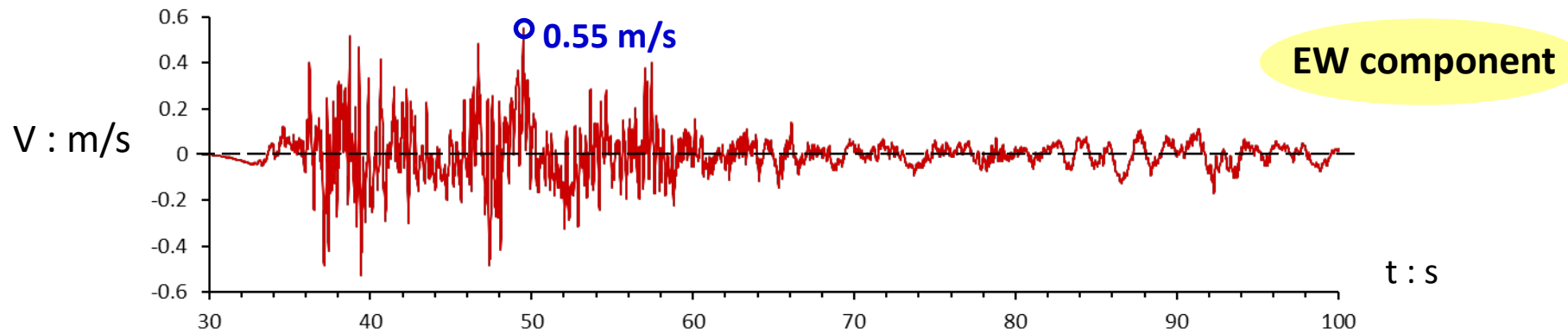
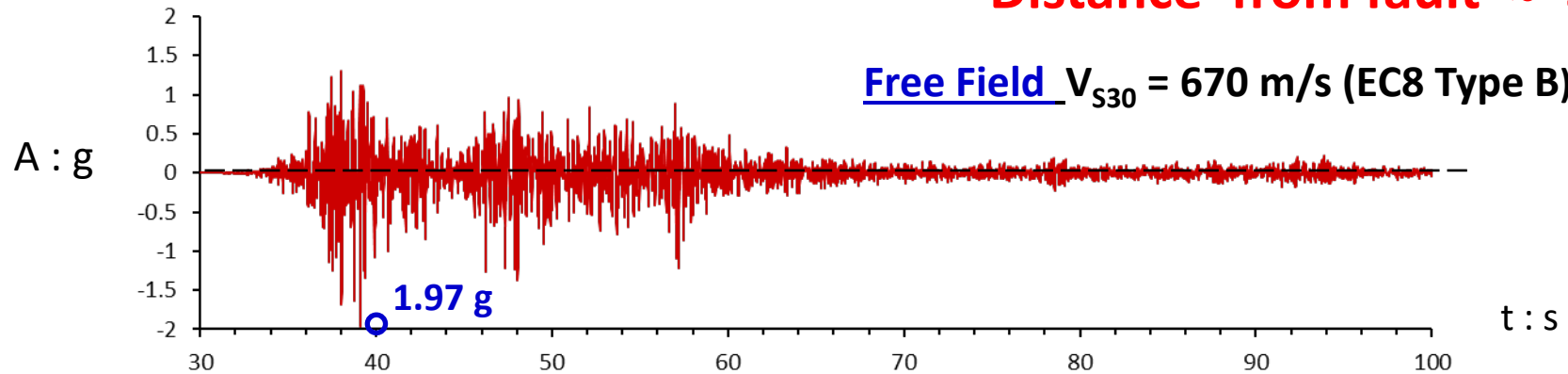


# 1<sup>st</sup> Mainshock $M_w 7.8$

Station 4614: at **Kahramanmaras**

**Distance from fault  $\approx 3$  km**

Free Field  $V_{S30} = 670$  m/s (EC8 Type B)

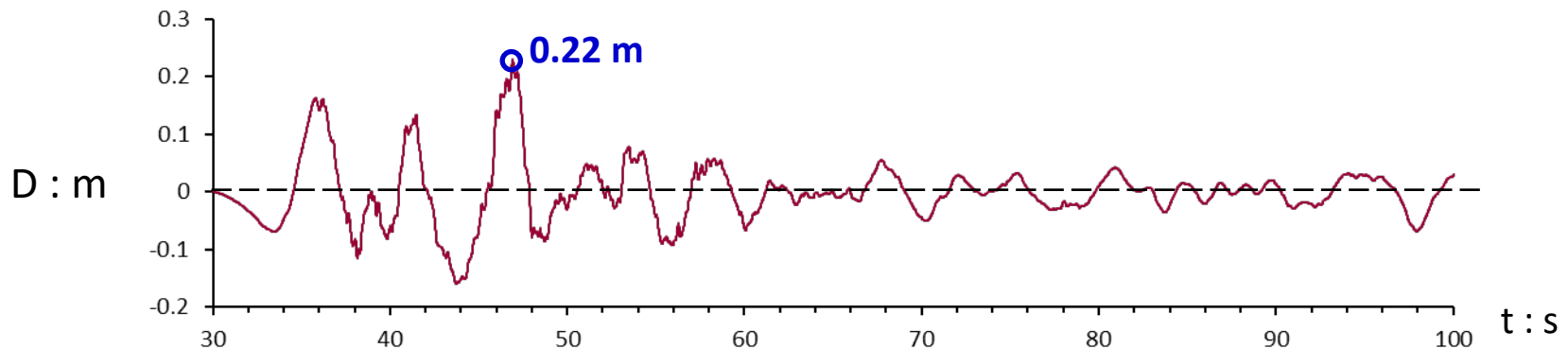
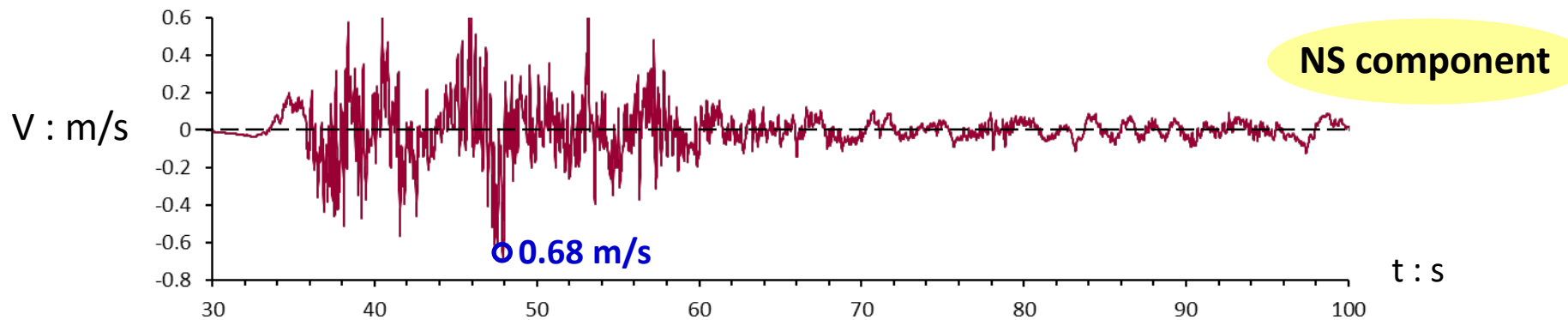
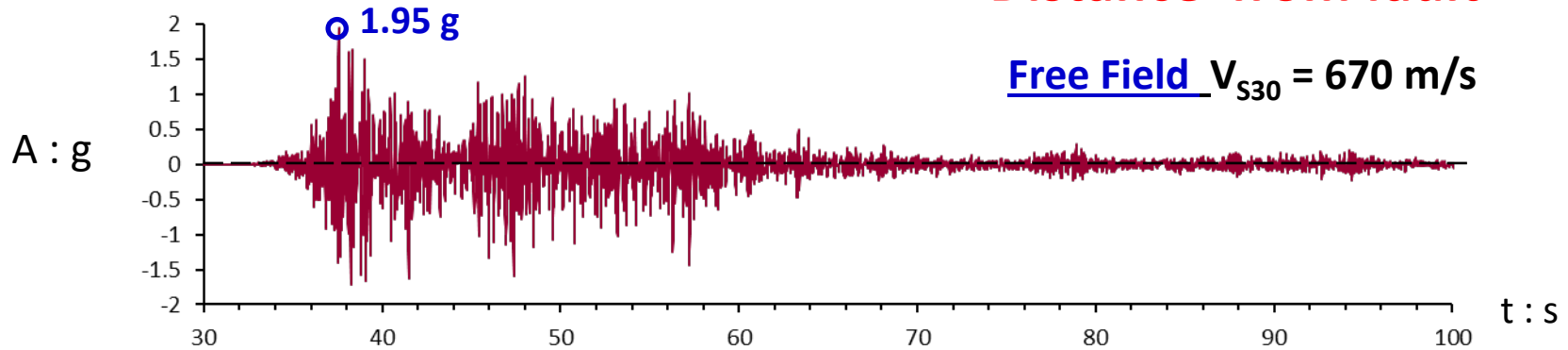


# 1<sup>st</sup> Mainshock $M_w 7.8$

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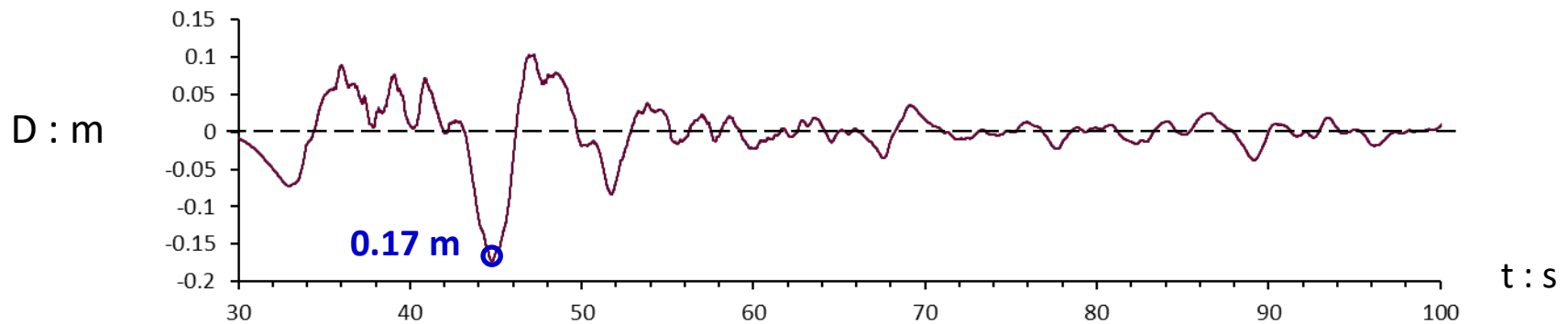
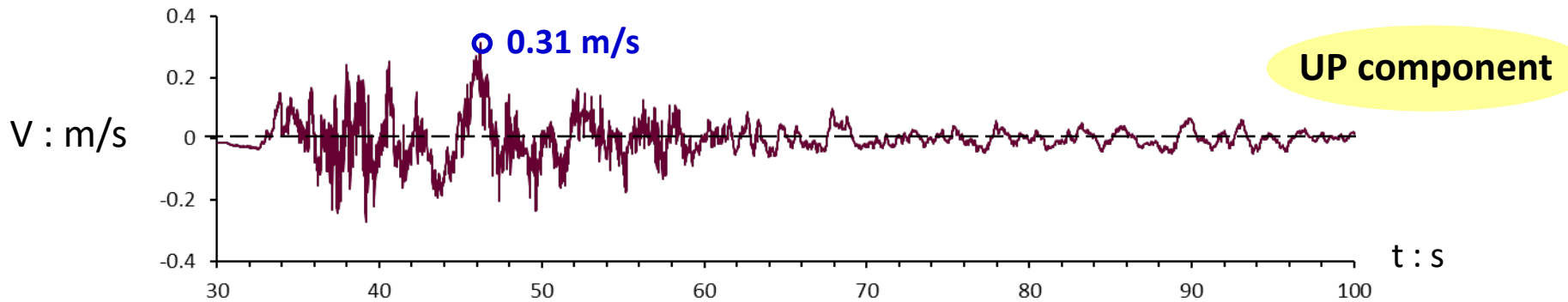
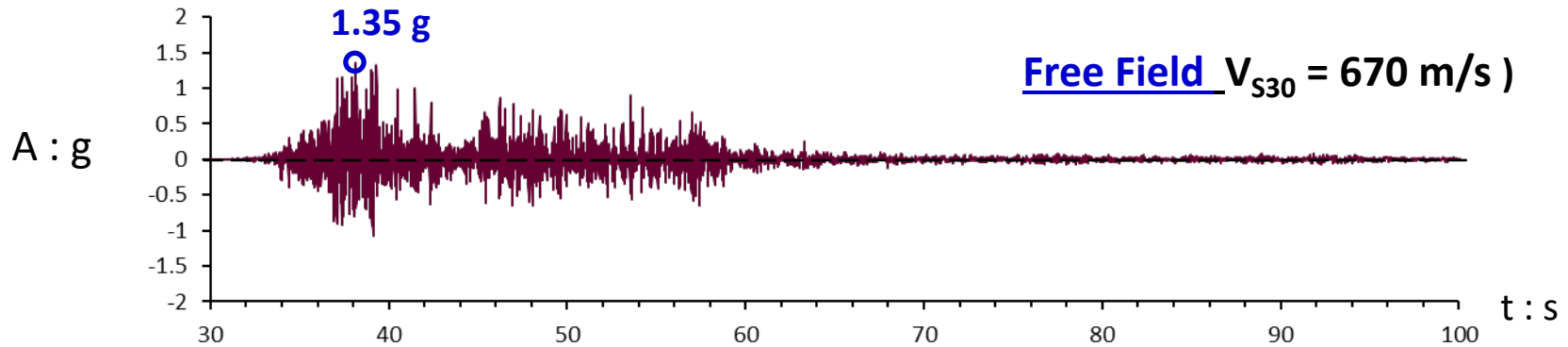


# 1<sup>st</sup> Mainshock $M_w$ 7.8

Station 4614: at **Kahramanmaras**

**Distance from fault  $\approx$  3 km**

Free Field  $V_{s30} = 670$  m/s )

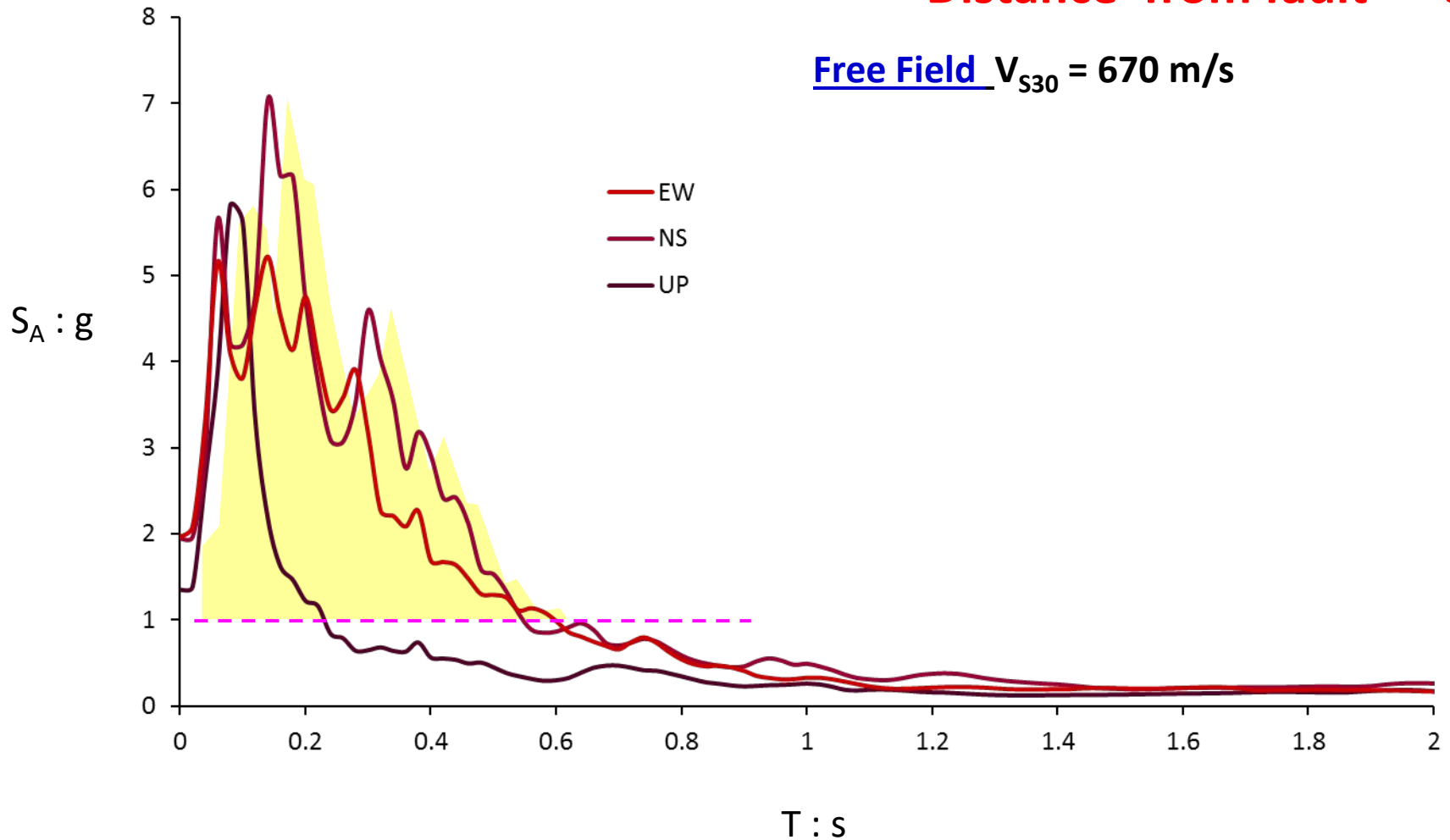


# 1<sup>st</sup> Mainshock $M_w 7.8$

Station 4614: at **Kahramanmaras**

**Distance from fault  $\approx 3$  km**

Free Field  $V_{s30} = 670$  m/s

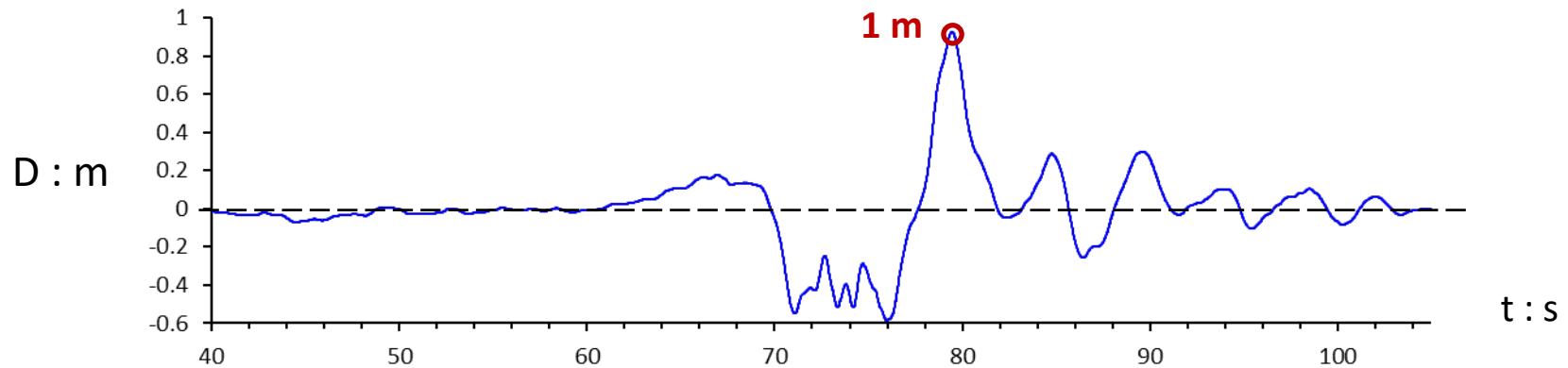
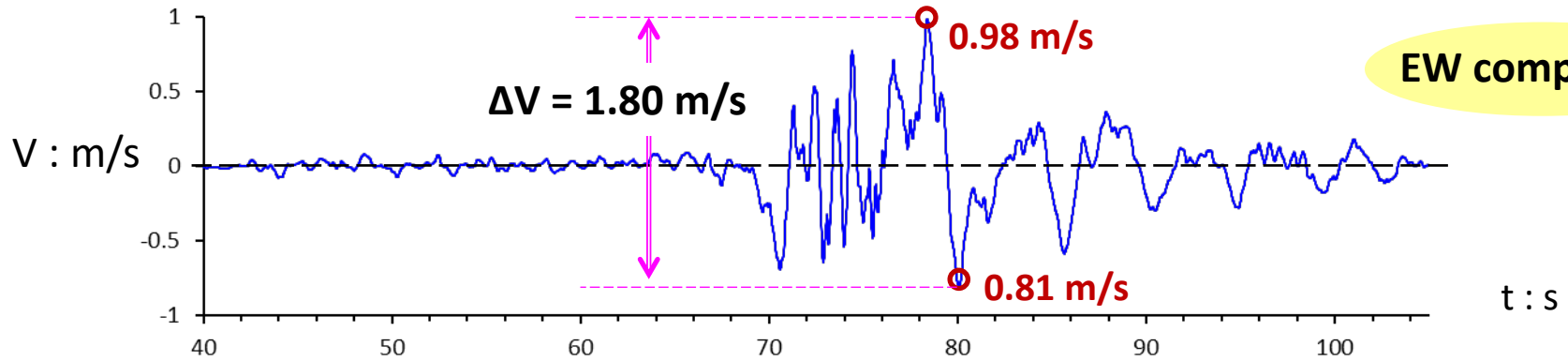
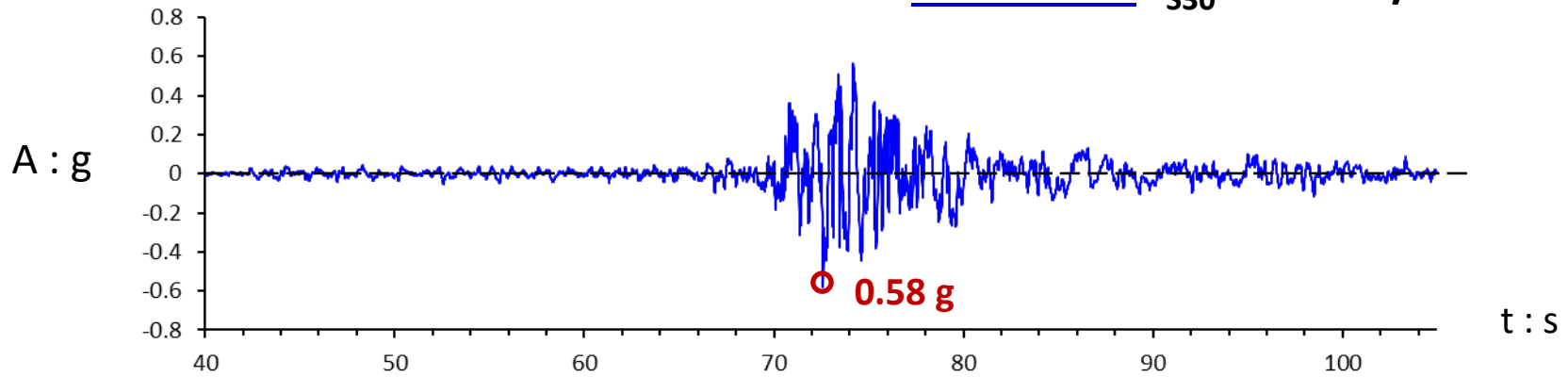




# 1<sup>st</sup> Mainshock $M_w 7.8$

Station 3123: at **Pazarck**

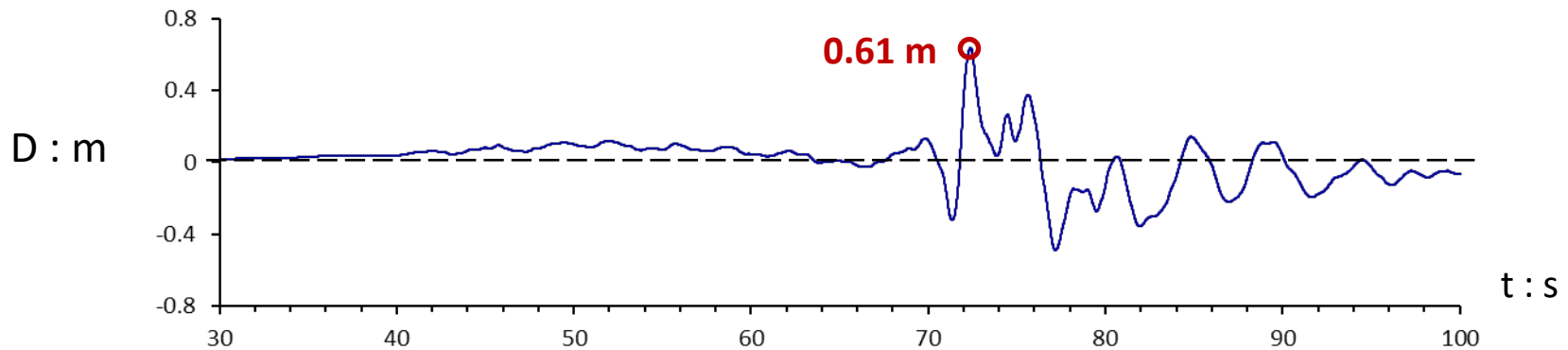
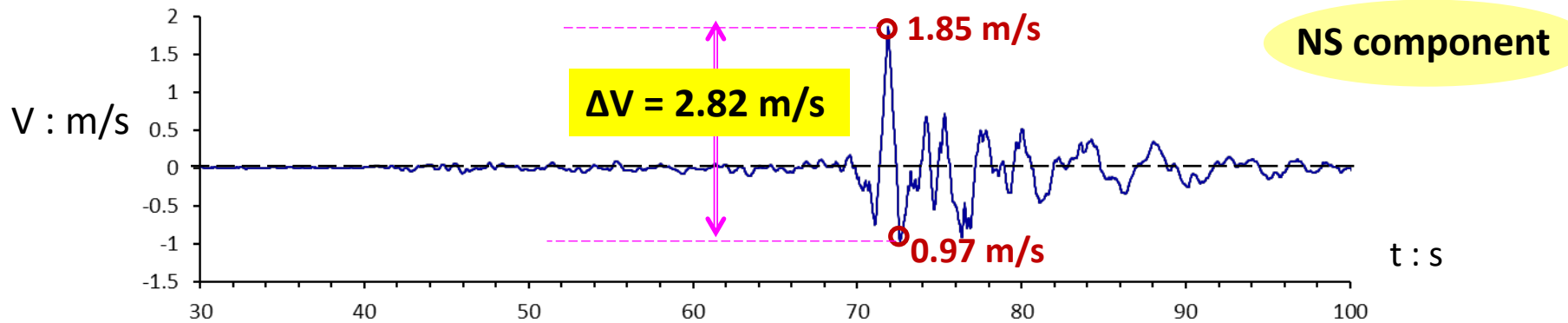
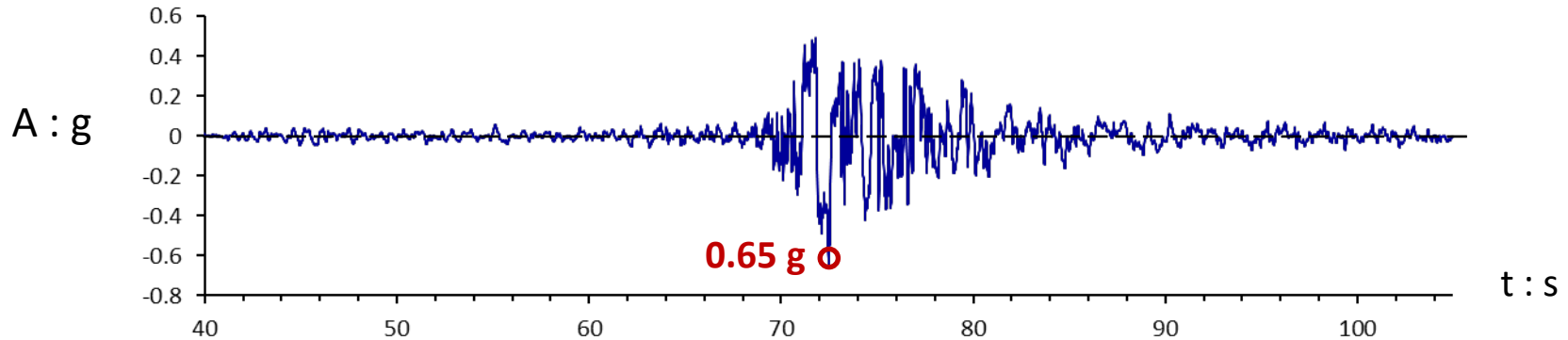
Free Field  $V_{S30} = 470 \text{ m/s}$



# 1<sup>st</sup> Mainshock $M_w 7.8$

Station 3123: at **Pazarck**

Free Field  $V_{S30} = 470 \text{ m/s}$

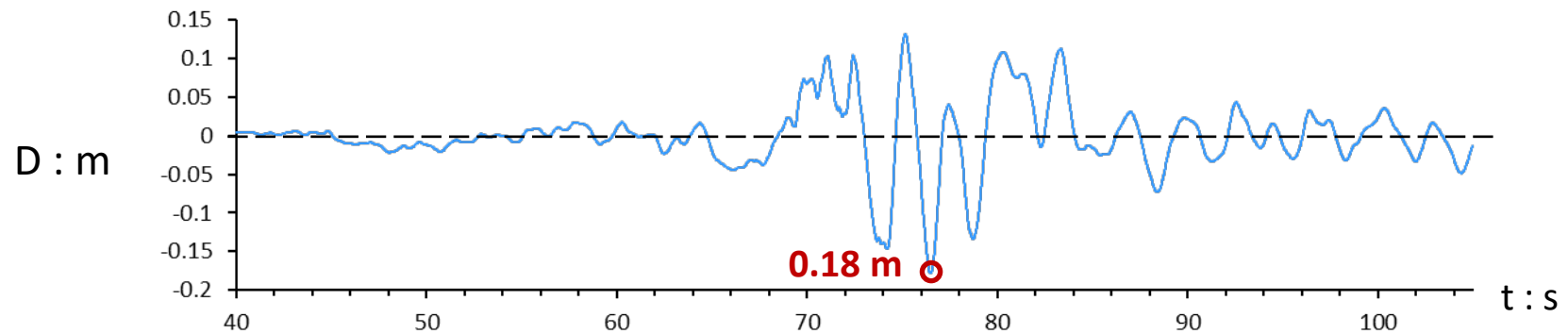
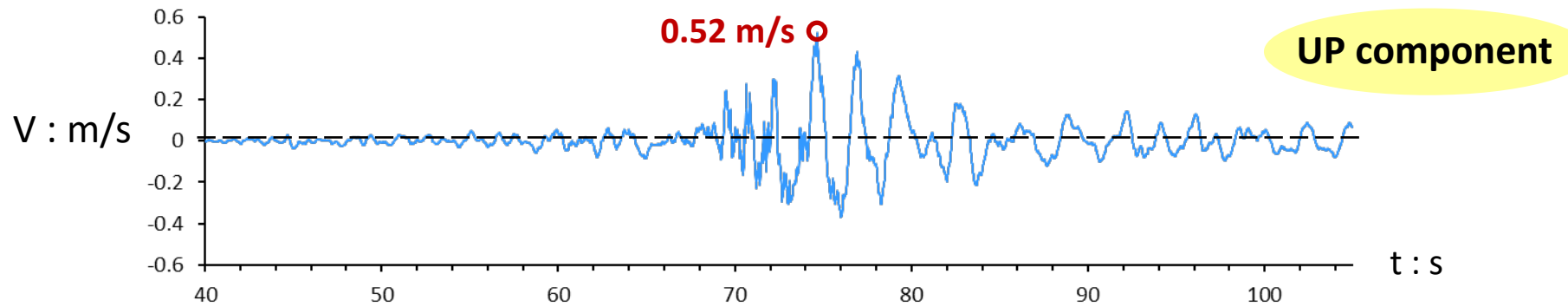
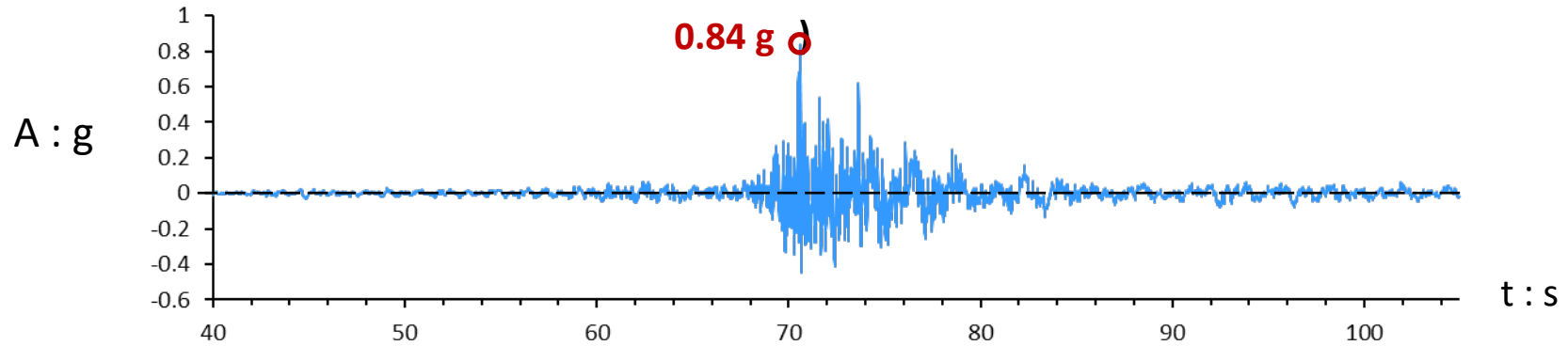




# 1<sup>st</sup> Mainshock $M_w 7.8$

Station 3123: at **Pazarck**

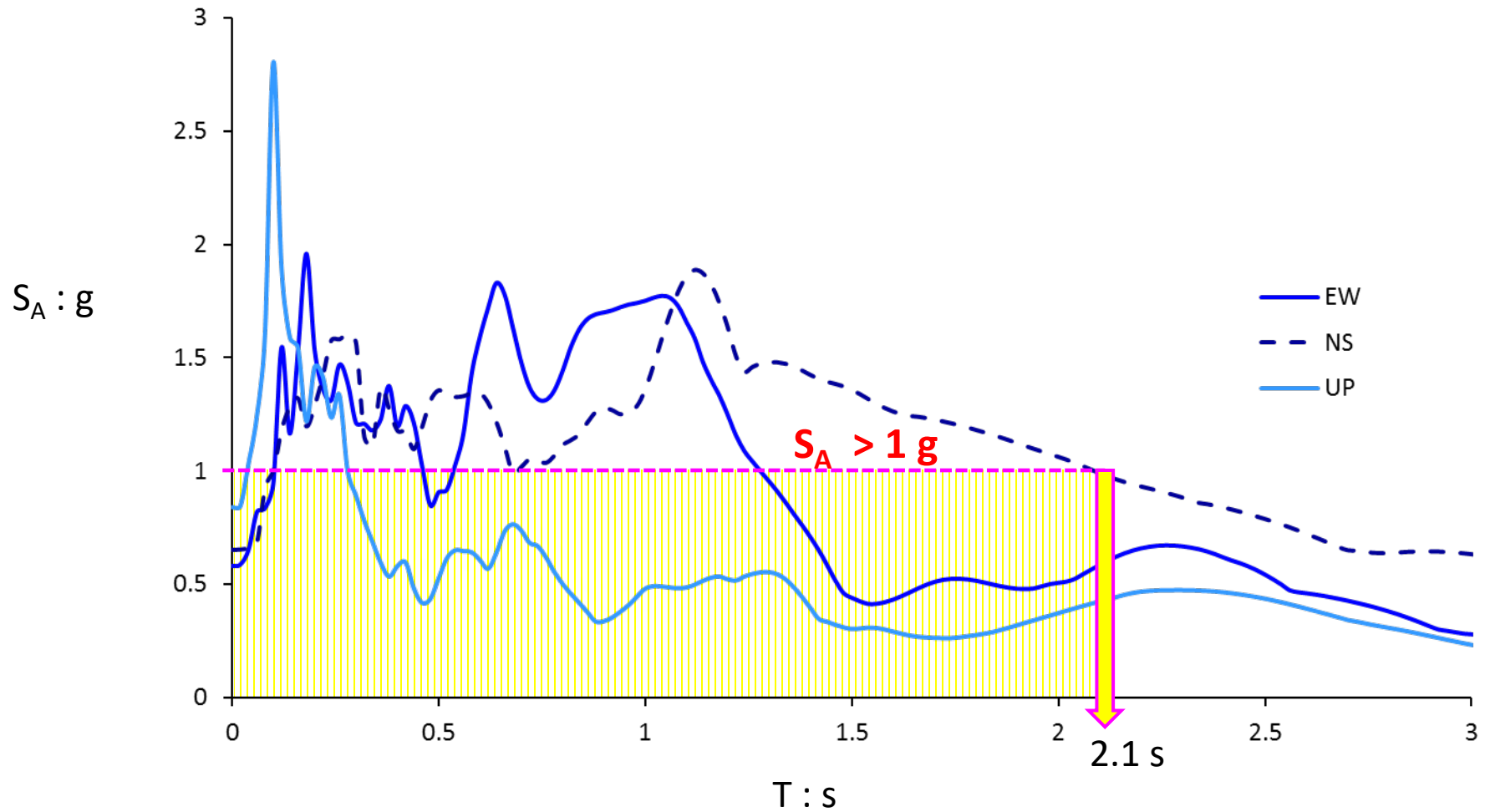
Free Field  $V_{S30} = 470$  m/s



# 1<sup>st</sup> Mainshock $M_w 7.8$

Station 3123: at at **Pazarck**

Free Field  $V_{s30} = 470$  m/s



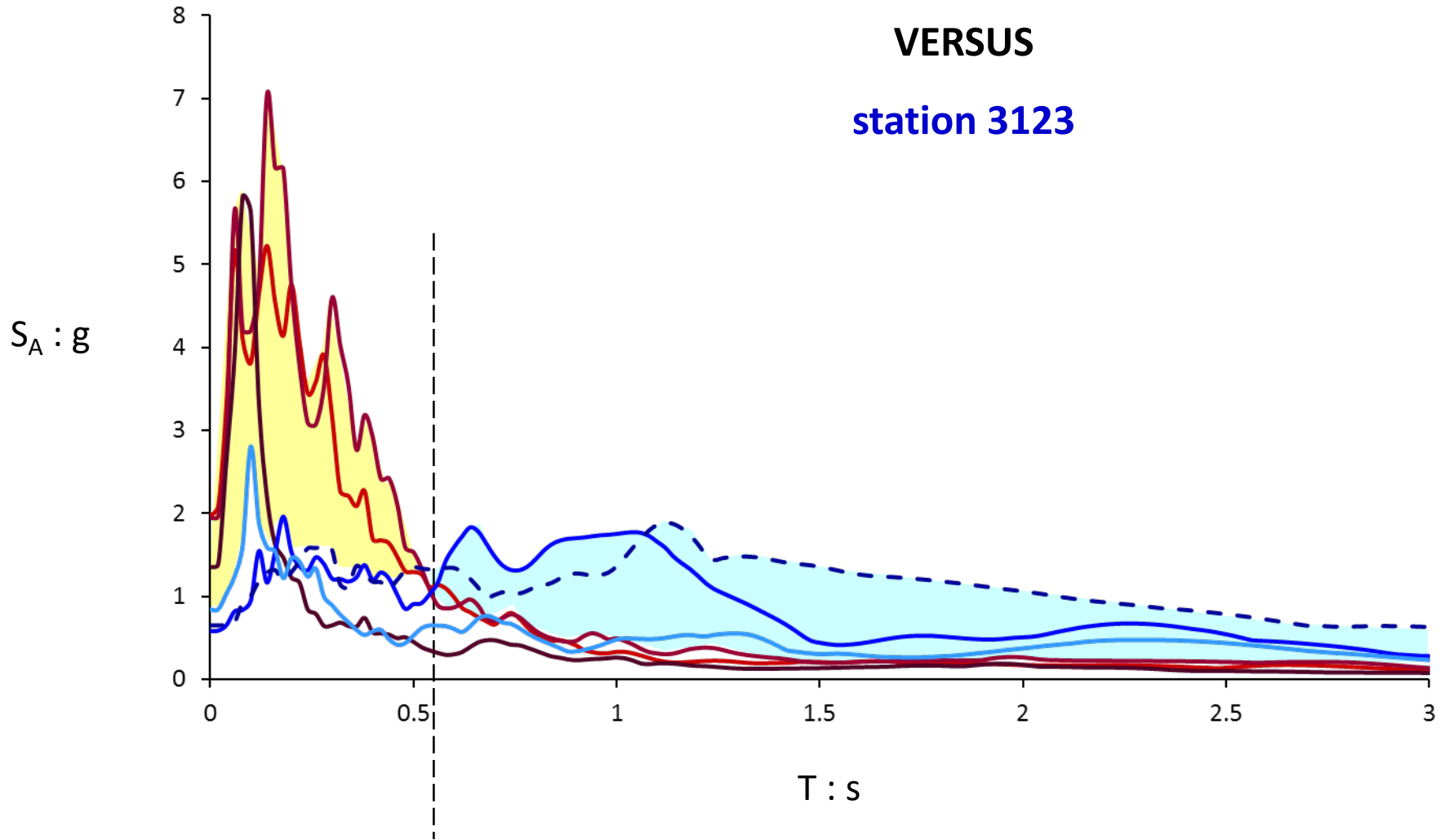


# 1<sup>st</sup> Mainshock $M_w$ 7.8

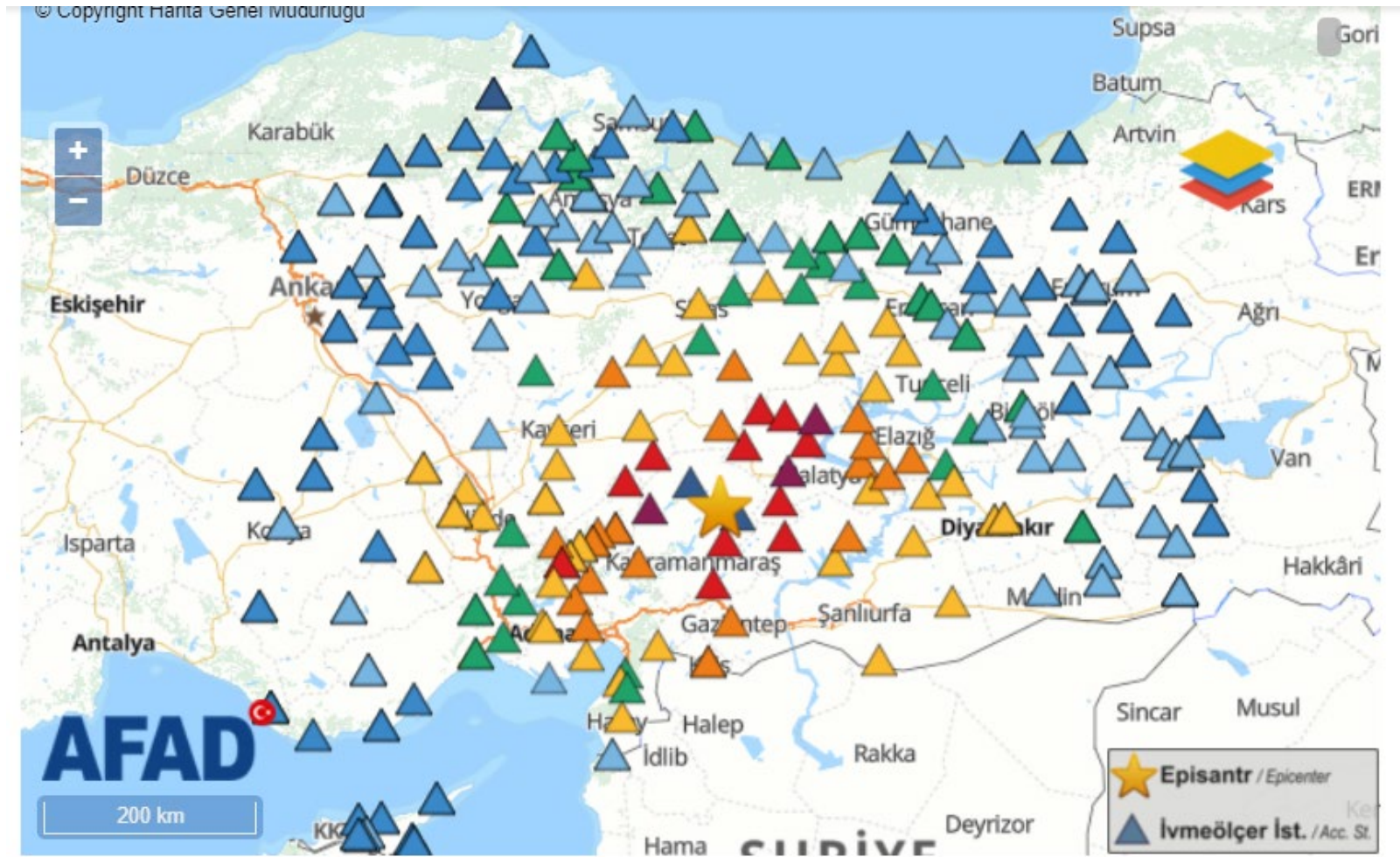
station 4614

VERSUS

station 3123



# 2<sup>nd</sup> Shock: $M_w$ 7.5



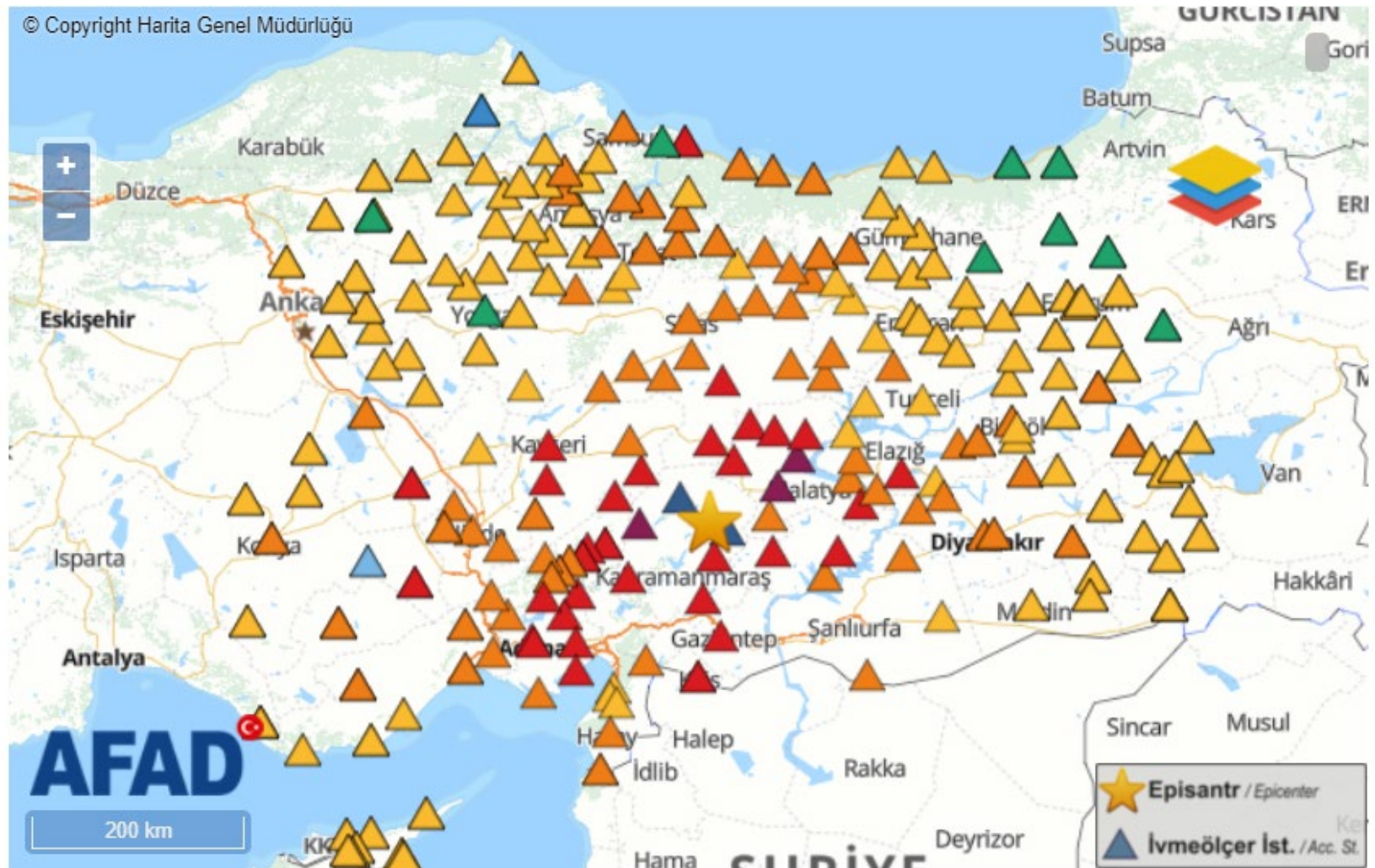
Distribution by:  PGA (cm/s<sup>2</sup>)  PGV (cm/s)  PGD (cm)

Legend





# 2<sup>nd</sup> Mainshock: $M_w$ 7.5 (6 February 2023 at 10:24)



Distribution by:  PGA (cm/s<sup>2</sup>)  PGV (cm/s)  PGD (cm)

Legend



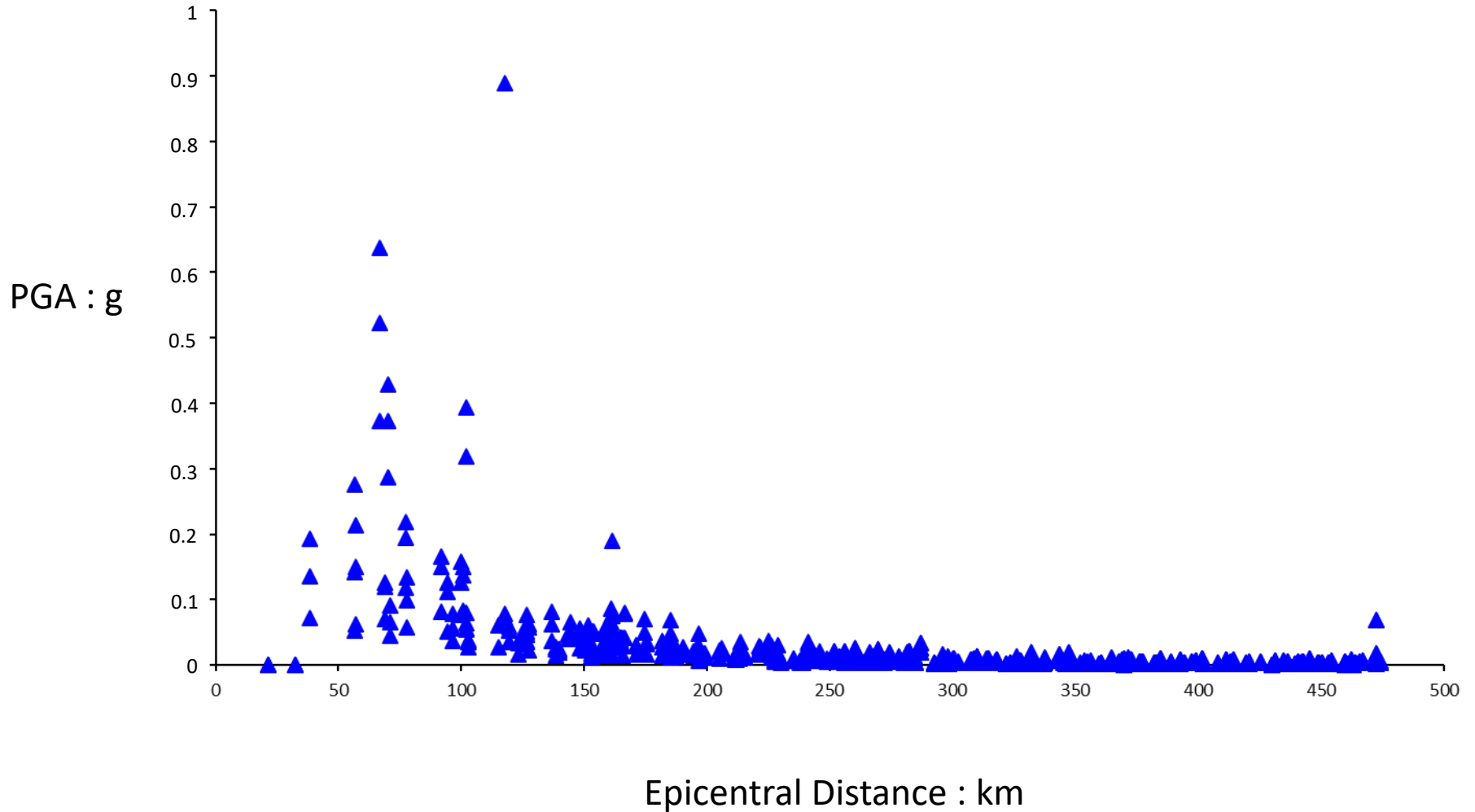
## 2<sup>nd</sup> Mainshock: $M_w$ 7.5

Accelerograms recorded by AFAD with  $PGA > 0.15$  g

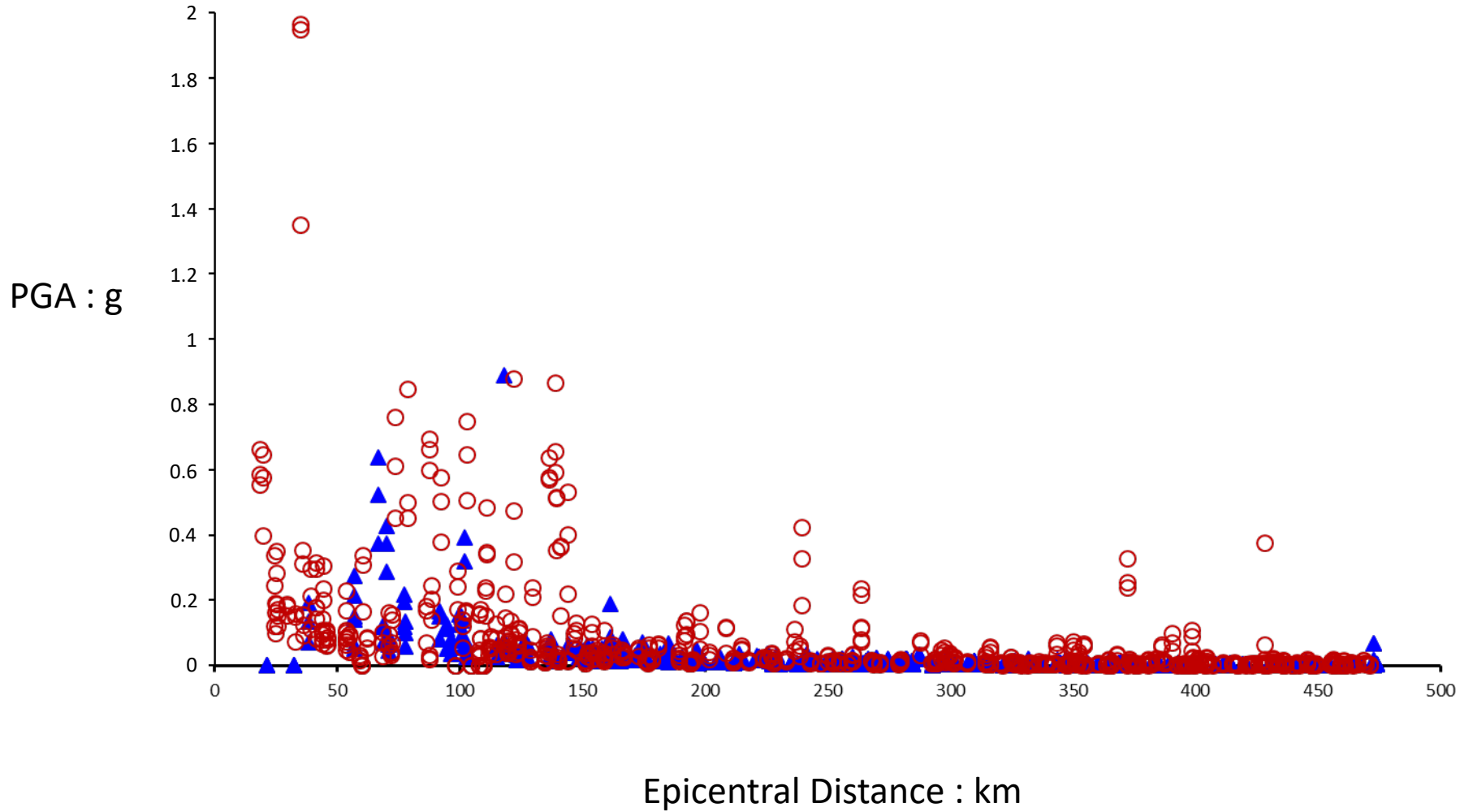
Station Code	$R_{epi}$ : km	$PGA_{NS}$ : g	$PGA_{EW}$ : g	$PGA_{UD}$ : g
4612	67	0.638	0.523	0.373
4406	70	0.428	0.373	0.286
131	102	0.394	0.319	0.079
4409	57	0.214	0.150	0.062
3802	77	0.194	0.219	0.118
4611	38	0.193	0.135	0.072
4412	100	0.157	0.125	0.076
129	92	0.150	0.166	0.081
4405	101	0.137	0.150	0.083
NAR	78	0.134	0.099	0.057
213	69	0.119	0.127	0.070
4410	95	0.112	0.125	0.051
141	161	0.079	0.189	0.074



# Peak recorded ground acceleration VS epicentral Distance for the 2<sup>nd</sup> Mainshock of M<sub>w</sub>7.5



- 1<sup>st</sup> mainshock
- ▲ 2<sup>nd</sup> mainshock



# **Structural Destruction (Turkey)**



## **Structural Damage in Turkey: An overview**

In total, around nearly 5000 buildings collapsed in ten provinces across Turkey. Many buildings were destroyed in Adiyaman and Diyarbakır. In Diyarbakır, a shopping mall collapsed.

About 130 building collapses also occurred in Malatya. The ancient Gaziantep Castle was seriously damaged. Kahramanmaras, a city of more than 1 million people, has been hit hard, as too have Malatya, Hayat region and reports suggest up to 10 major cities heavily affected by collapsing buildings.

In Adana, apartment buildings, one of them 17 stories high, collapsed, killing >> ten people.

In Hatay Province, the runway of Hatay Airport was split and uplifted. Two provincial hospitals and a police station were destroyed, and a gas pipeline exploded

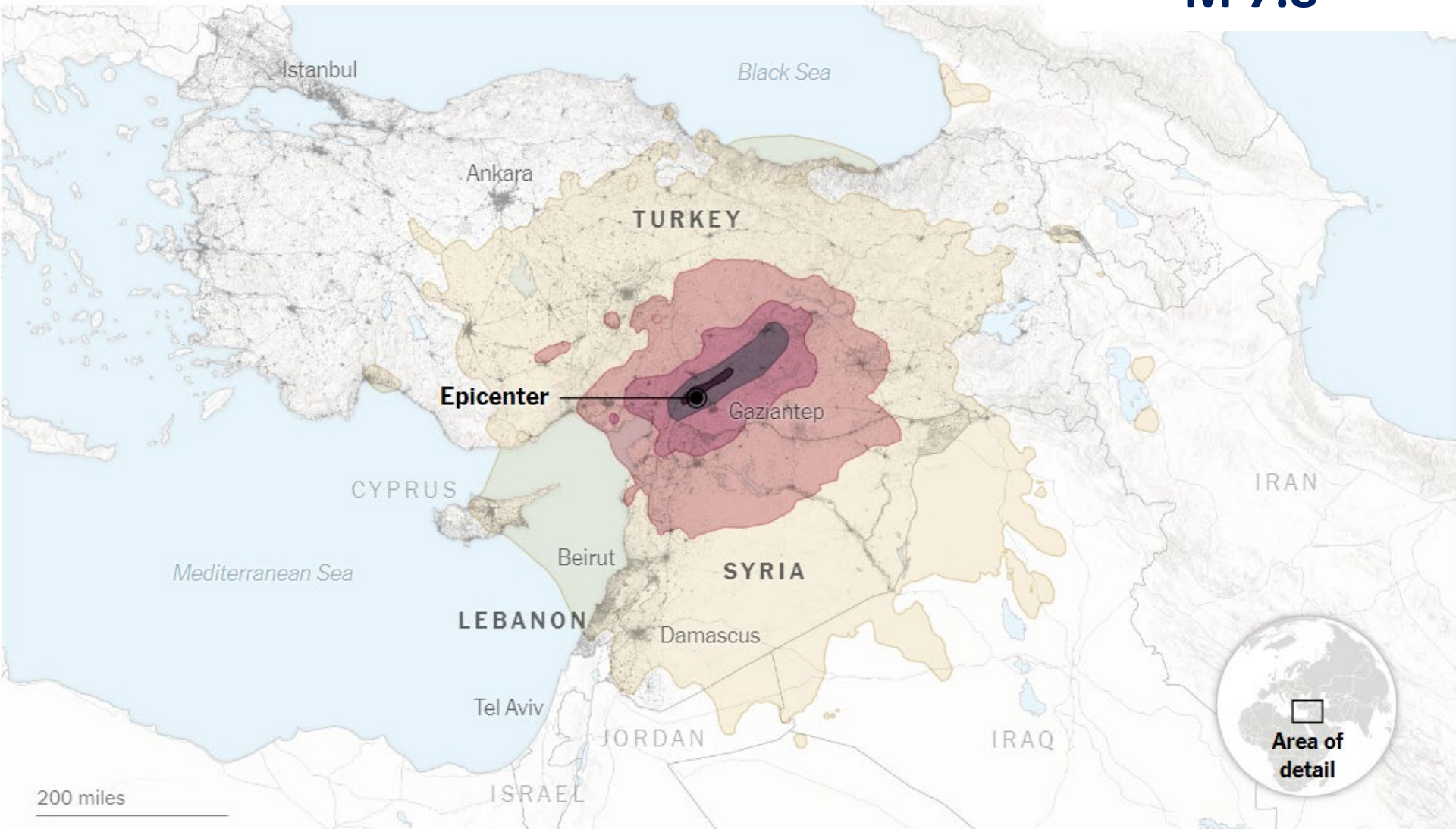
## **Structural Damage in Syria: An overview**

Collapses occurred in the cities of Aleppo, Latakia, and Hama. In Damascus, many people fled from their homes onto the streets. Hundreds were killed. The Crusader-built castle Margat suffered damage, with part of a tower and parts of some walls collapsing. The Citadel of Aleppo was also affected.

# The 1<sup>st</sup> shock of M 7.8

Area affected by the initial earthquake

Shake intensity



Source: The New York Times & U.S. Geological Survey

# Area affected by the second earthquake

# The 2<sup>nd</sup> shock of M 7.5

Shake intensity   
Very Strong Moderate

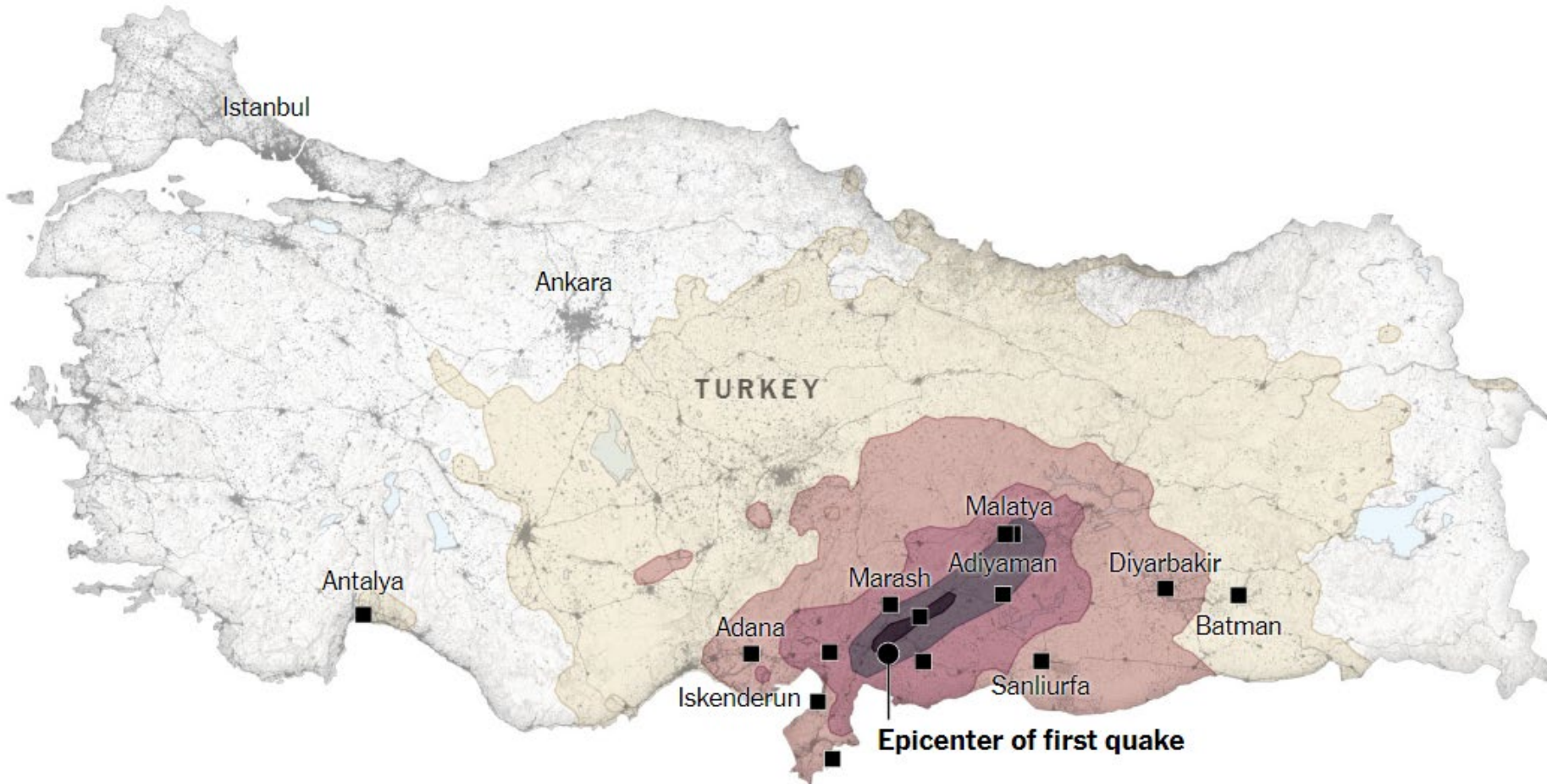


Source: The New York Times & U.S. Geological Survey



# Turkish cities damaged by the 2 earthquakes

Shake intensity of first quake  Severe Moderate



Source: The New York Times & U.S. Geological Survey















Distance to epicenter: 228.5 Km





People search through rubble following an earthquake in Diyarbakir, Turkey, February 6, 2023  
[Sertac Kayar/Reuters]





Rubbles of a destroyed building in Adana, Turkey, Monday, Feb. 6, 2023.  
Source: AP Photo/Khalil Hamra





EMSC





A collapsed building in Hatay, Turkey, February 7, 2023.  
(Photo: REUTERS/ Umit Bektas/ File Photo)





EMSC



Location: Kavaşlı, Turkey





Flattened buildings in Hatay  
Credit: Anadolu Agency, Erçin Ertürk









**A collapsed buildings in Kahramanmaras, Turkey, on Monday. (Ihlas News Agency/Reuters)**







Pazarcık district of Kahramanmaraş in the Elbistan district (Source: <https://gazeteoksijen.com/>).





Source: Oksijen Gazete





Source: Oksijen Gazete



## Rescue work continues at Iskenderun State Hospital, Turkey



SOURCE: <https://gazeteoksijen.com/turkiye/iskenderun-devlet-hastanesinde-arama-kurtarma-calismasi-suruyor-169816>

Location: Şakirpaşa, Turkey  
Distance to epicenter: 161.2 Km







Source: Oksijen Gazete





A view of a damaged building in Hatay, Turkey. Photograph: Anadolu Agency/Getty Images



Collapsed buildings following an earthquake in Kahramanmaras, Turkey, February 6 2023.

Picture: IHLAS NEWS AGENCY (IHA)/REUTERS







This aerial photo shows a damaged building in Adana. Oguz Yeter/Anadolu Agency via Getty Images





Rubble of a collapsed building in Hatay. Sezgin Pancar/Anadolu Agency/Getty Images



# The historic Yeni Mosque is damaged in Malatya.

Volkan Kasik/Anadolu Agency/Getty Images





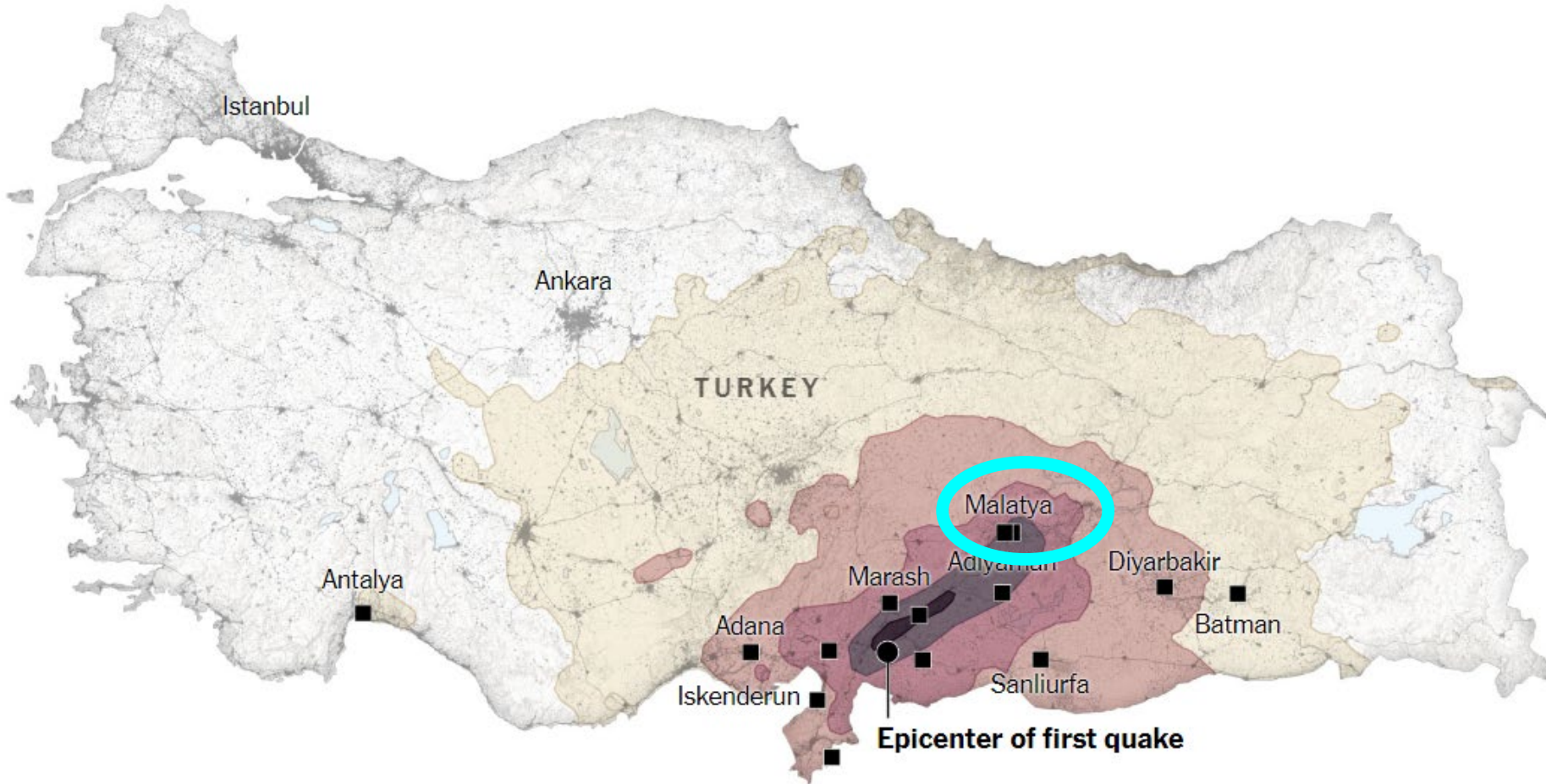


M7.8 and 7.5 earthquakes  
in Turkey damage runway  
of Hatay Airport

SOURCE: <https://aviationsourcenews.com>

# Cities damaged by the 2 earthquakes

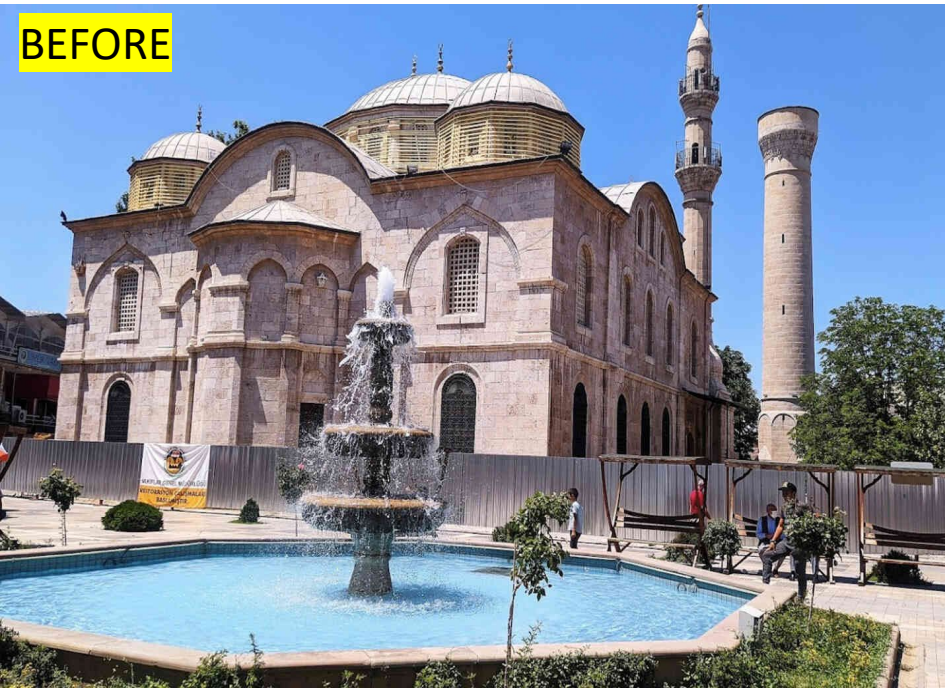
Shake intensity of first quake  Severe Moderate



Source: The New York Times & U.S. Geological Survey



# Yeni Mosque



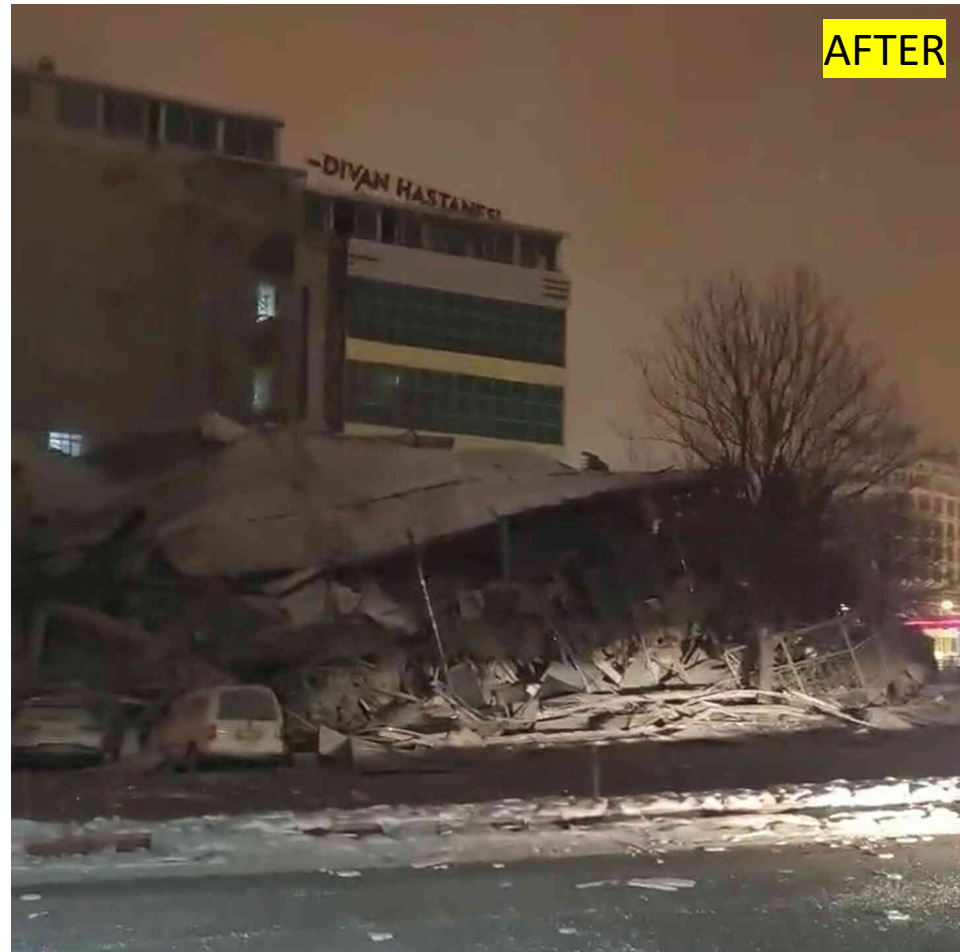
Source: The New York Times & Volkan Kasik/Anadolu Agency, via Getty Images

# Hotel Avsar

BEFORE



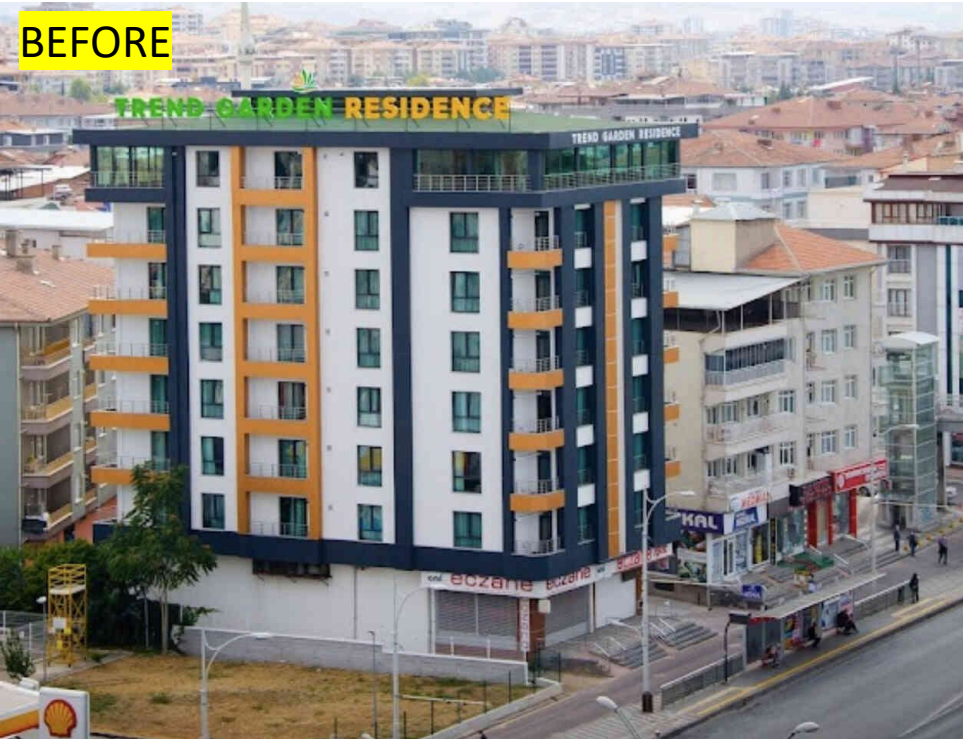
AFTER



Source: The New York Times & @Yedinoktabir via Storyful



# Trend Garden Residence Hotel

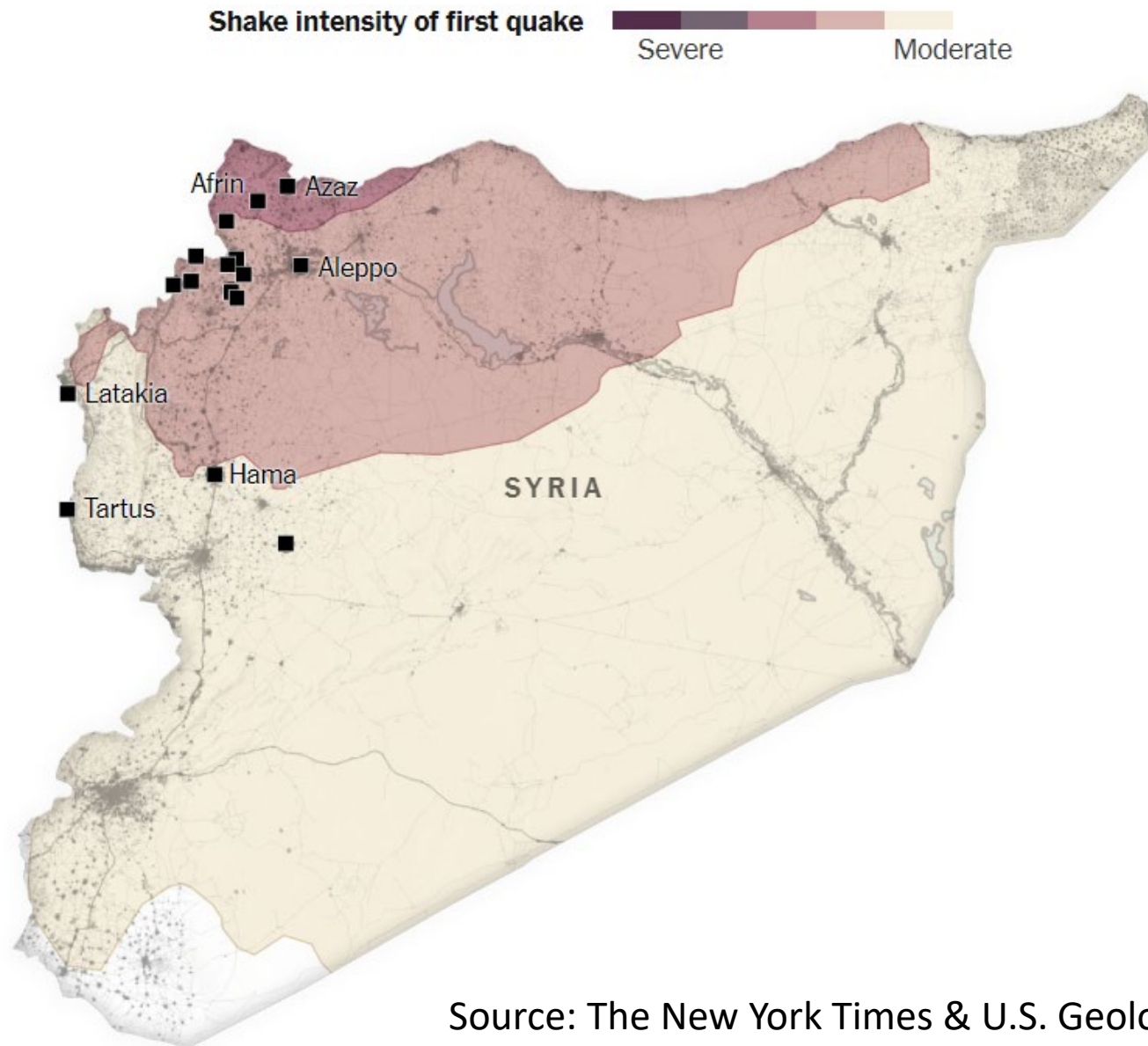


Source: The New York Times & Depo Photos via Reuters

# **Structural Destruction in Syria**



# Syrian Cities damaged by the earthquakes of 6<sup>th</sup> February 2023



Source: The New York Times & U.S. Geological Survey







Civil defense workers search through the wreckage of collapsed buildings in Hama, Syria, Monday, Feb. 6, 2023.

Source: AP Photo/Omar Sanadiki



Residents retrieve an injured girl from the rubble of a collapsed building in the town of Jindires  
Photo: AFP





Defense workers search through the collapsed buildings in the town of Harem near the Turkish border, Idlib province, Syria, Monday, Feb. 6, 2023.

Source: AP Photo/Ghaith Alsayed









Location: Syria  
Distance to epicenter: 64.5 Km



EMSC



Location: Idleb, Syria  
Distance to epicenter: 143.2 Km





Rescue teams search for victims and survivors in the rubble of a collapsed building in the Syrian city of Aleppo (Source: BBC, AFP)



# **Before and After Photos**



Gaziantep Castle in Turkey  
(Source: CNN webpage).





# Collapsed church in Iskenderun

Before



After



Source: Google, Getty

# Destroyed mosque in Malatya

Before



TURKEY  
Malatya

After



Source: Google, Getty



**the Sultansuyu Dam**, which was affected by the 7.7 magnitude earthquake in the Pazarcık district of Kahramanmaraş, **will be evacuated gradually** as a precaution.



Source: **Oksijen Gazete**