

The 2 earthquakes of February 6th 2023 in Turkey



Preliminary Report

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



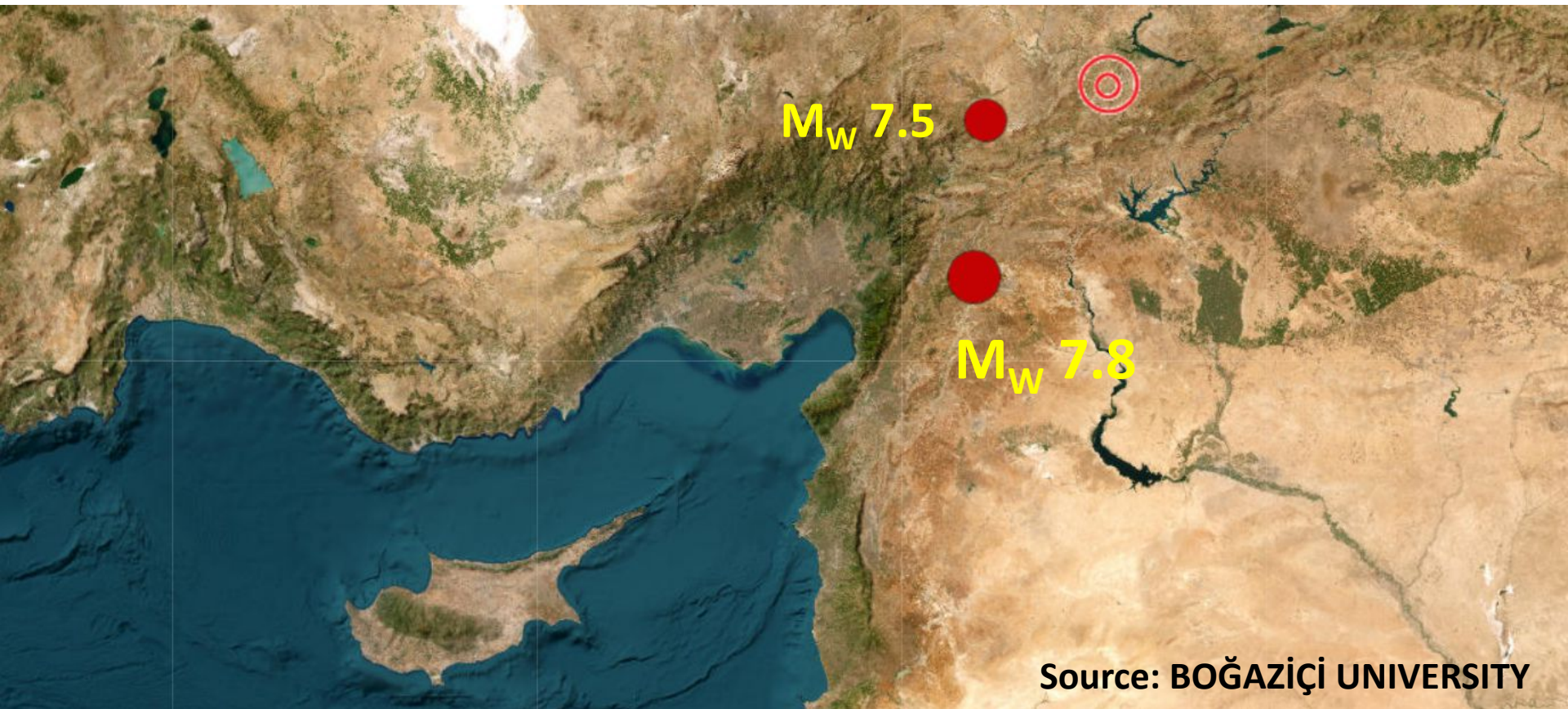
NTUA, Greece

PART A

Seismological Data of the M 7.8 and M 7.5 earthquakes

Tectonic setting-Intensity maps

7 February 2023



➔ 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>

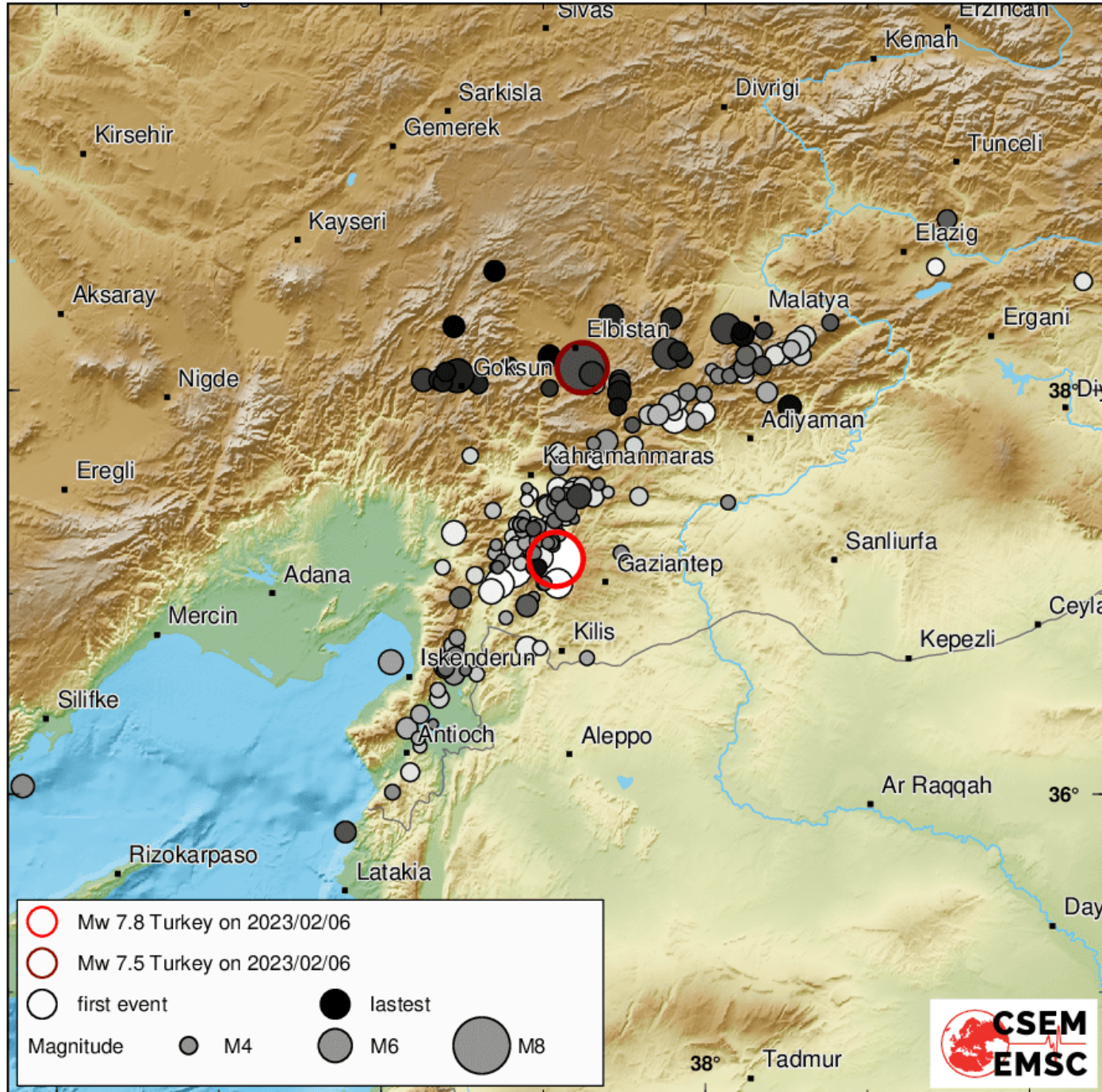
The **M 7.8** earthquake resulted from **strike-slip faulting** at shallow depth.

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

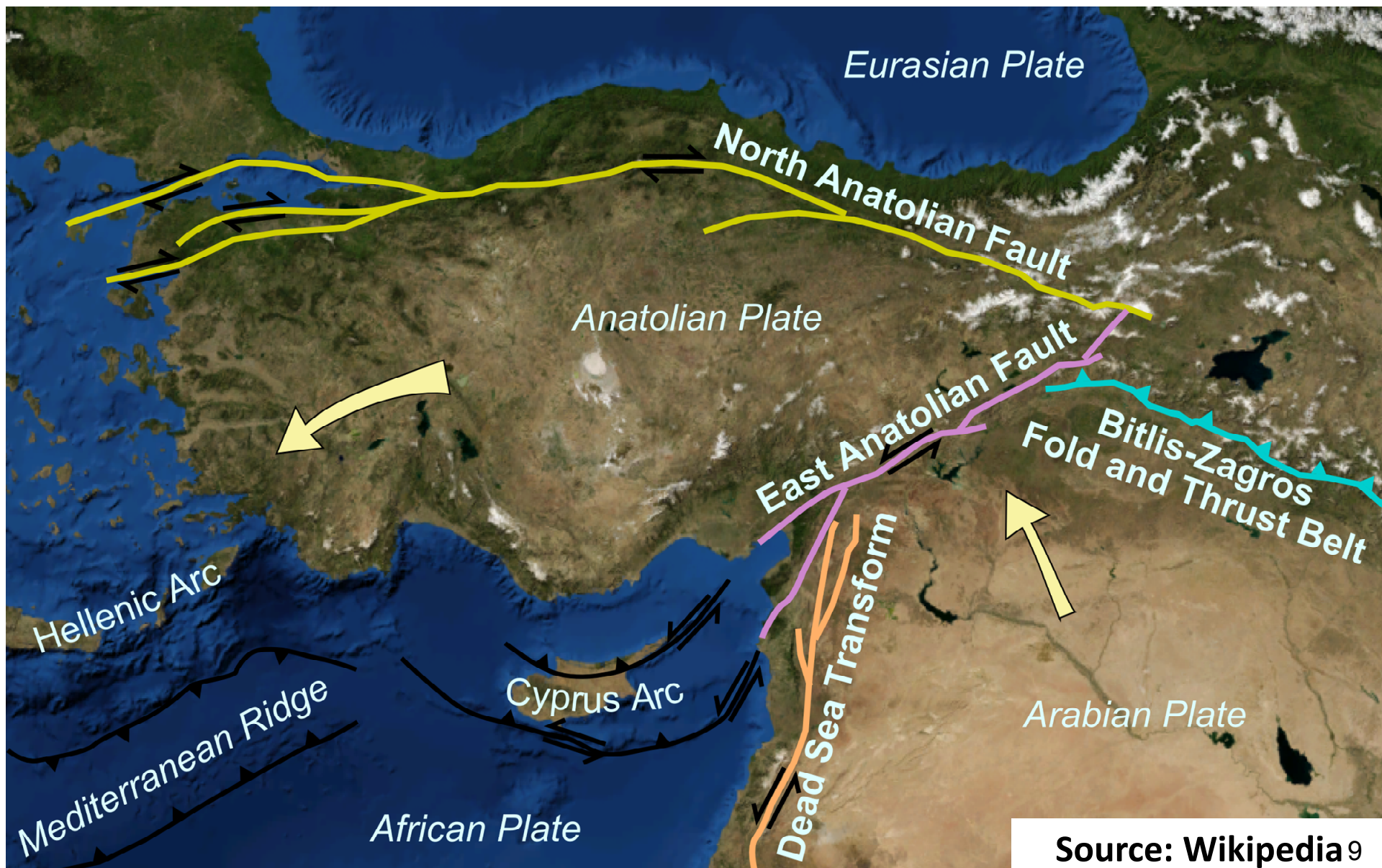


Source: INGV

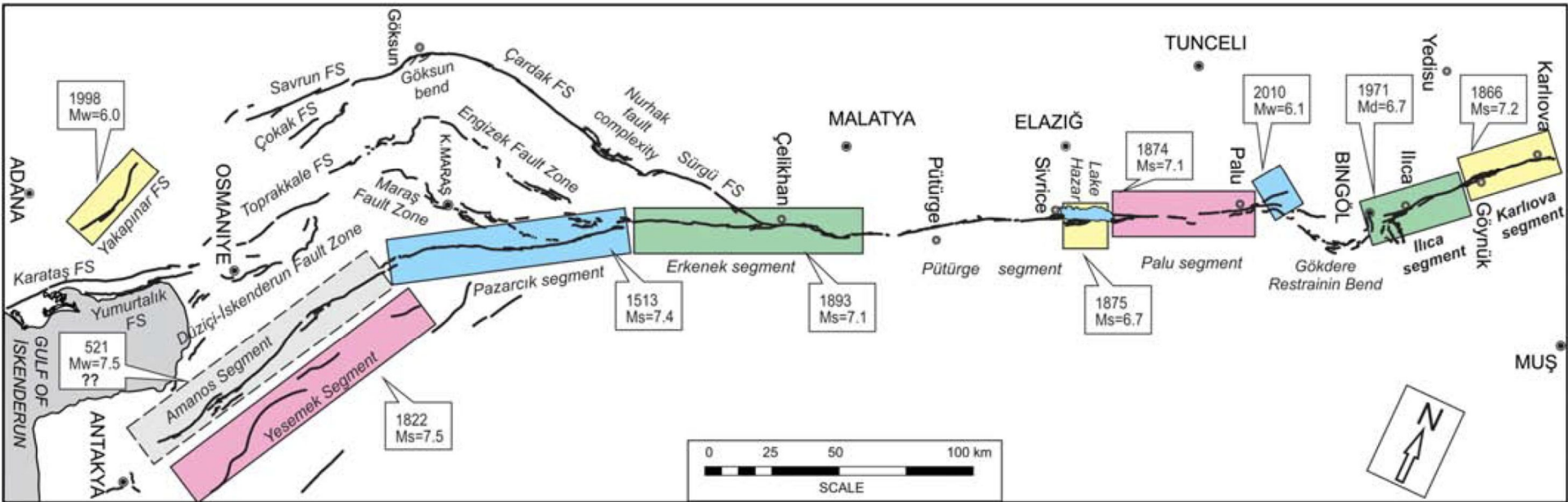


SEISMOLOGICAL INFO

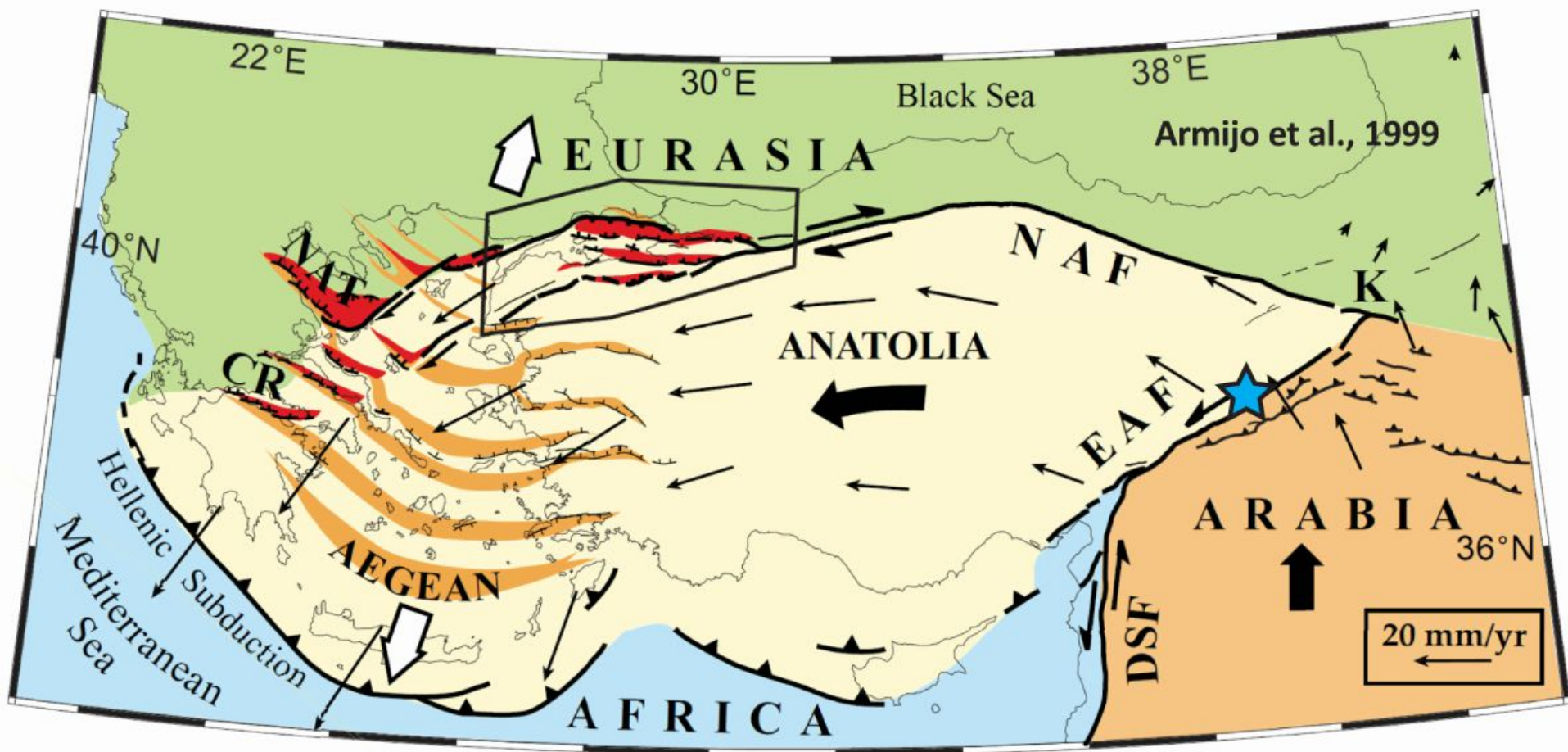
Map showing main tectonic structures around the Anatolian Plate.
The arrows show displacement vectors of the Anatolian and Arabian Plates
relative to the Eurasian Plate



Tectonics and fault system Map of the East Anatolian Fault



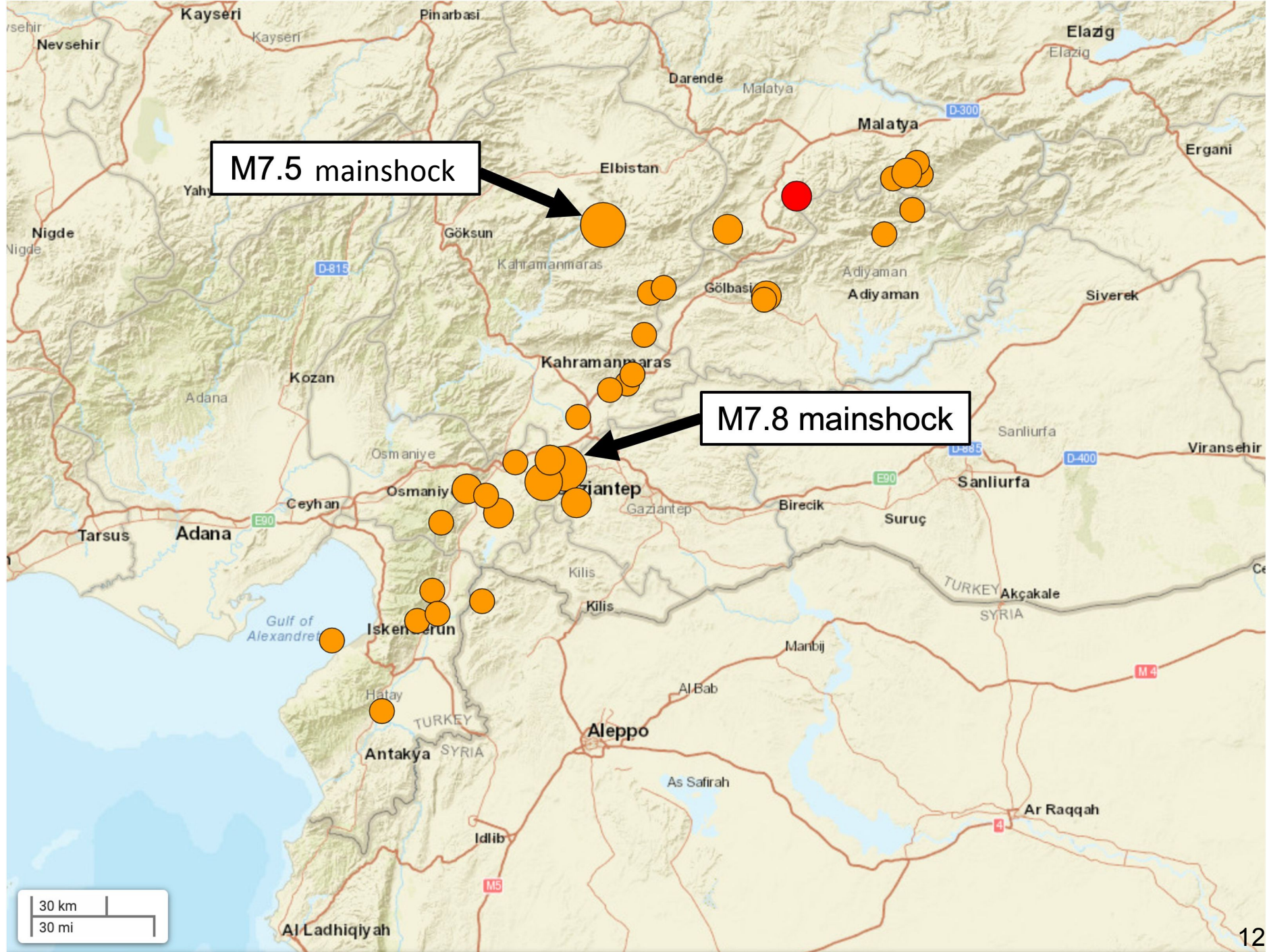
Source: Duman and Emre (2013)

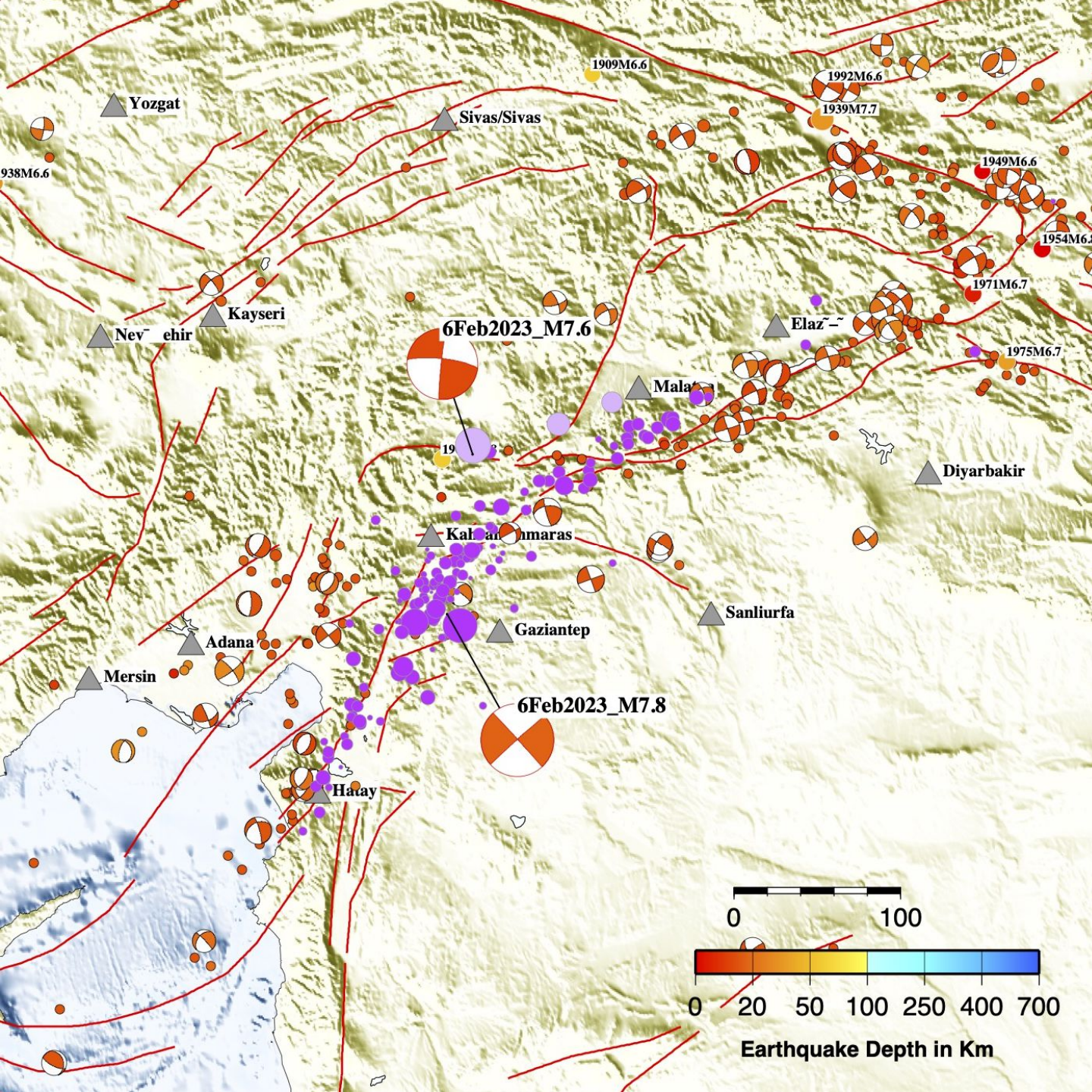


Source: CSEM-EMSC + GEM + USGS + Jason R. Patton

M7.5 mainshock

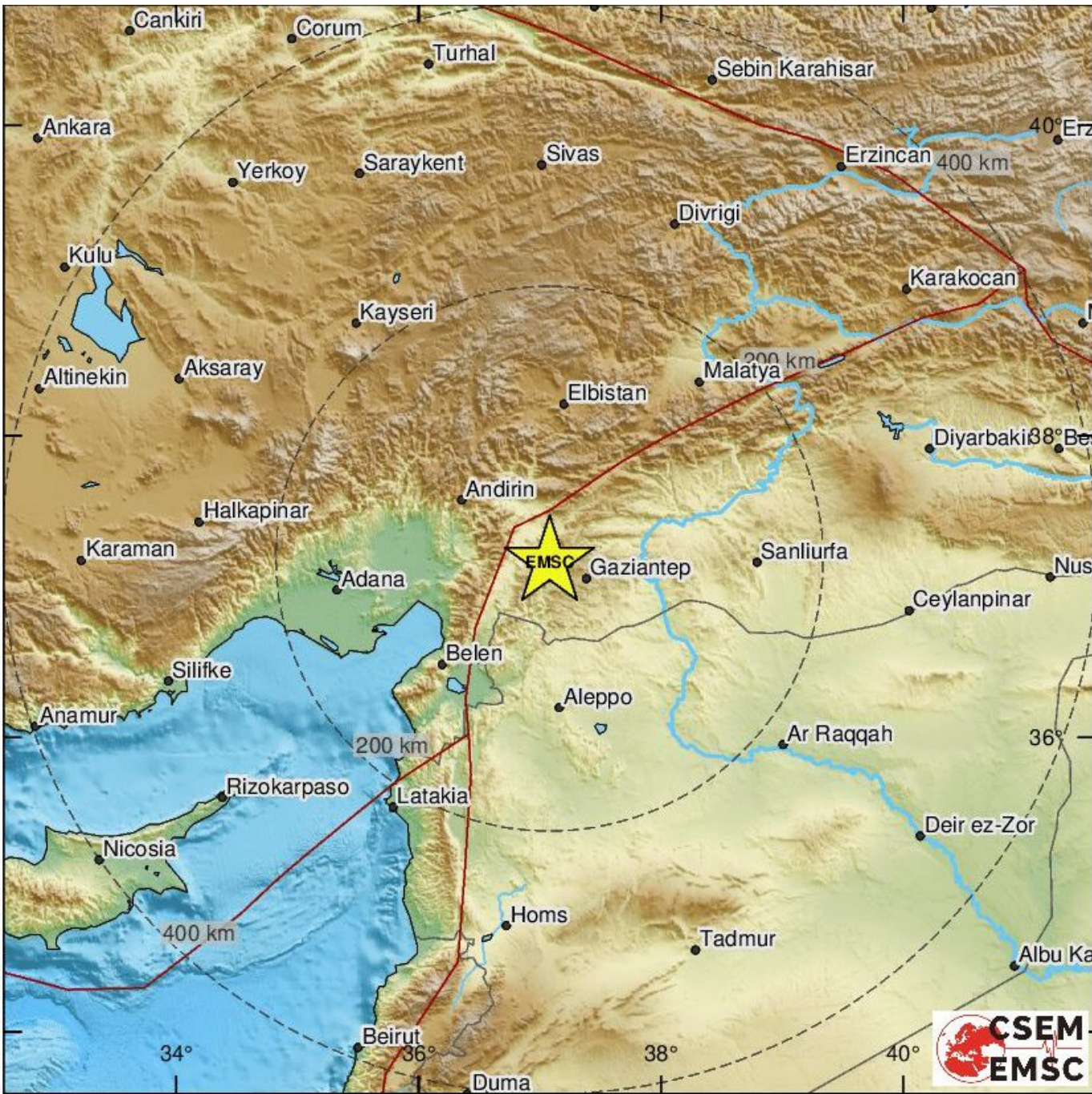
M7.8 mainshock





Source: Jascha Polet

The 1st mainshock of M7.8



100 km
— Political boundaries
— Tectonic plates boundaries

Depth

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



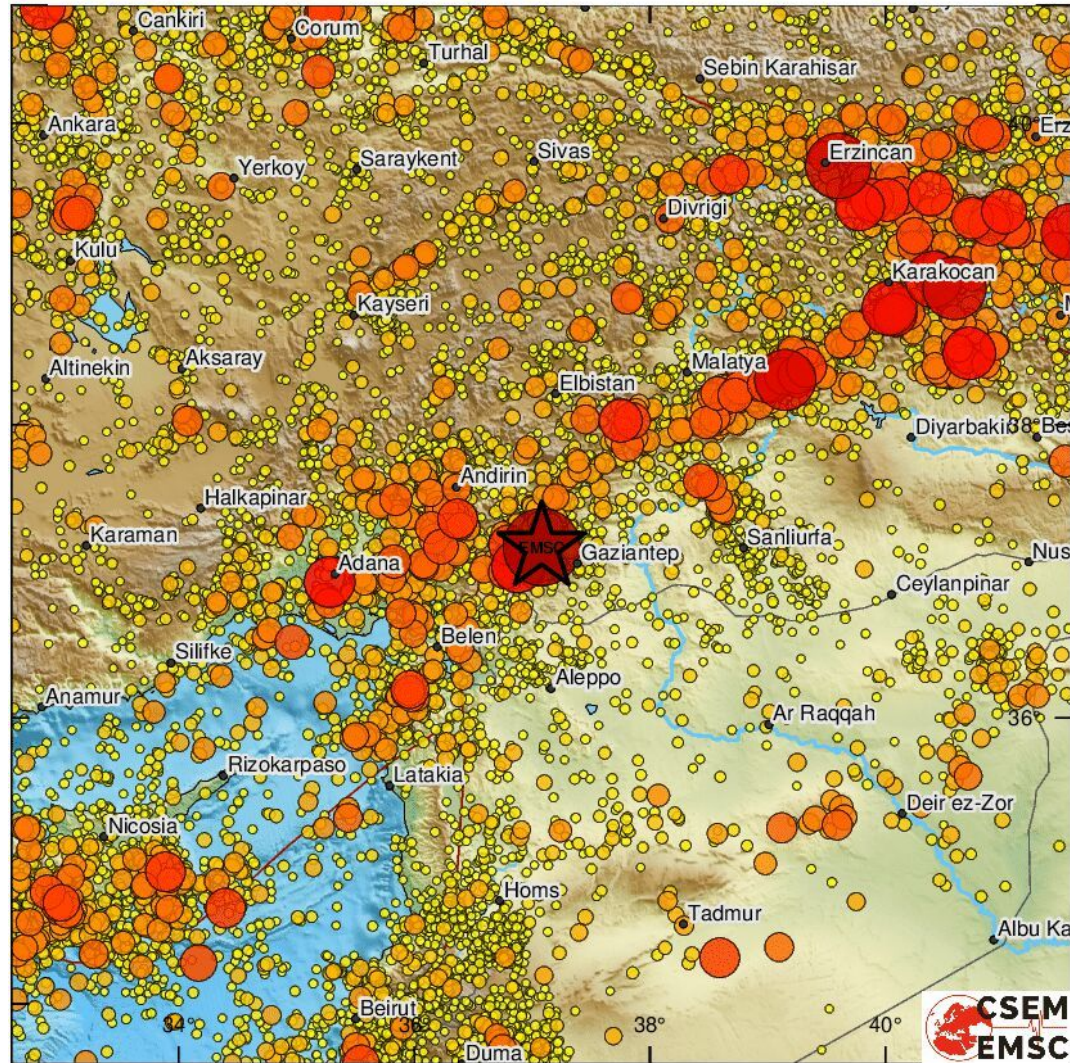
EMSC manual location

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

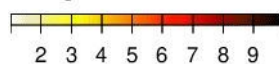
Lat: 37.17 Lon: 37.08 Depth: 20 km

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

(Total number of events with $M \geq 3$: 18778)



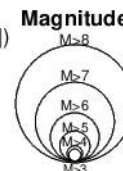
Magnitude



100 km

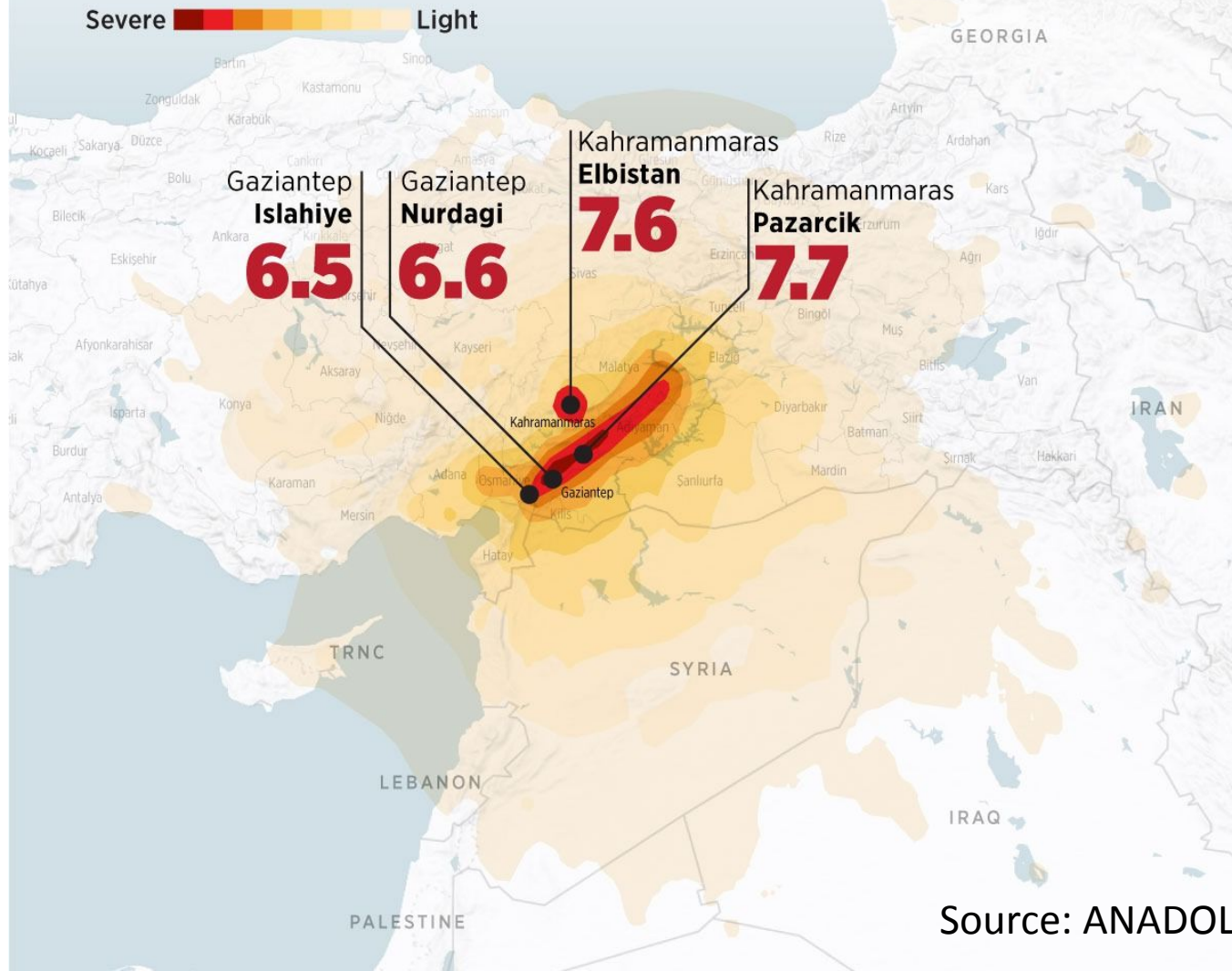
— Political boundaries
— Tectonic plates boundaries (Bird, P. [2003])

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



Impact area of earthquakes in Türkiye

Earthquakes in Türkiye's southern region also felt in Syria, Egypt, Lebanon, Northern Cyprus and Iraq

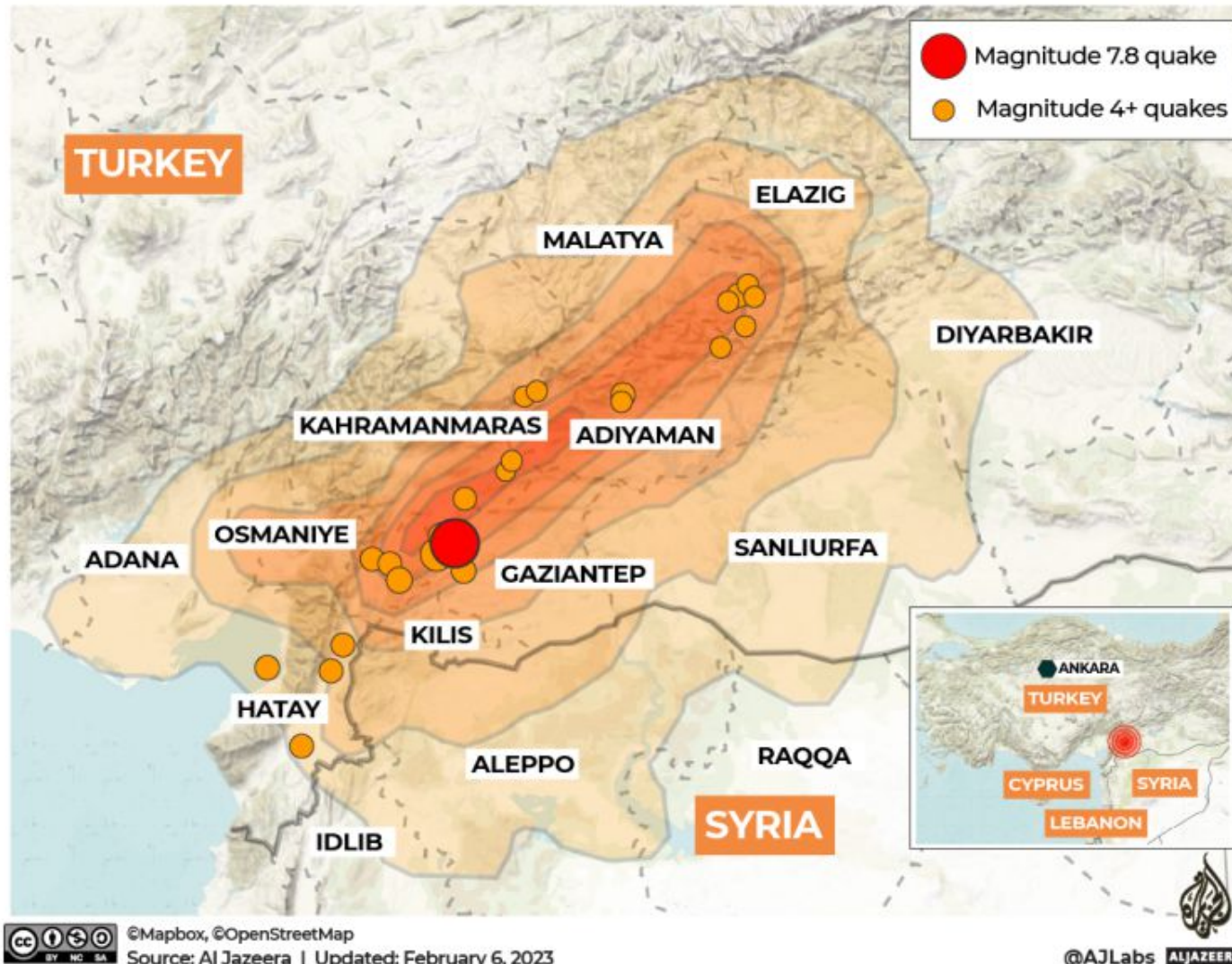


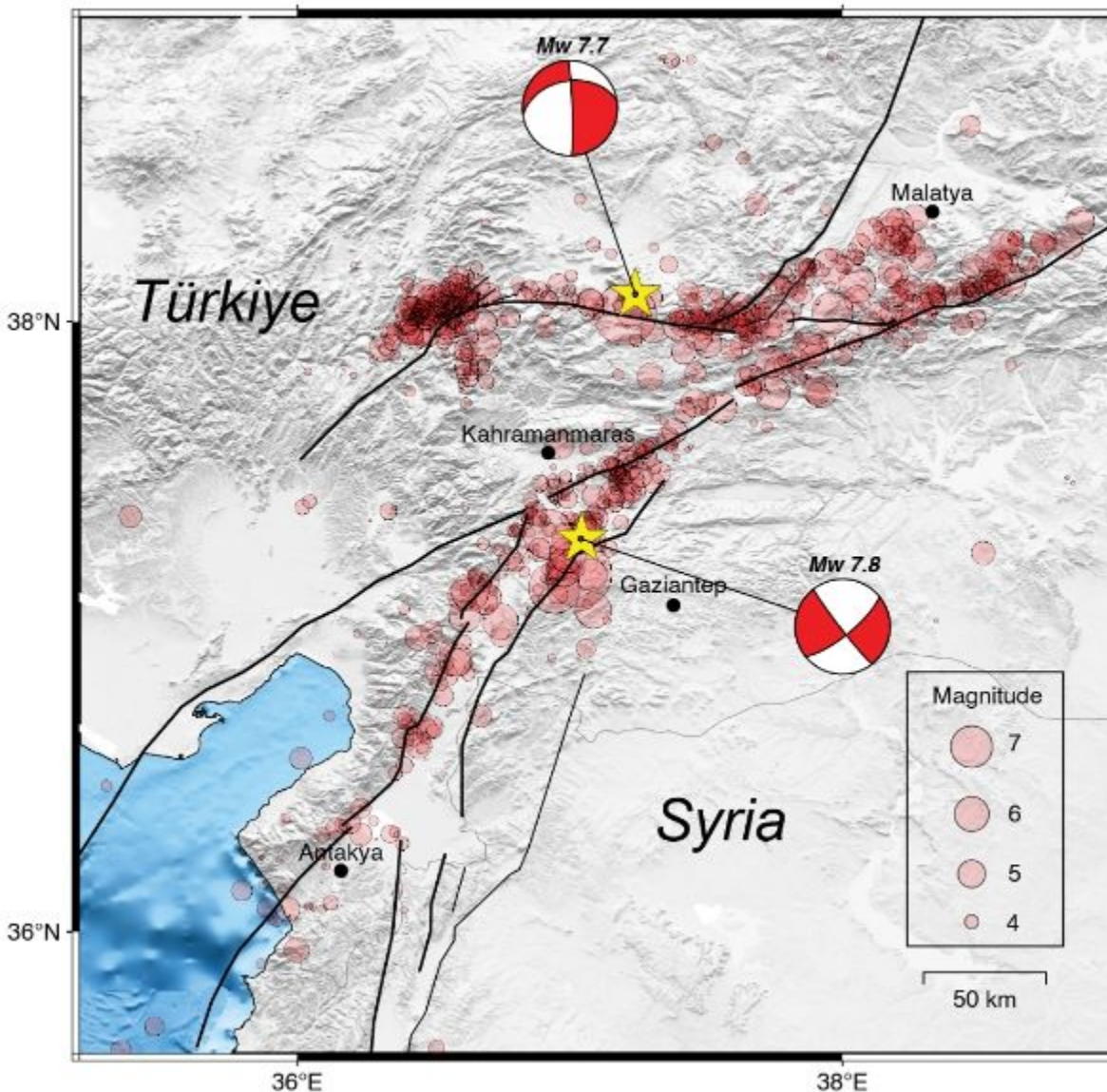
Source: ANADOLU AGENCY

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.



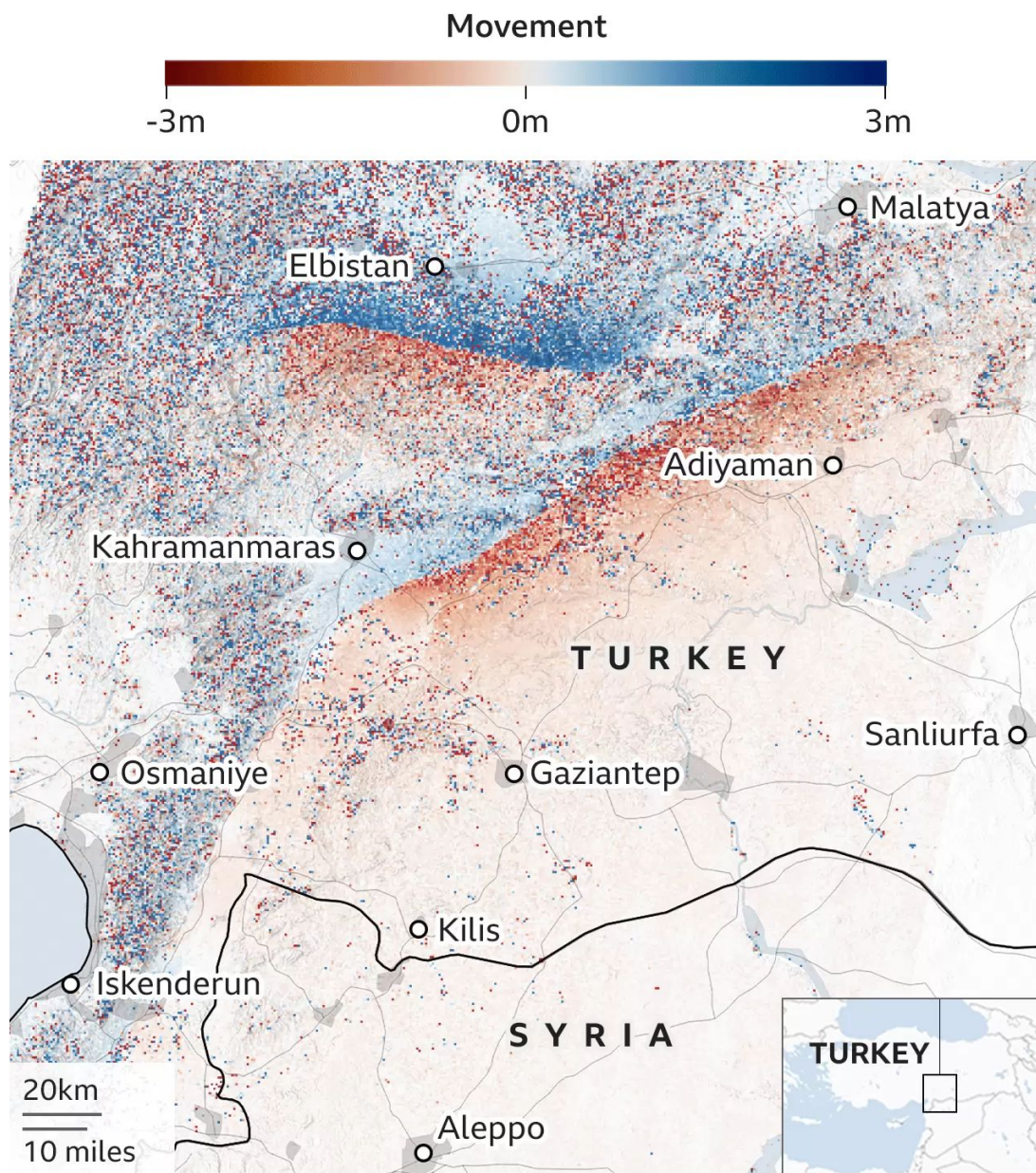


Map of the seismic activity of February 6, 2023, near the Türkiye–Syria border. Fault lines are shown in black. The first magnitude 7.8 mainshock (yellow star) occurred at 01:17 AM (UTC) on the East Anatolian Fault system. The second magnitude 7.7 mainshock (01:24 PM UTC; yellow star) occurred about 100 km north of the first event on a distinctly separate fault.

The first mainshock broke along an ~350 km long stretch of the EAF, while the 2nd mainshock was ~170 km long.

Graphic courtesy of **P. Martin Mai and Sigurjon Jonsson, Earth Science and Engineering, KAUST.**

EU satellite precisely maps earthquake faults



Ground movement measured closer to or further away from passing satellite

Source: Copernicus data, Esa, Comet 2023

PRELIMINARY REPORT

Failures of Multistorey Buildings in Turkey and Syria Due to the M 7.8 and M 7.5 Earthquakes

PART B: Structural Collapse and Interpretation

PART C: Recorded Accelerograms, Response Spectra

Evangelia GARINI and George GAZETAS

8 February 2023



**School of Civil Engineering,
National Technical University of Athens**

PART B

Some Remarks on the STRUCTURAL * Collapse of Multistorey Buildings

* and one purely GEOTECHNICAL Failure

Based on the following photos, and our experience from the Kocaeli (1999) earthquake, we draw some conclusions regarding the unprecedented extent of damage. In addition to the very strong seismic shaking, with PGAs in the order of at least 0.7 g – 1 g, the following structural deficiencies (that are clearly identified in these photos and are evident in perhaps all the collapsed buildings) were truly fatal:

- 1. Very thin columns, but rather thick slabs**
- 2. Very inadequate steel reinforcement (in size and number of longitudinal bars)**
- 3. Transverse reinforcing bars of inadequate density and improperly tied**
- 4. NO beams !! Slabs constructed directly on columns, without continuity of the longitudinal Rebars, and no proper joints**
- 5. Nowhere to be seen Shear Walls, even in > 10 story buildings**

(For comparison, a typical 2-story building in Cephalonia, Greece, is shown — from an area of similar seismicity as the region inflicted by the 7.8 earthquake.)

Source: <https://en.armradio.am/2023/02/08/turkey-and-syria-quake-toll-nears-8000/>



See next slide for details

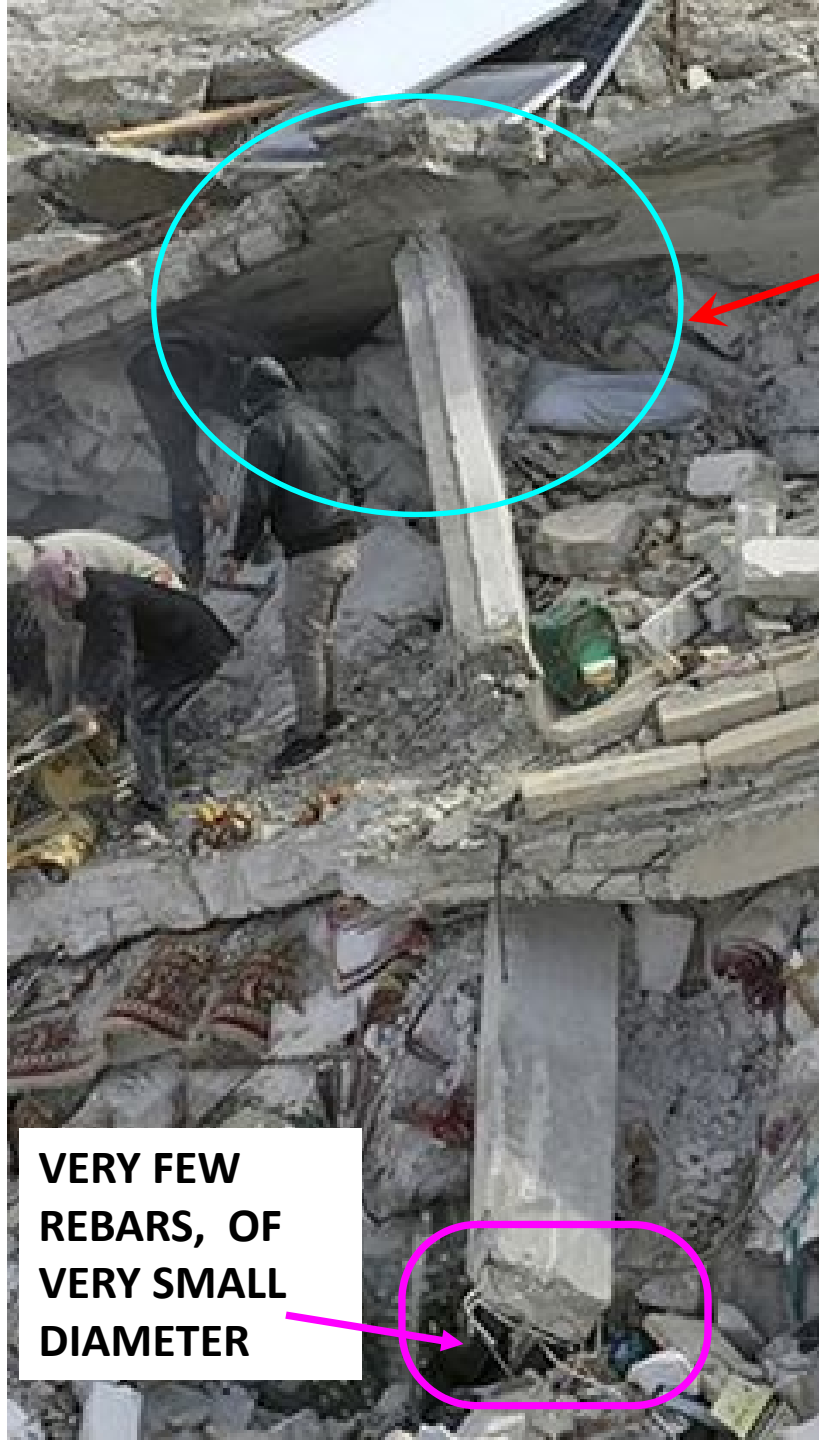


Numerous buildings without any beam, with small size columns (inappropriate even for 1-story buildings in a region of moderate seismicity).²⁴



Creator: Ghaith Alsayed
Credit: AP

See next slide for details



NO BEAMS
NO SHEAR WALLS



**POOR JOINT,
COLUMN
PENETRATES
THE SLAB**

**VERY FEW
REBARS, OF
VERY SMALL
DIAMETER**

Photo: Mahmoud Hassano/Reuters



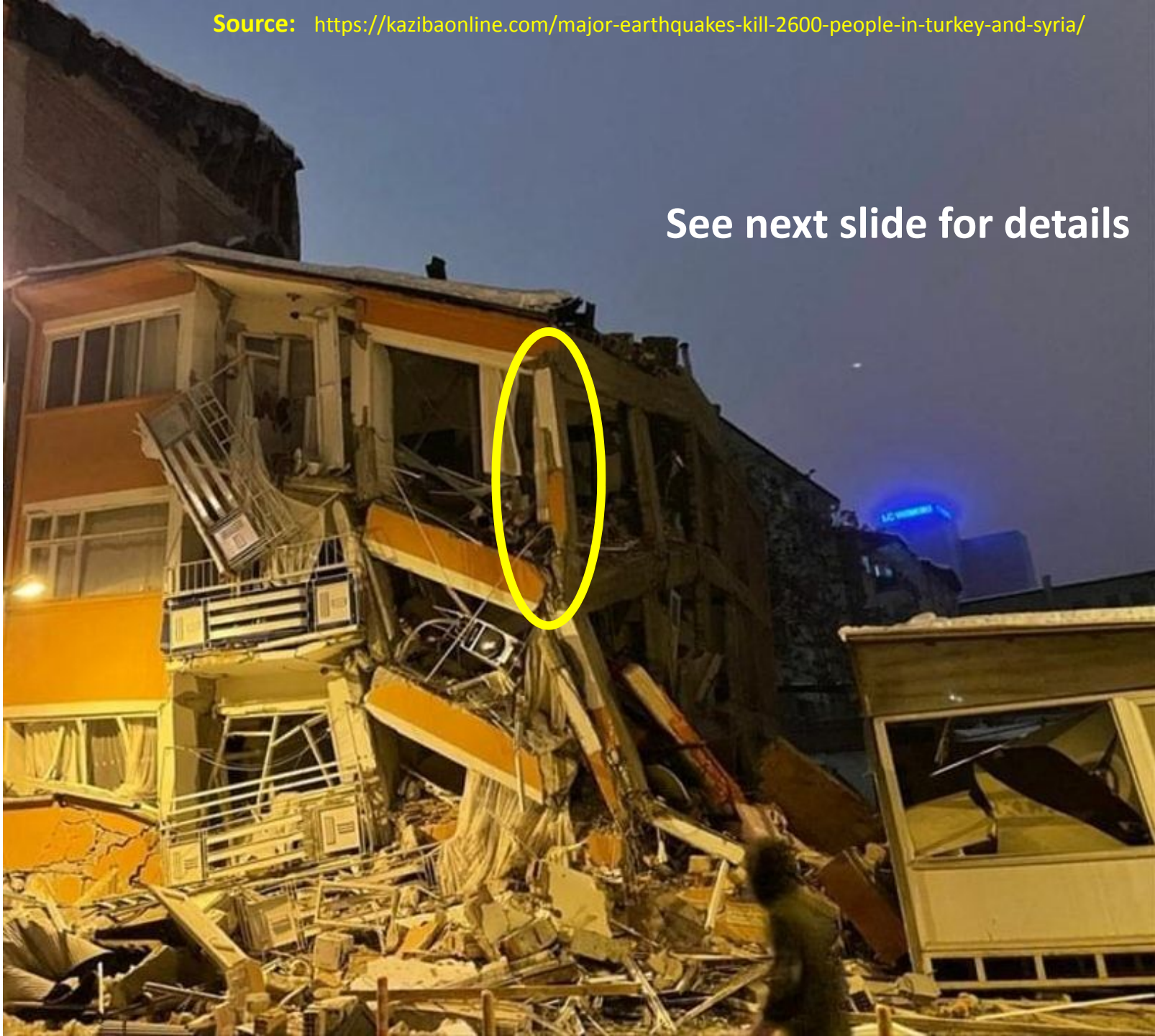
See next slide for details



The slab is effectively
SIMPLY-SUPPORTED, as
just resting on top of the
thin columns !

**VERY THIN
COLUMNS**
**NO Slab-Column
JOINT**

See next slide for details





Joints fail, as if there is no continuity of the longitudinal reinforcement (REBARS).

Essentially, NO Slab–Column JOINT



See next slide for details

Source: https://en.as.com/latest_news/turkey-and-syria-earthquakes-live-updates-death-toll-nears-100000-earthquake-map-video-of-magnitude-78-quake-n/



**VERY FEW REBARS,
OF VERY SMALL
DIAMETER**



Photo: ymphotos/Shutterstock

See next slide for details

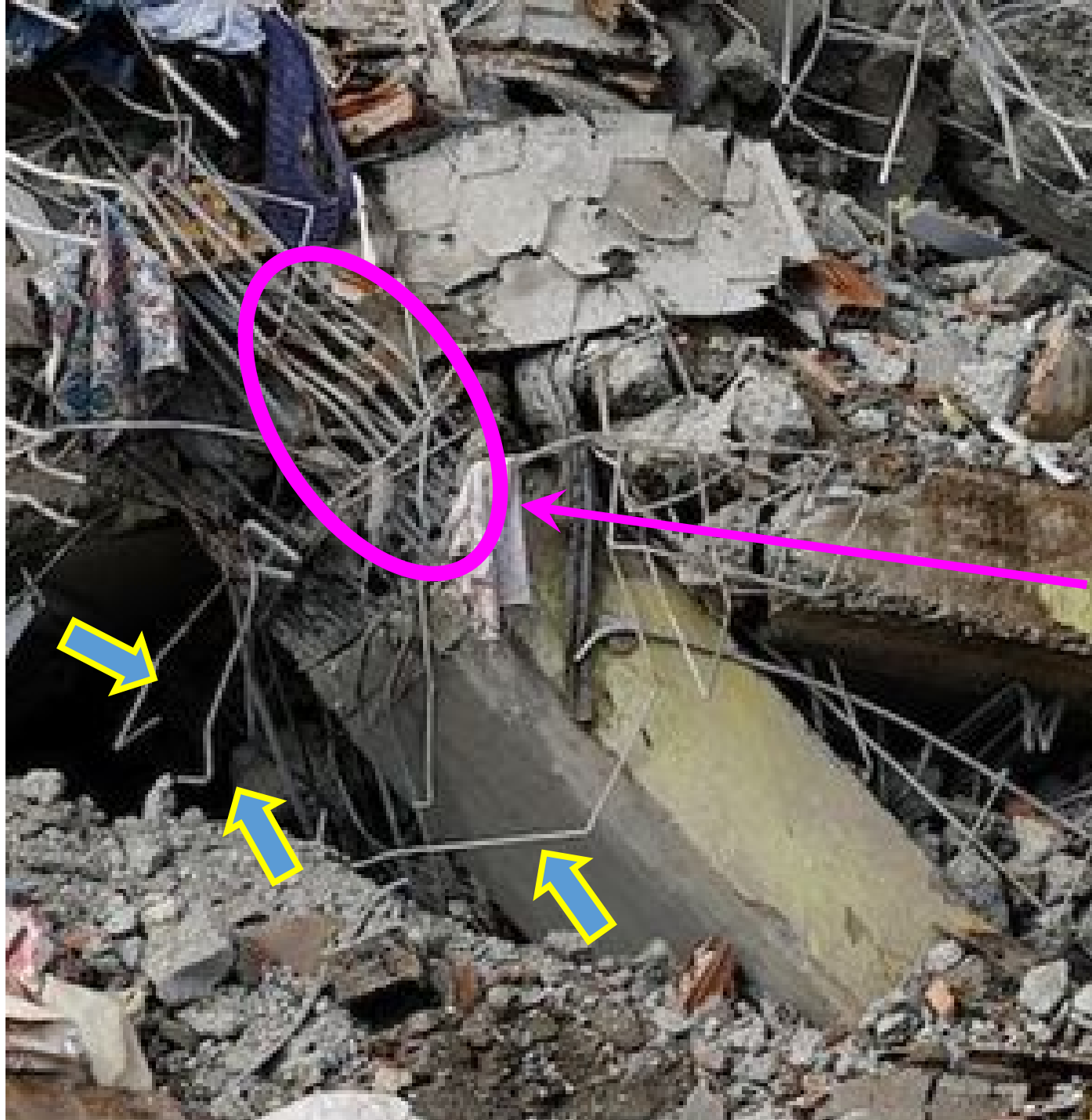


Transverse reinforcement almost effectively non-existing... it was untied, leading the inadequate longitudinal rebars to buckle.

Photo: Suhaib Salem/Reuters



See next slide for details



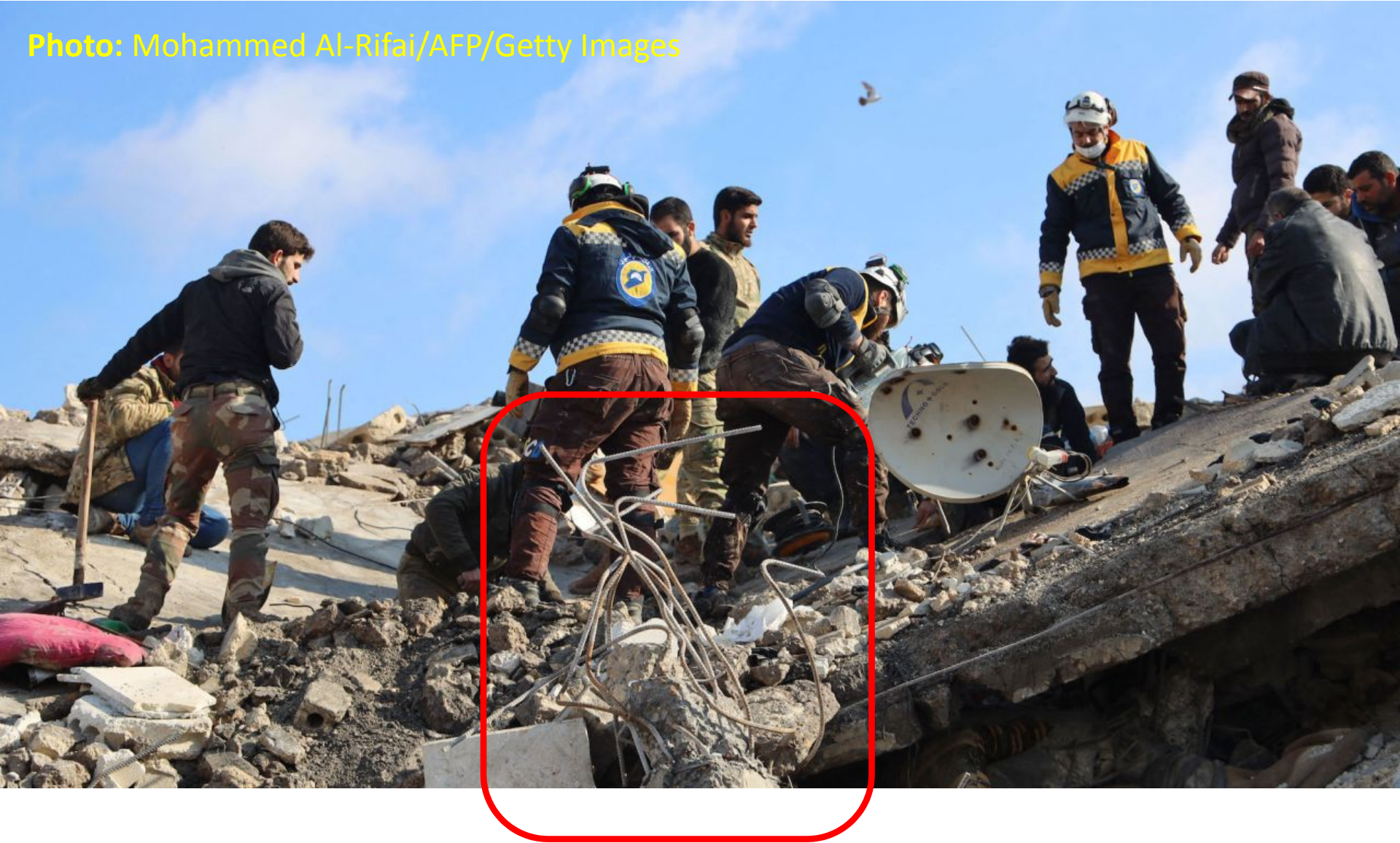
**Transverse bars
were un-tied.**

**Longitudinal
REBARS are of
VERY SMALL
DIAMETER**

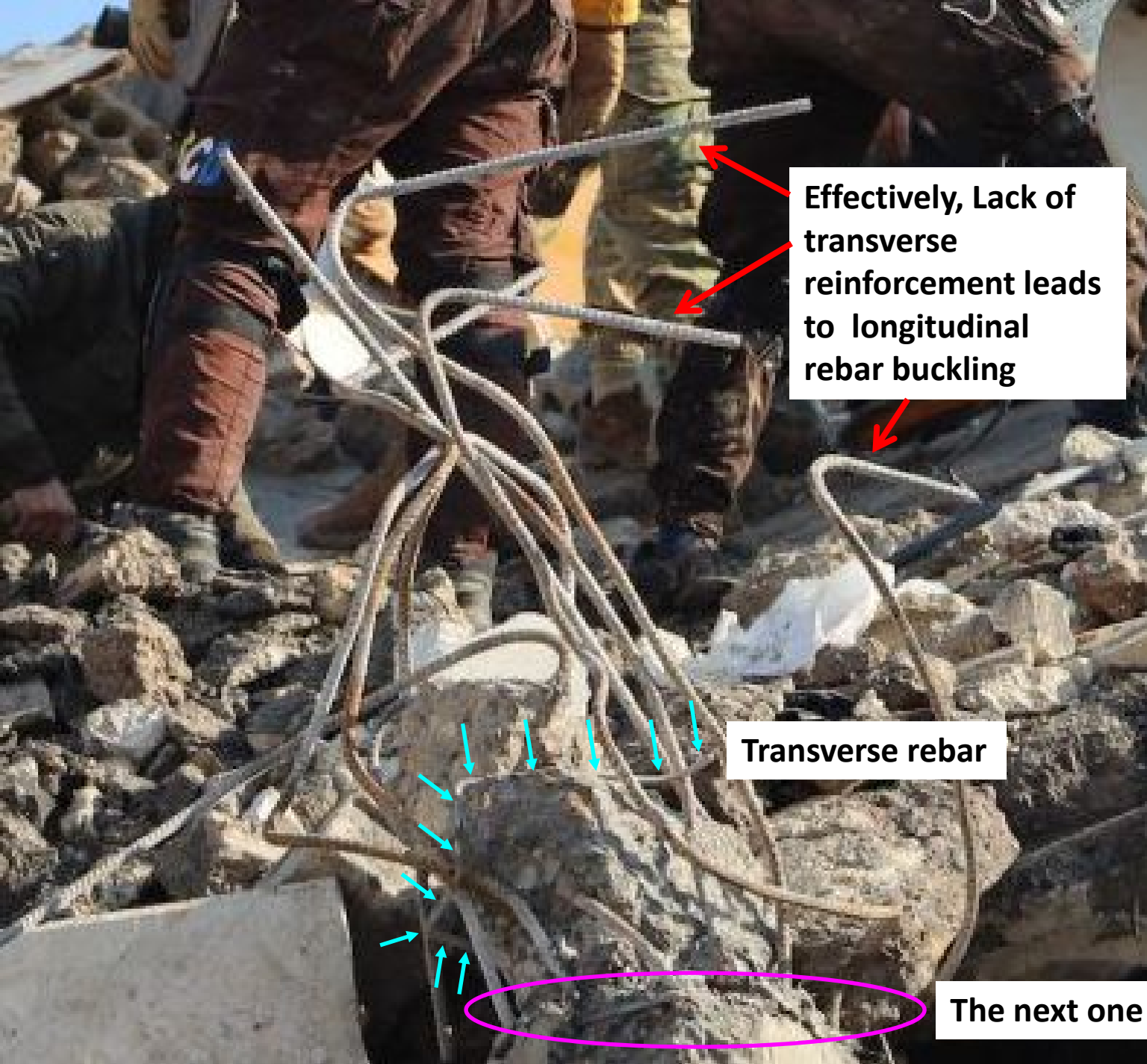
**NO BEAMS, POOR (or rather No)
JOINTS !**



Photo: Mohammed Al-Rifai/AFP/Getty Images



See next slide for details



Effectively, Lack of transverse reinforcement leads to longitudinal rebar buckling

Transverse rebar

The next one

Collapsed Building

**Another under
construction with the
same method !!**



Photo: **WHITE HELMETS /REUTERS**

See next slide for details

Same building seen from a different angle

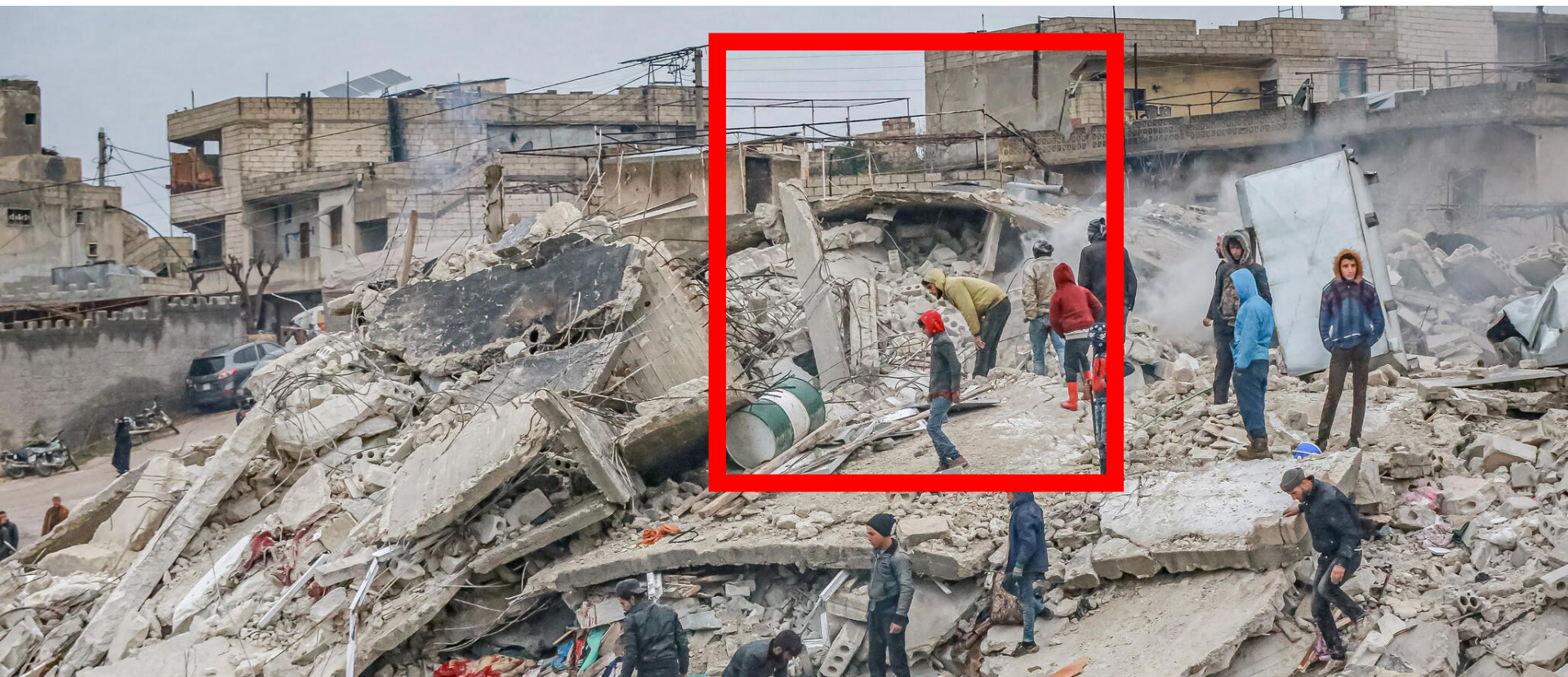
Photo: **WHITE HELMETS /REUTERS**



An aerial photograph showing the aftermath of a building collapse. The structure has fallen into a pile of rubble, with large concrete beams and twisted metal visible. Several people are standing on the debris field, providing a sense of scale. Annotations include a cyan circle highlighting a joint, and two red circles with arrows pointing to rebar details.

NO BEAMS, POOR JOINTS !

**VERY FEW
REBARS OF
VERY SMALL
DIAMETER**



Source: <https://www.rescue.org/article/earthquakes-near-turkish-syrian-border-deepen-crisis>

See next slide for details



**VERY THIN COLUMNS
NO BEAMS
POOR JOINTS**



See next slide for details

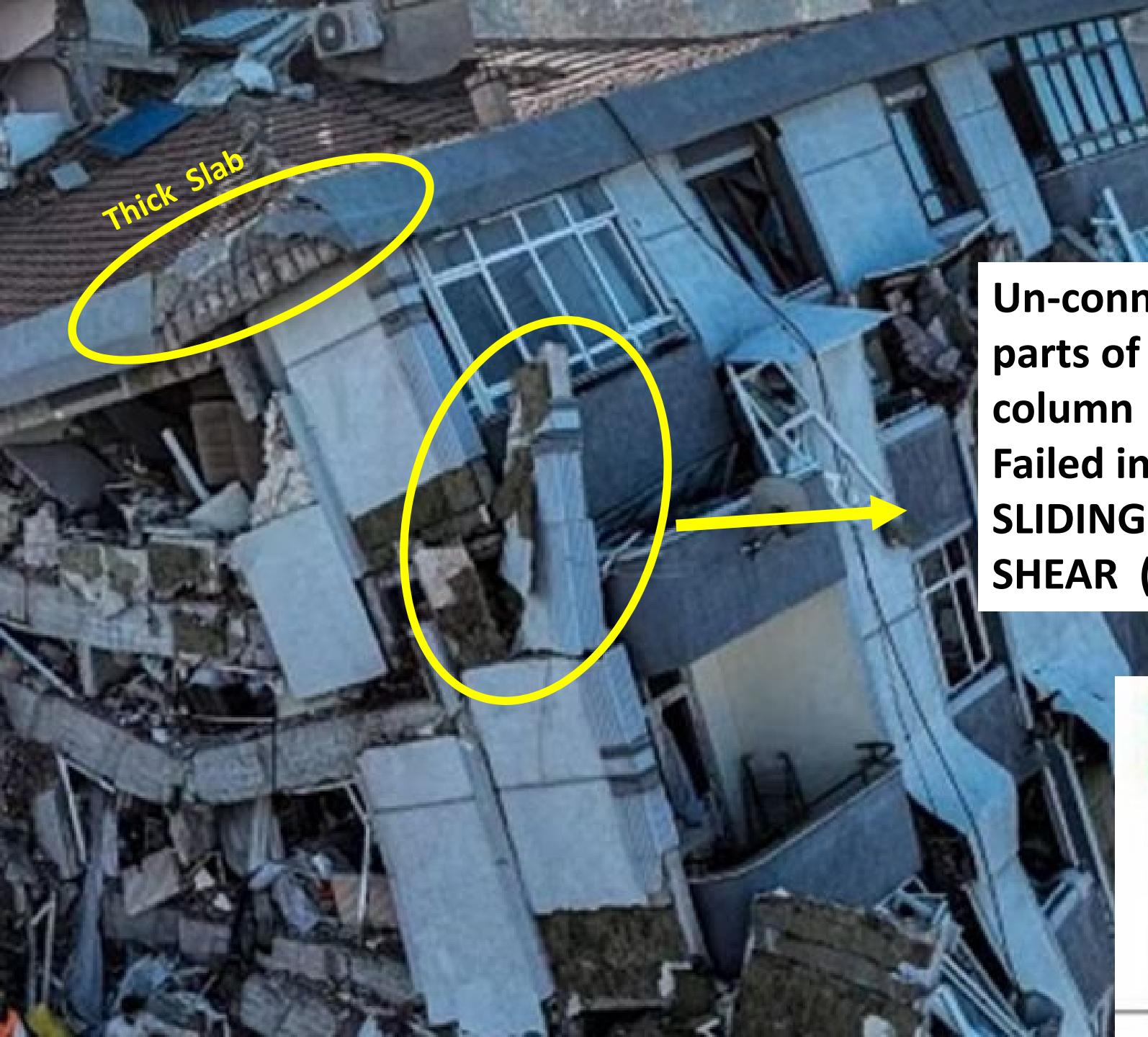


**Longitudinal REBARS have
penetrated the supported
slab !!**

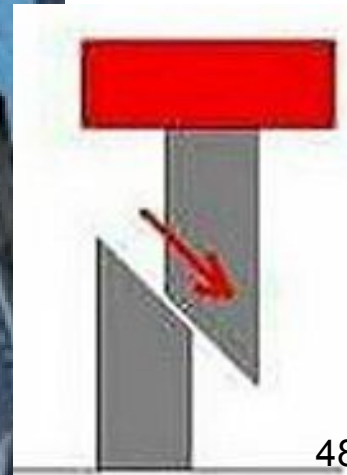


Aerial photo shows the destruction in Kahramanmaras, southern Turkey, Wednesday, Feb. 8, 2023. (Photo | AP)

See next slide for details

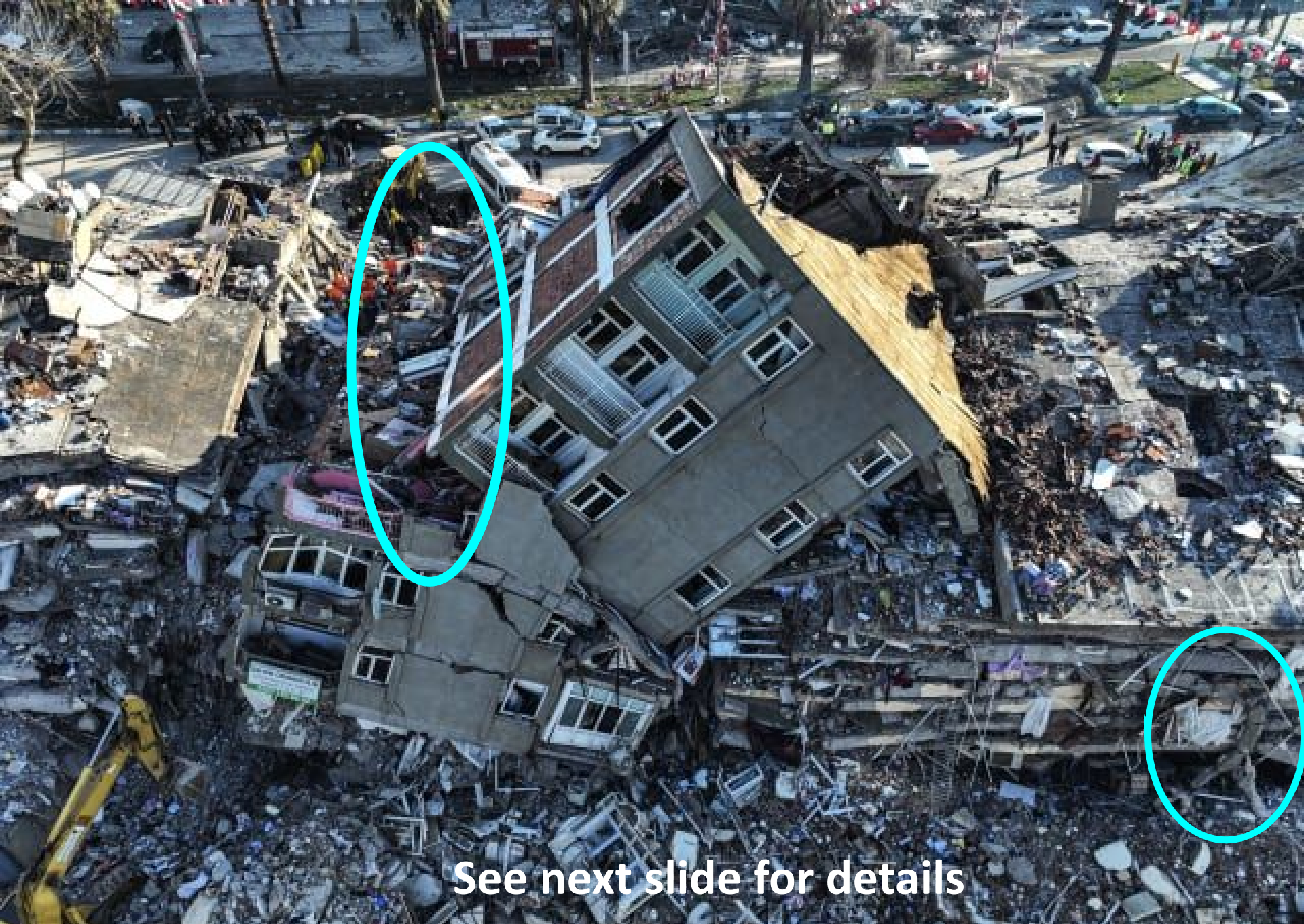


**Un-connected
parts of a
column !!
Failed in
SLIDING or
SHEAR (??)**



NO BEAMS, NO JOINTS, NO SHEAR WALLS





See next slide for details

An aerial photo from Kahramanmaraş, Turkey **CREDIT: Ahmet Akpolat/DIA via AP**



**Inadequate columns cannot
“follow” the above building on
its lateral movement**





See next slide for details



**FEW LONGITUDINAL REBARS,
OF VERY SMALL DIAMETER**

Transverse reinforcement ??



NO BEAMS !

**NO transverse
reinforcement ??**

**NO transverse
reinforcement**

**VERY FEW Longitudinal
REBARS, OF VERY
SMALL DIAMETER**



Rescue efforts in Diyarbakir, Turkey (Aydin Arik/Anadolu Agency/Getty Images)

See next slide for details 55



NO BEAMS, POOR JOINTS !



NO BEAMS, POOR JOINTS !



Rubbles of a collapsed building in Idlib, Syria, on February 6. (Aaref Watad/AFP/Getty Images)



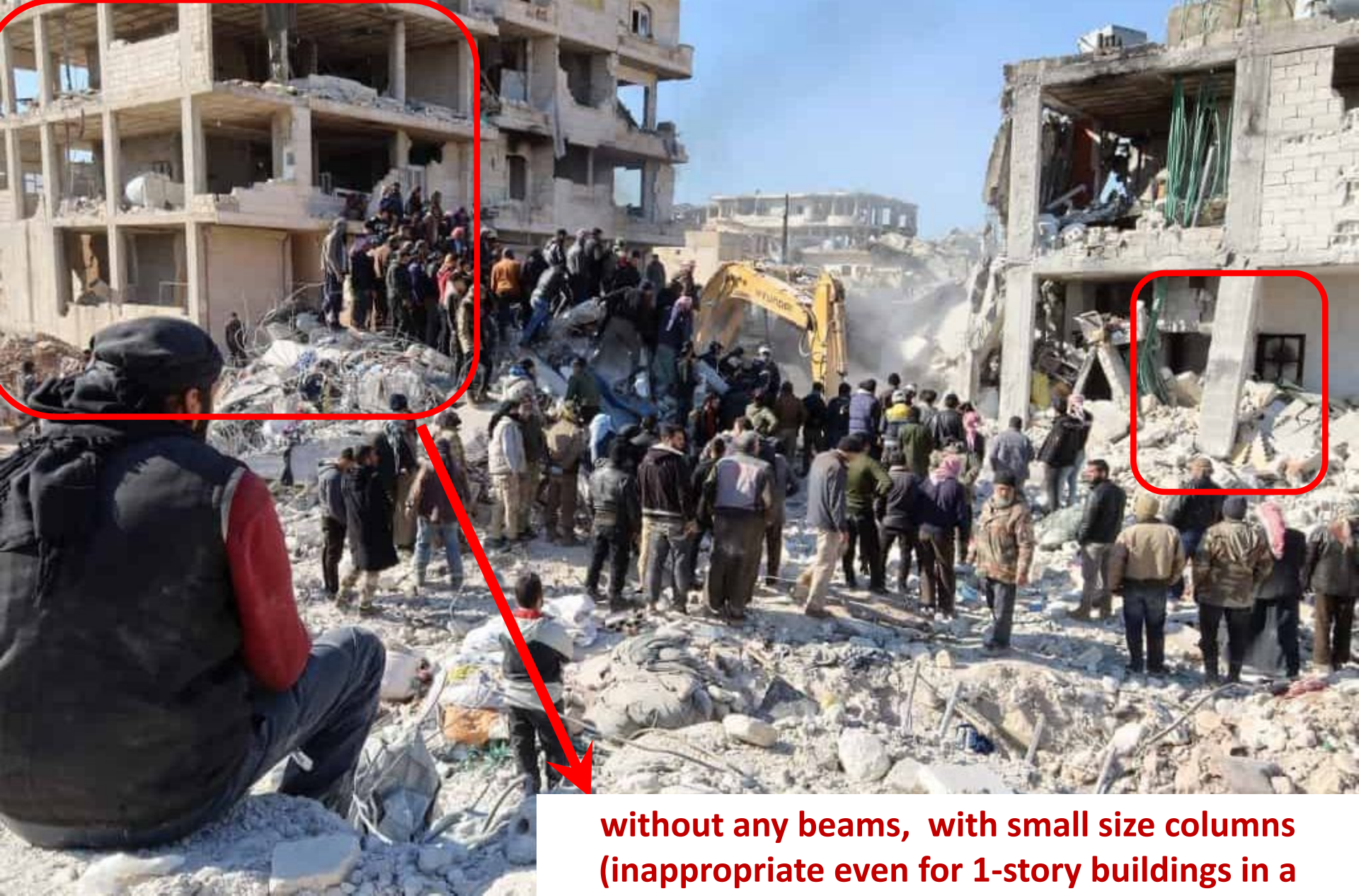
Thick SLABS

NO BEAMS, POOR JOINTS !



**NO CONTINUITY OF
REINFORCEMENT,
NO ANCHORING OF
BARS**

Residents retrieve an injured girl from the rubble of a collapsed building following an earthquake in the town of Jandaris.
AFP via Getty Images



(Photo by Mohammed AL-RIFAI / AFP)

without any beams, with small size columns (inappropriate even for 1-story buildings in a region of moderate seismicity). It is a miracle that it did not fully collapsed.



See next slide for comparison with a well-designed 2-story building in the island of Cephalonia, Greece (Design effective $A = 0.36 g$)

VISUAL COMPARISON with an UNDER-CONSTRUCTION 2-STORY BUILDING in CEPHALONIA, after two Earthquakes in 2014



Large shear walls, strong beams, brick masonry well-confined (with RC ties around openings and at mid-height).

(See Garini et al, 2017)



See next slide for details

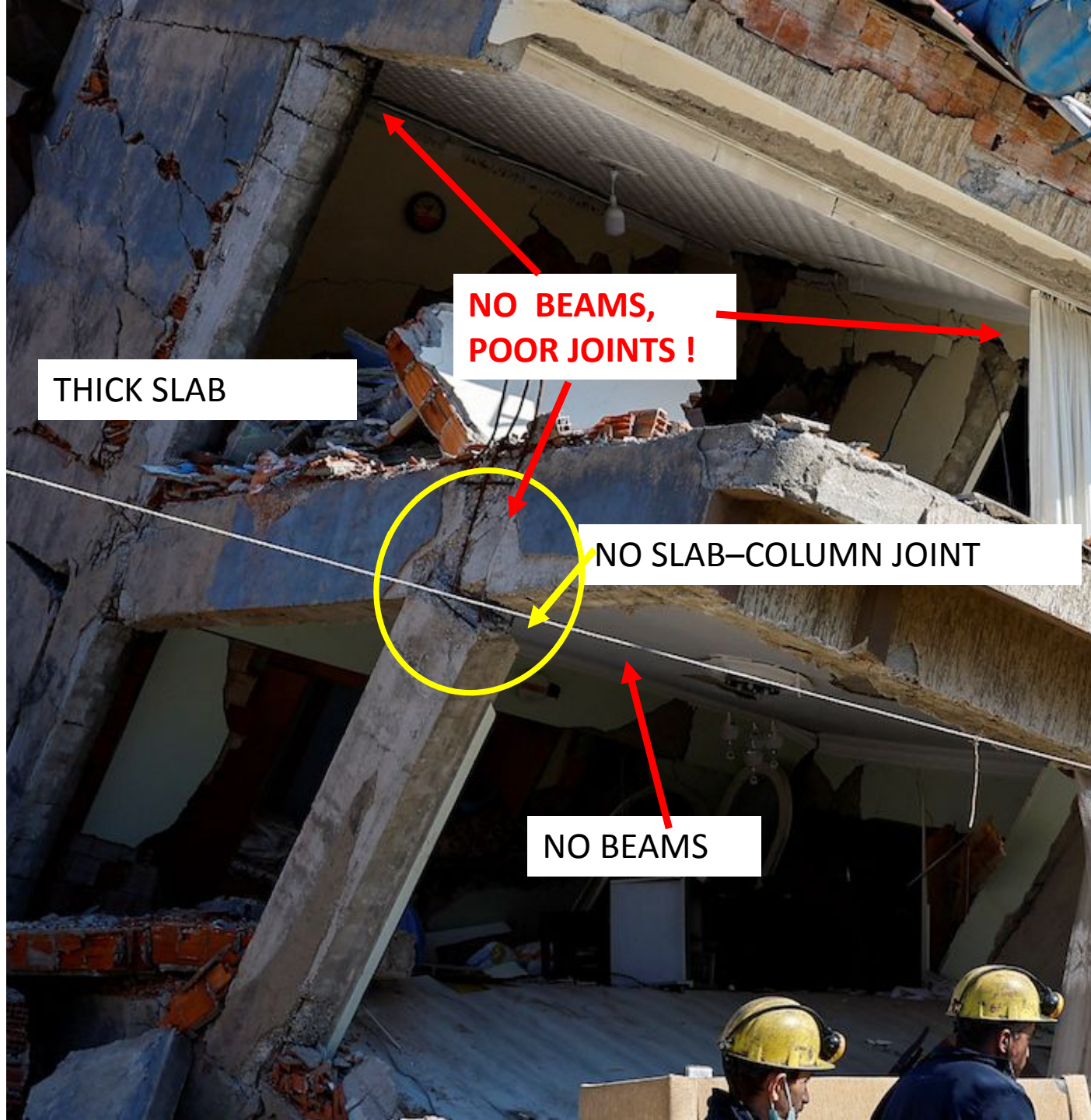
A woman sits on the rubble of a destroyed building in Nurdagi town on the outskirts of Osmaniye city southern Turkey, Tuesday, Feb. 7, 2023. **(AP Photo/Khalil Hamra)**



VERY FEW REBARS OF VERY SMALL DIAMETER



Photo: SUHAIB SALEM
Credit: REUTERS



THICK SLAB

NO BEAMS,
POOR JOINTS !

NO SLAB-COLUMN JOINT

NO BEAMS





THIN COLUMNS

Forget about transverse reinforcement !!!

Finally, a purely GEOTECHNICAL Failure :

Overturning of a building apparently due to bearing-capacity failure on soft soil (perhaps with a high water table) under strong seismic moment. No evident damage in the structure. The glass windows remain unscathed ! Similarly intact appears to be the foundation slab.

This is reminiscent of ADAPAZARI in the 1999 Kocaeli (Izmit) Earthquake !!!

Structure seems intact.
Glass windows: unbroken



Foundation Slab: NOT a CRACK

Some critical reasons for the collapse of a huge number of buildings

EXTREMELY STRONG GROUND SHAKING, PERHAPS LOCALLY SOIL-AMPLIFIED (see Part B)

DEFFECTIVE STRUCTURAL SYSTEMS WITH SEVERAL FATAL TECHNICAL FAULTS, as follows:

- 1. Very thin columns, but rather thick slabs**
- 2. Very inadequate steel reinforcement (in size and number of longitudinal bars)**
- 3. Transverse reinforcing bars of inadequate density and improperly tied)**
- 4. NO beams !! Slabs directly on columns, without continuity of Rebars, and no proper connection**
- 5. Nowhere to be seen Shear Walls, even in > 10 story buildings**

Our SOURCES

- 1) <https://en.armradio.am>
- 2) www.worldvision.org.uk
- 3) **Associated Press**: Ghaith Alsayed via AP, Ahmet Akpolat/DIA, Khalil Hamra
- 4) **Reuters**: Umit Bektas, Mahmoud Hassano, Suhaib Salem, WHITE HELMETS
- 5) **Getty Images**: Mohammed Al-Rifai/AFP, Anas Alkharboutli, Aydin Arik/Anadolu Agency, Aaref Watad/AFP, AFP via Getty Images,
- 6) <https://kazibaonline.com>
- 7) The New York Times: <https://www.nytimes.com/>
- 8) <https://en.as.com>
- 9) **Shutterstock**: Ymphotos/Shutterstock
- 10) <https://www.rescue.org>
- 11) USGS website: www.usgs.gov
- 12) **Twitter**: @PAOK_FC, The_Georgios
- 13) Garini E., Gazetas G., and Anastasopoulos I. (2017) "Evidence of Significant Forward Rupture Directivity Aggravated by Soil Response in an M_w 6 Earthquake, and the Effect on Monuments ", *Earthquake Engineering & Structural Dynamics*, 46: 2103–2120.

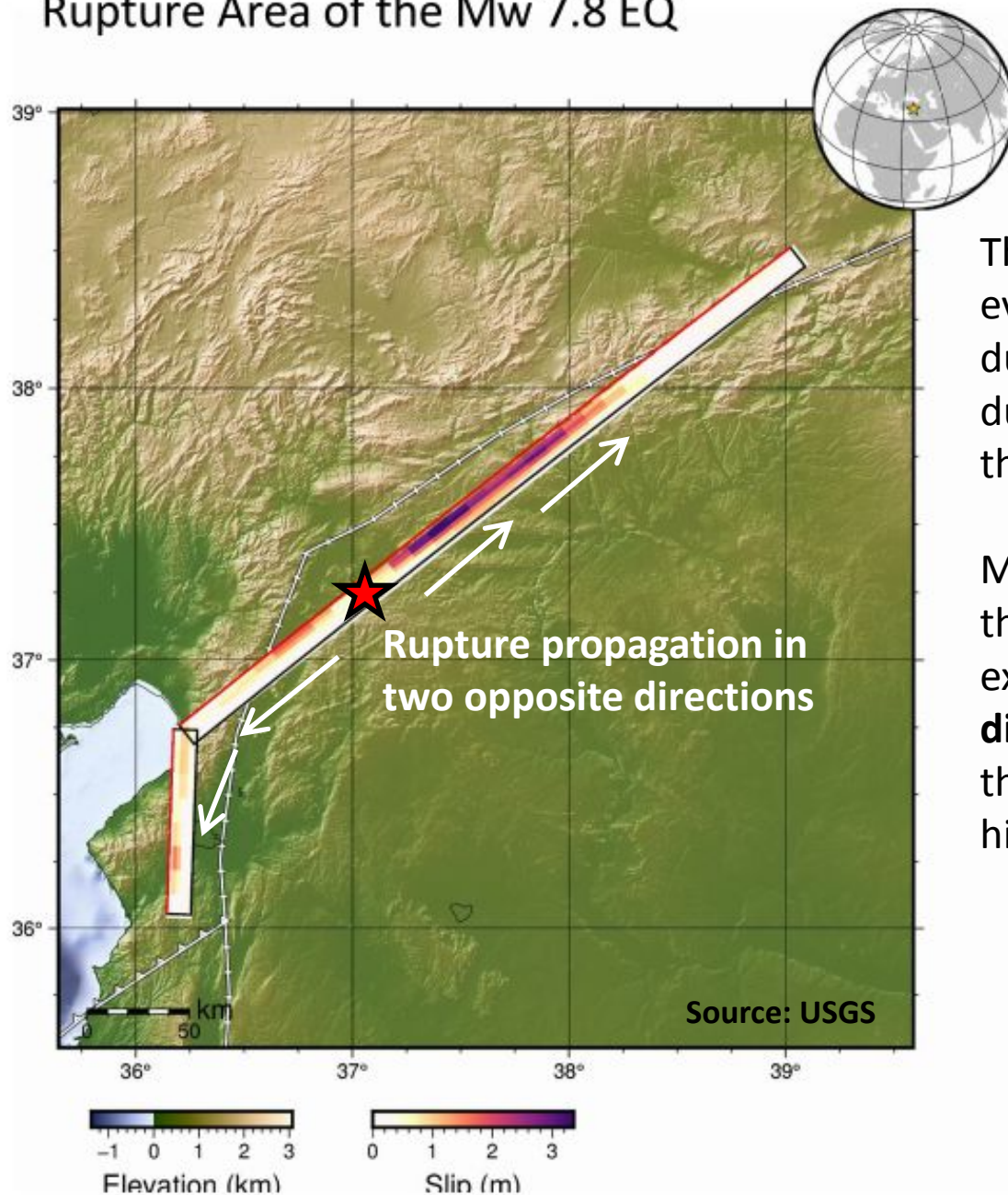
PART C

Recorded Accelerograms and their Response Spectra

Disclaimer: The data utilised are taken from the AFAD website, as they are published on 10 February 2023. Mistakes on baseline corrections or other issues are noticed by the Authors but are not solved here.

We are thankful to our Turkish colleagues for the immediate and open publishing of the huge number of accelerograms.

Rupture Area of the Mw 7.8 EQ



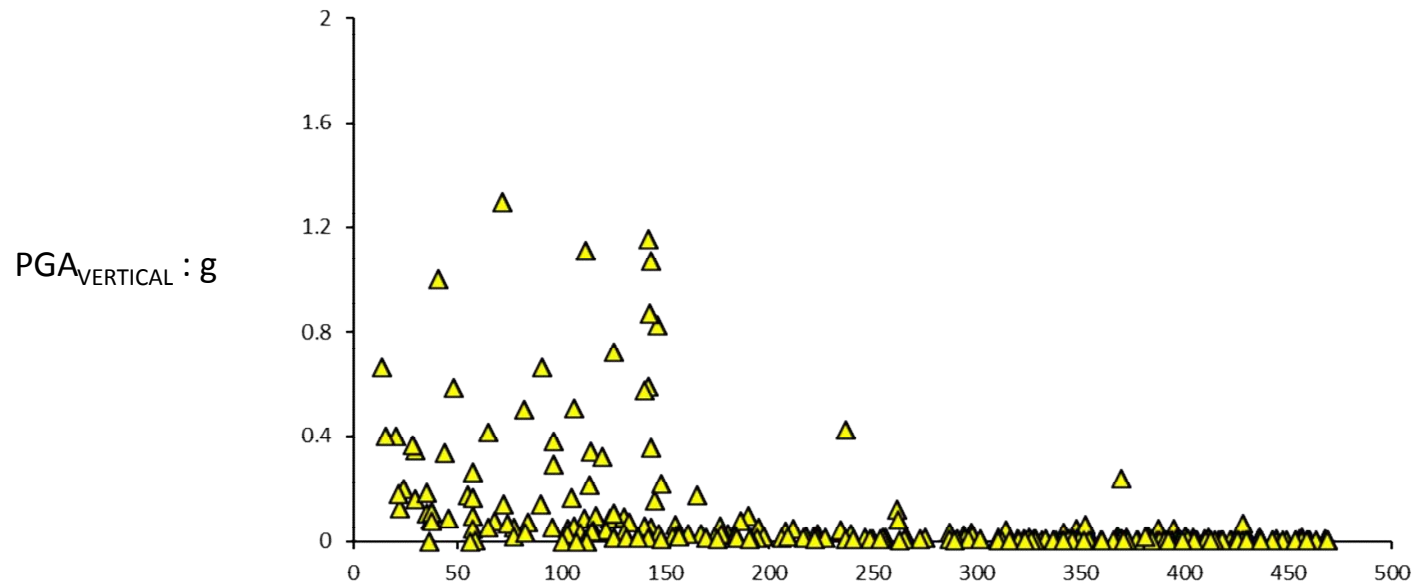
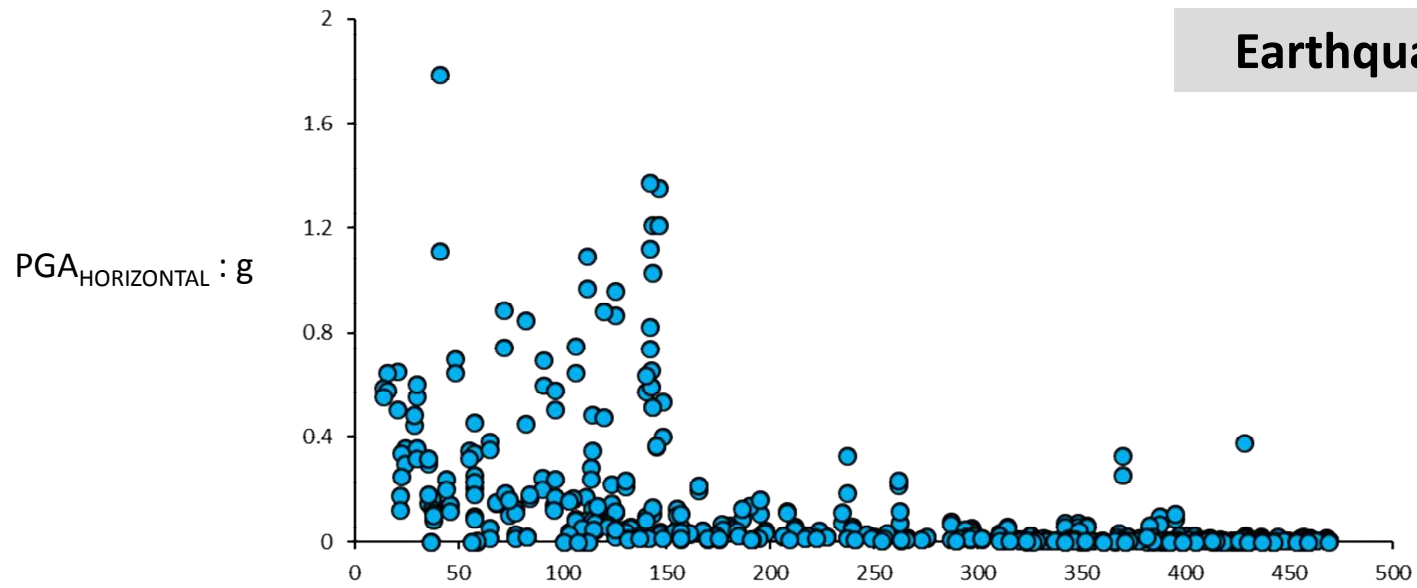
The recorded motions of this M7.8 event are of relatively limited duration (for such a huge magnitude) due to the **bilateral propagation** of the fault rupture.

Moreover, in the **southern part** (in the region of Antakya) the records exhibit strong **forward-rupture directivity effects** as you can see in the acceleration and velocity time histories.

Records from the $M_w 7.8$ event with $PGA > 0.5 \text{ g}$

Code	R_{epi} [km]	PGA_{NS} [g]	PGA_{EW} [g]	PGA_{UD} [g]
2708	41	1.788	1.110	1.003
3129	146	1.353	1.210	0.826
3126	144	1.211	1.030	1.071
3117	112	0.969	1.093	1.111
3141	125	0.961	0.869	0.723
3138	72	0.889	0.747	1.296
3125	142	0.823	1.122	1.152
3135	142	0.741	1.372	0.589
2718	48	0.702	0.645	0.586
3123	143	0.656	0.594	0.868
4616	21	0.653	0.503	0.397
3142	106	0.647	0.750	0.506
NAR	15	0.647	0.579	0.399
3145	91	0.600	0.696	0.663
4615	14	0.588	0.556	0.665
3139	96	0.577	0.505	0.379
3124	140	0.573	0.638	0.578
2712	30	0.555	0.603	0.346
3136	148	0.534	0.402	0.220
3132	143	0.515	0.515	0.354
201	120	0.474	0.880	0.319
3137	82	0.453	0.848	0.502

Earthquake $M_w 7.8$



Epicentral Distance : km

Earthquake $M_w 7.8$

Station 2708:

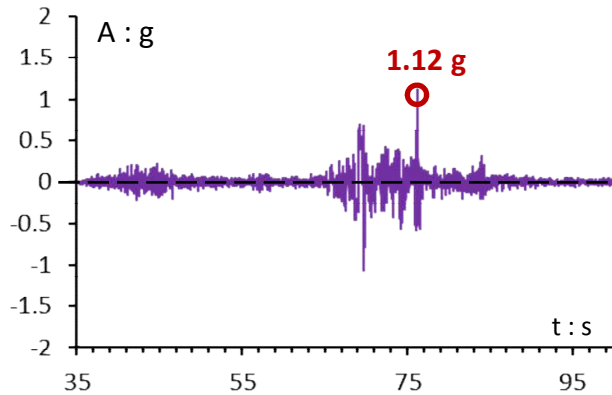


at **Gaziantep** city, Islahiye District

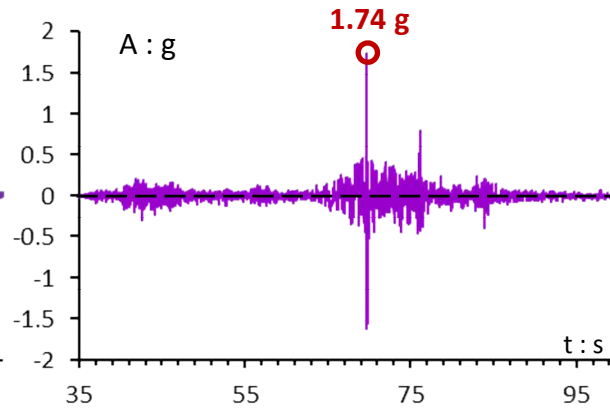
Station at **Free field**, $V_{s30} = 523 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.648373 (Long.) 37.09933 (Lat.)

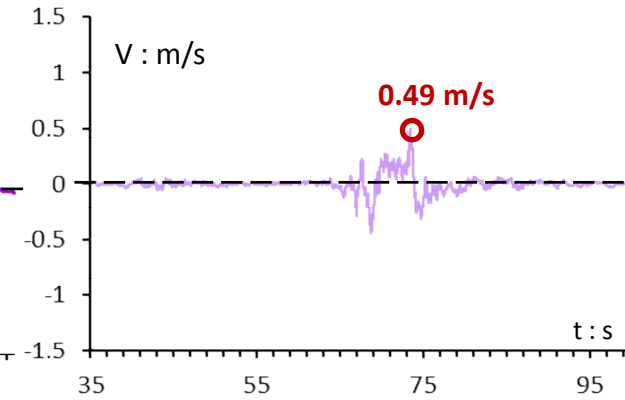
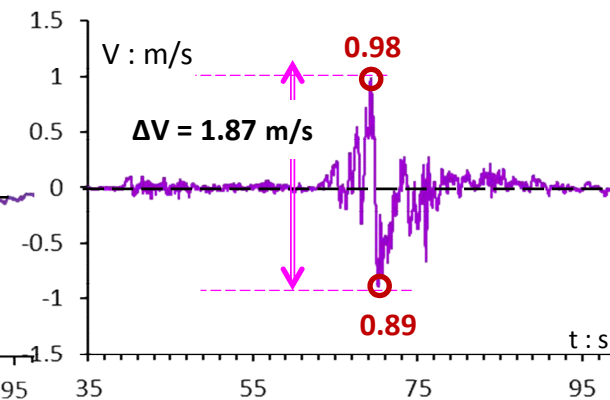
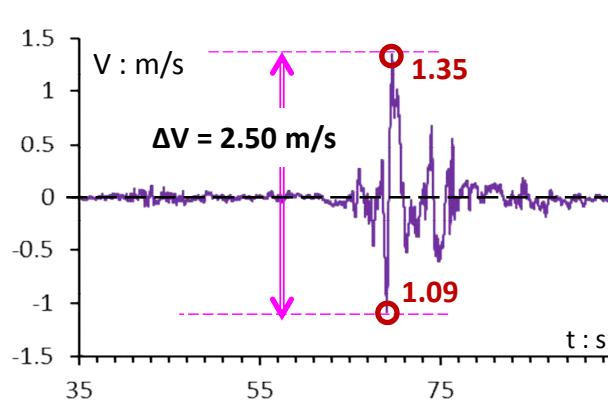
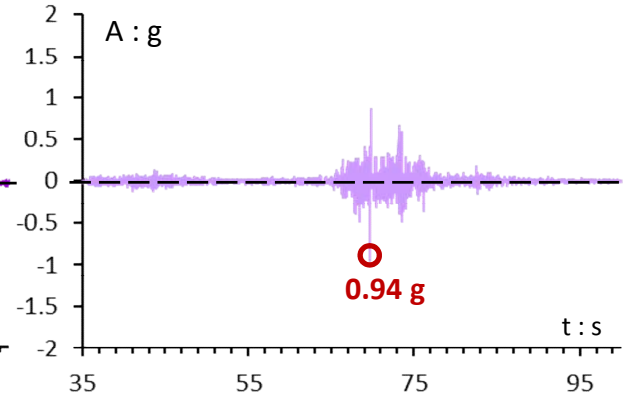
Horizontal EW
component



Horizontal NS
component



Vertical
component

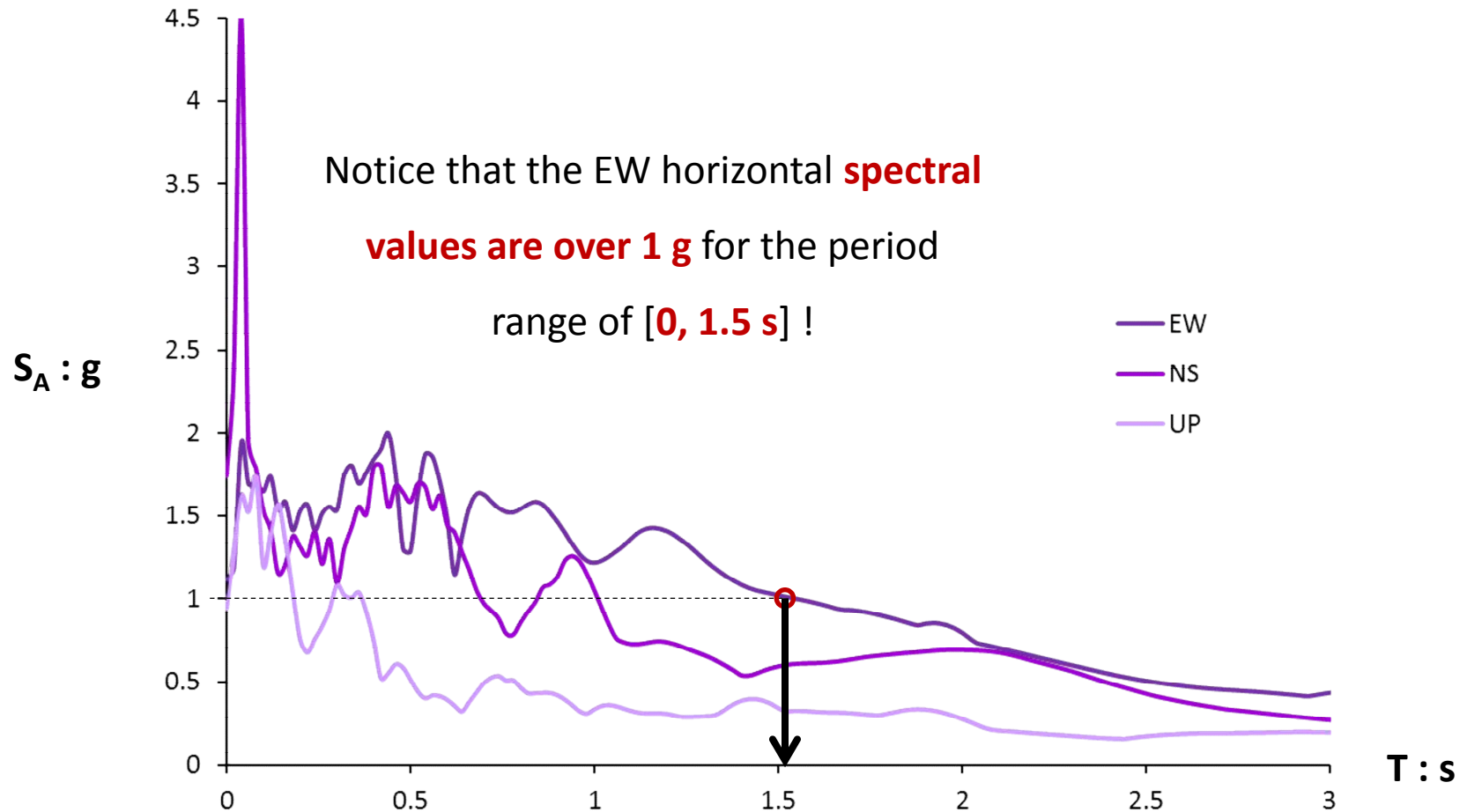


Earthquake $M_w 7.8$

Station 2708: at **Gaziantep** city, İslahiye District

Station at **Free field**, $V_{s30} = 523 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.648373 (Long.) 37.09933 (Lat.)



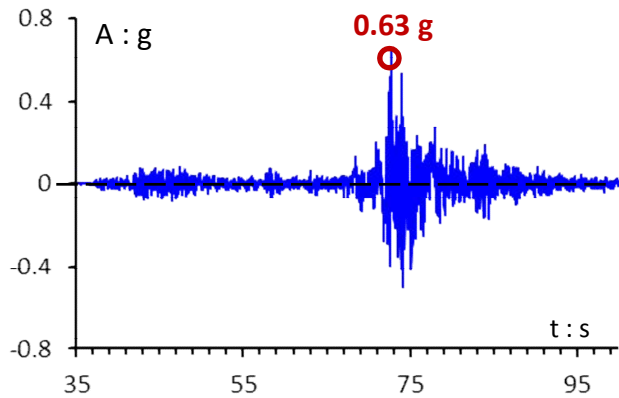
Earthquake $M_w 7.8$

Station 2718: at **Gaziantep** city, Islahiye District

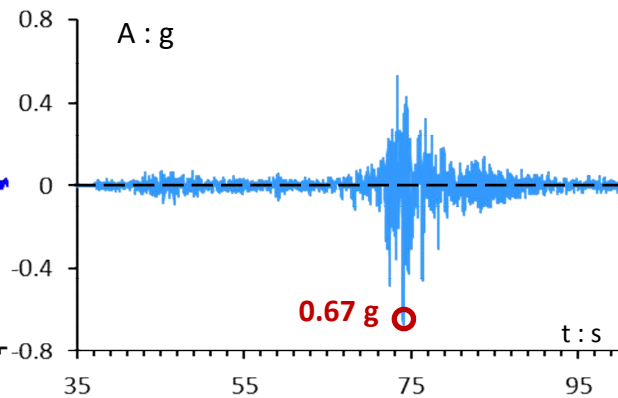
NO soil data available

Exact Location: 36.6266 (Long.) 37.00777 (Lat.)

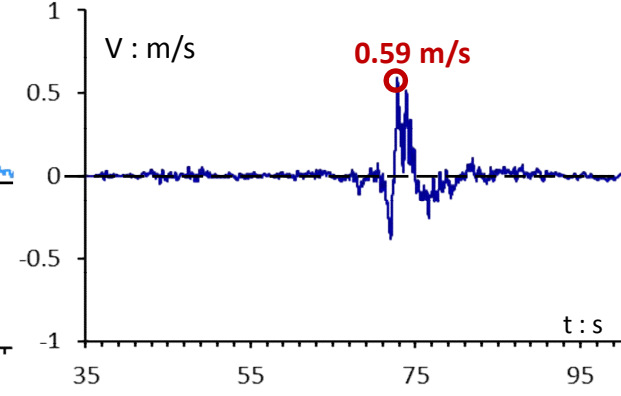
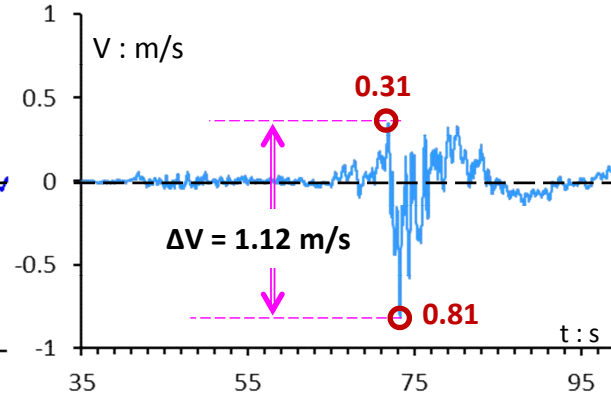
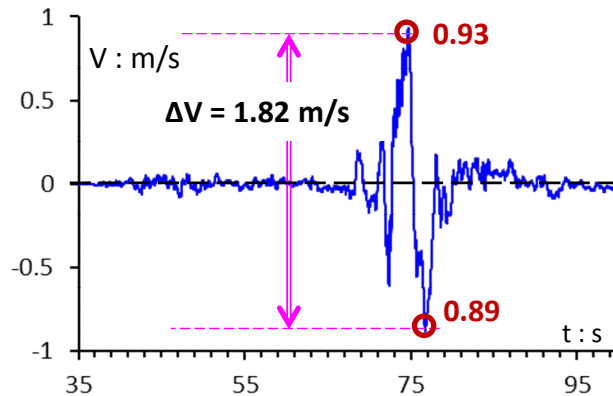
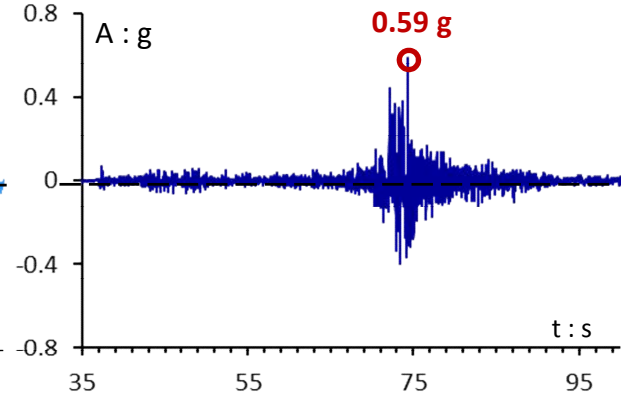
Horizontal EW
component



Horizontal NS
component



Vertical
component

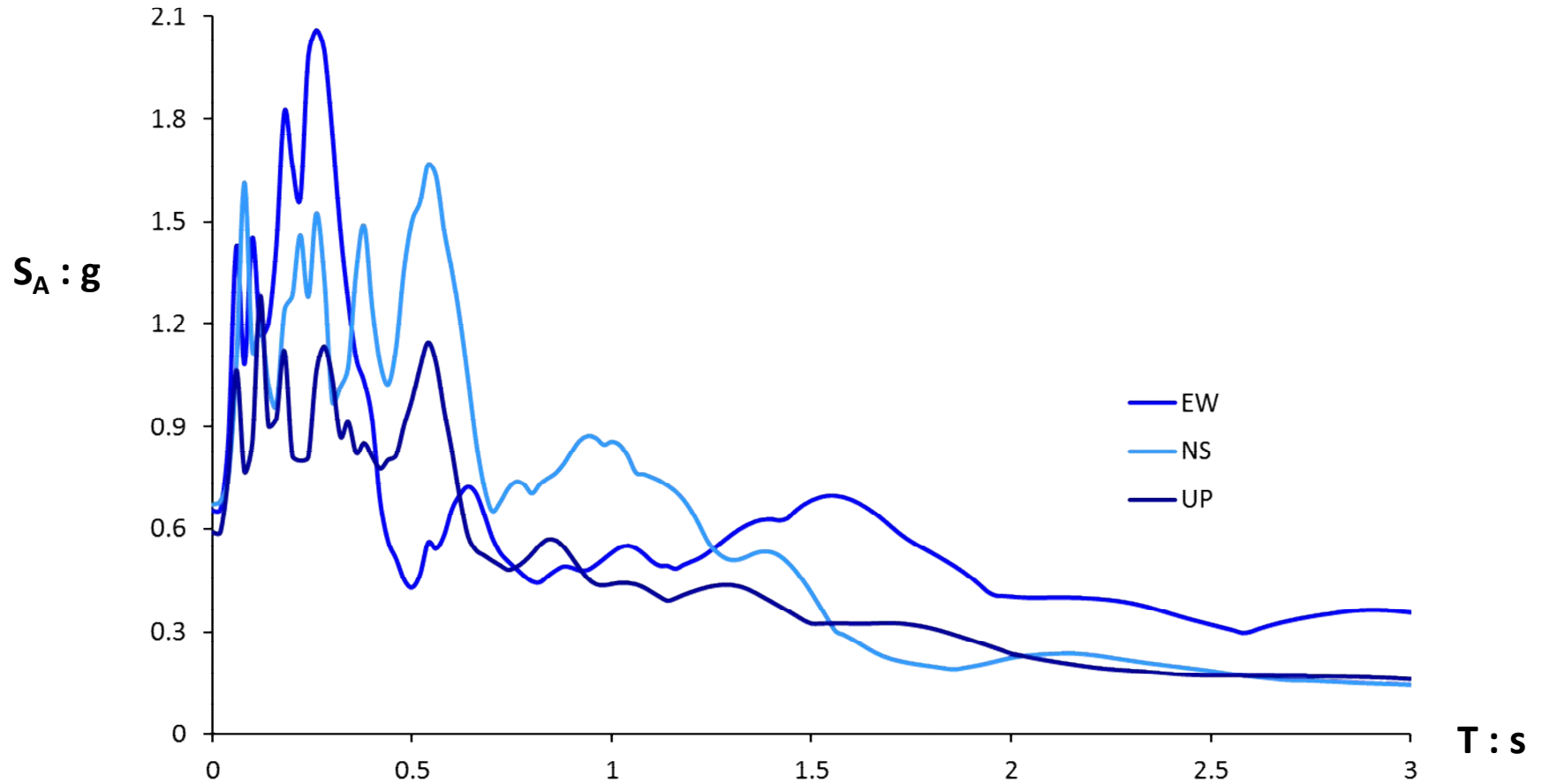


Earthquake $M_w 7.8$

Station 2718: at **Gaziantep** city, İslahiye District

NO soil data available

Exact Location: 36.6266 (Long.) 37.00777 (Lat.)



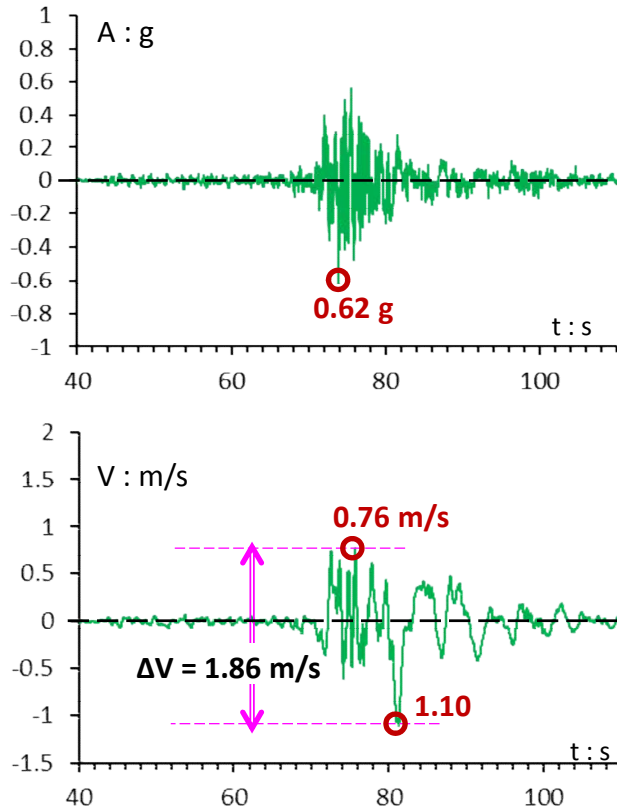
Earthquake $M_W 7.8$

Station 3123: at **Hatay** city, Antakya District

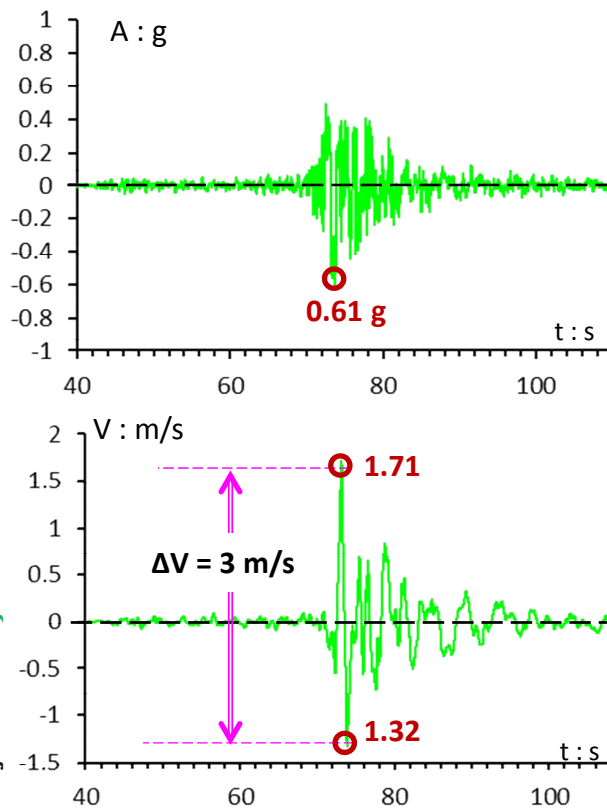
Station at **Free field**, $V_{s30} = 470 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.15973 (Long.) 36.21423 (Lat.)

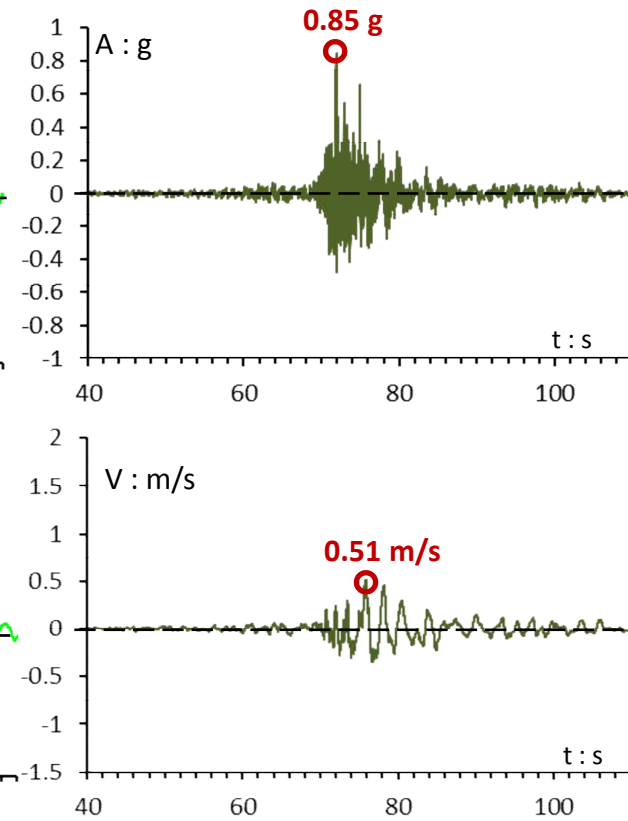
**Horizontal EW
component**



**Horizontal NS
component**



**Vertical
component**

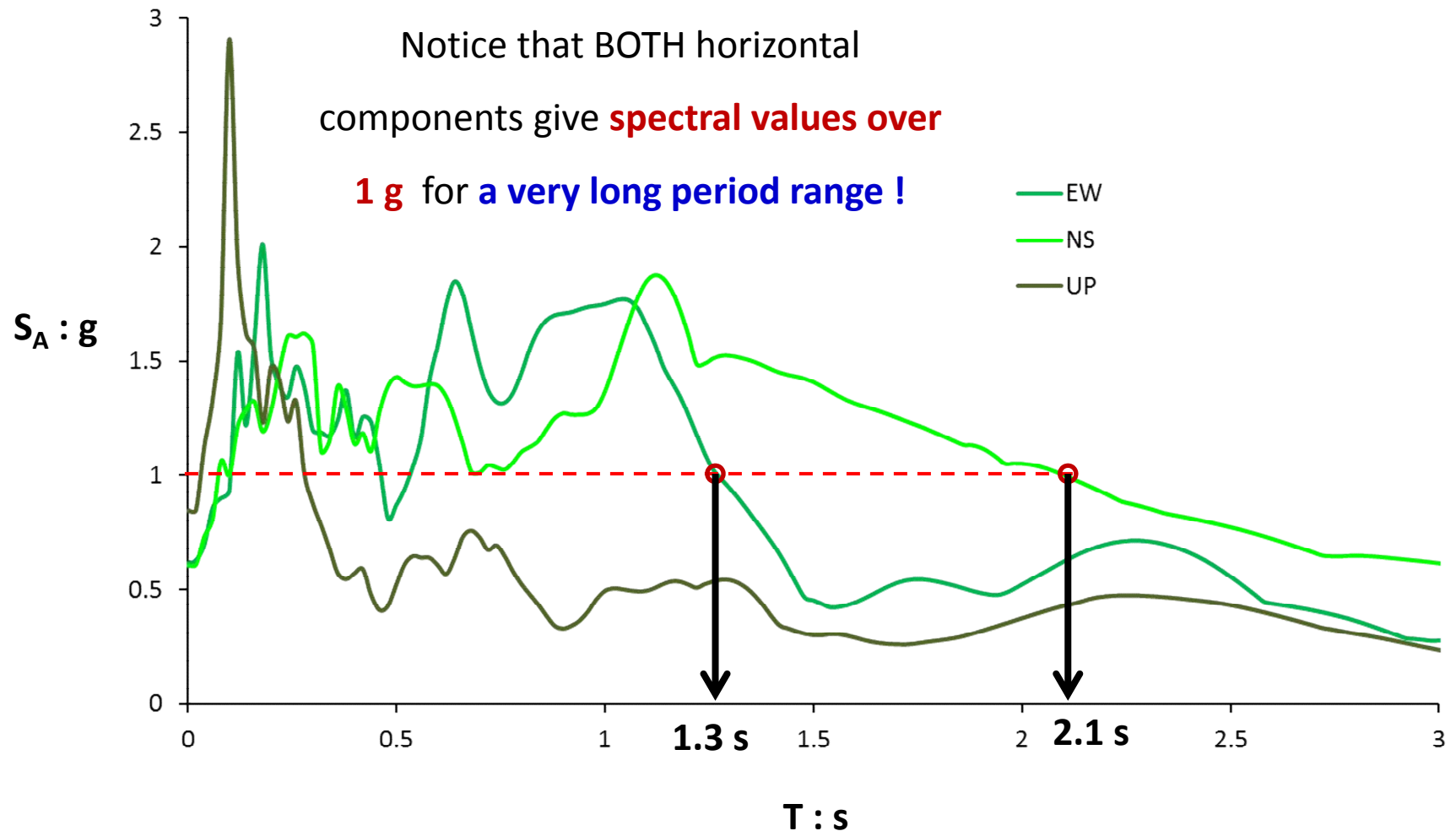


Earthquake $M_w 7.8$

Station 3123: at **Hatay** city, Antakya District

Station at **Free field**, $V_{s30} = 470 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.15973 (Long.) 36.21423 (Lat.)



Earthquake $M_W 7.8$

Station 3125:

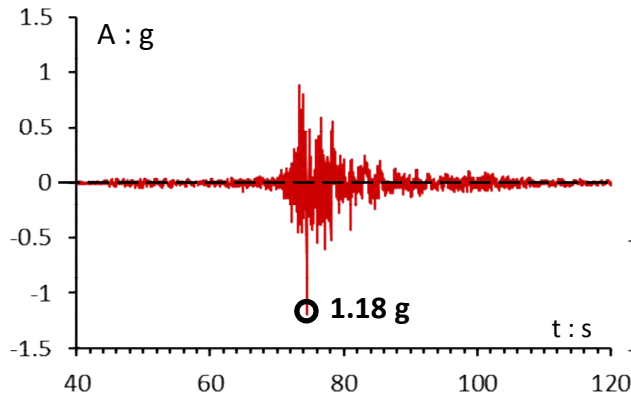


at **Hatay** city, Antakya District

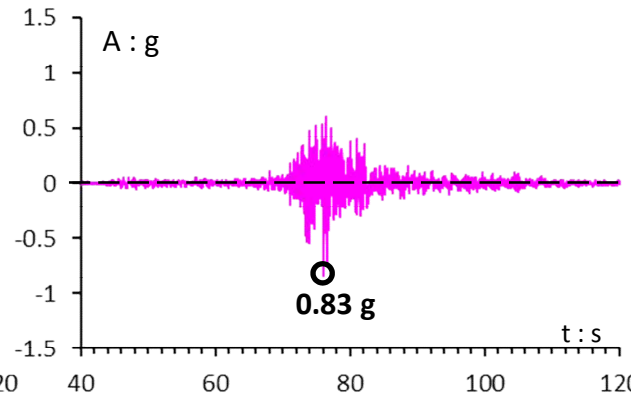
Station at **Free field**, $V_{s30} = 448 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.13264 (Long.) 36.23808 (Lat.)

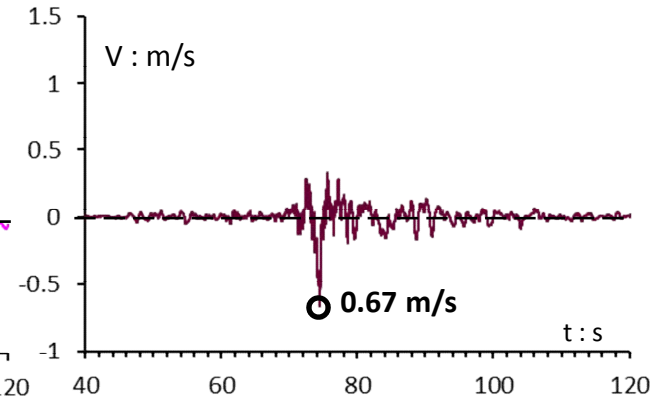
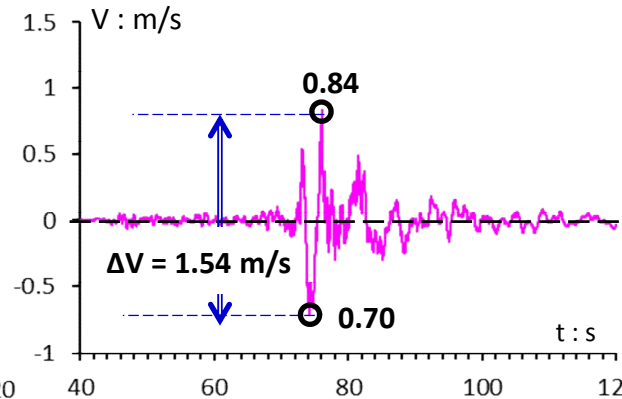
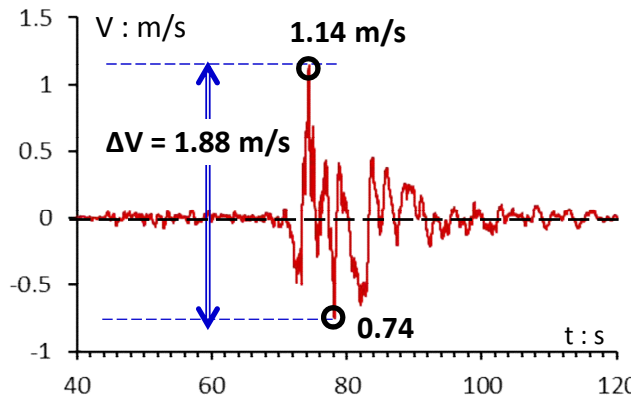
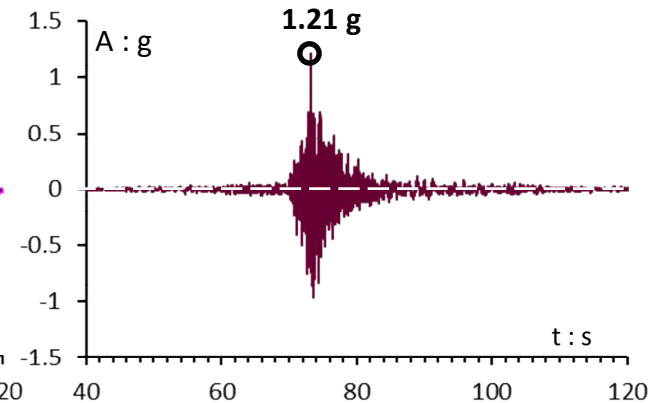
Horizontal EW
component



Horizontal NS
component



Vertical
component

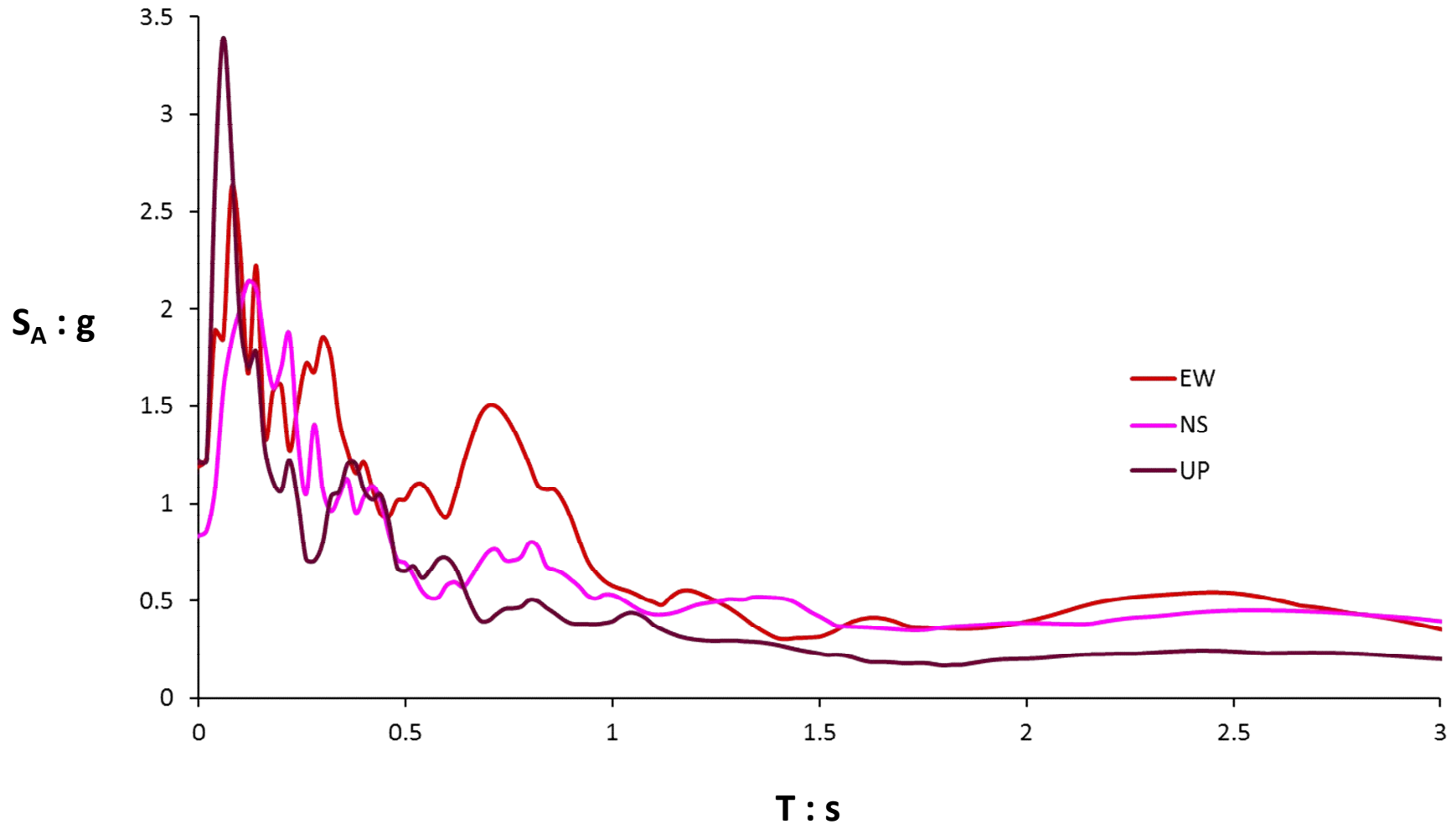


Earthquake $M_w 7.8$

Station 3125: at **Hatay** city, Antakya District

Station at **Free field**, $V_{s30} = 448 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.13264 (Long.) 36.23808 (Lat.)



Earthquake $M_W 7.8$

Station 3126:

at **Hatay** city, Antakya District

Station at **Free field**, $V_{s30} = 350 \text{ m/s}$ (EC8 Type C)

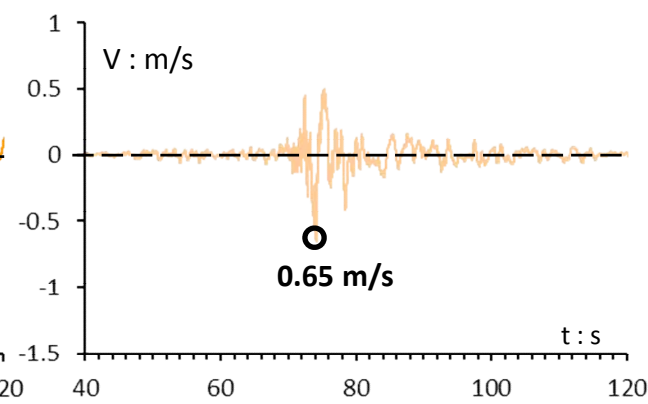
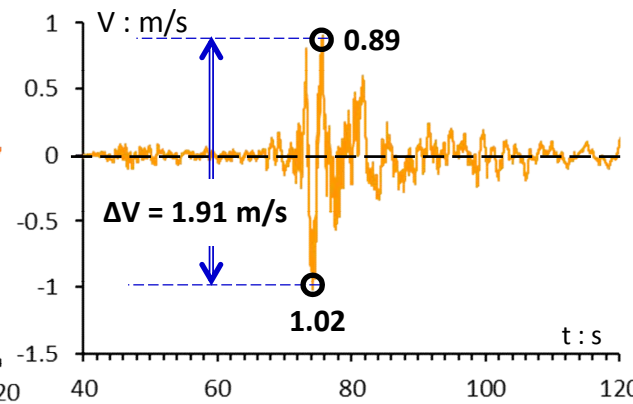
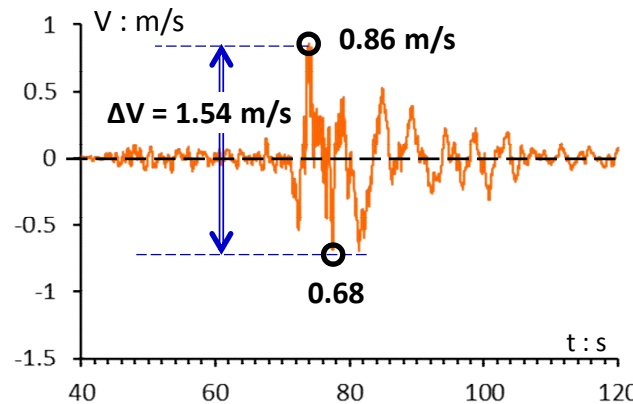
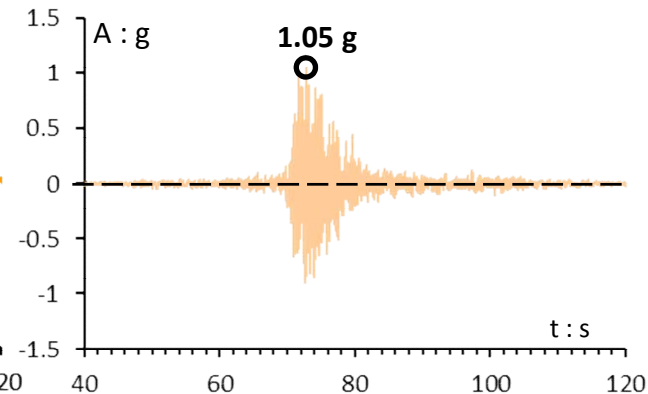
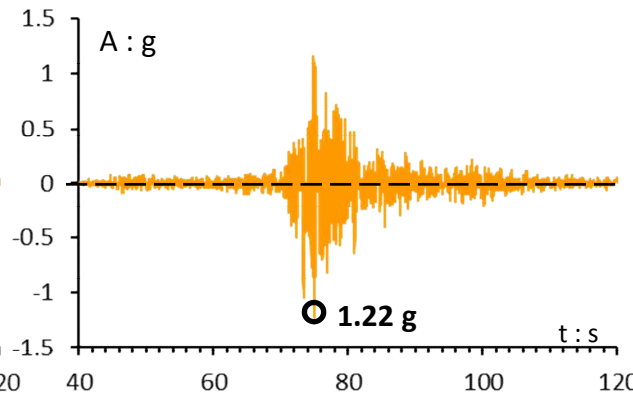
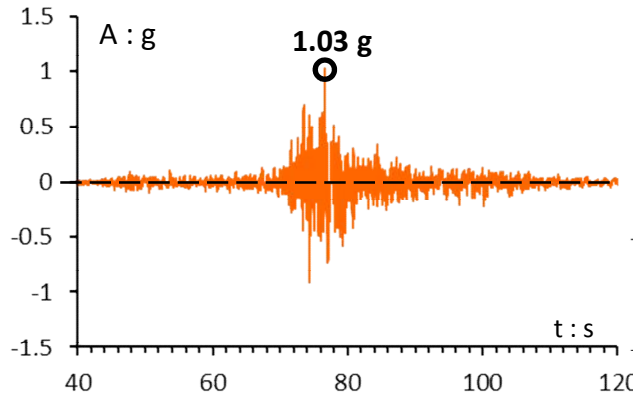
Exact Location: 36.1375 (Long.) 36.2202 (Lat.)



Horizontal EW
component

Horizontal NS
component

Vertical
component

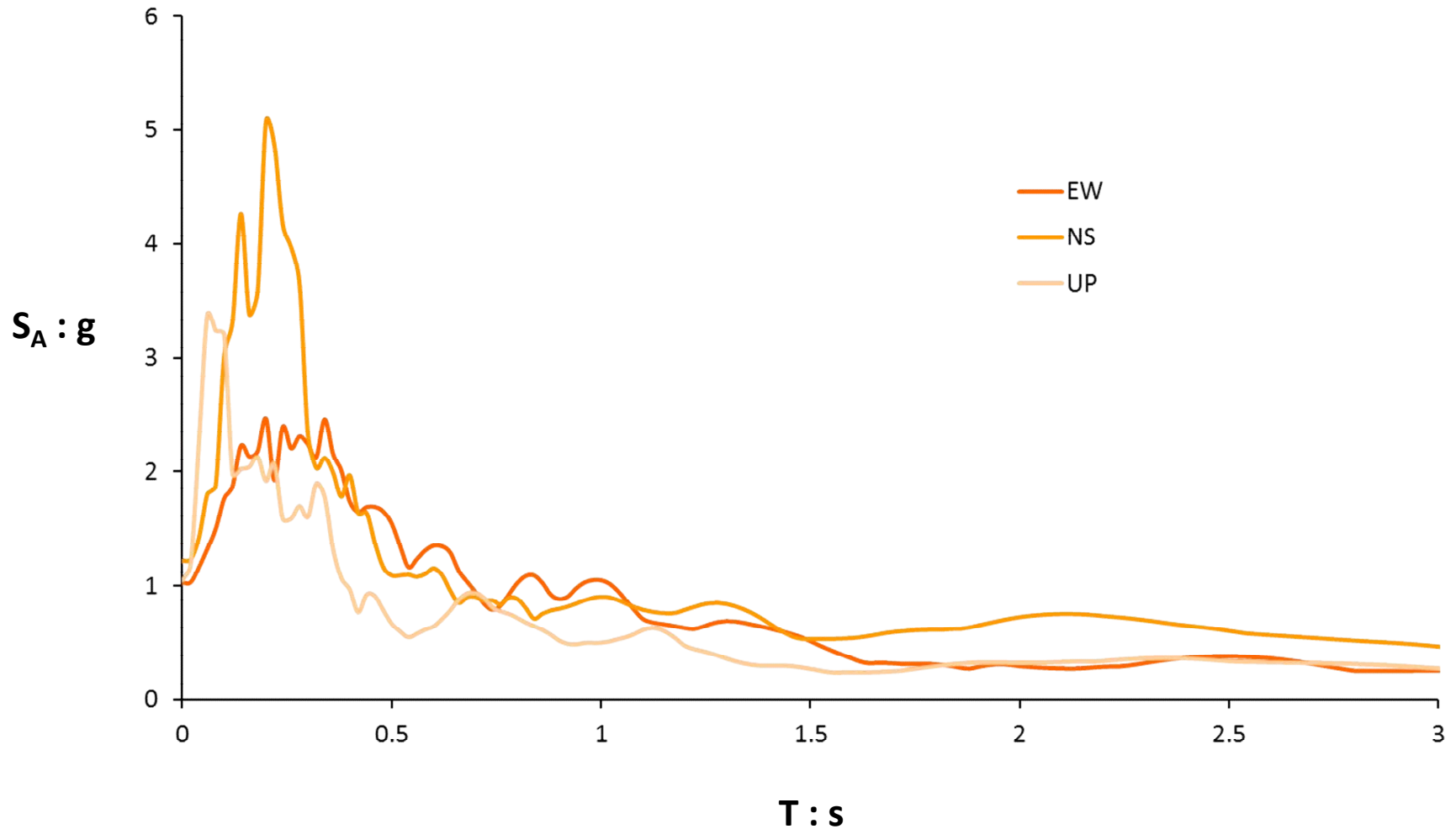


Earthquake $M_w 7.8$

Station 3126: at **Hatay** city, Antakya District

Station at **Free field**, $V_{s30} = 350 \text{ m/s}$ (EC8 Type C)

Exact Location: 36.1375 (Long.) 36.2202 (Lat.)



Earthquake $M_w 7.8$

Station 3129:

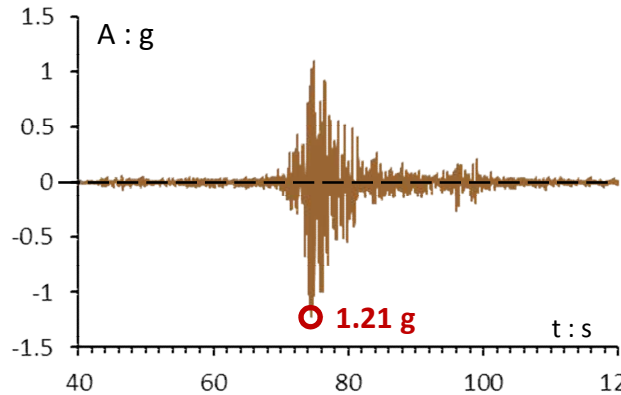


at **Hatay** city, Defne District

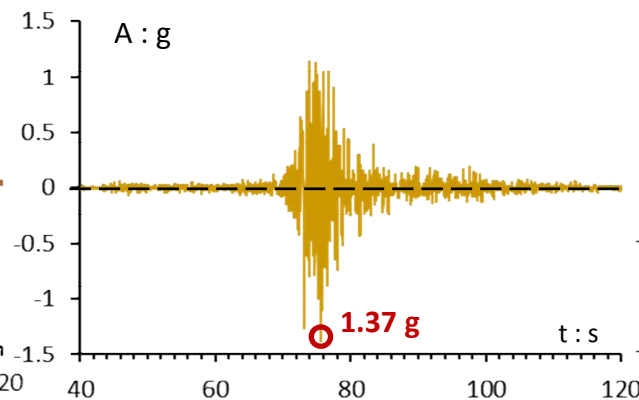
Station at **Free field**, $V_{s30} = 447 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.1343 (Long.) 36.19117 (Lat.)

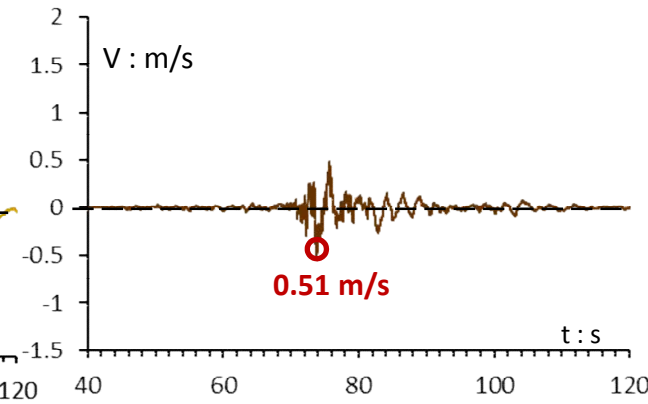
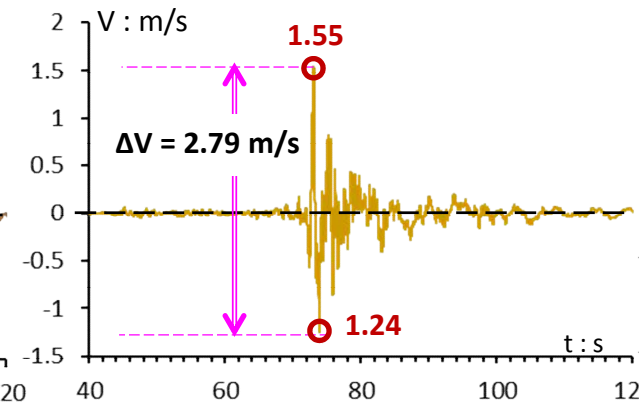
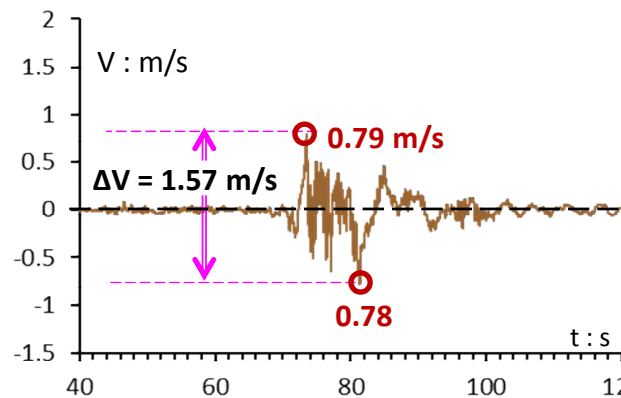
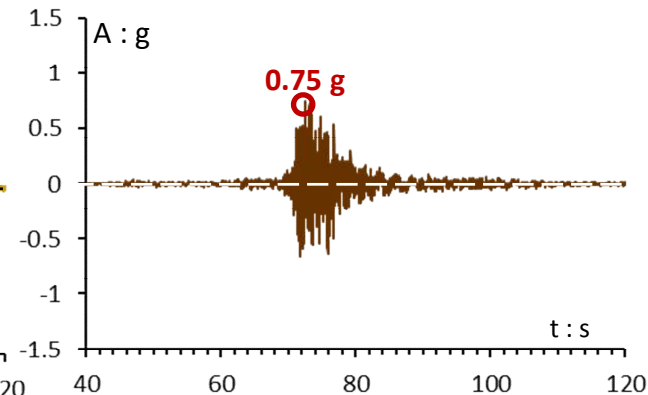
Horizontal EW
component



Horizontal NS
component



Vertical
component

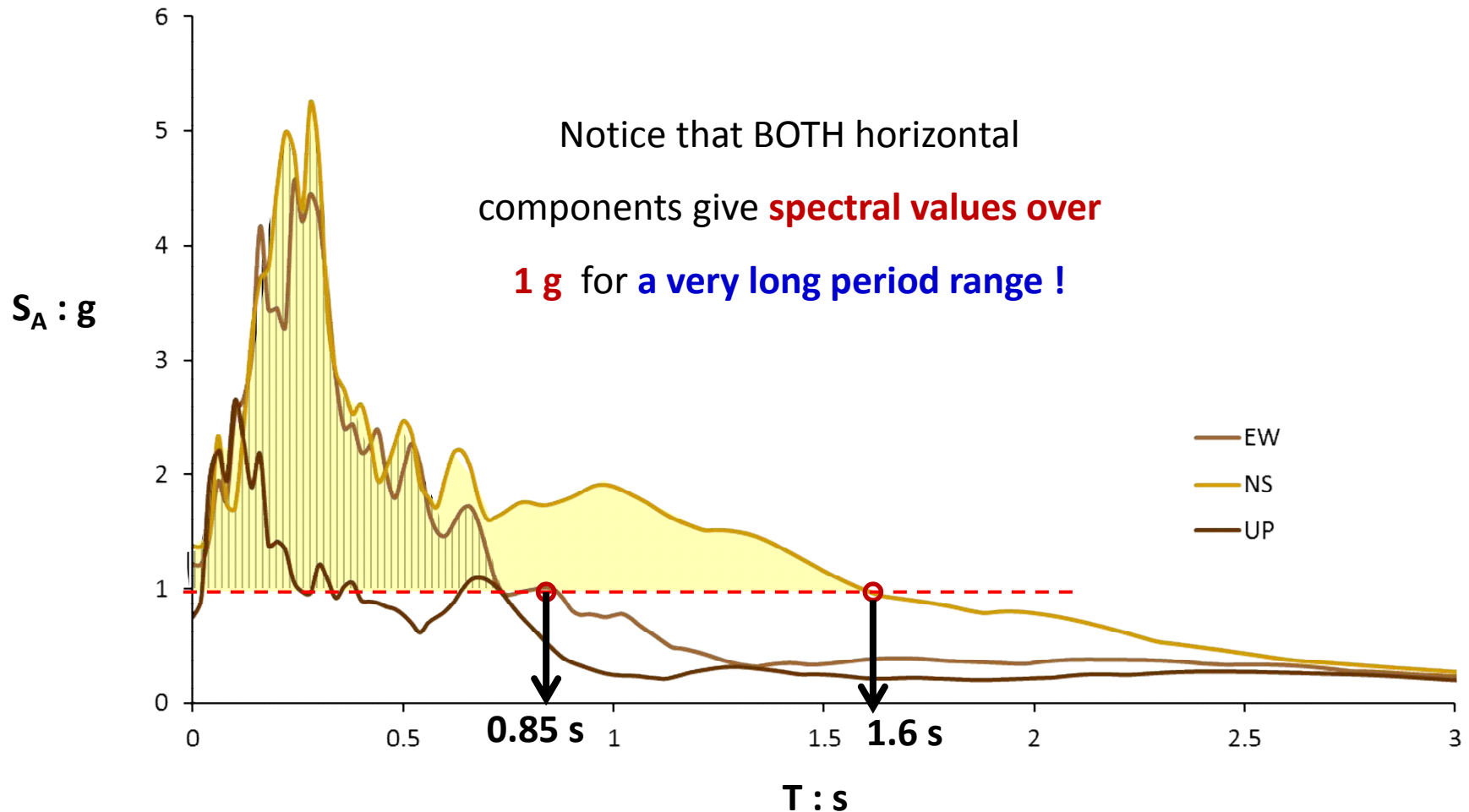


Earthquake $M_w 7.8$

Station 3129: at **Hatay** city, Defne District

Station at **Free field**, $V_{s30} = 447 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.1343 (Long.) 36.19117 (Lat.)



Earthquake $M_w 7.8$

Station 3135:

at **Hatay** city, Arsuz District

Station at **Free field**, $V_{s30} = 460 \text{ m/s}$ (EC8 Type B)

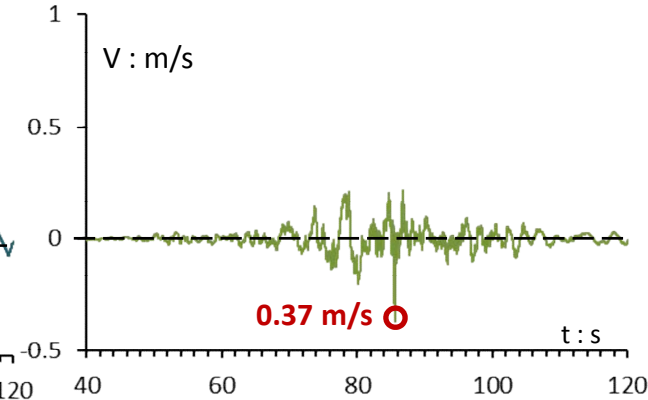
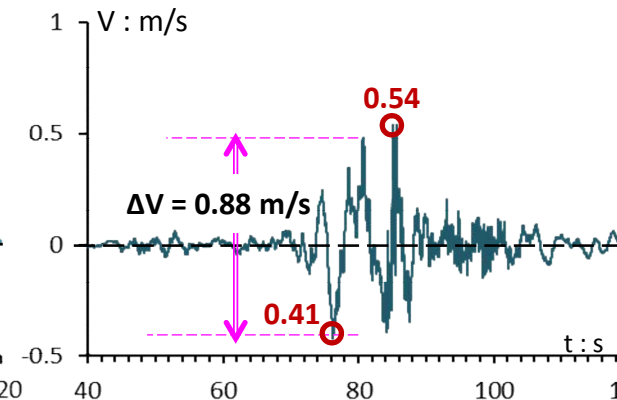
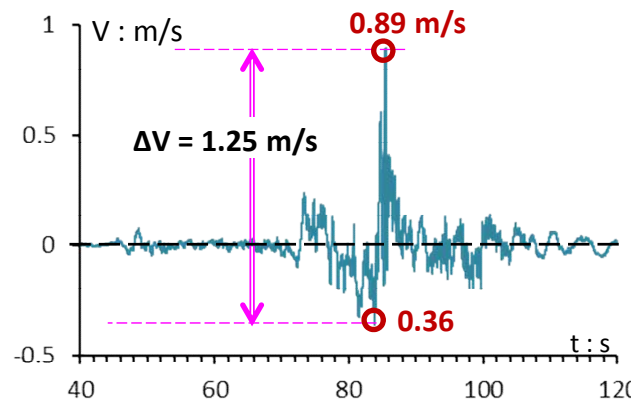
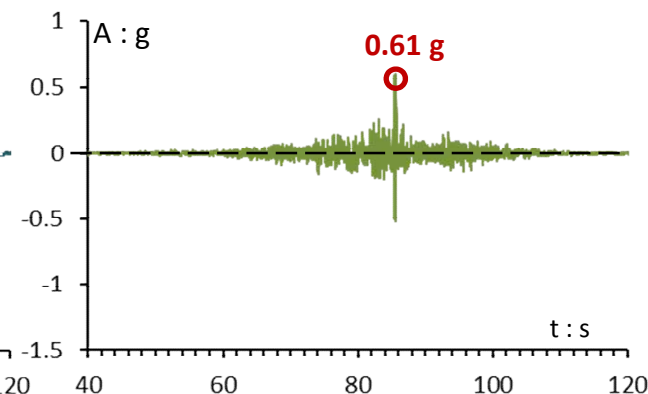
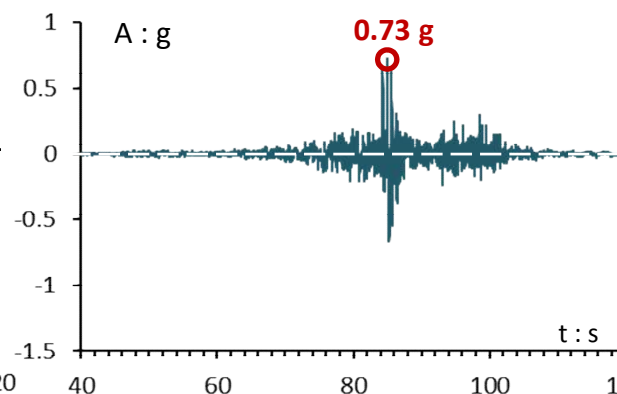
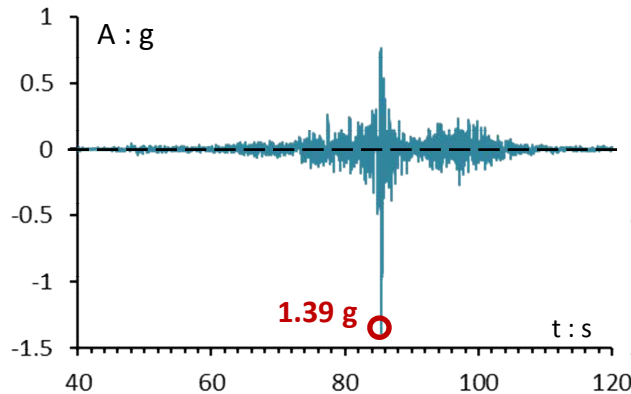
Exact Location: 35.8831 (Long.) 36.40886 (Lat.)



Horizontal EW
component

Horizontal NS
component

Vertical
component

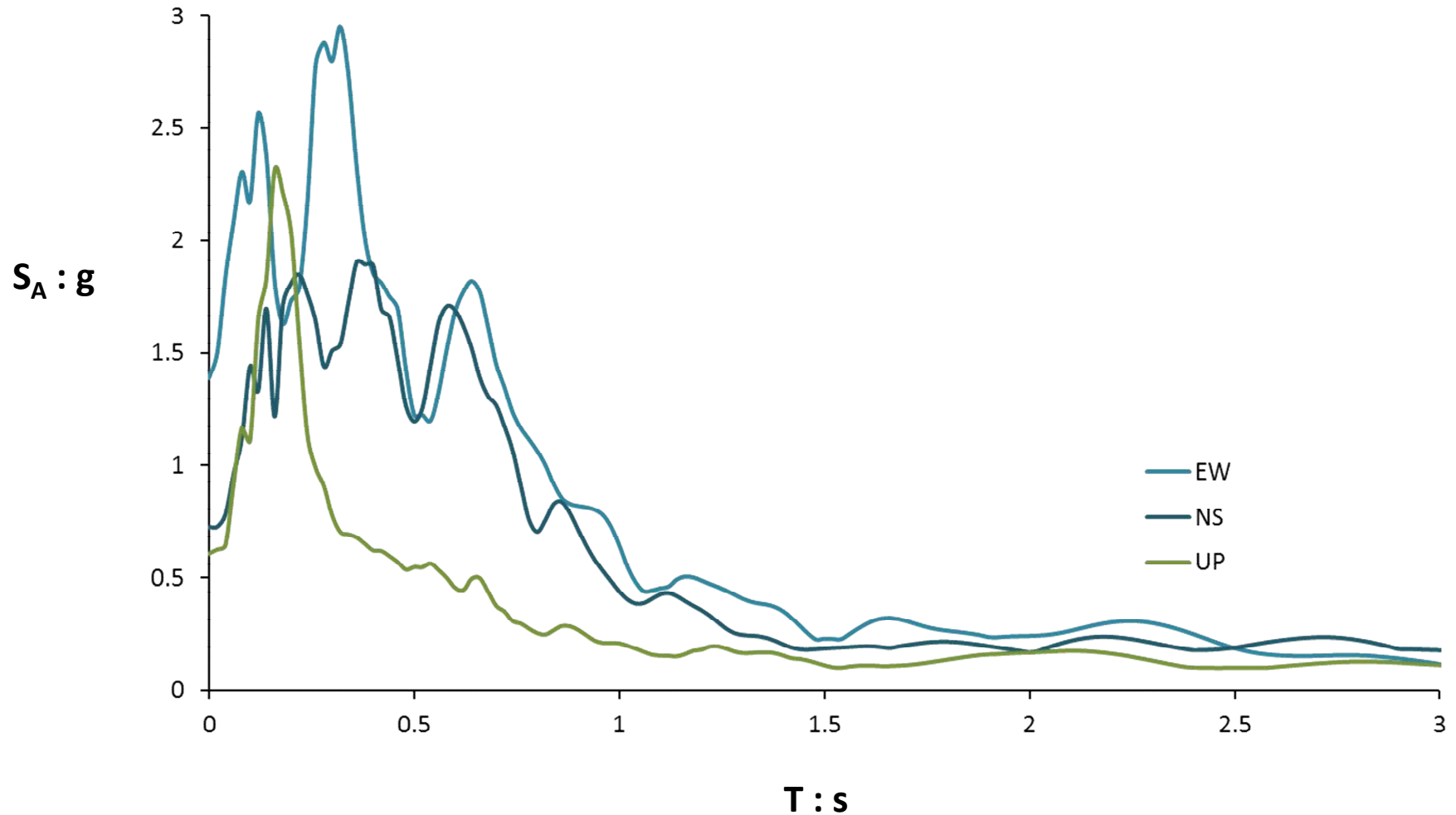


Earthquake $M_w 7.8$

Station 3135: at **Hatay** city, Arsuz District

Station at **Free field**, $V_{s30} = 460 \text{ m/s}$ (EC8 Type B)

Exact Location: 35.8831 (Long.) 36.40886 (Lat.)



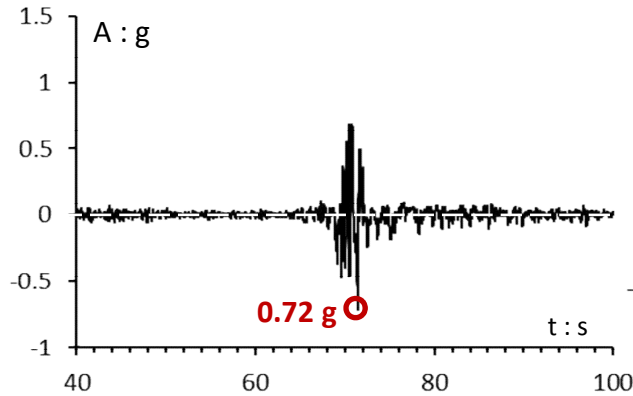
Earthquake $M_w 7.8$

Station 3138: at **Hatay** city, Hassa District

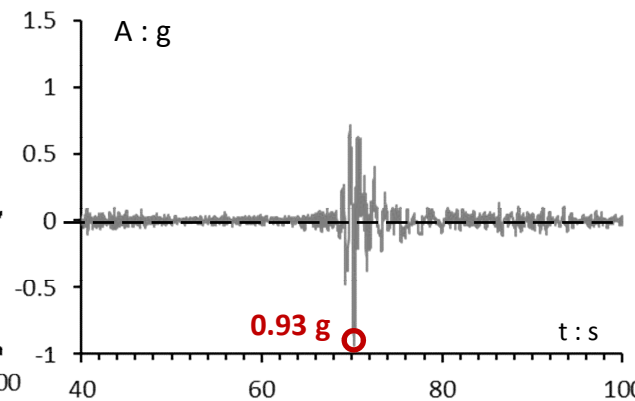
Station at **Free field**, $V_{s30} = 618 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.51119 (Long.) 36.80262 (Lat.)

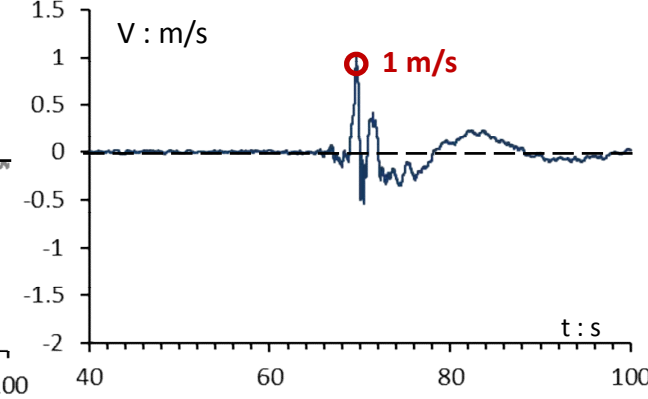
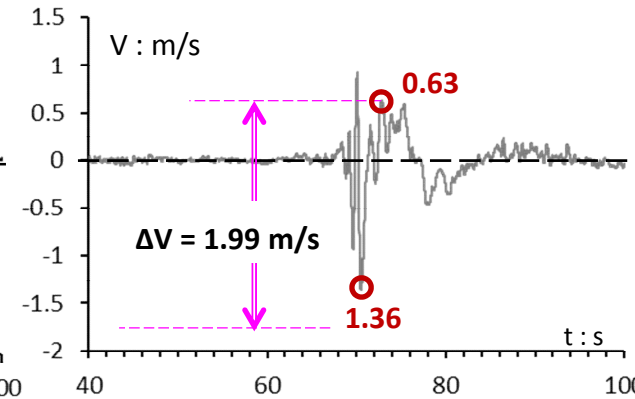
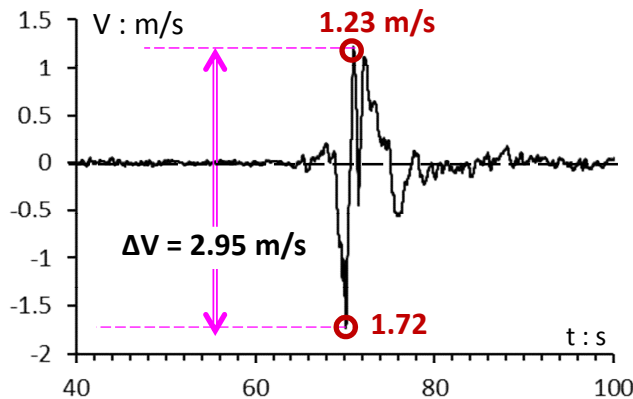
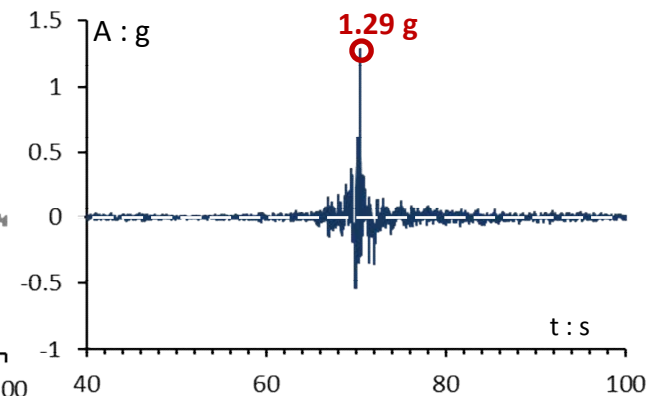
**Horizontal EW
component**



**Horizontal NS
component**



**Vertical
component**

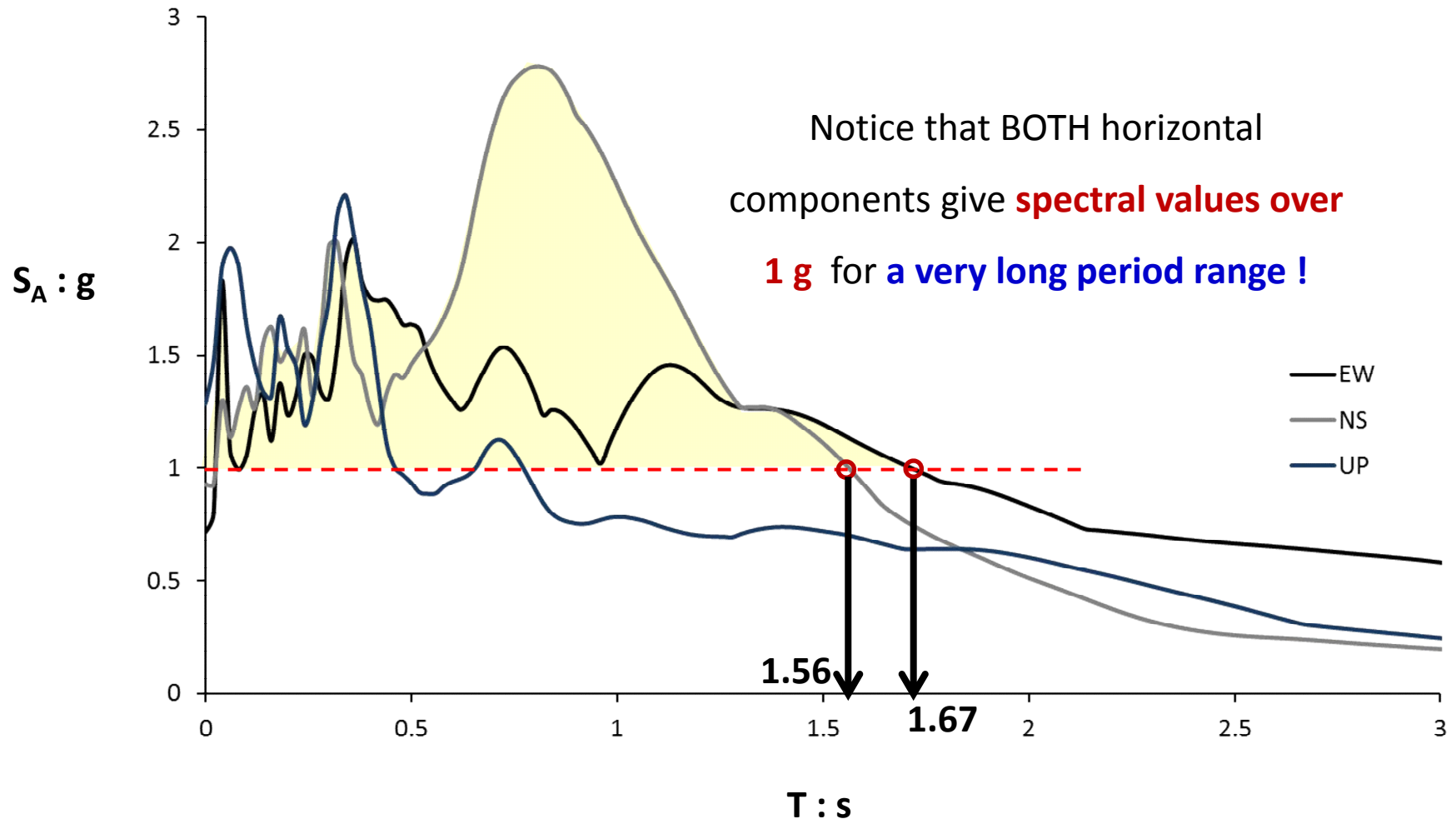


Earthquake $M_w 7.8$

Station 3138: at **Hatay** city, Hassa District

Station at **Free field**, $V_{s30} = 618 \text{ m/s}$ (EC8 Type B)

Exact Location: 36.51119 (Long.) 36.80262 (Lat.)



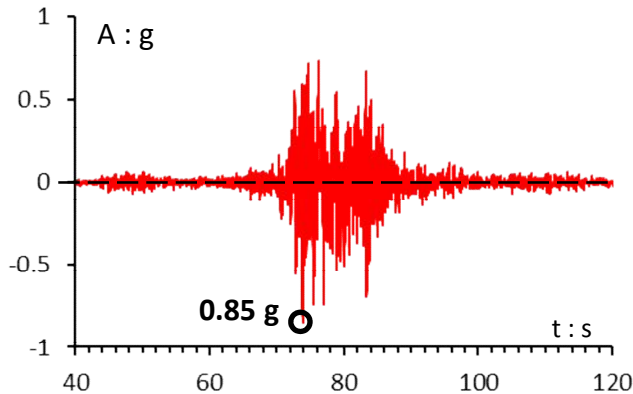
Earthquake $M_w 7.8$

Station 3141: at **Hatay** city, Antakya District

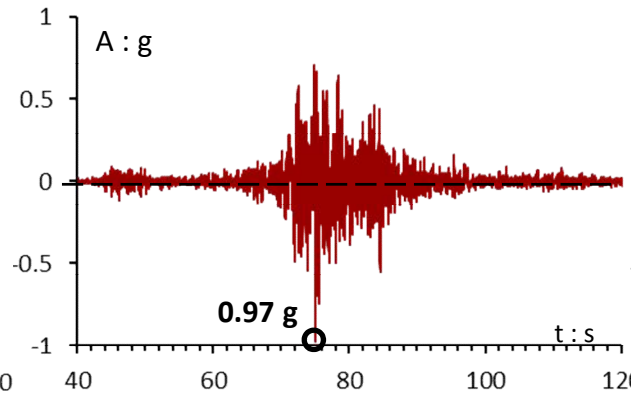
Station at **Free field**, $V_{s30} = 338 \text{ m/s}$ (EC8 Type C)

Exact Location: 36.21973 (Long.) 36.3726 (Lat.)

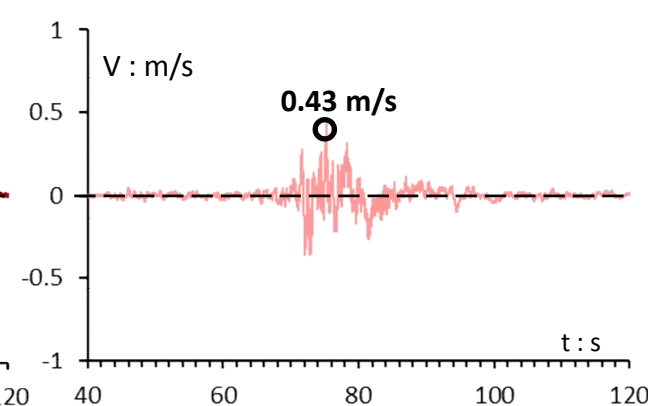
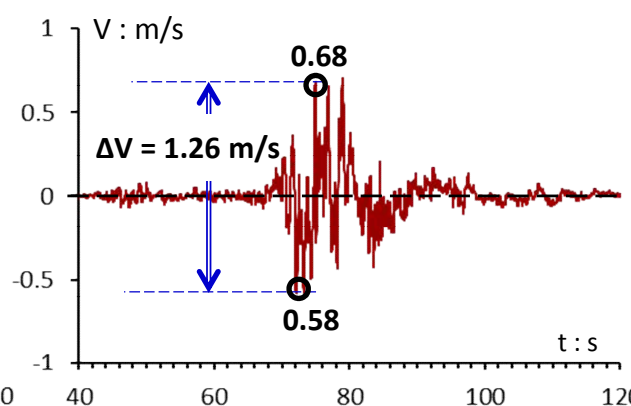
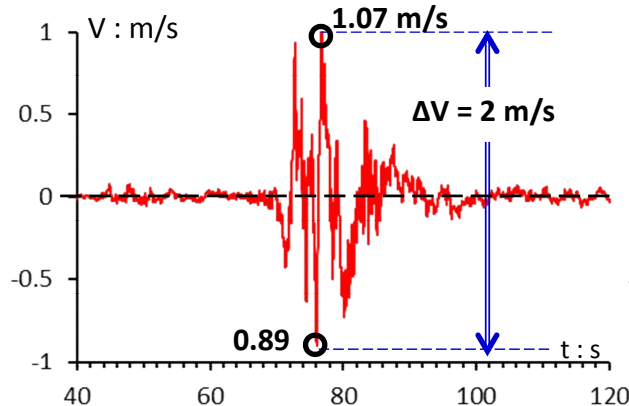
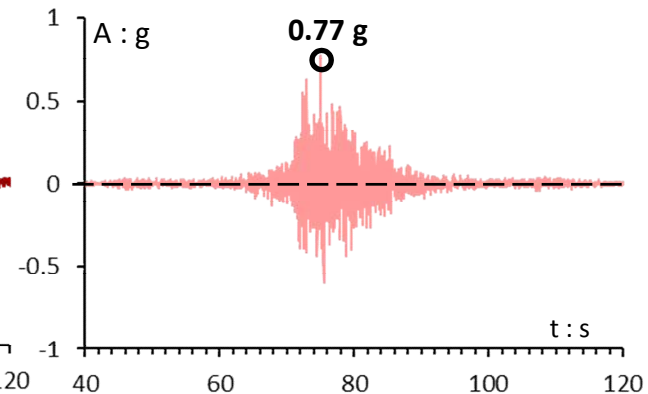
Horizontal EW
component



Horizontal NS
component



Vertical
component

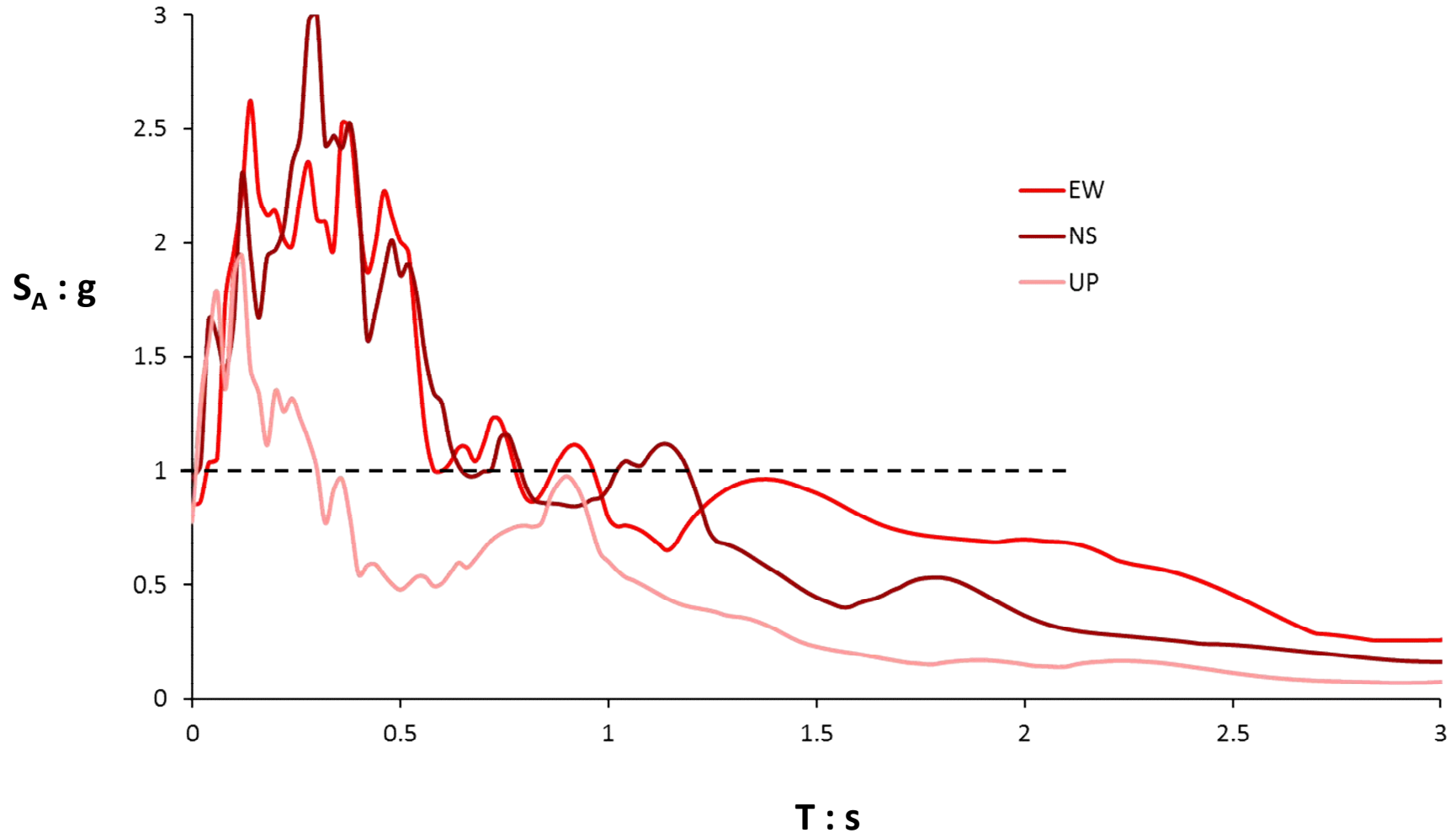


Earthquake $M_w 7.8$

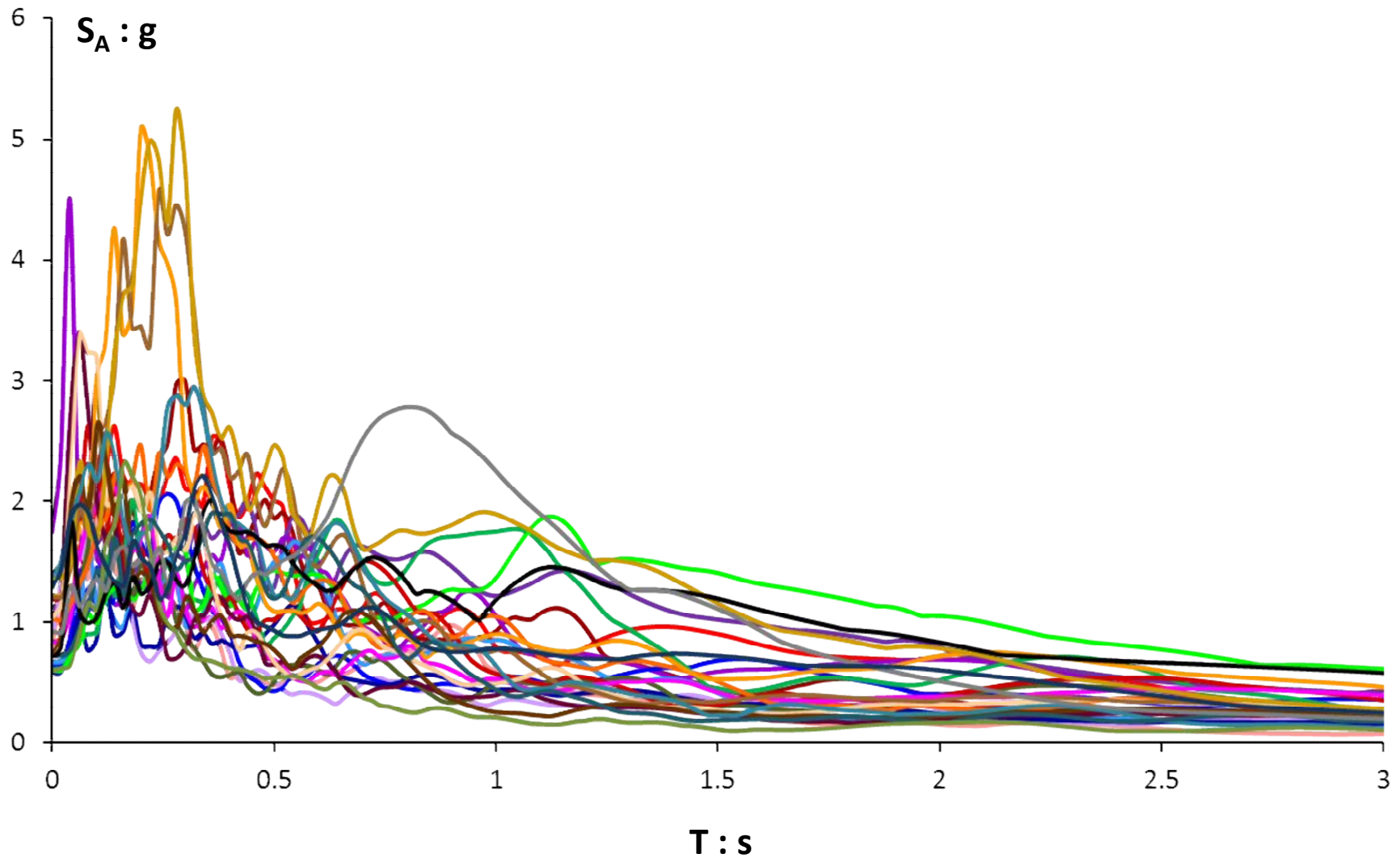
Station 3141: at **Hatay** city, Antakya District

Station at **Free field**, $V_{s30} = 338 \text{ m/s}$ (EC8 Type C)

Exact Location: 36.21973 (Long.) 36.3726 (Lat.)



**All the elastic response spectra
of the 10 stations of earthquake $M_w 7.8$ (presented herein)**



PRELIMINARY REPORT

M 7.8 and M 7.5 Earthquakes in Turkey and Syria

PART D: Emergence of the Fault Rupture on the Ground Surface and SOIL LIQUEFACTION

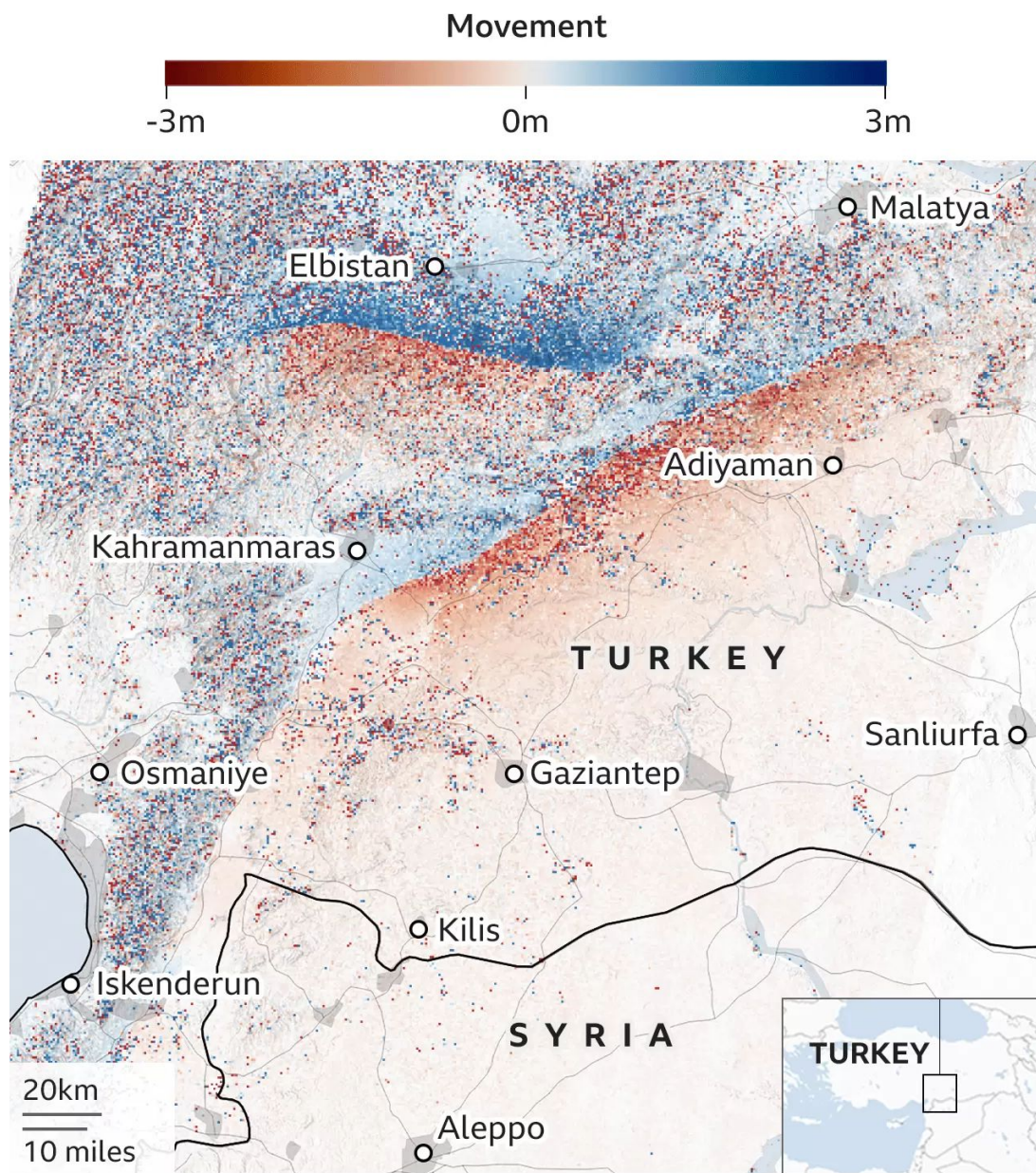
Evangelia GARINI and George GAZETAS

13 February 2023



**School of Civil Engineering,
National Technical University of Athens**

EU satellite precisely maps earthquake faults

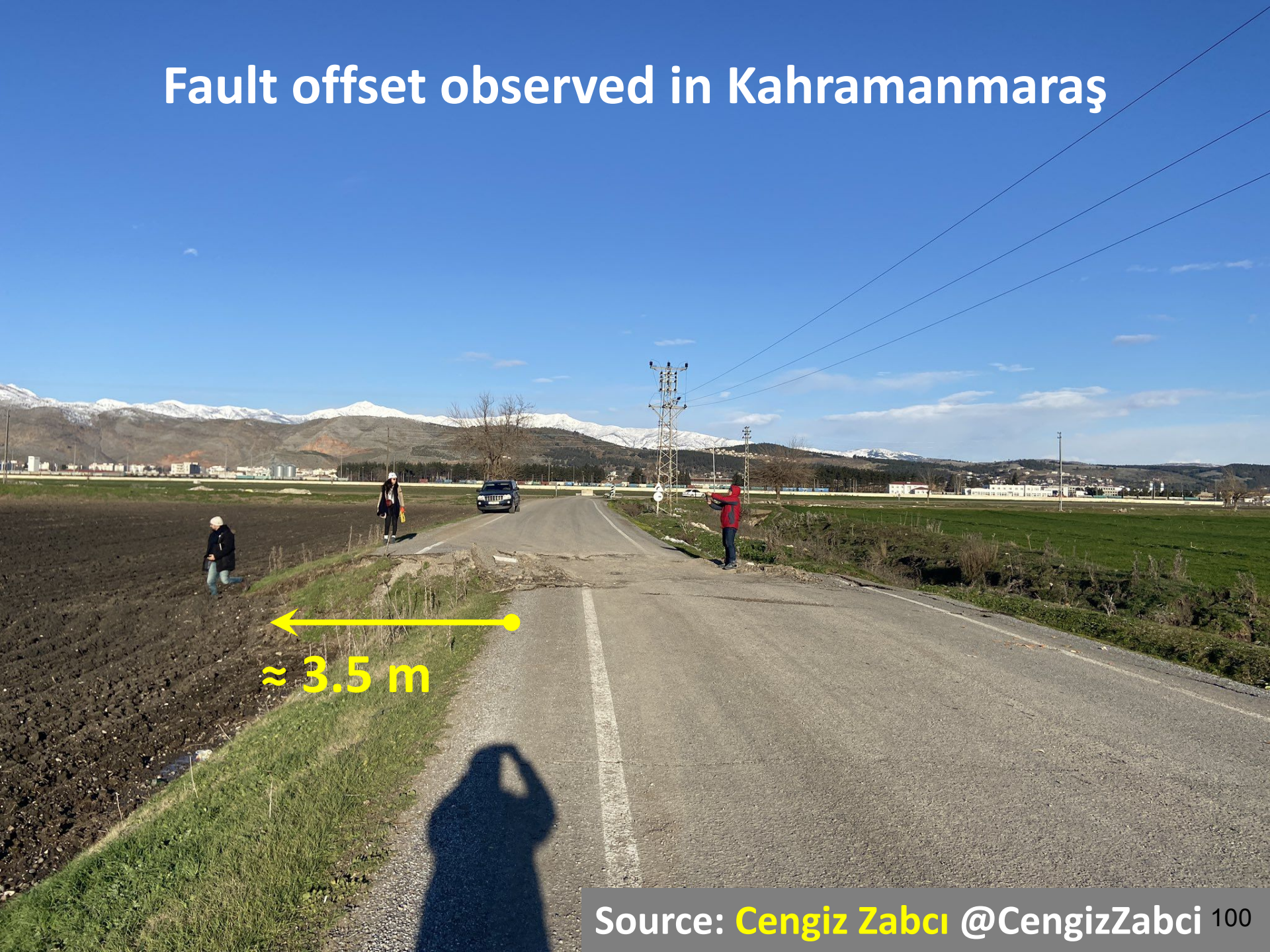


Ground movement measured closer to or further away from passing satellite

Source: Copernicus data, Esa, Comet 2023



Fault offset observed in Kahramanmaraş



Picture of a bent railway due to Fault rupture

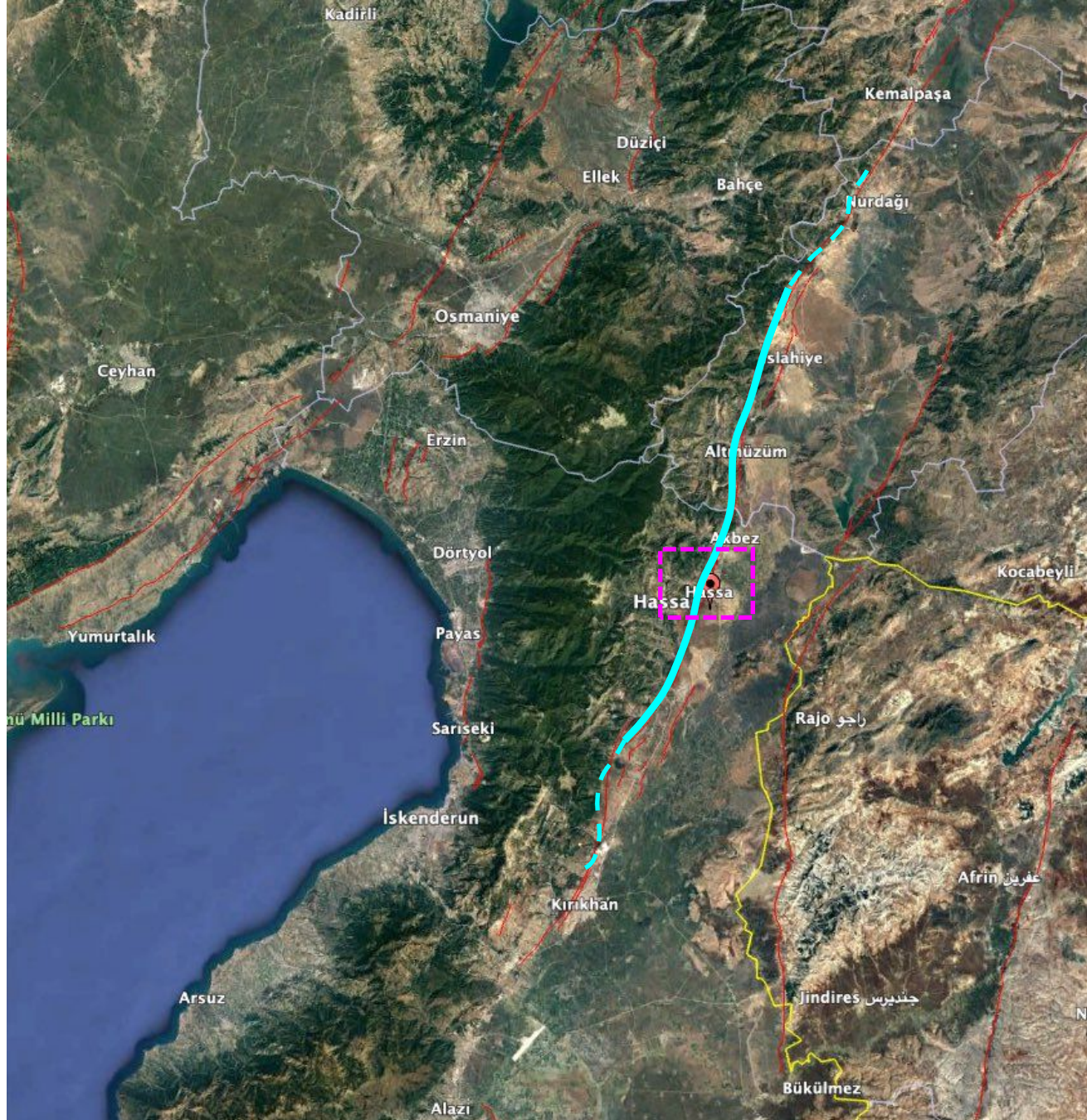


The strike slip fault as emerges at surface





New aerial images show a tens of km long surface rupture associated with the M7.8 Turkey earthquake near Tevekkelli, Kahramanmaraş. Credit: @trthaber



Source: <https://twitter.com/ziyadin/status/1623288689894871046>

Surface rupture at Hassa, southernmost
extent of the rupture observed by
OzdemirAlpay @geodesist_a



Fault offset

Surface rupture at Hassa Town





Source: https://twitter.com/Panthalassa_Z/status/1623040975848280107

Q ulkadiroğlu/Kahramanmaraş, Türkiye

Search



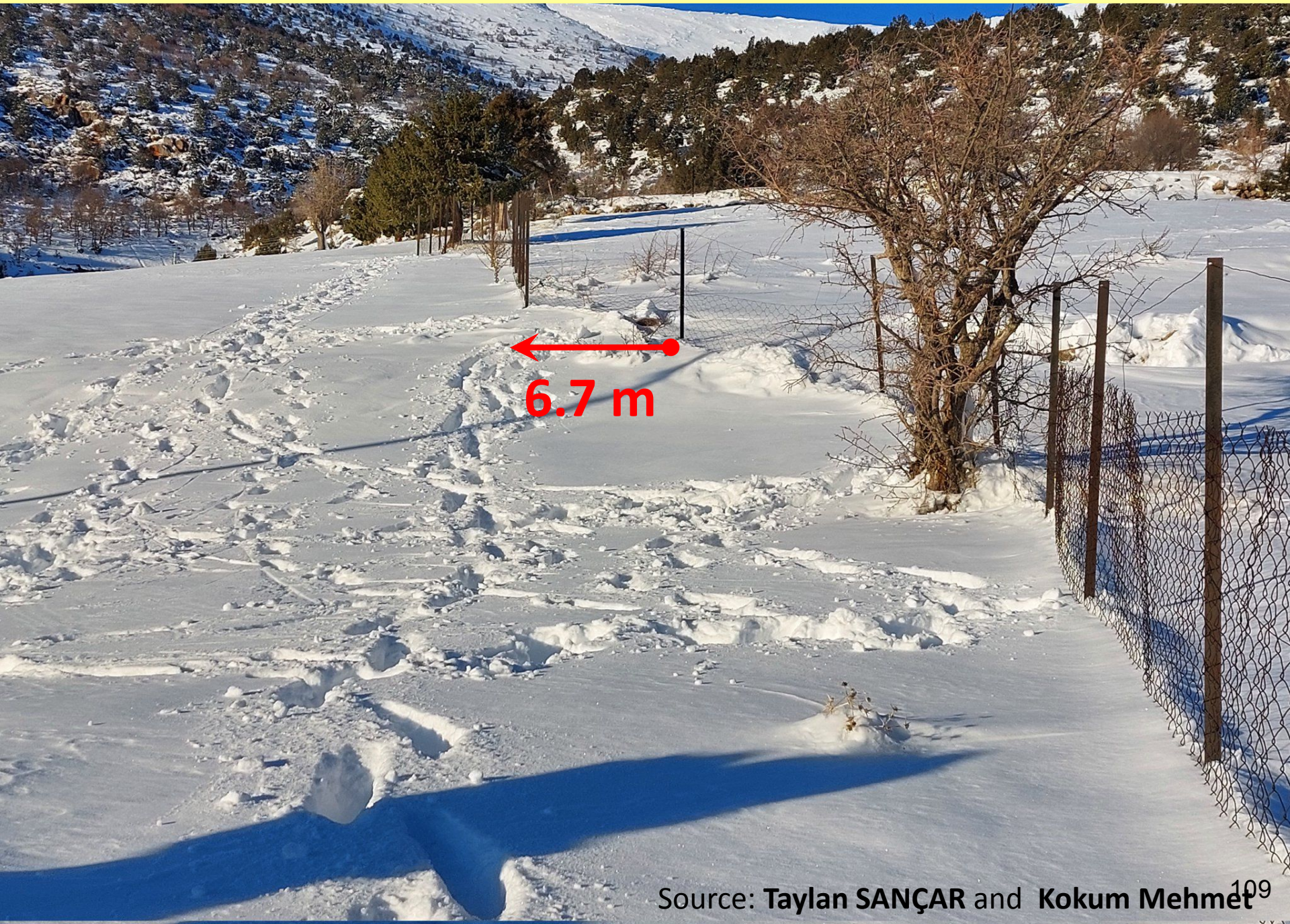
mapbox


**Surface rupture observed in Tevekkeli,
Tevekkeli Village Road, 46090**



Source: Twitter Zeliş @Panthalassa_z¹⁰⁸

6.7 m fence offset along the Sürgü-Çardak Fault





Offset at SE of Şekeroba **3.5±0.2 m**

@ActiveTectonic

@CengizZabci

@HNK390978941

Gursel Sunal, Erdem Kirkan, Nurettin
Yakupoglu, Asen Sabuncu

NE-SW orientated fracture systems formed within the deformation zone of the Malatya



Source: Taylan SANÇAR



**The fault rupture at the surface
in the east of Türkoglu.**

**Source: Gürsel Sunal, Erdem Kırkan,
Nurettin Yakupoğlu, Asen Sabuncu¹¹²**



Source: **Ömer Gür**

Soil Liquefaction

Liquefaction at the edge of Hatay city [Location: Lat:36.2459410,Long: 36.2045409)]



Source: Ozdemir Alpay15





Soil liquefaction in northern Syria after the M7.8 earthquake



Source: <http://yourweather.co.uk>.

Soil liquefaction in northern Syria after the M7.8 earthquake



Source: <http://yourweather.co.uk>.

Soil liquefaction in northern Syria after the M7.8 earthquake

