The 2 earthquakes of February 6\textsuperscript{th} 2023 in Turkey

Preliminary Report

by Evangelia GARINI and George GAZETAS
NTUA, Greece
Source: BOĞAZİÇİ UNIVERSITY

- **Magnitude**: $M_w 7.8$
- **Region**: CENTRAL TURKEY
- **Date time**: 2023-02-06 01:17:36.1 UTC
- **Location**: $37.17 \text{ N} ; 37.08 \text{ E}$
- **Depth**: 20 km

- **Magnitude**: $M_w 7.5$
- **Region**: CENTRAL TURKEY
- **Date time**: 2023-02-06 10:24:49.6 UTC
- **Location**: $38.11 \text{ N} ; 37.24 \text{ E}$
- **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
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
The 1\textsuperscript{st} mainshock of M7.8
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
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.
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 2nd shock $M_W$ 7.5

Strike = 277

Dip = 78

Rupture Front Contours Plotted Every 10 s

Source: USGS
Strong Motions Recordings:

ACCELEROMEGRAMS
1\textsuperscript{st} Mainshock: $M_w 7.8$ (6 February 2023 at 01:17)
1st Mainshock: $M_w 7.8$ (6 February 2023 at 01:17)
### 1st Shock: $M_w$ 7.8

Accelerograms recorded by AFAD with PGA $> 0.30$ g

<table>
<thead>
<tr>
<th>Station Code</th>
<th>$R_{epi}$ : km</th>
<th>PGA$_{NS}$ : g</th>
<th>PGA$_{EW}$ : g</th>
<th>PGA$_{UD}$ : g</th>
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<td>0.638</td>
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<td>4629</td>
<td>24</td>
<td>0.337</td>
<td>0.247</td>
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Peak recorded ground acceleration VS epicentral Distance

for the 1st Mainshock of $M_w 7.8$
1st 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)

$A : g$

$V : m/s$

$D : m$

$1.97 \, g$

$0.55 \, m/s$

$0.179 \, m$

EW component
1st Mainshock $M_W 7.8$

Station 4614: at Kahramanmaras

Distance from fault $\approx 3$ km

Free Field $V_{S30} = 670$ m/s
Station 4614: at Kahramanmaras

Distance from fault ≈ 3 km

Free Field $V_{S30} = 670$ m/s

1st Mainshock $M_W 7.8$

A : g

$1.35$ g

V : m/s

$0.31$ m/s

D : m

$0.17$ m

UP component
Station 4614: at Kahramanmaras

Distance from fault \( \approx 3 \) km

**Free Field** \( V_{S30} = 670 \) m/s

1\(^{st}\) Mainshock \( M_w 7.8 \)
1st Mainshock $M_W 7.8$

Station 3123: at Pazarck

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

- **EW component**
  - $A : g = 0.58 g$
  - $V : m/s = 0.98 m/s$
  - $V : m/s = 0.81 m/s$
  - $\Delta V = 1.80$ m/s
  - $D : m = 1$ m
1<sup>st</sup> Mainshock \( M_W 7.8 \)

Station 3123: at Pazarck

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

\[ A : g \]

\[ 0.65 \text{ g} \]

\[ t : s \]

\[ 0.61 \text{ m} \]

\[ \Delta V = 2.82 \text{ m/s} \]

\[ V : \text{m/s} \]

\[ 1.85 \text{ m/s} \]

\[ 0.97 \text{ m/s} \]

\[ \text{NS component} \]

\[ t : s \]
1<sup>st</sup> Mainshock $M_W 7.8$

Station 3123: at Pazarck

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

**A : g**

**V : m/s**

**D : m**

0.84 g

0.52 m/s

0.18 m

UP component

$0.18 \text{ m}$
1st Mainshock $M_W 7.8$

Station 3123: at at Pazarck

**Free Field** $V_{S30} = 470 \text{ m/s}$
1st Mainshock $M_w7.8$

station 4614

VERSUS

station 3123
2\textsuperscript{nd} Shock: $M_w 7.5$

Distribution by:  
- **PGA (cm/s\(^2\))**
- PGV (cm/s)
- PGD (cm)

Legend

- △ <1
- ▲ 1-5
- ▲ 5-10
- ▲ 10-20
- ▲ 20-50
- ▲ 50-100
- ▲ 100-300
- ▲ >300
2\textsuperscript{nd} Mainshock: $M_w 7.5$ (6 February 2023 at 10:24)
### 2nd Mainshock: $M_W 7.5$

Accelerograms recorded by AFAD with $PGA > 0.15$ g

<table>
<thead>
<tr>
<th>Station Code</th>
<th>$R_{epi}$ : km</th>
<th>$PGA_{NS}$ : g</th>
<th>$PGA_{EW}$ : g</th>
<th>$PGA_{UD}$ : g</th>
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<td>213</td>
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<td>0.051</td>
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<tr>
<td>141</td>
<td>161</td>
<td>0.079</td>
<td>0.189</td>
<td>0.074</td>
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</table>
Peak recorded ground acceleration VS epicentral Distance
for the 2\textsuperscript{nd} Mainshock of $M_w$7.5
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 Adıyaman and Diyarbakır. In Diyarbakır, a shopping mall collapsed. About 130 building collapses also occurred in Malatya. The ancient Gaziantep Castle was seriously damaged. Kahramanmaraş, 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 1st shock of M 7.8

The 2nd shock of M 7.5

Turkish cities damaged by the 2 earthquakes

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
A collapsed building in Hatay, Turkey, February 7, 2023. (Photo: REUTERS/ Umit Bektas/ File Photo)
Location: Kavaşlı, Turkey
Flattened buildings in Hatay
Credit: Anadolu Agency, Erçin Ertürk
A collapsed building in Kahramanmaras, Turkey, on Monday. (Ihlas News Agency/Reuters)
Pazarcık district of Kahramanmaraş in the Elbistan district (Source: https://gazeteoksjen.com/).
Source: Oksijen Gazete
Source: Oksijen Gazete
Rescue work continues at Iskenderun State Hospital, Turkey

Location: Şakirpaşa, Turkey
Distance to epicenter: 161.2 Km
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

Yeni Mosque

Hotel Avsar

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 6th February 2023

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
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
Before and After

Gaziantep Castle in Turkey
(Source: CNN webpage).
Collapsed church in Iskenderun

Before

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