December 4th, 2023 Mudanya-Bursa Earthquake (M5.1)

Earthquake Information Report

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05.12.2023

Description of the event

A moderate-sized earthquake of magnitude M5.1 occurred at 10:42 (UTC 7:42) in Mudanya, in the central part of Marmara region, Türkiye. The earthquake parameters reported by EMSC-CSEM are given in Table 1. The epicenter lies on the central branch of the North Anatolian Fault Zone extending along the southern shelf of the Sea of Marmara (Figure 1). The waveform modeling at the nearby seismic stations reveals that the ruptured plane shows a normal faulting mechanism. Moreover, the aftershock distributions portray a northeast dipping fault plane. About five minutes before the M5.1 mainshock, a foreshock of magnitude M3.1 took place near the mainshock (Figure 1). The earthquake was largely felt in the Marmara region. EMSC-CSEM received felt reports from Greece and Bulgaria as well. Modified Mercalli Intensity (MMI) is estimated as MMI VI in the felt reports by USGS. Light structural damage is expected in MMI VI due to the level of shaking. The felt reports at distances as far as 200 km indicate intensities close to MMI III as reported by USGS. Most of the felt reports are from the larger Istanbul area, located about 70-80 km away from the epicenter. Some important indicators of this event are given in Tables 1 and 2, and a map including earthquakes larger than M 5 are shown in Figure 2.

Table 1. Important indicators of the M5.1 Mudanya earthquake (source: EMSC-CSEM)

Magnitude*	5.1
Country	Türkiye
Date time	04.12.2023 07:42:20 UTC
Epicenter	40.402N - 28.860E
Depth**	5 km

* KOERI, AFAD, and USGS reported the magnitude of this event as M 5.1

** KOERI reported the depth as 5 km whereas AFAD and USGS solutions depict a depth value of 8.98 km and 6.5 km, respectively

Table 2. Nearest urban settlements to the epicenter of the earthquake (source: USGS)

Nearby Locations and Population
Mudanya, Bursa, 7.3 km, Population: 23,161
Gemlik, Bursa, 25.7 km, Population: 71,063
Bursa, 32 km, Population: 3,101,833
Gürsu, Bursa, 37.7 km, Population: 24,530
Orhangazi, Bursa, 38.7 km, Population: 51,792

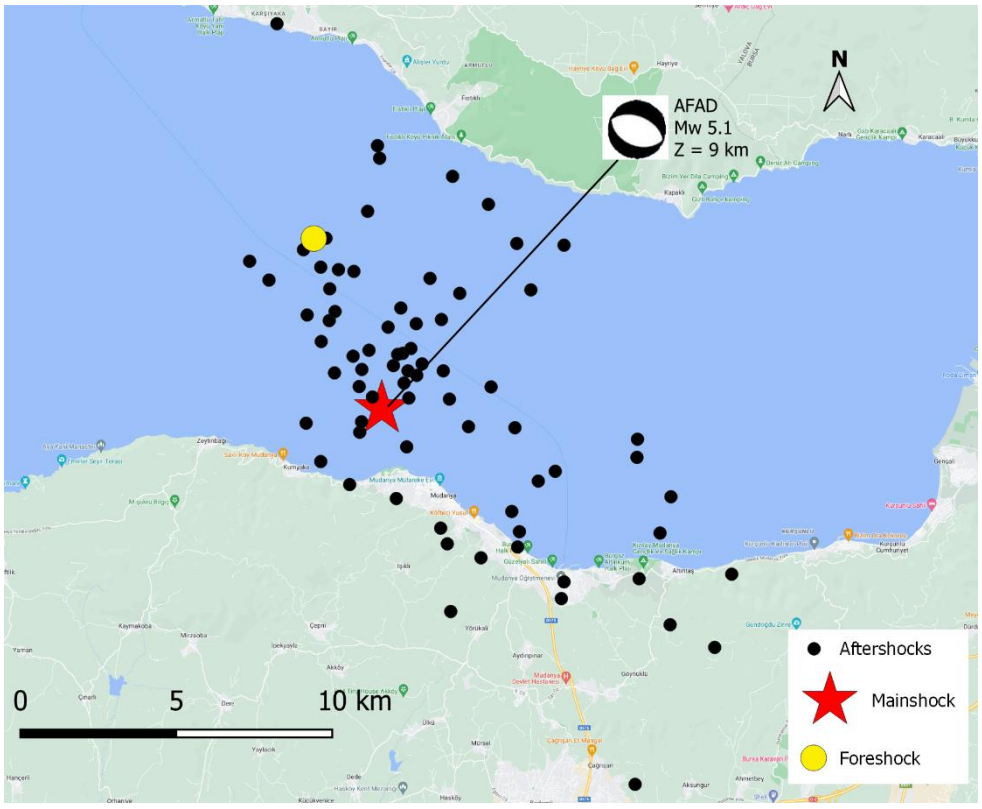

Figure 1. Epicentral location of the M5.1 Mudanya earthquake and its fore- and aftershock sequence as of Dec. 4th, 2023 (locations by KOERI). AFAD reports a predominant normal faulting mechanism for the mainshock.

Basic seismotectonics of the Marmara region

The region of the Marmara Sea is a transition zone between the extensional regime, to the west, and the strike-slip regime of the North Anatolian Fault Zone (NAFZ), to the east. The North Anatolian Fault accommodates much of the right-lateral horizontal motion (23-24 mm/yr) between the Anatolian micro-plate and Eurasian plate as the Anatolian micro-plate is being pushed westward to accommodate further the closure of the Mediterranean basin caused by the collision of the African and Arabian plates in southeastern Turkey.

Between 1939 and 1999 a series of devastating M7+ strike-slip earthquakes propagated westward along the North Anatolian Fault Zone, beginning with the 1939 M7.9 Erzincan earthquake on the eastern end of the North Anatolian Fault system. The 1999 M7.6 Izmit earthquake, located on the westward end of the NAF struck Kocaeli and Sakarya, one of Turkey's most densely populated and industrialized urban areas, killing more than 17,000 people.

In the Marmara region, the NAFZ bifurcates into three arms, namely, northern, central, and southern branches that form a 120 km wide deformation zone in the N-S direction, where predominantly strike-slip and normal faulting events take place. Owing to many ancient settlement locations in the Marmara region, its historical seismicity is rich and well-documented (Figure 2).

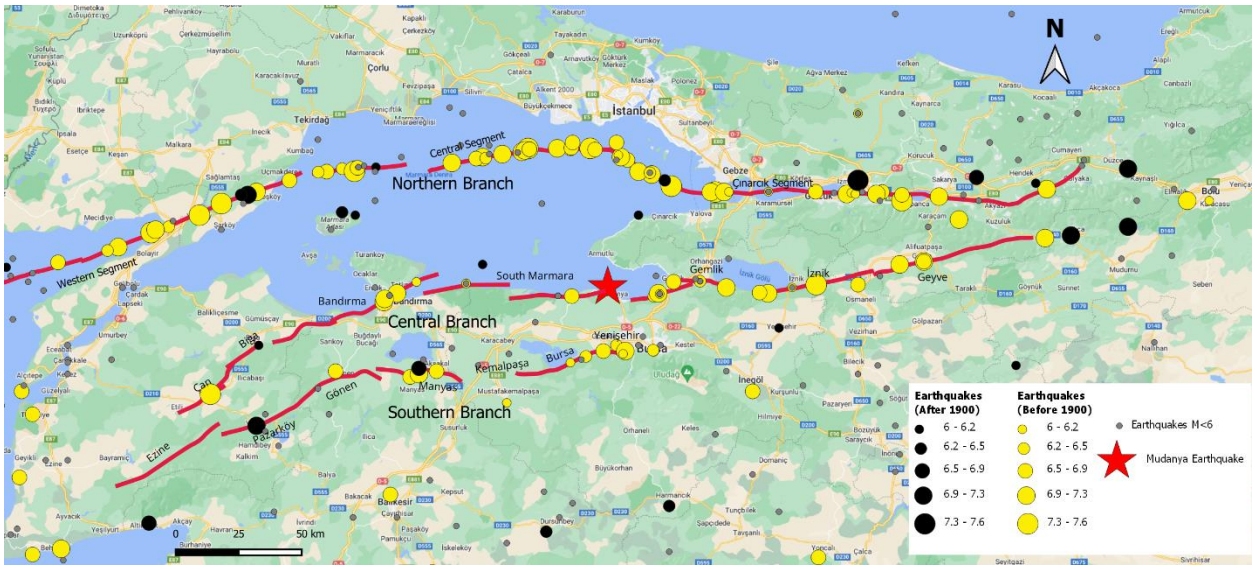

Figure 2. Historical and Instrumental period seismic activity in Marmara Region (source: T-Rupt).

References

- USGS, United States Geological Survey, (https://earthquake.usgs.gov/earthquakes/search, last accessed on Dec. 4th, 2023)
- EMSC, European Mediterranean Seismological Centre, (https://www.emsc-csem.org/Earthquake_information/, last accessed on Dec. 4th, 2023)
- KOERI, Kandilli Observatory and Earthquake Research Institute, Boğaziçi University (https://koeri.boun.edu.tr, last accessed on Dec. 4th, 2023)
- AFAD, Disaster and Emergency Management Presidency, Ministry of Interior of Republic of Türkiye (https://deprem.afad.gov.tr/event-focal-mechanism, last accessed on Dec. 4th, 2023)

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