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January 27th, 2024 Kuşadası Earthquake

Earthquake Information Report

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1. Introduction

An earthquake of moment magnitude M_w 5.0 occurred on January 27th, 2024, at 08:19 local time (05:19 UTC) in the Gulf of Kuşadası (Aydın, Turkey). The earthquake parameters reported by KOERI, AFAD, EMSC, and USGS are given in Table 1. The earthquake was felt in Aydın, İzmir, Muğla, Manisa, and Balıkesir regions with a macro-seismic intensity reaching MMI VI (reported by USGS and EMSC). Table 2 shows the densely populated urban settlements near the earthquake epicenter. The location of the event is shown in Figures 1 and 2. Figure 2 also shows the spatial distribution of $M_w \geq 4$ earthquakes in the last 100 years in the region.

Table 1. Important indicators of the Kuşadası (İzmir) earthquake (source: KOERI)

Magnitude	M_w5.0
Location	Kuşadası (Aydın)
Date time	27/01/2024 08:19:18
Epicenter	37.969 N, 27.143 E
Depth**	6.5 km

* USGS reported the magnitude as M_w5.1, AFAD reported the magnitude as M_w5.0,
** EMSC-CSEM and USGS reported the depth as 10 and 11 km, respectively.

Table 2. The nearest urban settlements and their populations to the epicenter of the January 27th M_w5.0 event (source: USGS)

Nearby Settlements and Their Populations
Özdere, İzmir, 5 km, population: 13,500
Kuşadası, Aydın, 24 km, population: 63,177
Selçuk, İzmir 20 km, population: 29,101
Torbalı, İzmir, 29 km, population: 50,303
İzmir, 51 km, population: 2,500,603

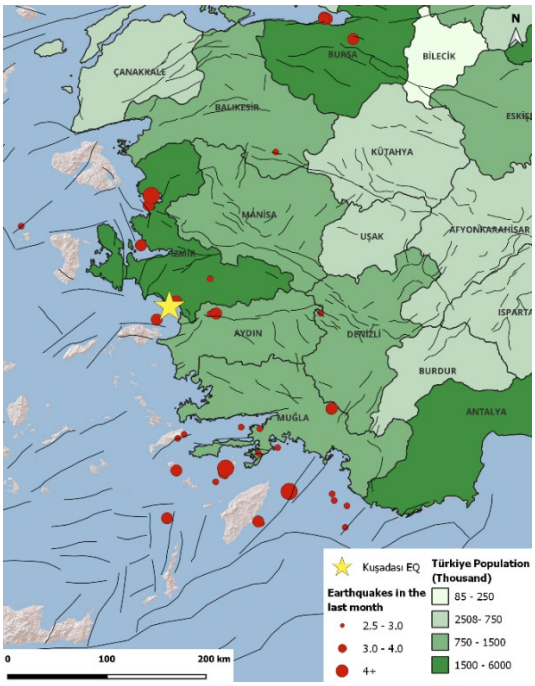

Figure 1. Epicenter of the M_w5.0 earthquake (yellow star) and the seismicity during the last 30 days (red circles).

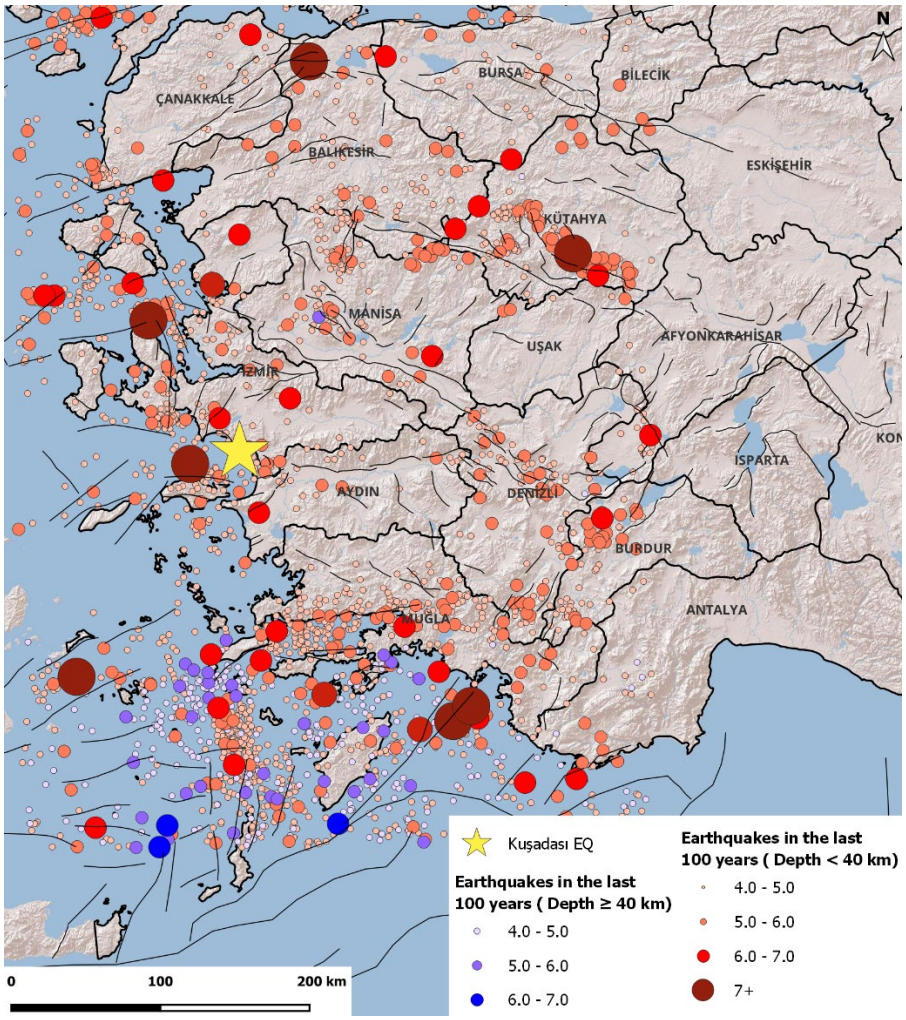

Figure 2. The seismic activity of the region during the last 100 years. (source: EMSC and USGS).

2. Seismotectonic features of the region

The January 27th, 2024, Kuşadası earthquake occurred in the vicinity of the October 30th, 2020 Kuşadası earthquake (M_w7.0) source. The October 30th, 2020 earthquake ruptured an east–west striking, offshore normal fault located the northern coast of Samos Island. The focal mechanism of January 27th, 2024 is similar to that of Kuşadası event. It is located to the east of the fault plane ruptured by the M_w7.0 event (Kiratzi et al., 2021).

The seismic activity in the source region of the January 27th, 2024 earthquake is considerably high where both normal and strike-slip fault events take place. The average return period for an event with a minimum magnitude of M_w6.0 is 25–30 yr, which increases to ~80–100 yr for M_w~6.5 that can potentially cause serious damage around the Gulf of Kuşadası. Historically, the 47AD M7.0 earthquake (occurred in the proximity of the 2020 M_w7.0 mainshock) caused heavy damage in Samos, Izmir, Ephesus, Miletus, and Chios (Kiratzi et al., 2021).

The geodynamic processes governing the tectonics and seismicity in the region are the westward extrusion of the Anatolian plate, the pulling forces associated with the subduction of the African plate along the Hellenic arc, and the gravitational forces associated with the elevated topography in western

Anatolia (Wortel and Spakman 2000; Ganas et al., 2009; Van Hinsbergen et al., 2010; Biryol et al., 2011; Jolivet et al., 2013; Roche et al., 2019; Kiratzi et al., 2021). As a result of the tectonic kinematics, the slip-rates along the strike-slip and normal faults in the region are in the order of 5-10 mm/yr (Vernant et al., 2014).

The İzmir region is influenced by the same geodynamic processes, and the surroundings of Izmir were hit by several large-size earthquakes such as those that occurred in 1668, 1739, and 1778 (Ambraseys and Finkel, 1995). The relatively large slip rates in the region (5-10 mm/yr) and the observed seismic activity in the proximity of Izmir potentially increases the likelihood of large earthquakes hitting this city. Such major earthquakes would inflict severe damage in Izmir, which was dramatically experienced in the October 30th, 2020 earthquake (117 people lost their lives in that earthquake).

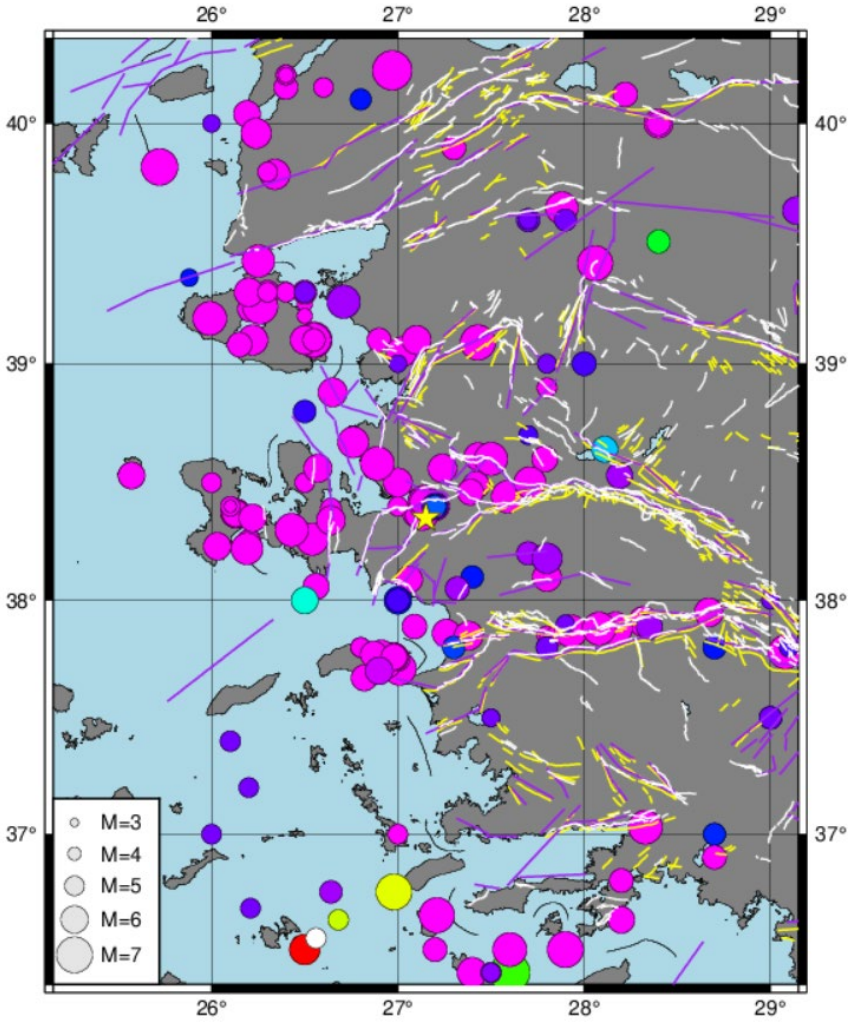

Figure 3. The historical earthquakes in the region during the period 1000-1899. Active faults in the region are also shown.

We note that several moderate-size earthquakes occurred around the city of Izmir in the past thirty years such as the 1992-Doganbey (M_w6.0), 2003-Urla (M_w5.7), and 2005-Seferihisar (M_w5.9) earthquakes that resulted in local (minor-to-moderate) damage. These observations also fortify the highlighted remark in the previous paragraph that pinpoints the expectation of significant loss in Izmir after being hit by a large earthquake.

3. Interaction Between the 30 October 2020 and the 27 January 2024 Events

The fault plane ruptured by the October 30th, 2020 earthquake is located to the north of Samos island dipping northward. Figure 4 shows the Coulomb failure stress fields for the optimally oriented normal faults since the fault plane solutions of the 2020 and 2024 earthquakes indicate a dominant normal faulting. The red colors in Figure 4 denote the regions of increased failure stress whereas the blue colors indicate the regions of decreased failure stress. It is obvious from Figure 4 that the January 27th, 2024 M_w5.0 earthquake is located in the area of increased stress resulting from the slip along the ruptured fault plane of the 2020 M_w7.0 earthquake.

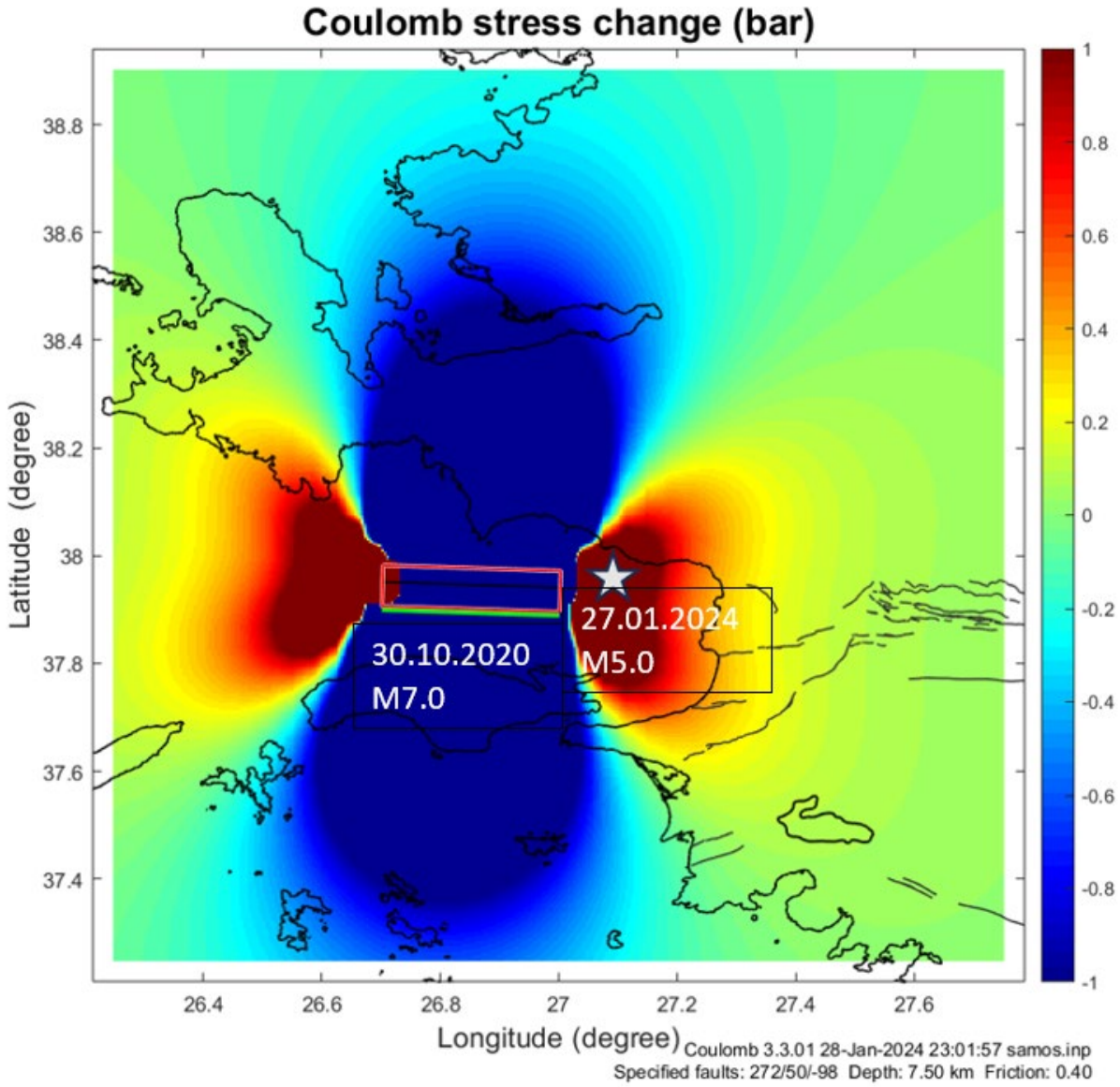

Figure 4. The kinematic interaction between the October 30th, 2020 Mw7.0 and January 27th, 2024 M_w5.0 earthquakes. The rectangle stands for the fault plane ruptured by the 2020 event and the star indicates the location of the 2024 earthquake. The red color denotes the regions of increased stress whereas the blue colored-regions are indicator of stress decrease.

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