Event Brief

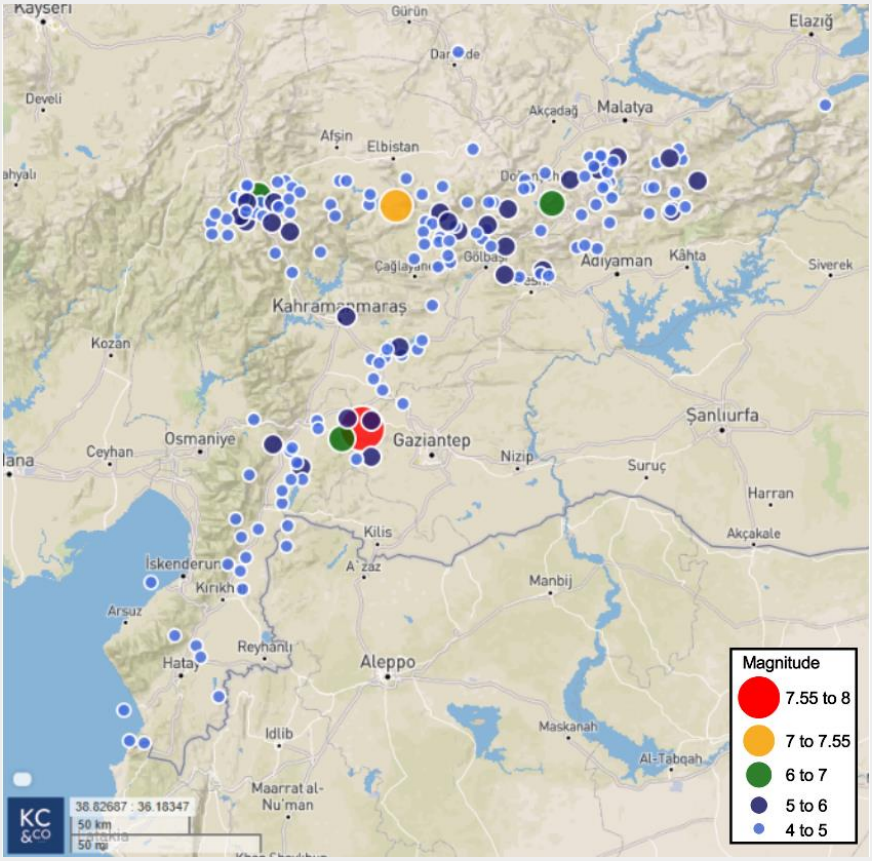
# 6 February 2023 – Dual Kahramanmaras Earthquakes

According to the high-resolution KCC Turkey Earthquake Reference Model, **the total property losses from the M7.8 and M7.5 earthquakes are expected to be close to $20 billion**, with the M7.8 earthquake accounting for the bulk of those losses. **Total insured losses are estimated to be $2.4 billion.** The loss figures do not include losses within Syria.

## Event Highlights

- On February 6, a M7.8 earthquake shook southeast Turkey and northwest Syria, with an epicenter in Kahramanmaras province, Turkey, followed hours later by a M7.5 earthquake with an epicenter 50 miles to the north
- Between February 3rd and February 10th, the region experienced 165 M4+ foreshocks and aftershocks, the largest of which was M7.5
- Because eastern Turkey sits at the convergence of the African, Arabian, and Anatolian plates, earthquakes in the area are not uncommon, though Turkey hasn't experienced an event of M7.8 since 1939
- Buildings, roads, and infrastructure suffered major damage, with more than 41,000 buildings badly damaged or collapsed and more than 35,000 lives lost

## Technical Summary




**Seismic activity from Feb 3-10, within ~300km of the M7.8 epicenter**

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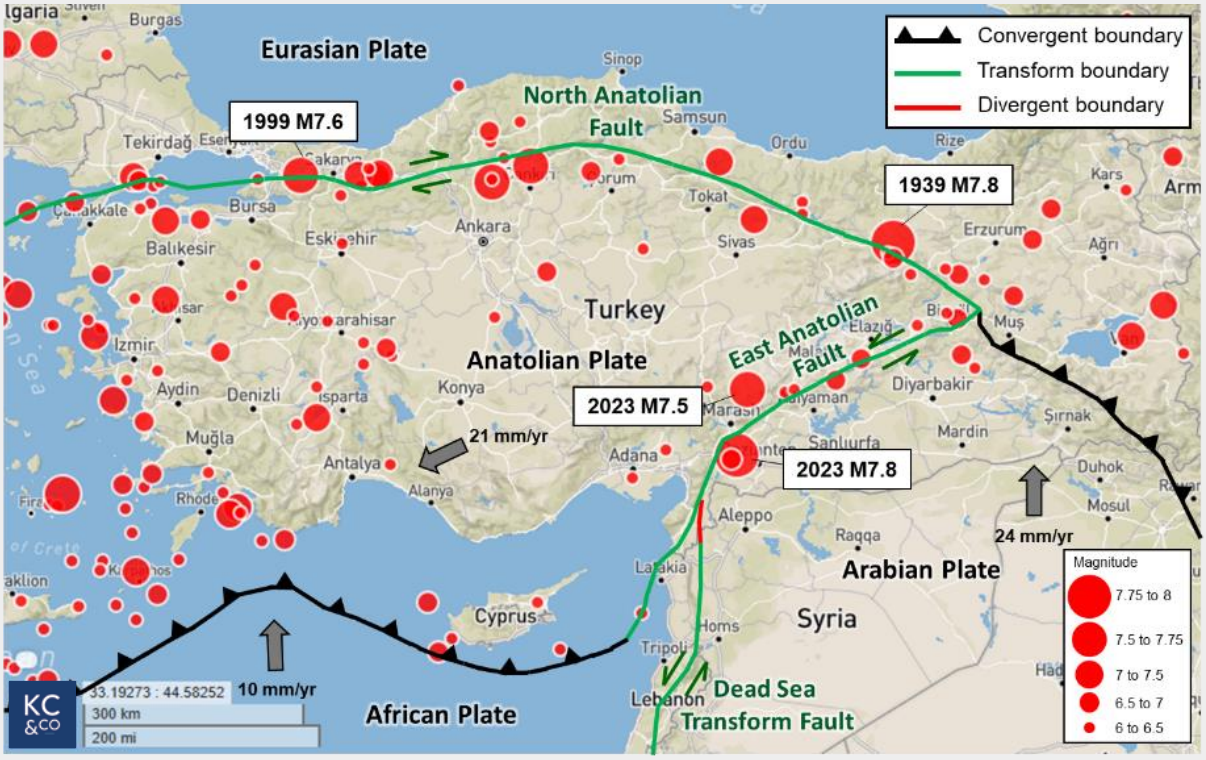
The February 6th M7.8 earthquake occurred near a triple junction of three tectonic plates in southeastern Turkey near the Turkey-Syria border, approximately 21 miles west of Gaziantep. It was followed by numerous aftershocks, the largest of which was a M7.5. **The mainshock is the largest magnitude event to occur in Turkey since the 1939 Erzincan M7.8 earthquake**, though a large-magnitude earthquake (M7.6) did strike the region near Izmit in 1999.




**Tectonic setting and historical seismicity (1900-2023) M6.0 and greater for Turkey**

The US Geological Survey (USGS) has attributed the mainshock event to *strike-slip faulting* at shallow depth on a steeply dipping fault, likely within the East Anatolian fault zone. Strike-slip faulting occurs when the (crustal) blocks on either side of the fault line slide past each other horizontally. Another well-known example of a plate boundary strike-slip fault is the San Andreas Fault.

In southeastern Turkey, the African, Arabian, and Anatolian plates meet along a series of primarily transform plate boundaries. In a process known as *tectonic accommodation*, plates adjust and deform in response to stress and strain. In this case, translational motion between the Anatolian and Arabian plates is accommodated along the East Anatolian fault zone, with the Anatolian plate moving southwest. In northern Turkey, the southwest motion of the Anatolian plate is accommodated along the North Anatolian fault zone, which delineates the transform boundary between the Anatolian and Eurasian plates. Earthquakes are common near these strike-slip fault systems, with more than 50 earthquakes of M6 or larger since 1900, including 12 earthquakes that were M7 or larger.

## Impacts

Across 10 of Turkey's 81 provinces, the earthquake destroyed or heavily damaged more than 41,000 buildings, most of which were poorly designed or constructed. Of those 41,000 buildings, many were mid-rise multi-family residences constructed of reinforced concrete, though many commercial and industrial buildings were also completely destroyed. More than 35,000 people are reported dead from the earthquake, a number that's expected to rise as search and rescue efforts continue. The death toll is now considerably higher than the 2011 Tohoku (19,759) and the 1999 Ismit (18,373) earthquakes.

Historically in Turkey, reinforced concrete buildings tend to fail because of poor concrete quality and lack of sufficient longitudinal and transverse reinforcement. In addition, buildings in the region are more likely to have open ground floors, making them more susceptible to *soft story* failure. And finally, weak links between columns and beams can lead to *pancake collapse*. Following the Izmit earthquake of 1999, Turkish authorities attempted to enforce building codes for new construction with more rigor, but most of Turkey's buildings were constructed before that change.

The most affected areas in Turkey are Gaziantep, Kahramanmaras, Malatya, Osmaniye, Iskenderun, Antakya, and Adana, with significant damage in Sanliurfa and Diyarbakir as well.

**The widespread damage to buildings, especially near the epicenter, can be attributed in part to ground motion acceleration that was much more intense than the buildings were designed to withstand. That said, much of the damage stems from poor construction practices and lax enforcement of building codes.**