EVALUATION OF RECENT EARTHQUAKES IN TERMS OF TURKEY AND THE EASTERN MEDITERRANEAN[1]

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ABSTRACT

According to the records of the Disaster and Emergency Management Presidency (AFAD), a devastating earthquake with an instrumental magnitude (Mw) of 7.8 occurred around Kahramanmaraş-Pazarcık on 06 February 2023 at 04:17 local time. Approximately 9 hours after this earthquake, a second destructive earthquake occurred around Kahramanmaraş-Elbistan at 13.24 local time with an instrumental magnitude (Mw) of 7.6. In AFAD records, the coordinates of the first earthquake in question are 37.288N - 37.043E, focal depth is 8.6 km; The coordinate of the second earthquake is 38.089N – 37.239E, and the focal depth is 7.0 km. On February 20, 2023, an earthquake with an instrumental magnitude (Mw) of 6.4 occurred around Hatay-Defne at 20:04 local time. In the AFAD-DDB records, the coordinate of the earthquake in question is 36.121N-36.074E, and the focal depth is 16.74 km. It was felt very strongly in Kahramanmaraş as well as in Hatay, Adıyaman, Gaziantep, Malatya, Kilis, Diyarbakır, Adana, Osmaniye and Şanlıurfa. In addition, more than 8,500 aftershocks with an instrumental magnitude of 6.6 occurred.

Keywords: Earthquakes, Turkey, The Eastern Mediterranean

INTRODUCTION

An earthquake is the event of seismic fluctuations that occur as a result of unexpected energy in the earth's crust and the shaking of the earth by these waves. Earthquakes may occur due to volcanic eruptions and major collapses on the earth, as well as earthquakes originating from faults (fractures) caused by tectonic activity in the earth's crust. However, the most known and common of these are tectonic movements and fault-induced earthquakes.

The average thickness of the earth's crust is 0-35 km. However, this thickness is 35-70 km in the continental crust and 5-8 km in the oceanic crust (Figure 1a). The part called the lithosphere consists of the earth's crust and the uppermost mantle, and has a thickness of 670 km from the earth's surface. As you go deeper into the ground, the Asthenosphere is passed. The asthenosphere is the molten portion of the upper mantle. This section is in basaltic lava composition and forms a magma source for volcanic activities. The lower mantle below it is in magnesium and ferrous silicate composition; It has a temperature of 1900 °C. The thickness

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of the mantle together with the lithosphere is 2900 km. The outer core is a mixture of molten iron and nickel, at a temperature of 3700 °C and a thickness of 2250 km. The inner core at the center of the Earth is 1220 km thick and has a temperature of 4500 °C. [1], [2].

The face of our world, which has existed for billions of years, has changed many times until today. The surface of the earth's crust is not made of a single whole crust as in a rubber ball, but without deforming its spherical shape; It consists of many pieces, such as cracked eggshells. Sometimes these single, giant or tiny pieces of crust that can cover oceanic and continental crustal areas together are called plates. There are many smaller plates in the earth's crust, apart from plates such as the Pacific Ocean, Eurasia, Arabia, South America, North America, Africa, Nazca, India-Australia, Antarctica, Cocos, Tongo, Anatolian plates (Figure 2a). Plates can be made up of continental crust that forms continents and oceanic crust that forms the bottom of the oceans, or just one of these. The heat produced in the central parts of the earth always tries to move outward by passing through the mantle. This event causes the movement of the upper mantle and the development of convection currents there (Figure 1b). These movements cause the fragile earth crust pieces (plates) covering the earth to move due to friction, causing the eruption of volcanoes due to the fractures that occur, and the opening or closing of the oceans between the continents. The continental crusts of the plates sometimes diverge like free-floating rafts in a lake, and sometimes they converge. The convergence causes the oceanic crust to rupture and plunge into the earth, thus colliding after the subduction of the oceanic crust. With the continental crust sections under the influence of convection currents moving away from each other, the crust splits into two parts and the pieces begin to move away from each other. This divergence allows for the development of an expanding ocean and a growing oceanic crust between the two parts. The movement speed of the plates varies up to 24 cm/year. As seen in Figure 2a, this causes constant changes in the geography and space of the continents and tectonic activity (earthquakes) on a global scale (Figure 2b).

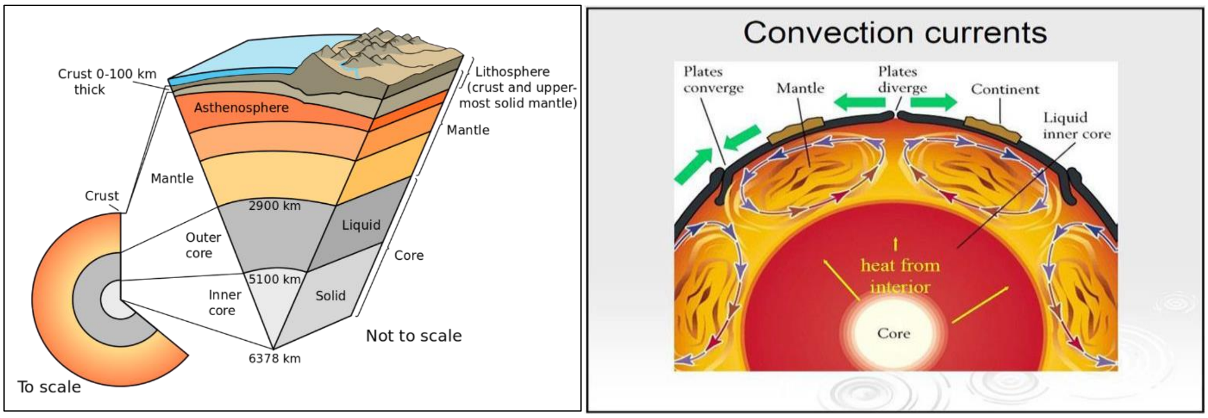

Figure 1- a) Figure showing the zoned internal structure of the Earth b) Schematic view of convection currents resulting from the movement of magma

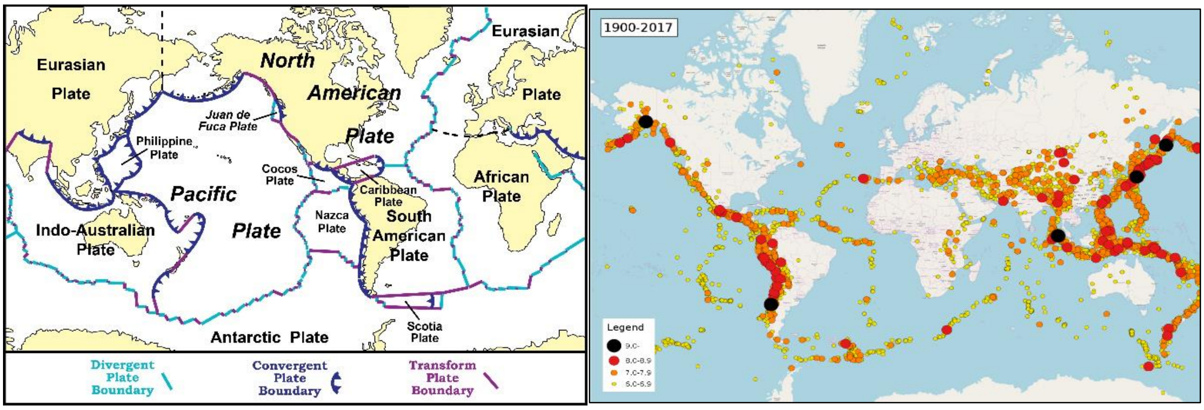

Figure 2- a) Large plates formed in the earth's crust b) Earthquake activities along plate boundaries between 1900-2017

WHY IS TURKEY AN EARTHQUAKE COUNTRY AND WHY ARE THESE EARTHQUAKES SO DESTRUCTIVE?

Turkey is a country under the influence of large plates on a global scale. For this reason, due to the thrust exerted by these large plates on each other, fractures occur along certain zones. The most well-known and largest of these fracture zones are the North Anatolian Fault Zone (NAFZ), the East Anatolian Fault Zone (EAFZ) and the Dead Sea Fault Zone (ÖDFZ). These faults are strike-slip faults due to their structure and mechanism. The faults are classified as normal faults and reverse faults that have vertical slip according to their working mechanisms in the earth's crust, and strike-slip faults that move laterally with respect to each other [2], [3]. Sometimes there are also oblique (oblique) slip faults with both vertical and horizontal components (Figure 3).

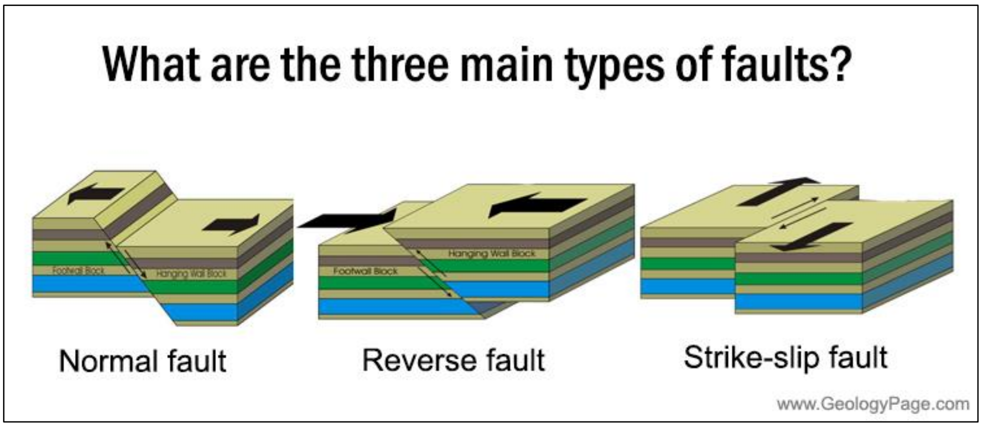

Figure 3- Schematic representation of fault types

The recent earthquakes we have experienced are earthquakes formed by strike-slip faults (EAFZ, ÖDFZ) at a triple junction point located in the vicinity of Kahramanmaraş, similar to the one in Japan. Seismic waves produced by strike-slip faults are R (Rayleigh) and L (Love) waves, which are called surface waves, and these are the most destructive waves on structures (Figure 4). Turkey is in the position of a country where large-scale and severe earthquakes are always possible with its active tectonic structure, which is close to the major plate boundaries and as a result of the movements of these large plates. The USGS (US Center for Geological Survey) has released an aftershock statement for the M7.8 earthquake, explaining what could happen next month. The statement describes three scenarios and the most likely scenario shows that the frequency of earthquakes has decreased by 90 percent and none greater than the M7. In this scenario, moderate aftershocks are likely between M5 and M6. These moderate earthquakes can cause damage, especially to weakened or old buildings that are not built to withstand earthquakes. The other two scenarios are less likely, but more extreme. There is a 10 percent probability that an aftershock will be M7.0, and the probability that the aftershock will be similar in size or greater than the M7.8 mainshock is about one percent. Whatever the scenario, smaller earthquakes between M3 and M4 will continue to be felt by people near their epicenters. Sequences of aftershocks can last for years to decades, long after people stop feeling increasingly smaller earthquakes. In order to minimize the damages of this situation, it is imperative to construct structures suitable for this active seismic structure and soils [4], [5].

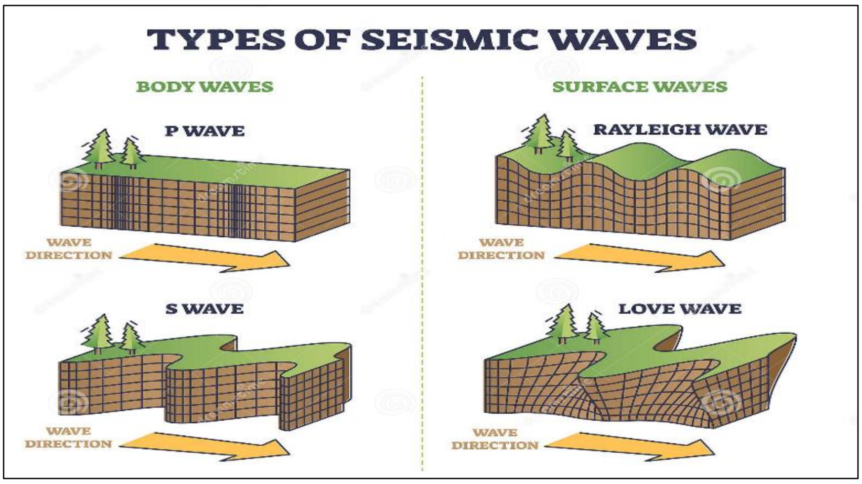

Figure 4- Types of seismic waves

POSSIBLE RISK AREAS FOR TURKEY AND THE EASTERN MEDITERRANEAN AND CONCLUSION

Along the border between the Eurasian and Anatolian plate, the Anatolian plate is moving relatively to the West. Earthquakes will continue to occur here with the temperature difference in the supply due to the plate boundary and the movement in the plates. As the energy accumulated in the region in recent earthquakes is relieved by rupture, it is expected that the new stress will be at the edge of the fault where the rupture occurs. Therefore, the area between Elazığ-Bingöl-Karlıova starting from Malatya on the Eastern Anatolian Fault Line in the north is also expected as areas that may pose a risk. In the south, there are Hatay and Adana basins, and after the earthquake in Hatay, the energy may have been transferred to other faults with the movement of the plate. The continuation of the Adana basin is bordered by Cyprus. For this reason, there is a risky area from Adana to the south to Cyprus, which can also include Lebanon (Figure 5). However, Turkey's most dangerous seismic boundary is a 1650-kilometer zone extending from Karlıova to Greece. The studies carried out always keep

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the possibility of a possible Marmara and Istanbul earthquake on the agenda. In addition, there are active faults in the İzmir region, and the large fault in the İzmir Bay carries the risk of producing earthquakes [6], [7].

Figure 5- Tectonic structure and fault zones of East Mediterranean

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