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A Study on Holosen-Pleistosen Sedimentology of Morphotectonic Structure and Seismicity of Gökova Bay

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***Abstract*—**In this research which has been prepared to show the relationship between Gökova Bay's morphotectonic structure and seismicity, it is clear that there are many active faults in the region. The existence of a thick sedimentary accumulation since Late Quaternary times is obvious as a result of the geophysical workings in the region and the interpretation of seismic data which has been planning to be taken from the Bay. In the regions which have been tectonically active according to the interpretation of the taken data, the existence of the successive earthquakes in the last few years is remarkable. By analyzing large earthquakes affecting the areas remaining inside the sediments in West Anatolian Collapse System, this paper aims to reveal the fault systems constituting earthquakes with the information obtained from this study and to determine seismicity of the present residential areas right next to them. It is also aimed to anticipate the measures to be taken against possible earthquake hazards, to identify these areas posing a risk in terms of residential and urban planning and to determine at least partly the characteristics of the basin.

***Keywords*—**Gökova Bay, seismic, sedimentation, West Anatolian Region.

I. Introduction

THE Gulf of Gökova, located in the southeastern Aegean Sea, is a significant active earthquake zone as a result of its continuous tectonic activity. In this study which is prepared to reveal the relationship between morphotectonic structure and seismicity of the Gulf of Gökova, seismic data were interpreted in the Gulf. The results obtained were compared with the current and historical earthquake activities of Gökova region. With the interpretation of the data obtained, it is noteworthy that the earthquakes have happened in last few years in succession in tectonically active regions.

The geological, geophysical and seismological research which has been carried out so far has revealed that Gökova Basin is located in a very large earthquake activity having many young faults and that it is still in an active graben process. When analyzed the historical and instrumental period earthquakes and active faults in the region, it is understood that large earthquakes frequently occurred in the Gulf of Gökova and its surrounding and that many settlements were destroyed by these earthquakes throughout history. The study area is located at the eastern margin of the Gökova rift in the southwest of Anatolia.

The Gökova rift is about 120 km long in the east-west direction, with a maximum width of approximately 30 km. A major part of the rift on the west remains beneath the Aegean Sea and is called the Gulf of Gökova. While NW-SE oriented faulting (pre Miocene rifting) is filled with middle Miocene to Quaternary deposits, EW oriented faulting (after Miocene rifting) is filled with Plio-Quaternary rocks. The Lycian Nappes covering large areas, constitute the basement for both systems (Figs. 1, 2).

Gökova is a tectonically active region where mostly east–west-striking active faults developed as the result of broadly north–south-oriented stress along the eastern coast of the Aegean Sea and the counterclockwise rotation of the western segment of the Aegean–Anatolian Microplate. Despite several on land and marine studies, the Pliocene–Quaternary tectonic evolution of the Gulf of Gökova remains poorly understood [4]-[9].

II. Geological Settings and the Morphotectonic Structure of the Area

The area of eastern Aegean along with the western coasts of Turkey consists of a part of a transition zone of deformation, with a width of the order of 100 km, where the change from the Anatolian movement is translated to the Aegean [10]. The Aegean Sea is characterized by dextral strike-slip faulting along NE-SW striking faults, along fault zones formed parallel to the North Aegean Trough (NAT) [11].

Gökova Fault Zone, one of the most active structure of the Aegean depression system, consists of a normal fault with a length of approximately 180 km starting from Ula in the east and extending to the SW of Istankoy [5], [12]. Two distinct morphological surface types are seen in the north of the Gulf of Gökova (Fig. 2). The topography of the northeastern region between the towns of Akyaka and Akbük includes a prominent hill with ~800 m elevation, with very steep slopes that lead southward to the shoreline [13].

The presence of the Lycian Nappes across the landmass surrounding the Gulf of Gökova strongly suggests that the basement in the marine areas must also consist of the Lycian Nappes. In the multi beam map, there is only a single structure oriented in a northeast–southwest direction. Previous studies have suggested the presence of a sinistral strike slip fault to explain this structure [6], [9].

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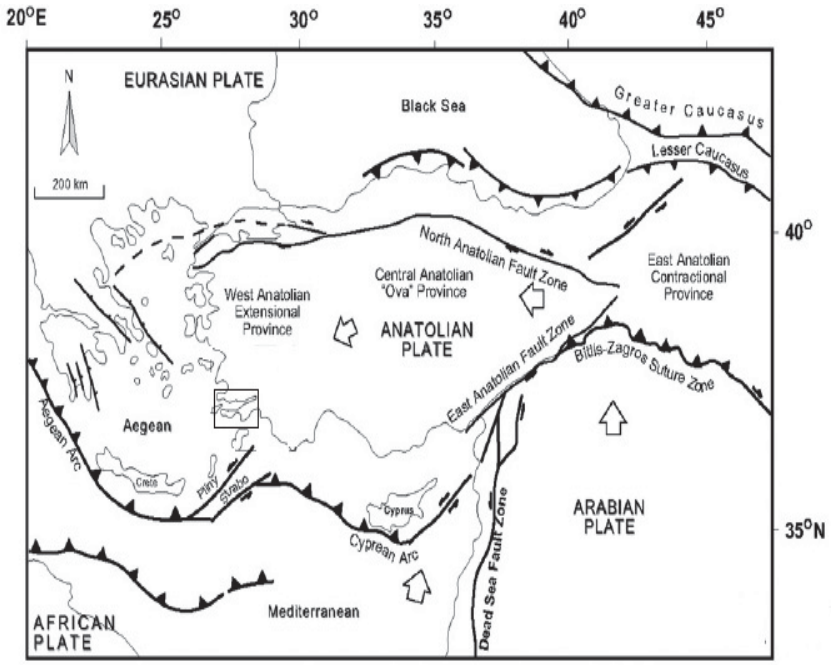


Fig. 1 Tectonic map of the Aegean and western Turkey showing the major tectonic structures (modified from [1], [2])

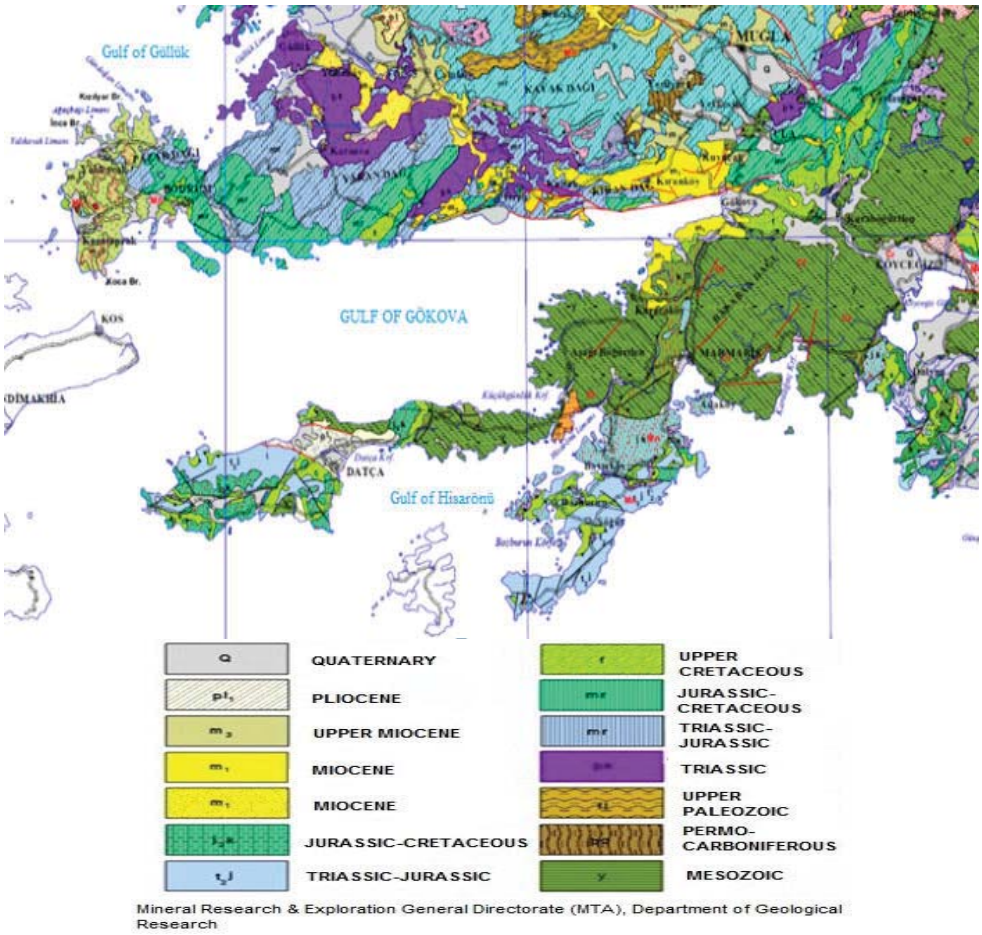


Fig. 2 Geological map of Gökova and Hisarönü region [3]

III. Regional Seismicity and Recent Earthquakes

Aegean region in which the Gulf of Gökova exists is under the influence of active tectonism due to the westward movement of the Anatolian plate as a result of the collision of Arab-African and Eurasian plates [14]-[17]. Where the Arabian plate has been moving toward the north for about 3 million years with the speed of 18-25 mm/year comparing Eurasia; the African plate has been moving toward the north with the speed of 10 mm/year [18]. Whereas the movement of Anatolia is 15/22 mm per year comparing Eurasia, the pace of this movement in Western Anatolia and the Aegean Sea is 30-40 mm/year. Strike-slip motion in NE-SW direction is broadly parallel to the convergence direction of the Aegean-Anatolian and African plates.

In recent and historical times, many destructive earthquakes have occurred in southwestern of Turkey. Most of the seismic activity is concentrated along the northern branch of Gökova Fault Zone and it is controlled by E-W trending normal fault system. Younger active faulting so-called Gökova Transfer Fault (GTF) trends NE in the central part of the Gulf of Gökova basin (Fig. 3). Gökova Fault Zone, one of the most active structure of the Aegean depression system, consists of a normal fault with a length of approximately 180 km starting from Ula in the east and extending to the SW of Istankoy [12], [5].

The Gulf of Gökova was exposed to many earthquakes in its history and the earthquakes which have occurred in this city in the last century can be given as; 1933 (Ms=6.5), 23 May 1941, Muğla Earthquake (Ms=5.9), 13 December 1941, Muğla Earthquake (Ms=5.7), 23 May 1961, Marmaris Earthquake (Ms=6.3), 27 and 28 April 1989 (Mw=5.1, Mw=5.4) and 05 October 1999 (Mw=5.2) Gökova Earthquake (Fig. 4 (a)). In the region, lastly in August 2004 and January 2005 seismic activities have been observed. The other activity affecting the city of Muğla occurred in May 2015 (Fig. 4 (b)).

With the conclusions drawn from the literature research, even though it is emphasized that the earthquake activity of the Gulf of Gökova (Fig. 5) and its surrounding is located in E-W trending faults and on its parallels which generally forms the gulf, it is seen that the ongoing earthquake activity which started inside the Gulf of Gökova on 29 May 2015 was not on the fault zones which has been anticipated so far. On the contrary as suggested by [9], it occurred on a new zone (Gökova Transfer Zone=GTZ) which divides the Gulf of Gökova in half in NE-SW direction. According to the generated model, it can be said that having divided in half along GTZ, western and eastern side of the Basin of Gökova move differently and that a new rift has probably started along this zone.

In Fig. 5, the focal distribution of the earthquakes recorded in the Gökova region shows that there is relatively a high activity in the northern part of the gulf and along the northeast - southwest oriented Gökova Transfer Zone. Necessary measures should be taken in the project development stage for any buildings to be constructed in the Gulf of Gökova and on its land extension considering the intense seismic activity seen in the area.

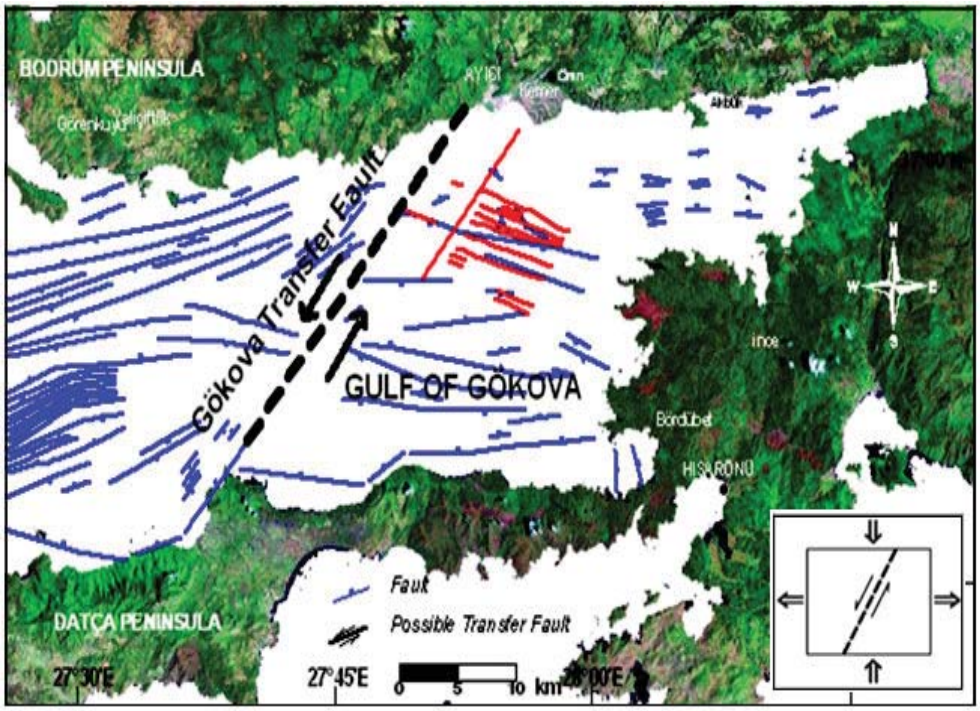
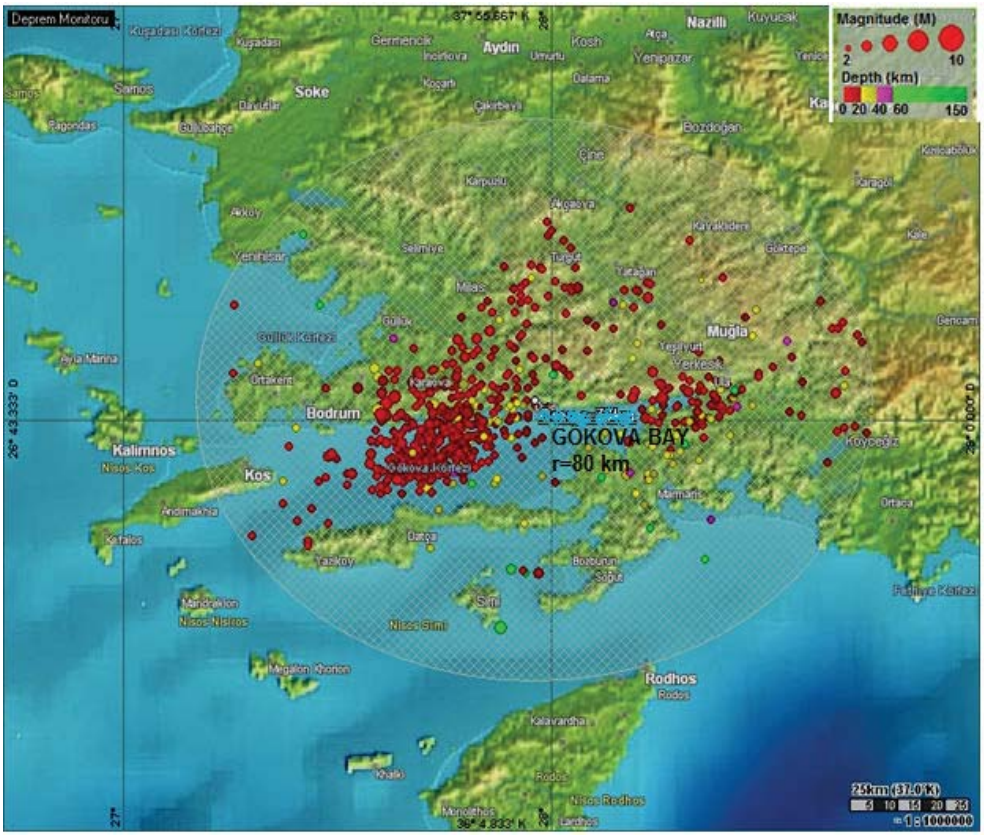
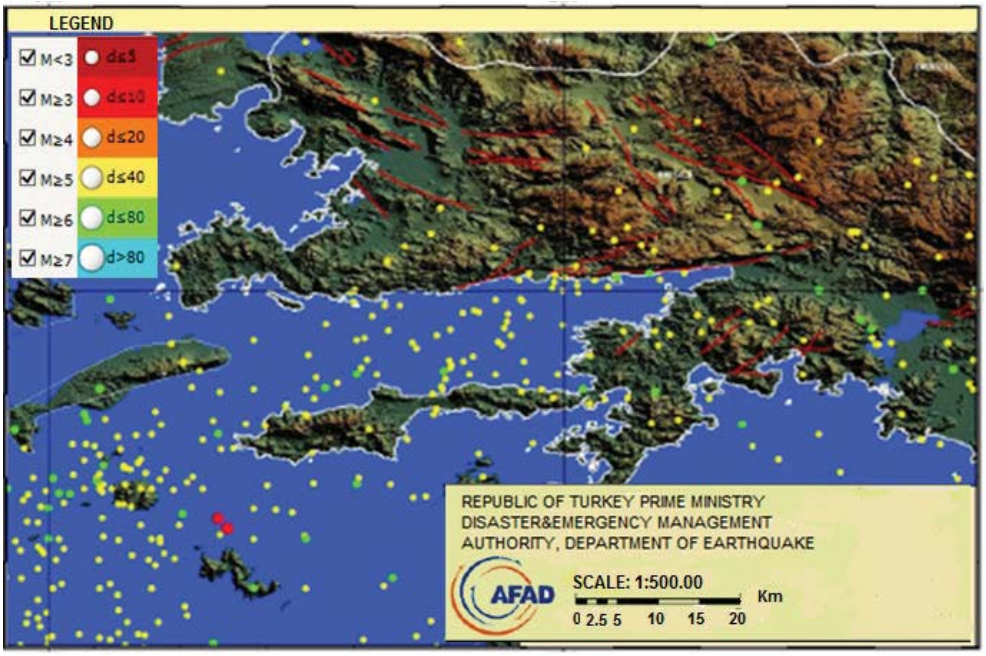


Fig. 3 Fault map of Gökova Gulf (modified from [9])



(a)



(b)

Fig. 4 (a) Recent Earthquakes in Gökova Bay (b) Gulf of Gökova Earthquake Activity, AFAD -TDVM [19]

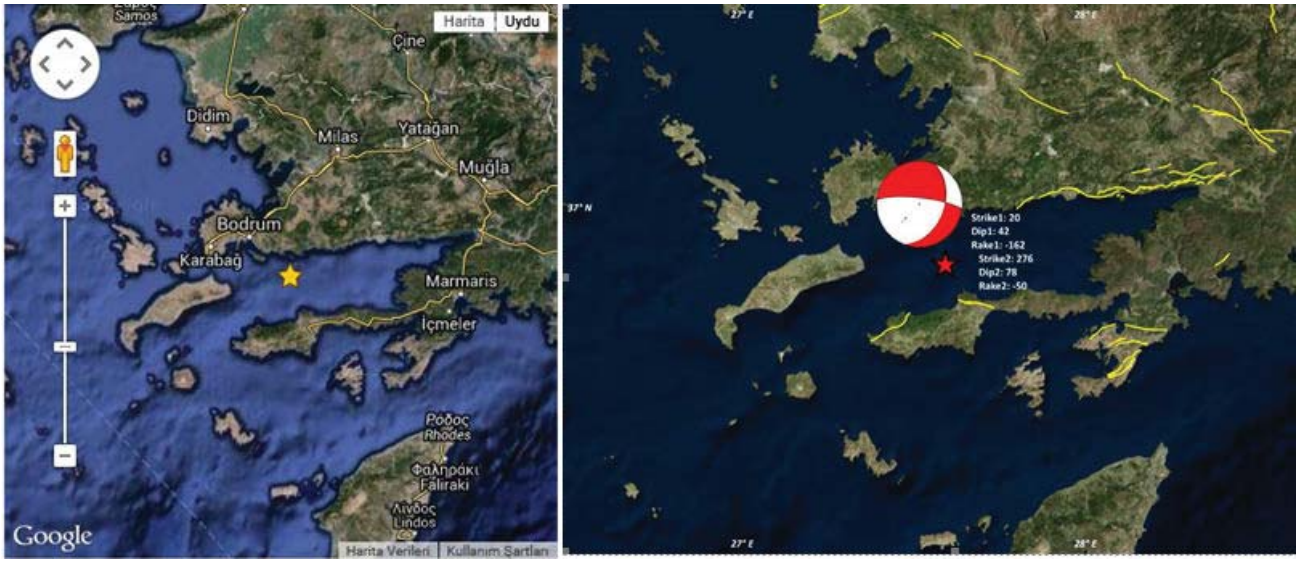


Fig. 5 On May 29th, 2015 at 11:02, an earthquake occurred in the Gökova Bay and its Focal mechanism solution [19]

IV. Materials and Methods

When considering the region's seismic activity, the presence of active earthquake faults within the bay is obvious. The onshore extensions of some faults which are also thought to be involved in the formation of the Gulf are known but its marine extensions can be inferentially shown. A high differential bathymetric map is used to detect the extension of these faults in the seabed, its location and its effects on the surface. Thus, these bathymetry studies, as well as the seismological and tectonic studies, are also important in terms of the determination of earthquake hazards in and around Gulf of Gökova and the introduction of earthquake scenarios with the minimized errors.

V. Conclusion

To determine the history of high seismic hazard fault system, their existing situation and potential to create future earthquakes is possible with the use of current techniques in the way that supports multidisciplinary studies. The recognition of fault systems with the potential to produce earthquakes is possible with paleo-seismology, improvement of earthquake catalog and detection of the past with the determination of the historical period of earthquake activity. It is also possible with evaluation of this information together with current geological, geophysical, geochemical and geodetic inputs.

Especially for regions with high seismic activity, this and similar studies will provide the collection of information about the seismo-dynamic features and seismicity of the region. Making more of this and similar studies will make an impact in raising awareness of earthquake socially and institutionally for all of Turkey.

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