TRACING ACTIVE FAULTS USING BY TECTONIC FEATURES IN SOMA (MANISA-TURKEY)

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Abstract - Western Anatolia is one of the seismically active regions in the world. Thus, the graben faults forming the Aegean Graben system produce many destructive earthquakes in historical and instrumental periods and the process is going on. The traces of some of these faults forming surface rupture may disappear over time or may be covered by recent Holocene sediments and they cannot be clearly observed on the surface. Some techniques are required to trace them. In this study, a buried fault location was examined to find out, using by morphotectonic data.

Index Terms - Tectonic, active fault, surface rupture, graben, Soma

I. INTRODUCTION

The western Aegean region of Turkey is dominated by grabens in E-W direction (Buyuk Menderes Graben, Gediz-Alasehir Graben, Kucuk Menderes Graben) due to the extension in N-S direction (Fig. 1). The NW-SE NE-SW directional grabens (eastern part of Gediz-Alasehir Graben, Denizli Graben, Dinar-Civril Graben) and NE-SW directional grabens (Baklan Graben, Acigol Graben, Burdur Graben) are located at the east of the Aegean region. The earthquake focal mechanisms of the regional earthquakes propose that active extension is in N-S and NNE-SSW direction [1, 2] and it started 14 million years ago.

Detailed geological surveys [3, 4, 5, 6, 7, 8] as well as many tectonic and seismo-tectonic models [9, 10, 11, 12, 13, 14, 15] have been suggested and discussed. The stress in N-S direction on Western Anatolian block and the Aegean Sea has caused by the compression in western Anatolia due to the movement along the North Anatolian fault. Additionally, Le Pichon and Angelier [16] and McKenzie [10] have claimed that the tension is entirely related to Hellenic subduction. Kocyigit [4] proposes that these structures developed in the form of block-faulting in four different directions of extension of NW-SE, NW-SW, NW-G and NW-D directions. Sengor et al., [17] and Sengor [14] (1987) interpreted these different orientations in western Anatolia as "cross-graben". Jackson [18] tried to explain the deformation in the Aegean Sea by using the broken boards model, it is thought that this model explains the deformation before the rotational movement of the Anatolian block. Barka and Reilenger [19] have identified a Western Anatolian block limited to the Eskişehir fault and the Fethiye-Burdur fault by considering GPS and neotectonic data.

Edge faults of the grabens formed by the extension in Western Anatolia are also active and these faults produced destructive earthquakes in the historical and instrumental period. Active faults that cause earthquakes in the region are generally known. However, in some of these faults that have produced earthquakes and surface ruptures in the past, the traces on earth cannot be seen clearly. The traces of them may have disappeared and/or the Holocene sediments may cover them over time. In addition, the sedimentation rate of current sediments may be high in residential areas. It is crucial to know these lines before any construction.

It is possible to determine these buried fault lines by using the tectonic features. In areas where these data are not available, some different methods can also be employed. The trenches were dug to trace the active faults and the tectonic development of the study area was explained in the light of the findings.

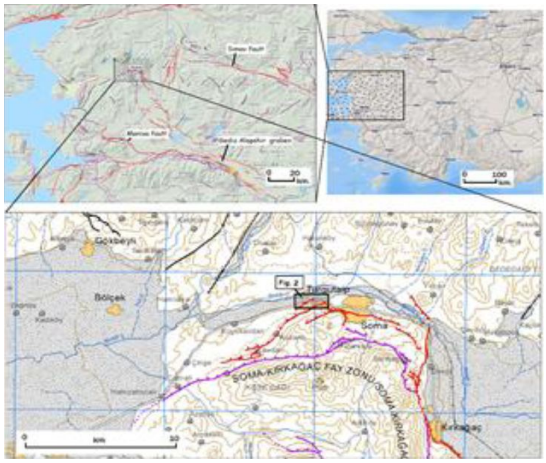


Fig. 1 Location map of the study area and active tectonic features in western Turkey [22, 23].

II. SEISMICITY OF THE WESTERN ANATOLIA AND SOMA REGION

Aegean Region is located in a very active earthquake zone not only at the instrumental period but also at the historical age. Consequently, they have become a very

important natural phenomenon leaving traces in many civilizations in the region. The large earthquakes in Western Anatolia have also generally formed surface ruptures. The Cyprus-Hellenic arc, located at the southern parts of the zone, is a subduction zone and the faults in this zone especially around Cretan and Rhodes produce earthquakes M>6.0. The earthquakes in Burdur Fethiye fault zone within are NE-SW trending. A study conducted by using the seismic moments and focal mechanism solutions of the earthquakes has revealed that Southeastern Anatolia extends within north-south direction with the speed of 13.5 mm in a year [20]. This study proposes that the majority of the earthquakes in Western Anatolia occur in the fragile section of the crust at the upper part with an area of 8-10 km and the crust has a more ductile structure at this depth. However, the earthquakes at offshore of Rhodes and Antalya gulf could reach up to 200 km depths.

Sultandagi-Cay (Afyon) earthquakes took place in February 2002 in the eastern of Western Anatolia. Four earthquakes and aftershocks M>5.0 occurred. Three earthquakes M>5.0 recorded in July 2003 in Buldan zone. Three earthquakes similar in Buldan in August 2004 on Mugla-Gokova fault and two earthquakes M>5.9 happened on the Izmir-Seferihisar fault in October 2005. The earthquake activity (M=5.7 and 5.6) has continued about a month in those area. Cameli earthquake (M=5.0) occurred in November 2007. Bodrum, Ula and Ayvalik earthquakes in western and eastern side of Gokova fault, at offshore of the Aegean Sea have been recorded respectively in 2017.

III. PALEOSEISMOLOGICAL STUDY IN SOMA

The morphotectonic linearization at the south of the Turgutalp region and the morphotectonic elevation nearby is exceptionally distinguishing structure. The bedding angles of the Neogene sediments suddenly increase along this line though the bedding angles are much lower in southern parts.

This indication is a clear evident of a fault line which should be located close to this site. This morphotectonic linearization was followed towards the NE due to the formation of lithological contacts at the same time. There is abundant decomposition and deformation zone in sedimentary deposits containing coal on a road cut in the north eastern part of the area. This data also strengthens the possibility that the fault will pass immediately north of this location.

Normally, the line fault which should continue towards NE cannot be traced because of the alluvium cover. However, a creek streams towards the west along the Akhisar-Bergama state road but it suddenly turns to the north. It was interpreted that a fault controls this morphological structure then a detailed study was made in this section (Fig. 2, 3). An appropriate location was selected on this structure and a trench was opened for paleoseismic examination.

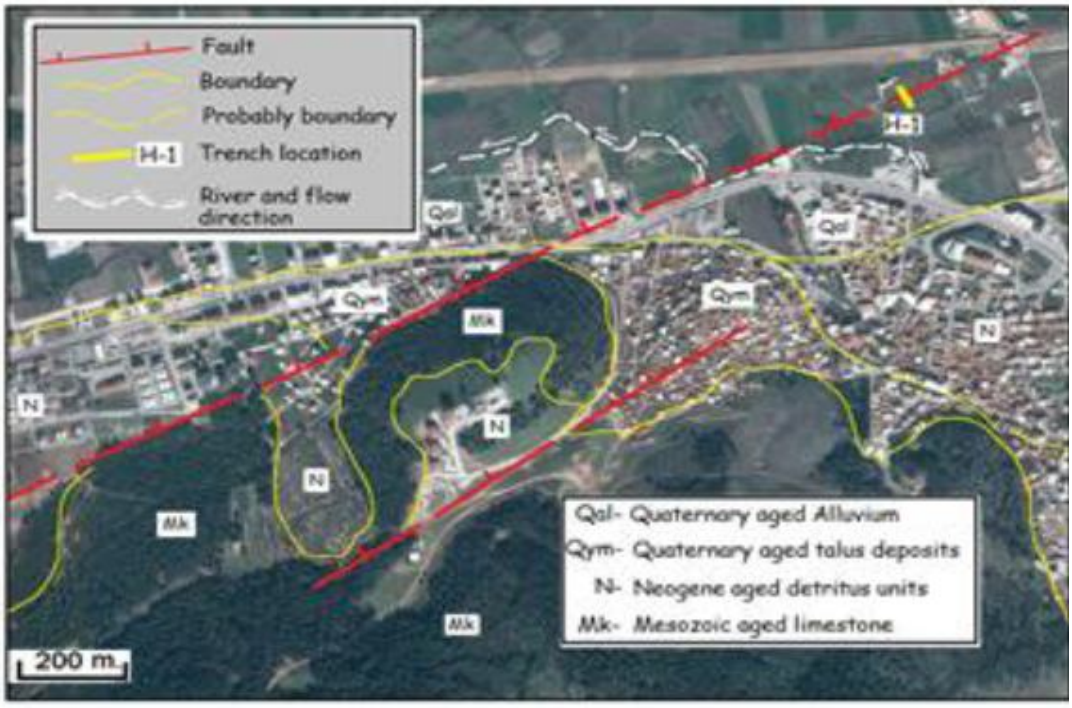


Fig. 2. Detailed geological map of the study area (on Google map)

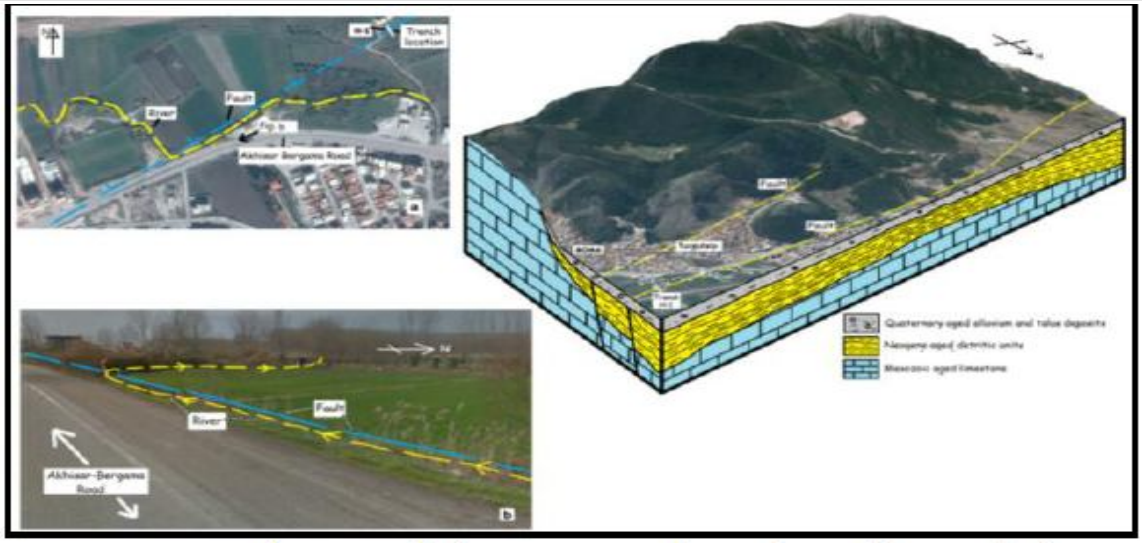


Fig. 3. Map and view of the examined creek, and unscaled block diagram of the area.

The trench dimension is 27 meters long, 2 meters depth and 2 meters wide opening in the direction of N30^{0}W is. The fault was clearly shown in this trench. The bottom of trench stratigraphy is dominated by sandy clay and only clay in some levels. On top of it, 5-10 cm thick light-gray colored clay is observed. On the of the trench, there is a clay band 80 cm thickness in SE and it reaches up to 1.5 meter towards NW. Gray clayey gravel level is located in the ceiling block of this fault. This level contains about 10-15 cm thick black gravel band. The color of the unit is originated from coal debris. Approximately 15 cm thick sandy is found on this unit. The natural soil is located at the top of the stratigraphy (Fig. 4). The fault position is in the N50^0-60^{0}E direction, the fault line inclination towards SW, and the inclination angle is 40^0. The gravely and clayey levels are encountered along the fault contact, which is a normal fault character. The level of black gravel found in the ceiling block is tilted as it approaches towards the fault line. The fault is covered up by natural soil (Fig. 4).

IV. DISCUSSION AND RESULTS

Western Anatolia is one of the highest earthquake risk areas in Turkey. Generally, E-W directional grabens and normal faults forming these grabens are the most prominent tectonic structures of the region. The majority of these faults have produced destructive earthquakes in historical and instrumental periods and they still continue to produce them. The examined line fault which should continue towards NE could not be traced because of the alluvium cover. However, a creek streamed towards the west along the Akhisar-Bergama state road but it suddenly turns to the north. It was interpreted that a fault controls this morphological structure. The detailed paleoseismic studies are essential in microzoning studies for urban planning. The tectonic features were made possible to trace the buried fault lines with a pinpoint accuracy are critical for determining possible bumper zones for the contruction.

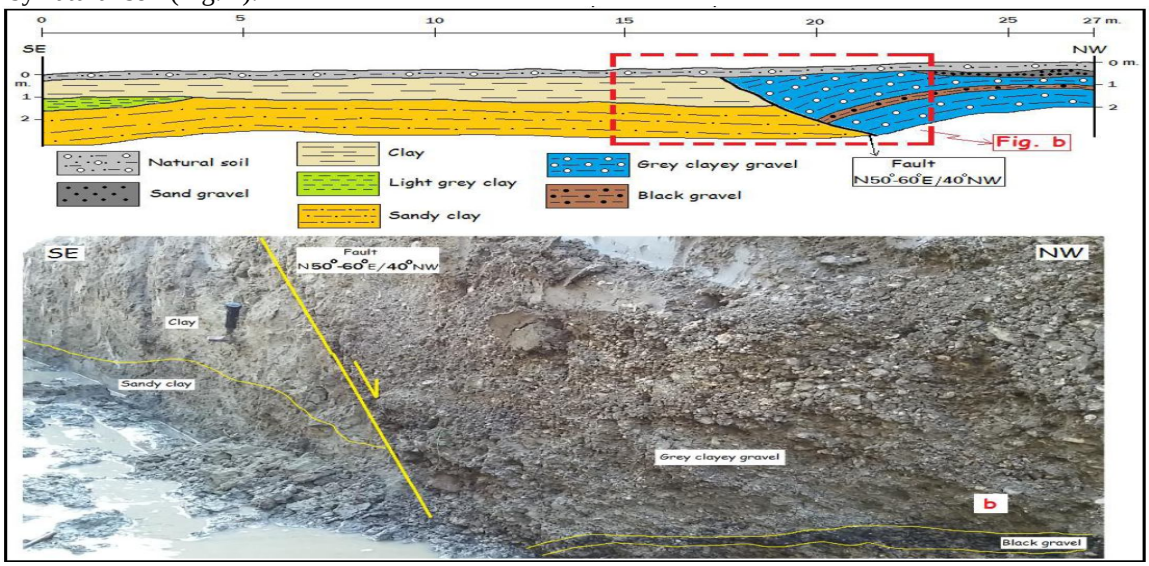


Fig. 4. Geological cross section of SW wall of the trench and it view with lithological units.

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