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The dense micro-earthquake activity at the boundary between the Anatolian and South Aegean microplates

Onur Tan*

TÜBİTAK Marmara Research Centre, Earth and Marine Sciences Institute, Gebze, Kocaeli, Turkey

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ABSTRACT

The Aegean coast of Turkey is a transition zone between the Anatolian and the South Aegean microplates. The recent geophysical studies suggest the existence of additional microplates and suggest a modification of the block boundaries; the Karaburun Peninsula is most likely located on one of these boundaries. The earthquake activity in and around the peninsula was very low until the M_w 5.8 Sığacık Bay earthquake of 17 October 2005. The continuing seismicity in the Karaburun Peninsula has been monitored with the help of the dense seismology network. I re-located more than 5000 earthquakes using the double-difference algorithm and obtained fault plane solutions to understand the seismotectonic properties of the region. It is found that the micro-seismic activity has increased towards the NW of the Sığacık Bay. These observations imply the existence of a NW–SE-oriented sinistral strike-slip fault. This fault is possibly a conjugate of the dominant NE–SW-oriented dextral strike-slip faults in this transition region occupying the area between western Anatolia and the mainland of Greece, where a dominantly extensional regime prevails. Moreover, it is clear that the micro-earthquake activity is related to the Uzunkuyu Intrusive located in the middle of an approximately 40 km strike-slip Karaburun Seismic Zone between the Sığacık and Gerence bays.

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1. Introduction

The Aegean is one of the most active continental extension areas on the Earth (McKenzie, 1972; Angelier, 1978; Şengör et al., 1984). The driving force of the N–S extension in the Aegean Sea and in western Anatolia is the slab pull force of the Hellenic subduction zone (McKenzie, 1978; Le Pichon and Angelier, 1979) and/or the westward escape of Anatolia (Dewey and Sengör, 1979; Taymaz et al., 1991). The GPS surveys performed in the last two decades enhance our understanding of the kinematics of the region (Billiris et al., 1991; Le Pichon et al., 1995; McClusky et al., 2000; Meade et al., 2002; Reilinger et al., 2010). Block modelling, used with mainly GPS data, shows that the crustal deformation in the Aegean cannot be defined with simplified tectonic models. The recent geophysical studies suggest additional microplates and modify the block boundaries to minimize the residuals between the observed data and the model (Meade et al., 2002; Nyst and Thatcher, 2004).

The tectonic evolution of western Anatolia has been the subject of several recent publications (Hancock and Barka, 1987; Bozkurt, 2001, 2003; Genç et al., 2001; Koçyiğit, 2005; Bozkurt and Rojay, 2005) and thus will not be discussed in this paper. Although large E–W graben systems (i.e., Gediz and Büyük Menderes) with normal faults are dominantly observed in western Turkey, the strike-slip faults that are capable of generating destructive earthquakes are mapped in the area surrounding the Karaburun Peninsula. Fig. 1 shows a simplified geological map of the Karaburun Peninsula derived from different studies (Kaya, 1981; Bozkurt, 2001; Emre et al., 2005; Çakmakoğlu and Bilgin, 2006; Uzel and Sözbilir, 2008; Sözbilir et al., 2009; Helvacı et al., 2009). The peninsula contains several Neogene sedimentary and volcanic units (Helvacı et al., 2009). No major faults have been mapped on the main land of the peninsula. The dextral strike-slip Gülbahçe Fault Zone (GFZ) is a boundary between the carbonates and sedimentary units on the isthmus. The Seferihisar Fault Zone (SFZ) is dextral strike-slip deformation zone that is 30 km long. The Orhanlı Fault Zone (OFZ) has several dextral strike-slip segments and extends 45 km (Emre and Barka, 2000; Genç et al., 2001; Uzel and Sözbilir, 2008; Uzel et al., 2012). Çakmakoğlu and Bilgin (2006) published a geological map of the region in studies of MTA (Mineral Research and Exploration Directorate of Turkey) from 1996 to 1998 and mapped a fault between the Sığacık and Gerence bays. However, there is no additional information about this fault. Ocakoğlu et al. (2005) processed marine seismic reflection data and mapped offshore active strike-slip faults in the south of the Karaburun Peninsula.

Fig. 1 also shows the distribution of the earthquakes in the study area ($M \geq 2$) reported by Boğaziçi University Kandilli Observatory and Earthquake Research Institute (KOERI) between January 1990 and September 2005. The Sığacık activity from October 2005

* Tel.: +90 262 677 28 74; fax: +90 262 641 23 09.
E-mail address: onur.tan@mam.gov.tr

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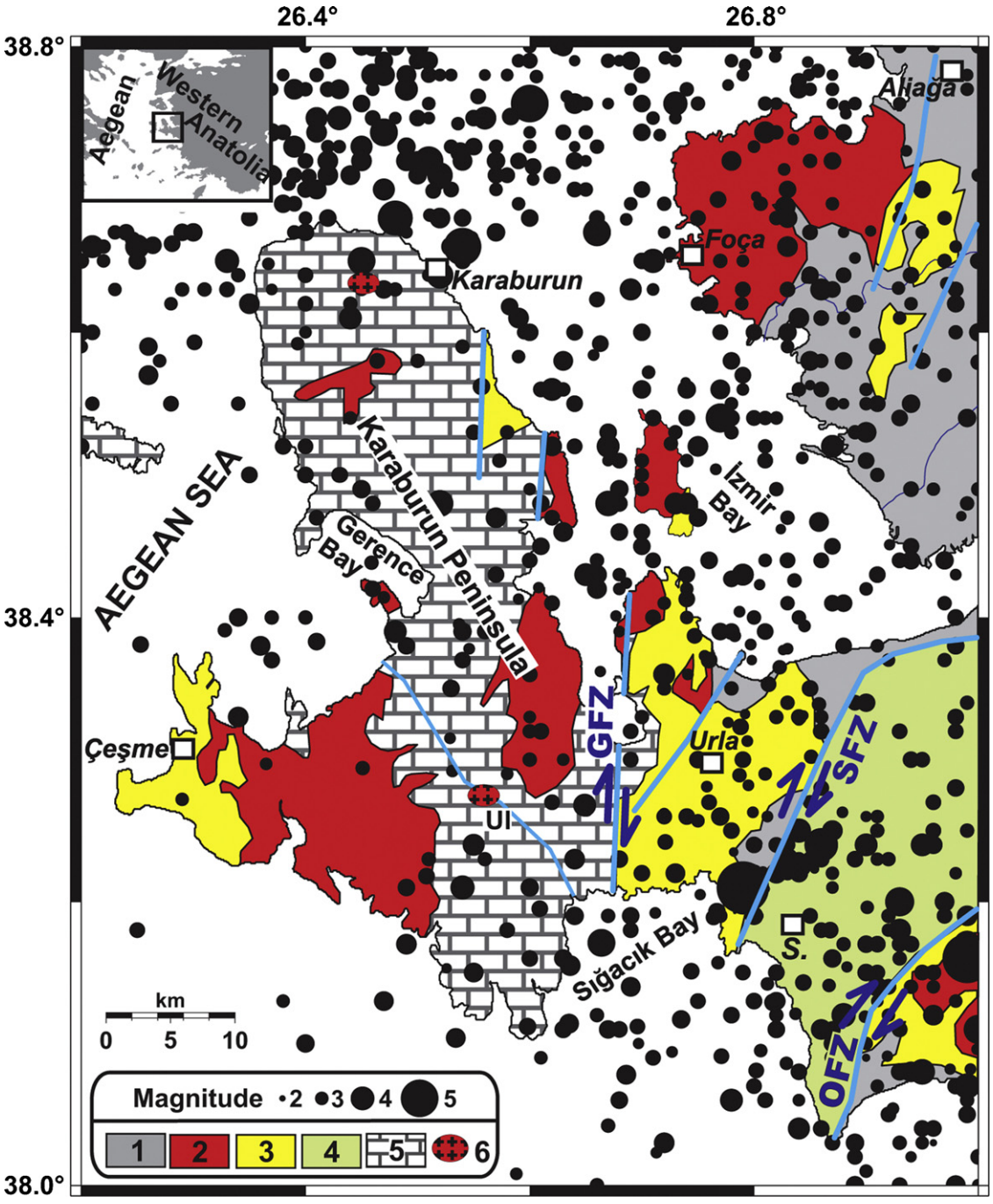

Fig. 1. Geological units (Uzel et al., 2012) and seismicity of the Karaburun Peninsula. The earthquake data ($M \geq 2$, January 1990–September 2005) are from Boğaziçi University Kandilli Observatory and Earthquake Research Institute (BU KOERI). Blue lines are faults. 1: Quaternary alluvium, 2: Neogene volcanics, 3: Neogene sediments, 4: Bornova flysch, 5: Paleozoic-Mesozoic carbonates, 6: Plutonic intrusives. GFZ: Gülbahçe Fault Zone, OFZ: Orhanlı Fault Zone, S: Seferihisar, SFZ: Seferihisar Fault Zone, UI: Uzunkuyu Intrusive.

(reported by Benetatos et al., 2006; Aktar et al., 2007) and later events are not shown on the map so as to clearly show the background seismicity in the Karaburun Peninsula and surroundings. The earthquake distribution in Fig. 1 indicates a scattered seismicity. The two important earthquakes were observed near Seferihisar. The events of 6 November 1992 ($M_w = 6.0$) and 10 April 2003 ($M_w = 5.7$) may be related to the SFZ and OFZ, respectively. Altınok et al. (2005) studied historical earthquakes in the region and reported some destructive events (i.e., 1881 and 1949); however, the data for this historical period have large location uncertainties, and the possible link with the recent earthquake activity seems difficult to discern (Aktar et al., 2007). Unfortunately, the national earthquake data catalogues are insufficient to discuss the local fault characteristics in western Anatolia. Hence, the "*Multi-Disciplinary Earthquake Researches in High Risk Regions of Turkey Representing Different Tectonic Regimes (TURDEP) Project*" has been initiated to observe the activities of the local faults and to improve observation capabilities (İnan et al., 2007).

In this paper, I discuss a seismic zone, the Karaburun Seismic Zone (KSZ), which is not mentioned previously on the Karaburun Peninsula, with a new high-precision earthquake data set ($M_L \geq 0.2$) obtained from a dense seismology network.

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