Tectonophysics 588 (2013) 56–68

Contents lists available at SciVerse ScienceDirect

Tectonophysics

journal homepage: www.elsevier.com/locate/tecto

Plio-Quaternary Stress State in the Burdur Basin, SW-Turkey

Semir Över [a,*], Hüseyin Yılmaz [b], Ali Pınar [c], Süha Özden [d], Ulvi Can Ünlügenç [e], Züheyr Kamacı [f]

[a] Department of Geophysical Engineering, Mustafa Kemal University, 31040, Hatay, Turkey
[b] Department of Geophysical Engineering, Cumhuriyet University, 58140, Sivas, Turkey
[c] Kandilli Observatory and Earthquake Research Institute, Boğazici University, 34684, Istanbul,Turkey
[d] Department of Geological Engineering, Çanakkale Onsekiz Mart University, 17020, Çanakkale, Turkey
[e] Department of Geological Engineering, Çukurova University, 01330, Adana, Turkey
[f] Department of Geophysical Engineering, Süleyman Demirel University, 32260, Isparta, Turkey

ARTICLE INFO

Article history:
Received 13 August 2012
Received in revised form 22 November 2012
Accepted 9 December 2012
Available online 21 December 2012

Keywords:
Inversion
Stress state
Extension
Burdur Basin
Hellenic/Cyprus arcs
SW Turkey

ABSTRACT

This study defines the Plio-Quaternary to present day stress regime in the Burdur Basin, located at the northeastern end of the Fethiye–Burdur Fault Zone in SW Turkey. This fault length, which is considered the landward continuation of the Pliny-Strabo trench, is an important feature in SW Turkey. The inversion slip vectors measured on fault planes indicate a consistent normal faulting stress regime during Plio-Quaternary time, continuing into recent times as indicated by earthquake focal mechanism inversions. Both states have consistent NW–SE trending horizontal minimum stress axes (σ_3). The orientation of fault sets is predominantly around the NE–SW direction in the major Fethiye–Burdur Fault Zone, making the extension NW–SE. The mean stress ratio is 0.74 indicating a triaxial stress state, which is clearly different from radial extension. The NW–SE extension is probably responsible for the formation of the Burdur Basin during Plio-Quaternary time. This extension, which is probably caused by slab-pull force due to the subduction process along the Cyprus arc, produces a dominant normal motion along the FBFZ.

1. Introduction

The Mediterranean area is a tectonically active region, where the roughly N–S convergence of the Eurasian, African, and Arabian plates (Reilinger et al., 2006) produces a complex tectonic system with different deformation styles located in adjacent and narrow areas (Fig. 1). The study area is located in the northeastern part of SW Anatolia, in the intersection region of the Hellenic and Cyprus arcs (Fig. 1). The neotectonic evolution of SW Anatolia is characterized by the development of extensional basins (e.g. Çameli, Burdur, Dinar and Acıgöl basins) during Late Miocene–Quaternary time (e.g., Alçiçek, 2007; Taymaz and Price, 1992; Temiz et al., 1997; Ten Veen et al., 2004). The major fault, known as the Fethiye–Burdur Fault Zone (FBFZ) trending NE–SW, runs along the southern border of the Burdur Basin. The NE–SW-trending Fethiye–Burdur Fault Zone, which is one of the principle structures of southwestern Turkey (Fig. 1), is well established by morphological features (Şaroğlu et al., 1992), seismicity (Taymaz et al., 1991) and by GPS studies (Reilinger et al., 2006, 2010). The FBFZ has been in general interpreted as the landward continuation of the Pliny–Strabo trench (Eyidoğan and Barka, 1996; Ten Veen and Kleinspehn, 2002; Ten Veen et al., 2004). There is a debate on the motion of the FBFZ; recent GPS data (Barka and Reilinger, 1997; Reilinger et al., 2006, 2010) suggest that this structure is an active left lateral fault zone, based on a seismotectonic study this fault is interpreted as a transtensional feature, i.e. left-lateral with a large component of extension (e.g., Taymaz and Price, 1992). Fault kinematic analyses which were carried out in the northeastern part of FBFZ, i.e., Burdur Basin (Temiz et al., 1997; Verheart et al., 2006) and in southwestern part of FBFZ, i.e., Çameli Basin (Alçiçek et al., 2006; Över et al., 2010) indicate a large extensional motion along this major fault. In the north, it links approximately NW–SE trending basins and associated normal fault systems such as the Dinar Basin and Dinar fault respectively. The Burdur, Dinar, Çivril and Acıgöl basins are interpreted as half graben systems (Price, 1989). The FBFZ is characterized by several segments of various ages which affected the Mesozoic sequence and ophiolites of Lycian nappes and the Plio-Quaternary deposits of the Burdur Basin (Bering, 1971; Price and Scott, 1994).

In the present study, both fault kinematic analysis and inversion of focal mechanisms of shallow earthquakes that occurred in the Burdur Basin are conducted to define the states of stress from the Plio-Quaternary to the present and to determine their probable significance in relation to regional tectonic events.

2. Geodynamic setting

The geodynamics of the eastern Mediterranean region are dominated by the relative motions of the Arabian, African and Eurasian plates. This region presents a large variety of tectonic processes: continental collision (in east Anatolia), subduction of oceanic lithosphere

* Corresponding author. Tel.: +90 326 6135613; fax: +90 326 6135600.
E-mail address: over@mku.edu.tr (S. Över).

0040-1951/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.tecto.2012.12.009

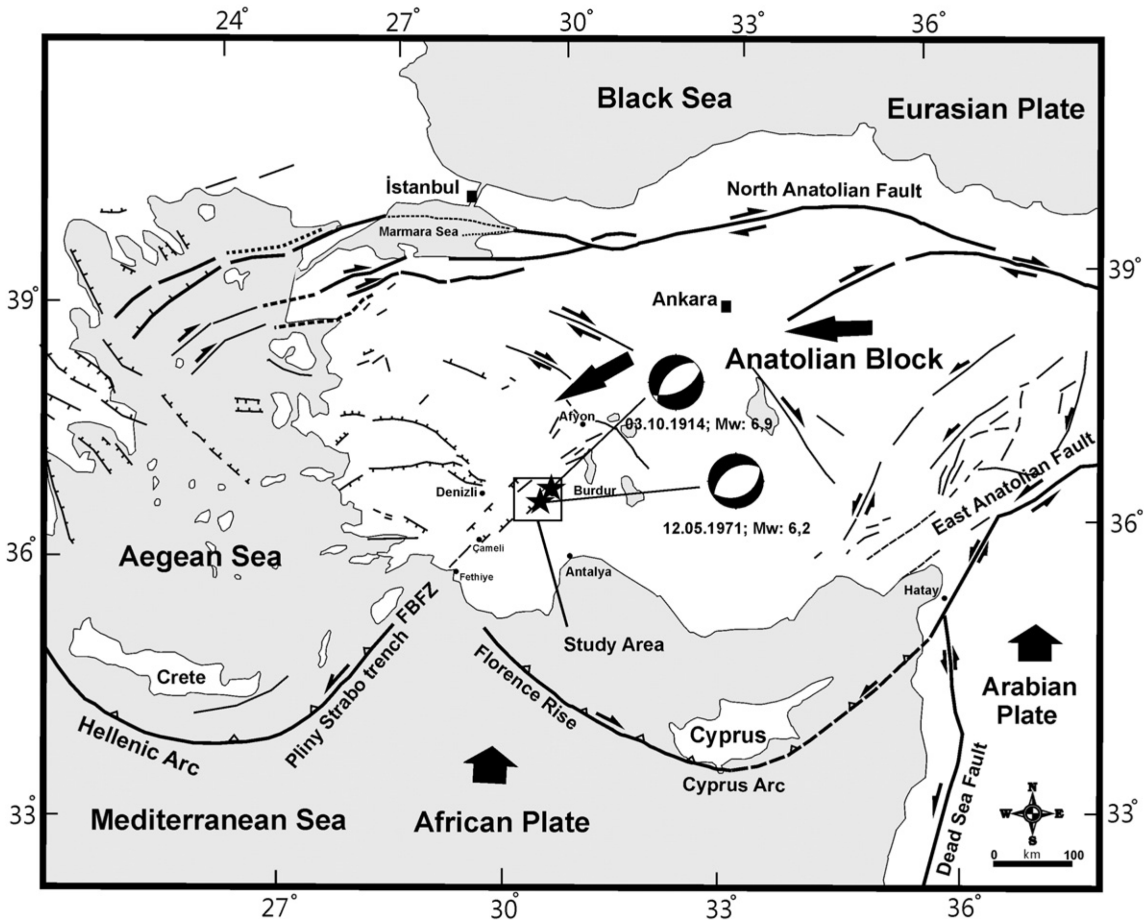

Fig. 1. Study area in The tectonic framework of the eastern Mediterranean (modified from Barka, 1992; Över et al., 2010).

and associated back arc spreading (Hellenic and Cyprus), continental escape (i.e., Anatolian block), major continental strike–slip faults (North, East Anatolian, and Dead Sea Faults) and continental extension (i.e., in the overriding Anatolian Block) (Reilinger et al., 2006). The Arabia/Anatolia collision is responsible for thickening of the crust in eastern Turkey and compressional deformation along the Bitlis Suture Zone since the late Miocene (Dewey et al., 1986). Contemporaneously, this northward motion with respect to Eurasia, gives rise to the westward extrusion of the Anatolian block along its northern and eastern boundaries as defined by the dextral North Anatolian Fault Zone (NAFZ) and sinistral East Anatolian Fault Zone (EAFZ), respectively. EAFZ, together with NAFZ, allows Anatolian extrusion because of northward movement of the Arabian plate (McClusky et al., 2000; McKenzie, 1972; Reilinger et al., 2006; Şengör et al., 1985). The collision controls lithospheric deformation throughout Anatolia, westward motion of the Anatolian block and subduction rollback along the Hellenic Trench (Reilinger et al., 2006). The model incorporating geological and seismological data with those GPS shows that the propagation of the NAF into Aegean and a large scale deformation should be related to interaction with the Aegean extension and the Hellenic arc-pull (Armijo et al., 2003; Flerit et al., 2004). Tomographic studies (Biryol et al., 2011) suggest the presence of a subducted portion of African lithosphere along the Cyprus and Aegean trenches.

The geodynamic processes ongoing in the Eastern Mediterranean region involve the interaction of several different boundary forces, which are superimposed in southwest Anatolia, to produce complex deformation domains. Southwest Anatolia represents the junction of the Hellenic and Cyprus arcs along which the African plate plunges northwards beneath the Aegean Sea and the Anatolian block (Fig. 1). The northward convergence of the African plate results in oceanic subduction along the Hellenic arc and also a transitional zone of collision–oceanic subduction along the Cyprus arc (Biryol et al., 2011; De Mets et al., 1990; Mart and Ryan, 2003; McClusky et al., 2000, 2003; McKenzie, 1972; Reilinger et al., 2010). GPS and geodetic studies show that western Turkey is currently undergoing a continental lithospheric extension (e.g., Agostini et al., 2010; Brun and Sokoutis, 2010; Erdoğan et al., 2009; Glover and Robertson, 1998; Kreemer et al., 2004; McClusky et al., 2000; Reilinger et al., 2006, 2010; Van Hinsbergen, 2010) over a time range of 10 My (Flerit et al., 2004). However, several different models exist to explain the Late Cenozoic crustal extension responsible for the deformation in western Turkey that are given in detail by, (e.g., Agostini et al., 2010; Bozkurt, 2001; Çemen, 2010; Çiftci and Bozkurt, 2009; Jolivet and Brun, 2010; Över et al., 2010). Some models (De Mets et al., 1990; Le Pichon and Angelier, 1979) suggest that the Hellenic trench moves southward, as a consequence of the rollback of the subducted slab. This mechanism induced by the sinking and by the suction of the slab, causes extensional tectonic processes in the overriding Anatolian block (Brun and Faccenna, 2008; Cianetti et al., 1997; Faccenna et al., 2004; Jolivet and Brun, 2010; Jolivet et al., 2008; Le Pichon, 1982; Mercier et al., 1989; Sorel et al., 1988; Wortel et al., 2006). Similarly, the crustal extension observed in SE Turkey, e.g. Hatay region (Boulton and Robertson, 2008), is attributed to subduction along the Cyprus arc (Över et al., 2002). In southern Cyprus, the slab is assumed to be dense Mesozoic Neotethyan ocean crust, leading to a rapid roll-back (Robertson, 2000; Robertson et al., 1991). Subduction along the Cyprus section is influenced by the collision of the Eratosthene Seamount, part of the African plate, with the Cyprus trench (Robertson, 1998; Robertson and Grasso, 1995; Glover and