Earth and Planetary Science Letters 481 (2018) 111–124

Contents lists available at ScienceDirect

Earth and Planetary Science Letters

www.elsevier.com/locate/epsl

A long-lived Late Cretaceous–early Eocene extensional province in Anatolia? Structural evidence from the Ivriz Detachment, southern central Turkey

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ARTICLE INFO

Article history:
Received 24 February 2017
Received in revised form 25 September 2017
Accepted 5 October 2017
Available online xxxx
Editor: R. Bendick

Keywords:
detachment
HP rock exhumation
extension
rollback
Eastern Mediterranean tectonics
slab segmentation

ABSTRACT

Central Anatolia exposes previously buried and metamorphosed, continent-derived rocks – the Kırşehir and Afyon zones – now covering an area of ~300 × 400 km. So far, the exhumation history of these rocks has been poorly constrained. We show for the first time that the major, >120 km long, top-NE 'Ivriz' Detachment controlled the exhumation of the HP/LT metamorphic Afyon Zone in southern Central Anatolia. We date its activity at between the latest Cretaceous and early Eocene times. Combined with previously documented isolated extensional detachments found in the Kırşehir Block, our results suggest that a major province governed by extensional exhumation was active throughout Central Anatolia between ~80 and ~48 Ma. Although similar in dimension to the Aegean extensional province to the east, the Central Anatolian extensional province is considerably older and was controlled by a different extension direction. From this, we infer that the African slab(s) that subducted below Anatolia must have rolled back relative to the Aegean slab since at least the latest Cretaceous, suggesting that these regions were underlain by a segmented slab. Whether or not these early segments already corresponded to the modern Aegean, Antalya, and Cyprus slab segments remains open for debate, but slab segmentation must have occurred much earlier than previously thought.

1. Introduction

The tectonic evolution of the Mediterranean region is dominated by accretion of tectonic slices detached from subducted oceanic and particularly continental lithosphere. These accreted units were tectonically buried, often metamorphosed, and incorporated into thick nappe stacks that underwent subsequent extension, crustal thinning, and exhumation (e.g., Faccenna et al., 2014). Metamorphic rocks, mostly of high-pressure/low-temperature (HP/LT), subduction-related metamorphic facies, but also local HT/LP units, are common in the internal zones of the Mediterranean orogenic belts (Faccenna et al., 2014; Jolivet et al., 2003).

The exhumation of such subducted material back to the surface is often linked to overriding plate extension (Jolivet et al., 2013). The timing and style of these processes reflect major changes in subduction zone dynamics and are keys to deciphering the motion history between the subducted slab and the overlying orogen. Exhumation in an overall convergent system is attributed to slab retreat relative to the overriding plate, creating the space needed for exhumation of HP-metamorphic rocks in subduction channels (Jolivet et al., 2003). Slab retreat also generates upper plate extension and development backarc (and forearc) basins, and can therefore trigger and assist exhumation of deeply buried portions of the orogen to the surface (Jolivet et al., 2003; Royden, 1993).

In the Mediterranean, metamorphic provinces occur associated with deep extensional and even oceanic basins, formed since the late Eocene–Oligocene and dominantly in the Miocene in the Alboran region, the Tyrrhenian Sea, the Pannonian Basin, and the Aegean region. In the latter, substantial volumes of metamorphosed rocks were exhumed extensionally (Faccenna et al., 2014; Jolivet et al., 2003; Rosenbaum and Lister, 2004; van Hinsbergen et al., 2010; van Hinsbergen and Schmid, 2012).

In Central Anatolia exhumed metamorphic rocks of the HP/LT Afyon Zone and the HT/LP Kırşehir Block (Fig. 1) are exposed in an

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https://doi.org/10.1016/j.epsl.2017.10.008
0012-821X/

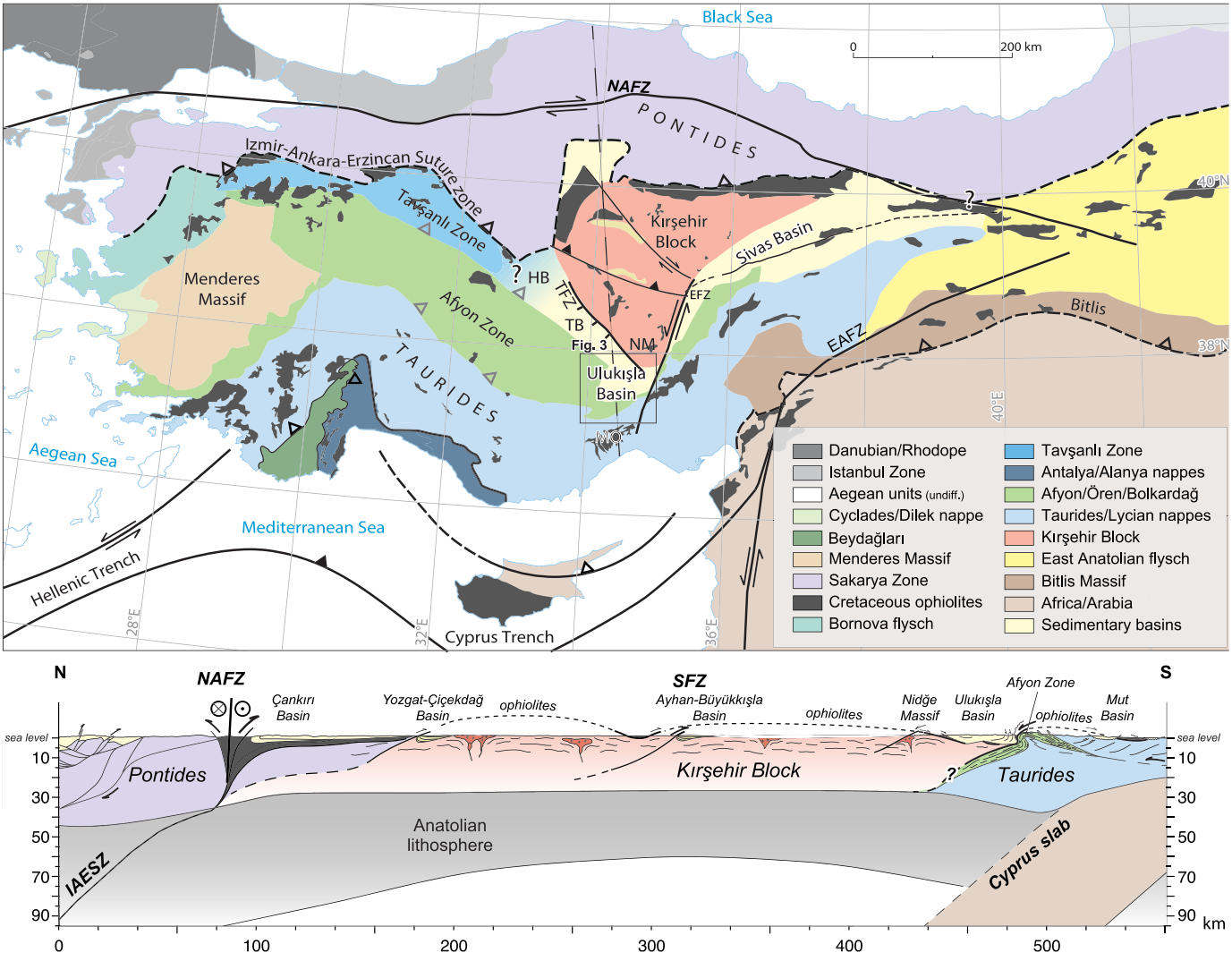

Fig. 1. Tectono-metamorphic units of Anatolia with associated suture zones, ophiolites, major faults (modified after Gürer et al., 2016). The basement units are the Pontides, the HT-metamorphic Kırşehir Block (with its southern tip the Niğde Massif (NM)), the Tavşanlı, and Afyon HP-metamorphic belts. Late Cretaceous to Paleogene forearc basins of Central Anatolia mentioned in the text: Ulukışla Basin (Fig. 3), HB = Haymana Basin, TB = Tuzgölü Basin, Sivas Basin. Major fault zones marked include the North Anatolian fault zone (NAFZ), the Ecemiş fault zone (EFZ), the Tuzgölü fault zone (TFZ), and the East Anatolian fault zone (EAFZ). Mersin Ophiolite = MO. The corresponding lithospheric scale cross-section is shown below.

area of ~300 × 400 km. The size is comparable to the Mediterranean provinces, but in Central Anatolia exhumation occurred much earlier, in the Cretaceous to Paleogene. Although recent studies have identified isolated occurrences of extensional detachments that aided the exhumation of the Kırşehir Block (Gautier et al., 2002; Lefebvre et al., 2011), it was unclear how exhumation was accommodated in case of the Afyon Zone, which can be traced from western to central Turkey over a distance of ~800 km, fringing the Kırşehir Block in the south (Figs. 1, 2).

The Afyon Zone is in contact with a non-metamorphic ophiolite and ophiolitic mélange sequence, as well as sediments of the overlying Ulukışla Basin (Fig. 3). The latter formed during latest Cretaceous to late Paleocene extension in a forearc to arc setting (Gürer et al., 2016). Here we describe lithologies and structures along contacts between the Afyon Zone and the ophiolitic mélange around Ivriz (Fig. 3). Along- and across-strike kinematic field and thin-section analyses document the role of this structure for the exhumation of the Afyon Zone and U/Pb ages constrain the timing of syn-kinematic granites. We discuss the implications of our findings in terms of direction and timing of regional extension and their profound consequences for the dynamics of eastern Mediterranean subduction evolution since the late Mesozoic.

2. Geological setting

2.1. Central Anatolian geology

Anatolia (Fig. 1) exposes an orogenic collage of rocks derived from continental and oceanic lithosphere that amalgamated since Mesozoic time during the closure of strands of the Neotethys Ocean. The northern part of the orogen is formed by the Pontides, which have been part of the southern Eurasian margin since at least the Mid-Mesozoic. The southern border of the Pontides, the Izmir–Ankara–Erzincan suture zone, demarcates the location of oceanic subduction since Jurassic time (Dokuz et al., 2017; and references therein; Fig. 1). To the south of this suture zone, there are the continent-derived, exhumed metamorphic rocks of the Kırşehir Block and the Afyon Zone. The latter overthrusted the external, Paleogene, E–W-trending thin-skinned Taurides fold-and-thrust belt (Özgül, 1984). All these elements are structurally overlain by isolated klippen of ophiolites and their underlying ophiolitic mélange (Fig. 1; Menant et al., 2016; van Hinsbergen et al., 2016). These ophiolites are interpreted to have formed above a second, intra-oceanic subduction zone within the Neotethys located south of the Pontide subduction zone. The oceanic lithosphere intervening be-