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New zircon U-Pb LA-ICP-MS ages and Hf isotope data from the Central Pontides (Turkey): Geological and geodynamic constraints

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ABSTRACT

The Central Pontides in northern Anatolia is located on the accretionary complex formed by the closure of Neotethyan Intra-Pontide Ocean between the southern Eurasian margin (Istanbul-Zonguldak Terrane) and the Cimmerian Sakarya Composite Terrane. Among other components of the oceanic lithosphere, it comprises not yet well-dated felsic igneous rocks formed in arc-basin as well as continent margin settings. In-situ U-Pb age results for zircons from the arc-basin system (öangaldağ Metamorphic Complex) and the continental arc (Devrekani Metadiorite and Granitoid) yield ages of 176 ± 6 Ma, 163 ± 9 Ma and 165 ± 3 Ma, respectively. Corresponding in-situ average (initial) $^{176}Hf/^{177}Hf$ initial ratios are 0.28261 ± 0.00003, 0.28267 ± 0.00002 and 0.28290 ± 0.00004 for these units and indicative of a subduction-modified mantle source. The new U-Pb ages and Hf isotope data from these oceanic and continental arc units together with regional geological constraints support the presence of a multiple subduction system within the Intra-Pontide Ocean during the Middle Jurassic.

1. Introduction

The closure of the Tethyan oceanic branches along the Alpine-Himalayan orogenic belt resulted in accretion of a number of oceanic and continental micro-plates (e.g. Şengör and Yılmaz, 1981) or terranes (e.g. Göncüoğlu et al., 1997; Okay and Tuysuz, 1999; Stampfli and Borel, 2002). In the Eastern Mediterranean and especially in Anatolia, the sutures of these oceanic branches existing during the mid-Mesozoic are known as the Neotethyan suture belts (e.g. Göncüoğlu, 2010). From these (Fig. 1), the southernmost (the Bitlis-Zagros Suture) and the middle (the Izmir-Ankara-Erzincan-Sevan-Akera Suture) are relatively well-studied (for a brief review see Robertson et al., 2013). However, the tectonic and geodynamic history of northernmost suture, the Intra-Pontide Suture (IPS), is still a matter of debate. It was initially suggested by Şengör and Yılmaz (1981) that the IPS is bound to the north by the Rhodope-Pontide fragment and by the Sakarya Continent to the south. However, the location, opening and closure ages, subduction polarity, even the existence of the corresponding oceanic branch (the Neotethyan Intra-Pontide Ocean (IPO)) is still disputed (e.g., Robertson and Ustaömer, 2004). Recent field studies in the central part of the IPS, supported by new and precise radiometric age data (Okay et al., 2014; Çimen, 2016) indicate that the IPS formed by the closure of the IPO during the Mid- Late Mesozoic resulting from N-ward subduction and stepwise accretion of oceanic/continent margin assemblages to the Eurasian margin (e.g. Okay et al., 2006; Göncüoğlu et al., 2014; Sayit et al., 2016; Çimen et al., 2016, 2017). In the Central Pontides (CP), the very thick structural complex comprising mainly oceanic assemblages is referred to as the Central Pontide Structural Complex (CPSC; Tekin et al., 2012). It is mainly represented by variably metamorphosed supra-subduction type basic volcanic rocks and associated sediments. A comparatively less-voluminous member of the IPS is characterized by felsic, intermediate and mafic extrusive and intrusive rocks (e.g. Ustaömer and Robertson, 1999; Okay et al., 2013; Çimen et al., 2016), of island-arc (Çangaldağ Metamorphic Complex), and continental arc (Çangaldağ Pluton; Çimen et al., 2017) origins. In contrast to the oceanic basalts, the tectono-magmatic evolutions as well as the ages of these arc-assemblages have yet to be studied in detail. Moreover, distinct arc-type magmatism of Jurassic age is reported (McCann et al., 2010; Meijers et al., 2010; Dokuz et al., 2017) from the neighbouring terranes such as the Eastern Pontides, Crimea and Greater Caucasus (Figs. 1 and 2). However, a reliable correlation of the age and tectono-magmatic setting of this arc-type magmatism with the rock assemblages present within the CP is hampered by the scarcity of radiometric age data.

In this paper, new radiometric age and Hf isotope data are reported from the widespread oceanic arc (Çangaldağ Metamorphic Complex; a

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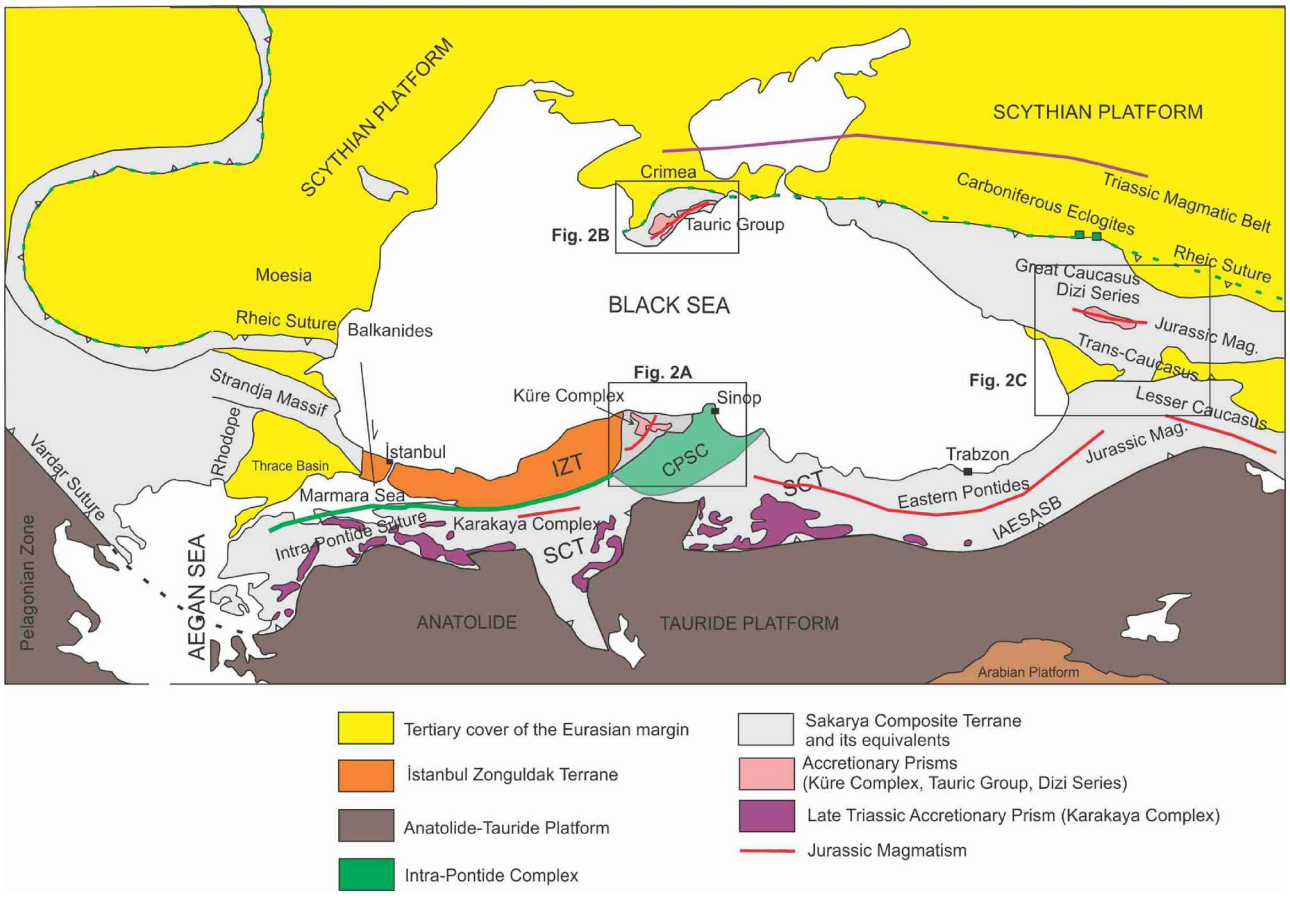

Fig 1. Tectonic map of the Black Sea region with the main alpine terranes (modified from Okay and Nikishin, 2015; Çimen et al., 2017); CPSC: Central Pontide Structural Complex. SCT: Sakarya Composite Terrane. IZT: İstanbul-Zonguldak Terrane. IAESASB: İzmir-Ankara-Erzincan-Sevan-Akera Suture Belt.

part of the CPSC) and continental margin (Devrekani Granitoid and Metadiorite) magmatism in the CP. The aim is to provide useful inferences and insights into the geological evolution of the CP and the Black Sea region during the Middle Jurassic.

2. Geological framework

The "Central Pontides" is a geographical term comprising several units with geographical (e.g. Devrekani Massif, Kargı Massif, Daday Massif, Ilgaz Massif) or tectonic (e.g. Küre Complex, Geme Complex, Devrekani Metamorphics, CMC, Elekdağ Complex, Domuzdağ-Saraycık Complex) origin (Yılmaz and Tüysüz; 1984; Ustaömer and Robertson, 1999; Kozur et al., 2000; Göncüoğlu et al., 2012,2014; Okay et al., 2006, 2013, 2014, 2015; Okay and Nikishin, 2015; Aygül et al., 2016; Sayit et al., 2016; Çimen et al., 2016; Gücer et al., 2016) (Fig. 2a). It includes the tectonic boundary between the Gondwana-derived İstanbul-Zonguldak Terrane (IZT) in the N, the Cimmerian Sakarya Composite Terrane (SCT) in the S and remnants of the Neotethyan IPS Belt (Figs. 1, 2a) between them (e.g. Göncüoğlu, 2010). The large area of metamorphic rocks in the southern part of the CP, previously interpreted as the remnant of Paleotethys (e.g. Göncüoğlu et al., 1997; Okay and Tuysuz, 1999) has been recently proven to be Mid-Jurassic-Cretaceous in age (e.g. Okay et al., 2006), and defined as the CPSC (Tekin et al., 2012; Frassi et al., 2016; Çimen et al., 2016) of the IPS. It comprises the Daday Massif in the west, the Elekdağ-Domuzdağ and Kargı massifs in the east, and the Çangaldağ Metamorphic Complex (CMC) in the north (Fig. 2a). The CMC is bounded in the north by the Çangaldağ Pluton that intrudes the southern Eurasian continental margin.

2.1. Pre-middle Jurassic structural units of the Eurasian margin

The Paleozoic Terranes of the Eurasian margin are represented by the Devrekani Metamorphics and Geme Complex (Okay et al., 2015; Gücer et al., 2016), and Permo-Carboniferous Sivrikaya and Deliktaş Granitoids (Nzegge, 2008) in the CP (Fig. 2a, d).

2.1.1. Geme Complex, Sivrikaya and Deliktaş granitoids

The Geme Complex has been recently studied by Okay et al. (2014). The complex comprises gneisses and migmatites with minor amphibolite and marble. It is intruded by the Middle Jurassic (163 Ma ± 4 Ma) Dikmen Porphyry and unconformably overlain by Lower Cretaceous sandstone and shale (Fig. 2a). The cross-cutting relations indicate a pre-Callovian metamorphic age for the complex. Okay et al. (2014) suggests that the Geme Complex represents the remobilized basement of the CP.

The Late Carboniferous Sivrikaya (300 ± 1 Ma) and the Early Permian Deliktaş (295 ± 1 Ma) granitoids (Fig. 2a) have been studied by Nzegge (2008). The Sivrikaya granitoid is composed of granodiorites, tonalites and two-mica granites, generated by mixing of partially melted lower continental crust and subcrustal lithospheric mantle. The Deliktaş pluton includes only muscovite-rich monzogranites displaying geochemical characteristics of S-type granites. Both granitoids have been interpreted as magmatic products of orogenic collisional tectonics, and crustal thickening during northward subduction of a Paleozoic ocean (the Paleotethys Ocean in Nzegge, 2008).

2.1.2. Devrekani Metamorphics

The Devrekani Metamorphics terrane is structurally located between the Küre Complex and the CMC (Figs. 2 and 3). It comprises medium-to high-grade metamorphic rocks including paragneiss,