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Research paper

Petrogenesis of the late Cretaceous Turnagöl intrusion in the eastern Pontides: Implications for magma genesis in the arc setting

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ABSTRACT

A series of Cretaceous plutons is present in the eastern Pontides of northeastern Turkey. The Turnagöl intrusion is the least studied and, thus, the least understood plutons in the orogen. This intrusion consists of hornblende-biotite granodiorites emplaced at 78 Ma based on LA-ICP-MS U-Pb zircon dating. It is of sub-alkaline affinity, belongs to the medium- to high-K calc-alkaline series, and displays features typical of I-type granites. The rocks of the intrusion are enriched in large-ion lithophile elements and light rare earth-elements with negative Eu anomalies ($Eu/Eu^* = 0.69–0.82$), but are deficient in high-field-strength elements. They have a small range of $(^{87}Sr/^{86}Sr)_i$ (0.7060–0.7063), ε_{Nd_i}(−2.6 to −3.1), and $\delta^{18}O$ (+8.1 to +9.1) values. Their Pb isotopic ratios are $^{206}Pb/^{204}Pb = 18.63–18.65$, $^{207}Pb/^{204}Pb = 15.62–15.63$, and $^{208}Pb/^{204}Pb = 38.53–38.55$. The fractionation of plagioclase, hornblende, and Fe-Ti oxides had key functions in the evolution of the Turnagöl intrusion. The crystallization temperatures of the melts ranged from 758 to 885 °C as determined by zircon and apatite saturation thermometry. All these characteristics, combined with the low values of K_2O/Na_2O and $(Na_2O + K_2O)/(FeO^t + MgO + TiO_2)$, as well as the high values of $(CaO + FeO^t + MgO + TiO_2)$, suggest an origin by dehydration melting from a metabasaltic lower crustal source.

1. Introduction

Turkey is located on an east-west trending segment of the Alpine-Himalayan orogenic belt. This belt embraces various arc-, collision-, and post-collision geologic settings. In this belt, Turkey, as the zone of interaction between the Eurasia and Gondwanaland plates, lies in an important geodynamic position. The Pontide unit (Ketin, 1966) of Turkey includes various intrusive and eruptive rocks that constitute the widespread eastern Pontide Terrane, many of which are related to the convergence of these two plates (Fig. 1A).

The crystallization ages of these intrusive rocks range from the Permo-Carboniferous (Çoğulu, 1975; Topuz et al., 2004, 2010; Dokuz, 2011; Kaygusuz et al., 2012) through the Cretaceous–Paleocene (Yılmaz et al., 2000; Boztuğ et al., 2006; İlbeyli, 2008; Kaygusuz et al., 2008, 2009, 2010; Kaygusuz and Aydınçakır, 2009; Karslı et al., 2010; Kaygusuz and Şen, 2011) to the Eocene periods (Boztuğ et al., 2004; Topuz et al., 2005; Yılmaz-Şahin, 2005; Arslan and Aslan, 2006; Karslı et al., 2007; Eyuboğlu et al., 2011b). The rocks were formed in different geodynamic environments, and the emplacements of these plutons occurred in a wide range of tectonic settings: from arc-collisional, through syn-collisional, to post-collisional (e.g., Yılmaz and Boztuğ, 1996; Okay and Şahintürk, 1997; Yılmaz et al., 1997; Yeğingil et al., 2002; Boztuğ et al., 2003).

Investigations on the intrusive rocks of the eastern Pontides are extensive (e.g., Delaloye et al., 1972; Yılmaz, 1972; Taner, 1977; Gedikoğlu, 1978; Moore et al., 1980; Jica, 1986; Yılmaz and Boztuğ, 1996; Okay and Şahintürk, 1997; Karslı et al., 2004; Boztuğ et al., 2004, 2006; Yılmaz-Şahin et al., 2004; Topuz et al., 2005; Yılmaz-Şahin, 2005; Dokuz et al., 2006; Kaygusuz et al., 2008, 2009, 2010, 2011, 2012). However, studies on the Turnagöl intrusion are limited

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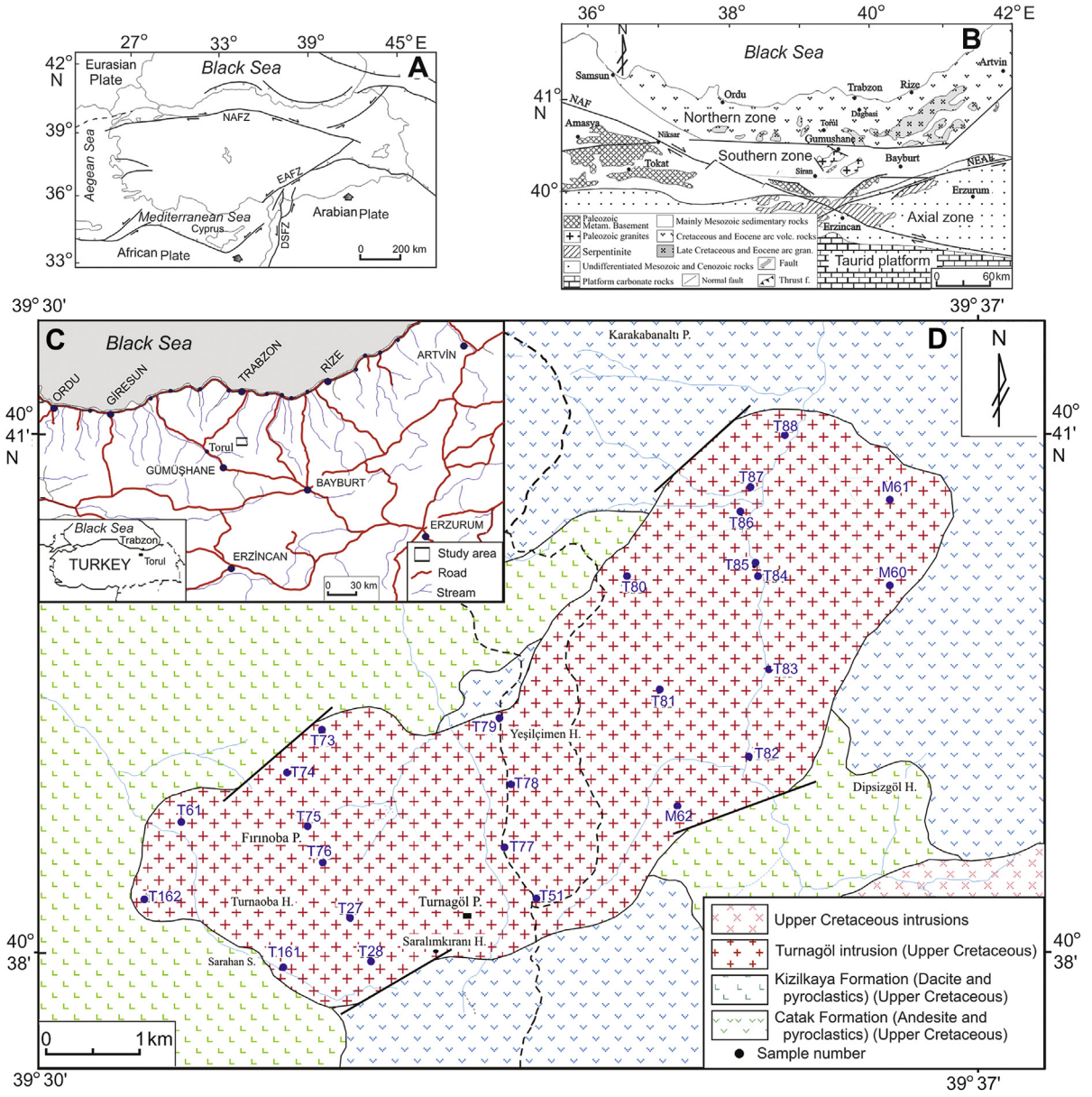

Figure 1. (A) Tectonic map of Turkey and surroundings (modified after Şengör et al., 2003); (B) Major structures of the eastern Pontides (modified from Eyuboğlu et al., 2007); (C) Location map of the study area and (D) Geological map of the study area. NAFZ: North-Anatolian fault zone; EAFZ: East-Anatolian fault zone; DSFZ: Dead Sea fault zone.

and primarily related to mine as well as general geological research (Yalçınalp, 1992; Güven, 1993). The present study examines the Turnagöl intrusion, which is geochemically and isotopically the least-studied series of plutons in the eastern Pontides. Before this study, the age of the Turnagöl intrusion has been uncertain, and no geochronological age of this intrusion is currently available. In this article, new petrographic, geochemical, Sr-Nd-Pb-O isotopic, and LA-ICP-MS U-Pb zircon data from the Turnagöl intrusion in the eastern Pontide magmatic arc are reported. These geochemical and isotopic data reveal the magma sources and magma production processes of the I-type, calc-alkaline granitoids from the eastern Pontides.

2. Geological background

The eastern Pontides orogenic belt is located within the Alpine metallogenic belt, and geographically corresponds to the eastern Black Sea region of Turkey. It is commonly subdivided into northern and southern zones (Fig. 1B) based on structural and lithological features (Özsayar et al., 1981; Okay and Şahintürk, 1997). These zones have different lithological characteristics and are separated by E–W, NE–SW, and NW–SE oriented fault zones that define the block-faulted tectonic style of the eastern Pontides (Bektaş and Çapkınoğlu, 1997). The late Cretaceous and middle Eocene volcanic and volcaniclastic rocks dominate the northern zone, whereas pre-late Cretaceous rocks dominate the southern zone (Arslan et al., 1997, 2000; Şen et al., 1998; Şen, 2007; Temizel et al., 2012). The basement of the eastern Pontides consists of early Carboniferous metamorphic rocks (Topuz et al., 2004, 2007), and is crosscut by granitoids of late Carboniferous age (Yılmaz, 1972; Çoğulu, 1975; Okay and Şahintürk, 1997; Topuz et al., 2010; Dokuz, 2011; Kaygusuz et al., 2012). The early Jurassic volcanic rocks of the eastern Pontides unconformably lie on a Paleozoic heterogeneous crystalline basement, and are crosscut by younger granitoids of Jurassic to Paleocene age (Okay and Şahintürk, 1997; Dokuz et al., 2006; Kaygusuz et al., 2008, 2009, 2010; Karslı et al., 2010). Volcanic and volcano-sedimentary rocks of early and middle