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Timing of post-obduction granitoids from intrusion through cooling to exhumation in central Anatolia, Turkey

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ABSTRACT

The Middle to Late Cretaceous central Anatolian granitoids intrude the supra-subduction zone-type central Anatolian ophiolite and medium- to high-grade metasediments of central Anatolian crystalline complex and are overlain by Late Palaeocene to Early/Middle Eocene sediments. Their single-zircon ^{207}Pb–^{206}Pb evaporation ages define three clusters: (1) Cenomanian–Turonian (weighted-mean age: 94.9 ± 3.4 Ma), (2) Turonian–Santonian (85.5 ± 5.5 Ma) and (3) Campanian (74.9 ± 3.8 Ma). Their hornblende and biotite ^{40}Ar–^{39}Ar and K–Ar cooling ages cluster around 80–65 Ma. The close hornblende and biotite ages reflect rapid exhumation of a mid-crustal section during the Campanian–Maastrichtian. Early to Middle Palaeocene (57–62 Ma) apatite fission-track age clusters date the tail end of this exhumation episode. It is proposed that the central Anatolian granitoid melts were generated in a post-collisional extensional setting following the docking of an oceanic island arc onto the Tauride–Anatolide platform. Campanian–Maastrichtian to Early/Middle Palaeocene rapid exhumation event is considered to result from continent–continent collisions between Eurasian plate and the Tauride–Anatolide platform along the İzmir–Ankara–Erzincan suture zone.

1. Introduction

Investigation of the central Anatolian granitoids (CAG) since the 1990s has helped to reconstruct the geological evolution of central Anatolia (Erler et al., 1991; Akıman et al., 1993; Güleç, 1994; Göncüoğlu and Türeli, 1994; Boztuğ, 1994; Boztuğ et al., 1994, 1996; Erler and Göncüoğlu, 1996; Boztuğ et al., 1997; Ekici and Boztuğ, 1997; Tatar and Boztuğ, 1998; Otlu and Boztuğ, 1998; Yılmaz and Boztuğ, 1998; Güleç and Kadıoğlu, 1998; Kadıoğlu et al., 1998). CAG petrogenesis is important for reconstructing stages of Neo-Tethyan convergence; almost all petrological studies indicate a syn- to post-collisional geodynamic setting associated with the closure of the İzmir–Ankara–Erzincan ocean, one of the northern strands of the Neo-Tethys (Boztuğ, 1998; Yalınız et al., 1999; Boztuğ, 2000; Düzgören-Aydın et al., 2001; Köksal et al., 2001; Boztuğ et al., 2003a; Köksal et al., 2004; İlbeyli et al., 2004; İlbeyli, 2005; Tatar and Boztuğ, 2005; Boztuğ and Arehart, 2007; Boztuğ et al., 2007a, b). Kadıoğlu et al. (2003), in contrast, first suggested an arc-related magma source, derived from the north-dipping subduction zone of the Inner Tauride ocean for the Ağaçören granitoid suite in the western part of CAG but later proposed a syn-collisional setting related to the final closure of the Inner Tauride ocean (Kadıoğlu et al., 2006).

Recent single-zircon ^{207}Pb–^{206}Pb (Boztuğ et al., 2007c), apatite fission-track (Boztuğ and Jonckheere, 2007) and amphibole/biotite K–Ar (Boztuğ and Harlavan, 2008) investigations of the CAG have provided age constraints on the emplacement, cooling and exhumation of the CAG. The present study aims to integrate 20 new precise ^{40}Ar–^{39}Ar age determinations (11 amphiboles, 9 biotites) into the existing dataset in order to address the question of the spatio-temporal relationship between the emplacement, cooling and exhumation of CAG and the Neo-Tethyan closure in central Anatolia.

2. Regional tectonic setting

Central Anatolia is part of the northern Neo-Tethyan realm comprising the İzmir–Ankara–Erzincan ocean between the Eurasian plate in the north and the Tauride–Anatolide platform in the south and the Inner Tauride ocean located within the Tauride–Anatolide platform (Şengör and Yılmaz, 1981; Bozkurt and Mittwede, 2001). The Neo-Tethyan oceans began to close during Cenomanian–Turonian (95–90 Ma; Garfunkel, 2004). However, Okay et al. (2006) have recently reported an Albian metamorphism age (ca. 105 Ma) for the

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Table 1
A general compilation on the field relations, textural features, mineralogical composition and rock types of studied CAG.

Granitoid	Type	Field relation	Texture/mineralogy/rock description	Reference
Danacıobası	S-type	Part of composite Behrekdağ batholith; unconformably covered by Palaeocene–Eocene sedimentary rocks	Coarse- to medium-grained equigranular/qu + Kfeld + plg + bio/biotite leucogranite	Tatar and Boztuğ (2005)
Sarıhacılı	S-type	Intrudes the central Anatolian ophiolite (CAO) and unconformably overlain by Palaeocene–Eocene sedimentary rocks	Coarse- to medium-grained equigranular/qu + Kfeld + plg + bio/biotite leucogranite	Ekici and Boztuğ (1997), Boztuğ (2000)
Yücebaca	S-type	Intrudes the metasedimentary rocks of central Anatolian crystalline complex (CACC); unconformably covered by Palaeocene–Eocene and Miocene sedimentary rocks	Medium-grained equigranular/qu + Kfeld + plg + bio/biotite leucogranite	Alpaslan and Boztuğ (1997)
Felahiye	S-type	Intrudes the CAO rocks; unconformably overlain by Eocene sedimentary rocks	Medium-grained equigranular/qu + Kfeld + plg + bio/biotite leucogranite	Boztuğ and Tatar (2003)
Yassıağıl, Karakaya, Adatepe, Akçakoyunlu, Cankılı (Yozgat)	I-type	Intrusive within the crustal metasedimentary rocks of the CACC and CAO rocks; unconformably overlain by Eocene sedimentary rocks	K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + aug + bio/monzogranite, quartz monzonite, monzonite, monzodiorite	Erler and Göncüoğlu (1996), Tatar and Boztuğ (1998), Boztuğ et al. (2007a)
Halaçlı (Çiçekdağ)	I-type	Intrudes the CAO rocks, unconformably covered by Mio-Pliocene sedimentary rocks	K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + aug + bio/monzogranite	Yılmaz and Boztuğ (1998)
Konur (Behrekdağ)	I-type	Intrudes the crustal metasedimentary rocks of the CACC and CAO rocks; unconformably overlain by Palaeocene–Eocene sedimentary rocks	K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + aug + bio/monzogranite, quartz monzonite	Tatar and Boztuğ (2005)
Hasandede	Felsic A-type	Part of composite Behrekdağ batholith; unconformably overlain by Palaeocene–Eocene sedimentary rocks	K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + aug + bio/quartz monzonite	Tatar and Boztuğ (2005)
Kızdede	Mafic A-type	Part of composite Behrekdağ batholith; unconformably covered by Palaeocene–Eocene sedimentary rocks	Equigranular texture/plg + aug + aeg-aug + hbl + Kfeld + bio/monzogabbro, monzodiorite	Tatar and Boztuğ (2005)
Eğrialan	Felsic A-type	Intrudes the CAO rocks, unconformably covered by Mio-Pliocene sedimentary rocks	K-feldspar megacrystic porphyritic with a medium-grained groundmass/plg + Kfeld + qu + hst + rib + aeg + bio/quartz monzonite/syenite	Yılmaz and Boztuğ (1998)
Hamit	Felsic A-type	Intrusive within the CAO units and CACC metasedimentary rocks; unconformably covered by Palaeocene–Eocene sediments; MME occurrences	K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + aug + bio/quartz syenite	Otlu and Boztuğ (1998)
Çamsarı	Felsic A-type	Intrusive within the metasedimentary rocks of CACC and CAO units; unconformably covered by Palaeocene–Eocene sediments	Equigranular texture/Kfeld + plg + hst + bio/quartz syenite	Otlu and Boztuğ (1998)
Bayındır	Felsic A-type	Intrusive within the metasedimentary rocks of CACC and CAO units; unconformably covered by Palaeocene–Eocene sediments	Equigranular texture/Kfeld + plg + hst + bio + canc + neph/feldspathoidal syenite	Otlu and Boztuğ (1998)
Durmuşlu	Mafic A-type	Vein rocks emplaced within the Hamit granitoid and CAO units	Porphyritic with an aphanitic groundmass/plg + Kfeld + rib + aeg + mel + nos + bio + /porphyritic feldspathoidal syenite	Otlu and Boztuğ (1998)
Baranadağ	Felsic A-type	Intrusive within the CACC metasedimentary rocks; covered by Palaeocene–Eocene sediments; MME occurrences	K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + aug + bio/quartz monzonite	Otlu and Boztuğ (1998)
Çayağzı	Felsic A-type	Intrusive within the CACC metasedimentary rocks; unconformably covered by Palaeocene–Eocene sediments	Medium-grained equigranular/Kfeld + plg + qu + hst + bio + fluo/quartz syenite	Bayhan and Tolluoğlu (1987), Tolluoğlu (1993)
Buzlukdağ	Felsic A-type	Intrusive within the CACC metasedimentary rocks; unconformably covered by Palaeocene–Eocene sediments	Medium-grained equigranular/Kfeld + plg + qu + hst + bio + fluo/quartz syenite	Bayhan and Tolluoğlu (1987), Tolluoğlu (1993)
Davulalan	Felsic A-type	Intrusive within the CACC metasedimentary rocks; unconformably covered by Miocene sedimentary rocks	Coarse- to medium-grained equigranular/Kfeld + plg + bio + hst + aeg/syenite	Alpaslan and Boztuğ (1997)
Karaçayır	Felsic A-type	Intrusive within the CACC metasedimentary rocks; unconformably covered by Palaeocene–Eocene sediments	Coarse- to medium-grained equigranular/Kfeld + plg + bio + phlg + mus + neph + fluo/syenite	Boztuğ et al. (1996)
Dumluca	Bi-modal A-type	Intrudes the Divriği ophiolite and Munzur limestone; unconformably covered by Miocene volcano-sedimentary rocks	Felsic rocks: K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + hst + aug + bio/quartz monzonite-syenite. Mafic rocks: medium-grained equigranular texture sometimes includes K-feldspar megacrysts/aeg-aug + hst + ol + bio + plg + Kfeld/monzodiorite, monzogabbro	Boztuğ et al. (1997, 2007b)
Murmana	Bi-modal A-type	Intrudes the Divriği ophiolite and Munzur limestone; unconformably covered by Miocene volcano-sedimentary rocks	Felsic rocks: K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + hst + aug + bio/quartz monzonite-syenite. Mafic rocks: medium-grained equigranular texture sometimes includes K-feldspar megacrysts/aeg-aug + hst + ol + bio + plg + Kfeld/monzodiorite, monzogabbro	Boztuğ et al. (1997, 2007b)
Yellice	Felsic A-type	Intrusive within the CAO units; unconformably covered by Neogene Yamadağ volcanics	K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + hst + aug + bio/quartz monzonite-syenite	Boztuğ et al. (2003b)
Mursal	Felsic A-type	Unconformably covered by Neogene Yamadağ volcanics	K-feldspar megacrystic porphyritic with a medium-grained groundmass/Kfeld + plg + qu + hbl + hst + aug + bio/quartz monzonite-syenite	Boztuğ et al. (2003b)
Kuluncak	Felsic A-type	Intrusive within the CAO units; unconformably covered by Eocene sedimentary rocks and Neogene Yamadağ volcanics	Medium-grained equigranular/Kfeld + plg + hbl + hst + rib + aeg + bio/syenite	Boztuğ et al. (2003b), Leo et al. (1974)

Kfeld = K-feldspar; plg = plagioclase; qu = quartz; hbl = hornblende; aug = augite; bio = biotite; aeg-aug = aegirine-augite; hst = hastingsitic amphibole; rib = ribekitic amphibole; aeg = aegirine; canc = cancrinite; neph = nepheline; nos = nosean; fluo = fluorite; phlg = plogopite; mus = muscovite; ol = olivine.