Deformational and geochemical features of syn-tectonic Koyunoba and Egrigöz granitoids, western Turkey

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Introduction

Western Turkey comprises two major tectonic units, namely, the Sakarya zone to the north and the Menderes-Taurus platform to the south. These two tectonic units are separated from each other by the Izmir-Ankara-Erzincan suture that represents lithospheric remnants of the northern branch of the Neo-Tethys (Sengor & Yilmaz 1981) (Fig. 1a). Collision of these two tectonic units in the Late Palaeocene/Eocene caused the crustal thickening and the main phase of Alpine deformation and related metamorphism of the Menderes Massif (Sengor et al. 1984). The Menderes massif, a good example of metamorphic core complex formation, is an integral part of the Menderes-Taurus platform (Fig. 1a). The massif has been subdivided into a core consisting mainly Precambrian migmatites, gneisses and schists, and an overlying metasedimentary cover that was deposited in Paleozoic to early Tertiary time (Dora et al., 1990). The massif underwent early Palaeogene compressional deformation followed by Tertiary to recent extension. The study area is located to the northern part of Menderes core complex. Isik et al. (1997) and Isik & Tekeli (1998, 2001) have documented that Simav Detachment Fault, a low-angle normal fault, separates the non-mylonitic and mylonitic footwall rocks from allochthonous brittle deformed hanging rocks. The footwall rocks, which contain migmatitic banded gneiss, biotite gneiss, orthogneiss, high-grade schist, marble and amphibolite, are intruded by two syn-tectonic granitic plutons. The hanging wall of study area is lithologically heterogeneous. These units, from structurally lowest to highest, consist of schist-marble group, Mesozoic limestone/recrystallised limestone, and ophiolitic melange. Neogene sedimentary and volcanic rocks cover all rocks as fault-bounded relation (Seyitoglu 1997, Isik et al. 2003b). The footwall rocks of the Simav detachment fault contain evidence for a continuous ductile to brittle N-NE directed Cenozoic extensional deformation similar to the footwalls of many extensional detachment faults in the world. Igneous rocks brought to the surface from deep crustal levels during upward bending of Simav Detachment that is a northern continuation of Datca-Kale main breakaway fault (Isik et al. 2003a, Seyitoglu et al. 2003).

Koyunoba and Egrigöz Granitoids

Tertiary igneous rocks in study area expose as two distinct plutonic bodies called Koyunoba and Egrigöz granitoids, which are dome shaped and extend in a N-S and NE-SW direction (Fig. 1b). Margins of these granitoids were deformed within the shear zone that was formed during Tertiary extensional tectonic event. In the study area, non-deformed granitoid rocks pass into foliated granitoids in shear zone. The most voluminous rocks of non-deformed these granitoids are granodiorite, quartz monzonite and granite, with lesser amounts of quartz diorite and diorite. The

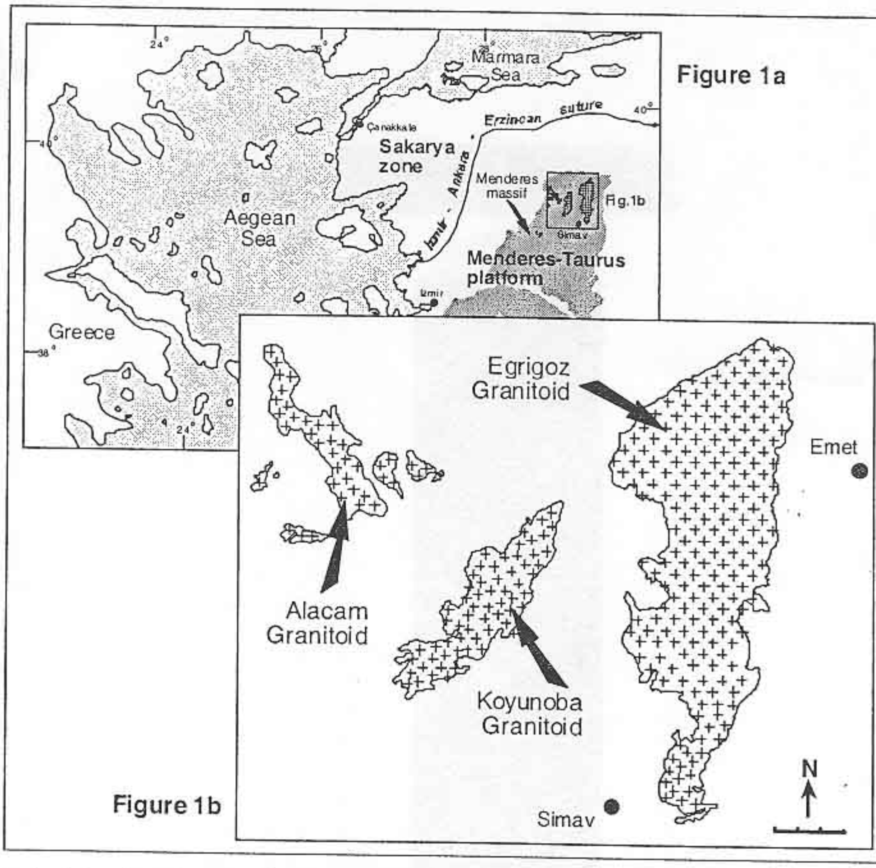

Figure 1. (a) showing main two zone in western Turkey and study area of the Menderes massif, (b) displaying situation of the granitoids in the study area.

granitoids are grey, brownish-greenish grey in colour, mostly medium-grained and equigranular, but locally porphyritic. All of these rocks are cut by fine-medium-grained dykes of variable composition. The dominant minerals in these granitoids include plagioclase, K-feldspar, quartz, biotite and hornblende. Common accessory minerals include apatite, zircon, sphene, allanite and opaque minerals. Biotite and hornblende are the main mafic minerals. Plagioclase is moderate in composition and commonly displays zoning. Perthite and myrmekite textures are rarely common within the K-feldspar.

Granitoids display intrusive relation with the mylonites that derived from high-grade metamorphites of the footwall rocks. Within the granitoids near the contact mylonite enclaves of variable size is observed. In the shear zone, granitoids exhibit foliation with increasing intensity towards the contact with the mylonites. Either foliated granitoids or mylonitic metamorphites display the same attitude of foliation. This is an evidence of syn-tectonic relationship between granitoids and mylonites. The thickness of foliated granitoids is quite variable and ranges from a few meters to a few ten meters. Foliation commonly strikes NE, dipping gently to moderately SE in the south and NW in the north. The mylonitic foliation is defined by flattened quartz aggregates and biotite. The lineation is penetrative on hand specimen scale and defined by stretched quartz, feldspar grains plus grain shape preferred orientations of mica, which shows a mean trend of approximately NE-SW. A mesoscopic-scale S-C structure can be observed occasionally. Furthermore, asymmetric microstructures, such as feldspar porphyroclasts, biotite fish, S-C and -C′, and oblique quartz grain-shape foliation suggest top-to-N-NE sense of shear coinciding with the sense of shear in the other ductilely (mylonitic) deformed the footwall rocks of the Simav detachment fault.

Isik et al. (2003b) obtained $^{40}Ar/^{39}Ar$ age data both mylonite and Egrigöz granitoid, suggesting that mylonitic deformation at least occurred at 23 Ma whilst the cooling age of the syn-extensional granitoid is 20 Ma in the northern part of the Menderes massif.

The preliminary geochemical data conducted on the Egrigöz and Koyunoba granitoids ascertained that both are subalkaline and peraluminous (A/CNK>1.5) I-type intrusives. The aluminium saturation index (ASI) decreases with increasing SiO_2 from about 1.67 to 1.48 in all granitoids. They belong to medium-K series. The role of magmatic differentiation as fractional crystallization in both intrusions is pointed out by the negative trend in Al_2O_3/TiO_2 versus TiO_2 diagram. The primitive mantle-normalized incompatiable trace element patterns of Egrigöz and Koyunoba granitoids are characterized by negative Nb, Ba, Sr, P and Ti anomalies and display enrichment in Th, Zr and La elements and are compatible to upper continental crust than lower crust (Fig. 2a). On the other hand, Koyunoba monzogranite is more depleted in Ba, Nb, Sr, P, Zr, Ti, Y, Cr and Ni than Egrigöz granitoidiorite. It has been suggested that Egrigöz granodiotites and Koyunoba monzogranodiorites may have been generated by 20-50% dehydratation melting of a basaltic/amphibolitic source at 900-1000ºC and affected by the similar differentiation processes. The Rb/Nb+Y tectono-magmatic discrimination diagram of Pearce et al. (1984) show that both Egrigöz and Koyunoba granitoids plot in upper right corner of volcanic arc fields areas (Fig. 2b), which coincides with the post collisional field of Pearce (1996) as it is the case in many Tertiary granitoids of Rhodope (Jones et al. 1992, Pe-Piper et al. 1997; Altherr & Siebel 2002). The positive Th, Zr and La enrichment of the granitoides are coincident with an upper continental crust as source whereas the Nb and Ti depletion may be related to the slab-derived fluids/melts. Therefore we conclude that the magmas of both granitoides may represent a hydride nature with dominating upper continental crust material. According to our preliminary geochemical data Koyunoba/Egrigöz granitoids may be emplaced in the early stage of extension. Hence it is reasonable to see the subduction related geochemical signature at the beginning of extensional tectonics, which gradually disappear in the following 15 Ma as documented by the volcanic evolution in western Turkey (Seyitoglu et al. 1997).

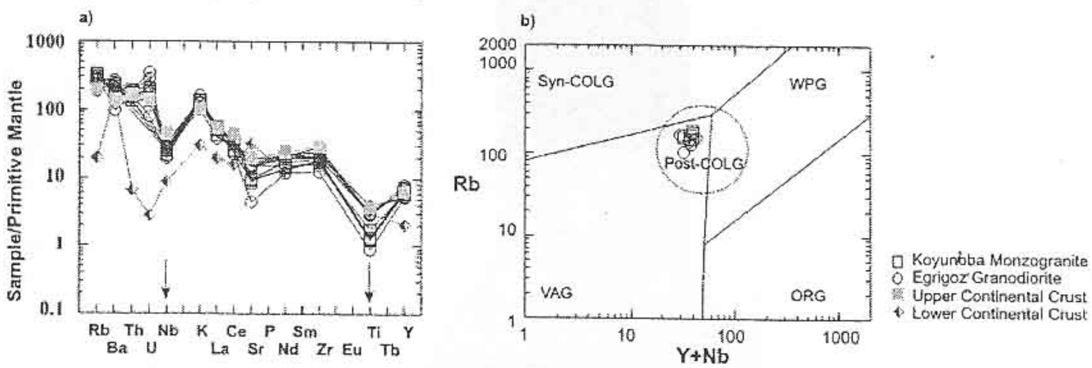

Figure 2. (a) Spider diagram of primitive-mantle normalised trace element distributions of Koyunoba monzogranite and Egrigöz granodiorite (normalisation data after Taylor and Mc Lennan, 1985). (b) Rb/Y+Nb tectonic discrimination diagram (Pearce et al. 1984): VAG (volcanic arc granite); ORG (oceanic ridge granite); WPG (within plate granite); Syn-COLG (syn-collisional granite); POG (post orogenic granite, field after Pearce 1996).

Conclusion

Egrigöz and Koyunoba granitoids are syn-tectonic intrusions of the footwall rocks of the Simav Detachment Fault. The granitoids were deformed and transformed into mylonitic rocks in shear zone during Tertiary time. Preliminary geochemical data shows that these granitoides are subalkaline and peraluminous I-type intrusives and may be emplaced, similar to the coeval Oligo-Miocene granitoids in the central Aegean Sea, in the early stages of continental extensional tectonics.

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