GEOLOGICAL JOURNAL
*Geol. J.* **34**: 233–242 (1999)

# Terlemez quartz monzonite of Central Anatolia (Aksaray–Sarıkaraman): age, petrogenesis and geotectonic implications for ophiolite emplacement

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The Terlemez quartz monzonite is one of the Central Anatolian Granitoids and is exposed to the east of one of the main granitoid belts trending in a NW–SE direction and situated at the western end of the Central Anatolian Crystalline Complex.

The Terlemez quartz monzonite is medium- to coarse-grained with granoblastic texture. It is essentially composed of quartz, plagioclase, hornblende and K-feldspar and variable contents of biotite. It is mostly compact and massive, but close to the contact with the ophiolitic basic rocks it shows a chilled margin. It characteristically includes K-feldspar megacrysts up to 3 cm in width and 10 cm in length, and contains irregular, angular or sub-rounded micromafic granular enclaves as well as xenoliths and large 'roof-pendants' of gabbroic composition derived from the Sarıkaraman Ophiolite, which is the most representative member of the supra-subduction zone type of Central Anatolian Ophiolites.

The Terlemez quartz monzonite is a calc-alkaline, metaluminous intrusion. It typically displays moderately developed negative Ba and Nb trace element anomalies and enrichment in light rare earth elements relative to heavy rare earth elements without any significant Eu, Sr and Ti anomalies. On the basis of field, petrographic and geochemical data, the Terlemez quartz monzonite has been classified as H-type (hybrid type), which requires significant input from a mantle-derived mafic magma. The intrusion represents the advanced stage of the post-collisional magmatism of the Central Anatolian Crystalline Complex.

Unlike the other Central Anatolian Granitoids, the Terlemez quartz monzonite has a clear intrusive contact with the well studied Middle Turonian–Lower Santonian Sarıkaraman Ophiolite. The K-Ar hornblende age obtained from the quartz monzonite ($81{\cdot}5 \pm 1{\cdot}9$ Ma) is interpreted as the intrusion age. These data suggest a post-Early Santonian to pre-Early Campanian emplacement age for the supra-subduction zone type of Central Anatolian Ophiolites. The data further suggest that the post-collisional magmatism in Central Anatolia post-dates the emplacement of fore arc-type ophiolites onto the passive margin of the Tauride–Anatolide platform. The very short time interval between the formation and emplacement ages of supra-subduction zone-type ophiolites seems to be a very typical feature of the fore arc-type Eastern Mediterranean Ophiolites. 

KEY WORDS Teremez quartz monzonite; Central Anatolian Crystalline Complex; post-collisional granite; H-type granite; Ophiolite emplacement

## 1. INTRODUCTION

Igneous, metamorphic and ophiolitic rock assemblages in Central Anatolia are collectively named the Central Anatolian Crystalline Complex (Göncüoğlu *et al.* 1991). The complex lies in Central Anatolia as a

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Contract/grant sponsor: NATO.
Contract/grant number: CRG 960549.
Contract/grant sponsor: TÜBİTAK.
Contract/grant number: YDABÇAG-85.

CCC 0072–1050/99/030233–10$17·50 

triangular area bounded by the Tuzgölü Fault to the west, the Ecemiş Fault to the east and the İzmir–Ankara–Erzincan Suture to the north (Figure 1). The Central Anatolian Crystalline Complex represents the metamorphosed passive northern edge of the Tauride–Anatolide platform (Figure 1). It has been recently studied and mapped by the METU-Central Anatolian Study Group (Göncüoğlu *et al.* 1994 and references therein). The metamorphic rocks of the Central Anatolian Crystalline Complex are collectively named the Central Anatolian Metamorphics. The metamorphics are tectonically overlain by the Central Anatolian Ophiolites and intruded by the Central Anatolian Granitoids (CAG). The complex is disconformably overlain by uppermost Maastrichtian, Lower Palaeocene and Eocene volcanic, clastic and carbonate rocks, Oligocene–Miocene evaporates and clastic rocks and Miocene–Pliocene continental clastic rocks (Göncüoğlu *et al.* 1991, 1992, 1993).

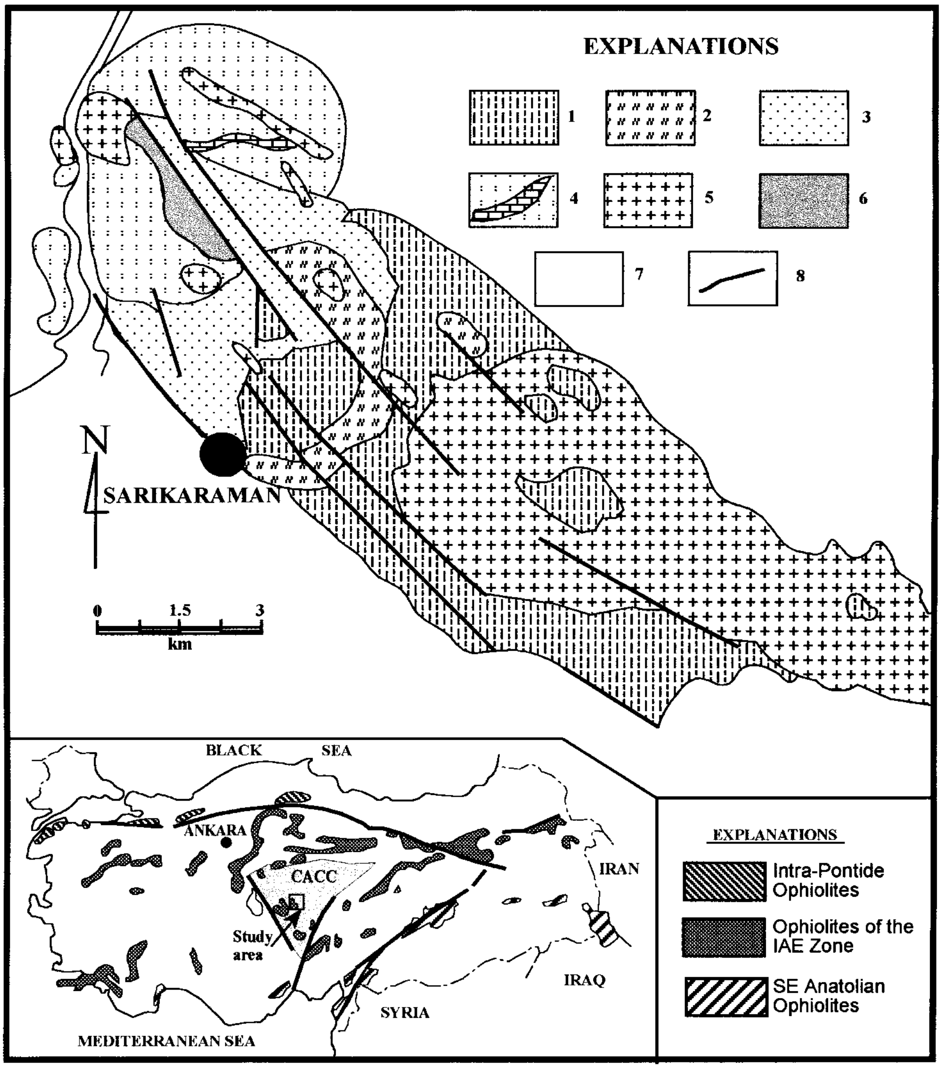


Figure 1. Location and simplified geological map of the Terlemez quartz monzonite in the Central Anatolian Crystalline Complex (simplified after Yalınız 1996). 1 = Isotropic gabbro with plagiogranites; 2 = dolerite dyke complex; 3 = pillow lava and pillow breccia; 4 = epiophiolitic cover with pelagic limestones; 5 = Terlemez quartz monzonite; 6 = Upper Maastrichtian–Lower Palaeocene volcaniclastic cover; 7 = Neogene cover; 8 = faults. The inset map shows the distribution and zonation of the Neotethyan Ophiolites in Turkey and the location of the study area within the Central Anatolian Crystalline Complex (CACC; shaded area)

 

Isolated outcrops of Central Anatolian Ophiolites are found as allochthonous bodies in the Central Anatolian Crystalline Complex (Yalınız and Göncüoğlu 1998). The ophiolitic rocks were generated in a supra-subduction zone setting within the İzmir–Ankara–Erzincan segment of Neotethys and were emplaced southward onto the Tauride–Anatolide passive margin (Göncüoğlu and Türeli 1994; Yalınız *et al.* 1996).

The CAG comprises granitoids and syenitoids that display volcanic arc granite–collisional granite (VAG–COLG) geochemical features and form a significant portion of the complex (Akıman *et al.* 1993; Erler and Göncüoğlu 1996). Although they have been subjected to numerous geological, petrographical and geochemical studies, their tectonic setting and nature of the relevant magmatism are still unresolved and a consensus as to whether these rocks are the products of VAG or COLG type magmatism has yet to be reached. In addition, the radiometric age data on the CAG are few and their petrogenetic and isotopic features are too fragmentary to draw any serious conclusion on the emplacement age and mechanism for the CAG within the Central Anatolian Crystalline Complex.

The Terlemez quartz monzonite is one of the CAG and is exposed in the western central part of Central Anatolian Crystalline Complex (Figure 1). It is located to the east of one of the main granitoid belts (Western Granitoid belt; Akıman *et al.* 1993; Erler and Bayhan 1995) treading NW–SE and situated at the western part of the Central Anatolian Crystalline Complex (Figure 1). Unlike the other CAG, the Terlemez quartz monzonite has a clear intrusive contact with the well studied supra-subduction zone type Middle Turonian–Lower Santonian Sarıkaraman Ophiolite (Yalınız 1996; Yalınız *et al.* 1997). The Sarıkaraman Ophiolite is a somewhat dismembered ophiolite body but retains a recognizable and well preserved magmatic pseudostratigraphy; it is one of the best representative members of the supra-subduction zone type Central Anatolian Ophiolites (Yalınız *et al.* 1996; Floyd *et al.* 1998). The age and petrogenesis of the Terlemez quartz monzonite have an important bearing on reaching any serious conclusion about the emplacement age and mechanism of the Sarıkaraman Ophiolite, and hence the Central Anatolian Ophiolites. This paper summarizes the main field, petrographic and geochemical features of the Terlemez quartz monzonite and evaluates the emplacement age of the Central Anatolian Ophiolites.

## 2. TERLEMEZ QUARTZ MONZONITE

### *2a. Field characteristics*

The Terlemez quartz monzonite clearly intruded the well studied Sarıkaraman Ophiolite; it covers approximately one-third of the Sarıkaraman area, and contact metamorphosed the Middle Turonian–Lower Santonian pelagic cherty limestones resulting in the formation of Ca-silicate minerals such as epidote, diopside and coarse calcite. The earliest sedimentary rocks disconformably cover the Terlemez quartz monzonite and consist of conglomerates dominated by granitoid and ophiolite clasts. These are followed by sandstones and shallow-marine carbonates that yield uppermost Maastrichtian-lowermost Palaeocene fossils (Göncüoğlu *et al.* 1991, 1997).

The best and largest exposure of the Terlemez quartz monzonite is white to light grey in colour and was observed around Terlemez village (Figure 1). It is also observed as small intrusive bodies, less than 1 km in diameter, to the northwest of the mapped area. Dykes related to the unit trend in a NW–SE direction.

Macroscopically, the Terlemez quartz monzonite is mainly medium- to coarse-grained equigranular in texture, with a high content of mafic minerals including both biotite and hornblende. However, the smaller intrusions are mainly characterized by the presence of K-feldspar megacrysts in a dark grey-coloured fine-grained matrix. The distinguishing feature of the Terlemez quartz monzonite is the occurrence of K-feldspar megacrysts which are up to 3 cm in width and 10 cm in length. They exhibit a well developed flow lineation in the dykes, trending NW–SE. Feldspar megacrysts are mostly epidotized in the dykes and small intrusions. The Terlemez quartz monzonite also contains irregular, angular or sub-rounded micromafic granular enclaves as well as xenoliths derived from the Sarıkaraman Ophilolite. Large gabbro blocks are observed as 'roof-pendants'. The Terlemez quartz monzonite is later intruded by pinkish to light-coloured, very fine-grained alkali feldspar-rich dykes.

### 2b. *Petrography*

The Terlemez quartz monzonite is composed essentially of quartz, plagioclase, hornblende, K-feldspar and variable amounts of biotite. Epidote, chlorite, sericite and kaolinite are secondary minerals, whereas the accessory minerals are represented by apatite, sphene and zircon, with some opaque minerals. The Terlemez quartz monzonite has a holocrystalline granular texture. Plagioclase varies from 45 to 57% of the rocks and forms subhedral to euhedral crystals; it is generally zoned and exhibits variable degrees of alteration. Sericite, kaolinite and occasionally epidote occupy the core or sometimes the whole of the plagioclase crystal. Hornblende occurs as small to medium, subhedral to anhedral grains. Sieve-textured, large, commonly twinned, patchy grains of hornblende (3–7 mm across) are common. They are poikilitic with inclusions of euhedral plagioclase, apatite and opaques, thus showing that these minerals preceded amphibole crystallization. Amphiboles are partly altered to chlorite or brown biotite. The alkali feldspar occurs in perthitic form as Carlsbad twins. Usually it is a pure orthoclase but it may be intermediate and rarely kaolinitized.

### 2c. *Geochemistry*

A total of 16 samples from the Terlemez quartz monzonite were analysed for their whole-rock major and trace element contents (Table 1). Major oxide content of the samples have a limited compositional range (Table 1). The analysed samples from the Terlemez quartz monzonite fall within the calc-alkaline field of the AFM diagram of Irvine and Baragar (1971) (Figure 2). They plot within the subalkaline field of the total alkalies versus $SiO_2$ diagram of Irvine and Baragar (1971), and metaluminous field of the Shand index diagram (Maniar and Piccoli 1989) which is consistent with the presence of hornblende and biotite.

Five selected samples were further analysed for their rare earth element (REE) chemistry. They display similar REE patterns without significant discordance (Figure 3). Their chondrite-normalized REE abundances fall in the range 5–200 $\times$ chondrite and reveal enrichment in light REE (LREE) relative to heavy REE (HREE) without noticeable Eu anomalies. On the ocean ridge granite-normalized spidergram, they display large ion lithophile element (LILE) enrichment relative to high field-strength elements with notable negative Ba and Nb anomalies (Figure 4). Lack of Eu anomalies can be attributed to combined fractionation of plagioclase and hornblende, whereas presence of negative Nb anomalies can be source-related (i.e. reflect subduction-modified processes). It is important to note that subduction-modified magmas do not necessarily require a direct link between magma genesis and subduction. Overall, geochemical features of the Terlemez quartz monzonite are comparable with those of the other granitoid intrusions of the Cental Anatolian Crystalline Complex (e.g. Yozgat Intrusion) classified as H-type (hybrid) of Barbarin (1990) (Aydın *et al.* 1997). In support of this, field and petrographic features of the intrusion, including K-feldspar megacrysts, mafic microgranular enclaves and the presence of abundant mafic minerals (e.g. hornblende), are comparable with those of the other H-type granitoids of the Central Anatolian Crystalline Complex (e.g. Agaçören granitoid; Kadıoğlu and Güleç 1996). These field, petrographic and geochemical features require a significant input from a mafic magma.

### 2d. *Geochronology*

Two K-feldspars and one amphibole were separated for K-Ar analysis from the Terlemez quartz monzonite in order to determine the intrusion age. The K content of each sample was measured by atomic absorption spectrometry at the University of Geneva, using standard techniques. Analytical precision is *c.* 0·5%. For calculating the age, Steiger and Jager (1997) constants were used.

 

Table 1. Whole-rock major, trace and REE analyses of the Terlemez quartz monzonite samples

| | M-1 | M-2 | T-1 | T-2 | T-3 | 7297 | Adat | Ky-38 | Ky-42 | Ky-43 | Ky-44 | M-3 | M-4 | M-5 | M-6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (wt%) | | | | | | | | | | | | | | | |
| $SiO_2$ | 62·75 | 63·62 | 63·30 | 63·59 | 64·00 | 62·39 | 63·39 | 64·33 | 62·14 | 62·99 | 63·54 | 64·12 | 64·15 | 64·34 | 63·82 |
| $TiO_2$ | 0·37 | 0·35 | 0·37 | 0·35 | 0·37 | 0·55 | 0·55 | 0·35 | 0·38 | 0·39 | 0·38 | 0·32 | 0·37 | 0·32 | 0·35 |
| $Al_2O_3$ | 15·98 | 15·98 | 16·10 | 15·98 | 15·95 | 15·65 | 15·52 | 15·88 | 16·15 | 16·04 | 16·07 | 15·57 | 15·54 | 15·43 | 16·05 |
| $Fe_2O_3$ | 5·39 | 5·07 | 5·10 | 4·89 | 5·01 | 4·87 | 4·44 | 4·51 | 5·29 | 5·26 | 4·89 | 5·00 | 4·81 | 4·89 | 4·82 |
| MnO | 0·08 | 0·09 | 0·08 | 0·08 | 0·08 | 0·09 | 0·08 | 0·08 | 0·10 | 0·09 | 0·09 | 0·09 | 0·12 | 0·06 | 0·09 |
| MgO | 1·67 | 1·87 | 1·73 | 1·69 | 1·68 | 1·85 | 1·70 | 1·60 | 1·81 | 1·69 | 1·63 | 1·67 | 1·78 | 1·63 | 1·71 |
| CaO | 5·33 | 5·23 | 5·24 | 5·28 | 5·03 | 5·20 | 5·22 | 4·91 | 5·75 | 5·27 | 5·01 | 5·24 | 5·06 | 5·21 | 5·21 |
| $Na_2O$ | 3·33 | 3·15 | 3·12 | 3·28 | 3·00 | 2·56 | 2·59 | 3·32 | 3·47 | 3·34 | 3·28 | 3·14 | 3·39 | 3·33 | 3·32 |
| $K_2O$ | 4·29 | 4·16 | 4·15 | 4·19 | 4·15 | 4·10 | 4·04 | 4·16 | 4·27 | 4·14 | 4·29 | 4·18 | 4·18 | 4·12 | 4·17 |
| $P_2O_5$ | 0·25 | 0·21 | 0·20 | 0·23 | 0·21 | 0·12 | 0·12 | 0·18 | 0·23 | 0·22 | 0·17 | 0·21 | 0·27 | 0·19 | 0·21 |
| LOI | 0·60 | 0·36 | 0·73 | 0·45 | 0·53 | 2·69 | 2·69 | 0·64 | 0·50 | 0·52 | 0·68 | 0·48 | 0·30 | 0·37 | 0·30 |
| Total | 100·04 | 100·09 | 100·12 | 100·01 | 100·01 | 100·07 | 100·34 | 99·96 | 100·09 | 99·95 | 100·03 | 100·02 | 99·97 | 99·91 | 100·05 |
| (ppm) | | | | | | | | | | | | | | | |
| Cr | 38 | 38 | 35 | 35 | 37 | 40 | 26 | 30 | 32 | 32 | 40 | 34 | 32 | 31 | 39 |
| Ni | 11 | 10 | 11 | 11 | 10 | 11 | 9 | 9 | 12 | 9 | 9 | 10 | 11 | 10 | 12 |
| V | 72 | 75 | 79 | 67 | 75 | 64 | 55 | 65 | 76 | 89 | 65 | 75 | 65 | 62 | 64 |
| Cu | 13 | 17 | 15 | 13 | 13 | 14 | 12 | 15 | 14 | 12 | 12 | 13 | 13 | 11 | 15 |
| Pb | 45 | 40 | 40 | 48 | 40 | 43 | 77 | 44 | 45 | 38 | 41 | 41 | 40 | 37 | 39 |
| Zn | 64 | 61 | 63 | 66 | 54 | 71 | 79 | 59 | 70 | 54 | 68 | 66 | 66 | 60 | 60 |
| Rb | 176 | 172 | 178 | 179 | 178 | 186 | 156 | 184 | 168 | 184 | 175 | 179 | 175 | 181 | 181 |
| Ba | 876 | 925 | 852 | 885 | 938 | 824 | 715 | 656 | 1047 | 729 | 930 | 912 | 887 | 882 | 820 |
| Sr | 825 | 794 | 830 | 785 | 810 | 535 | 616 | 758 | 887 | 840 | 706 | 815 | 795 | 829 | 835 |
| Ga | 22 | 22 | 22 | 21 | 21 | 21 | 21 | 21 | 22 | 23 | 23 | 21 | 21 | 21 | 20 |
| Nb | 19 | 18 | 19 | 19 | 19 | 18 | 17 | 18 | 20 | 20 | 19 | 21 | 20 | 19 | 20 |
| Zr | 219 | 221 | 217 | 213 | 228 | 207 | 202 | 189 | 237 | 212 | 227 | 218 | 219 | 210 | 218 |
| Y | 25 | 20 | 21 | 21 | 23 | 23 | 22 | 19 | 22 | 22 | 23 | 22 | 20 | 23 | 20 |
| Th | 32 | 29 | 33 | 34 | 35 | 30 | 30 | 38 | 43 | 36 | 29 | 31 | 33 | 31 | 31 |
| La | 45·00 | 50·00 | 56·60 | 38·30 | 54·90 | | | | | | | | | | |
| Ce | 87·00 | 90·00 | 94·10 | 81·50 | 101·40 | | | | | | | | | | |
| Pr | 9·90 | 10·00 | 8·80 | 9·00 | 11·10 | | | | | | | | | | |
| Nd | 29·00 | 30·00 | 26·80 | 28·90 | 37·00 | | | | | | | | | | |
| Sm | 4·70 | 5·00 | 3·70 | 4·40 | 5·90 | | | | | | | | | | |
| Eu | 1·18 | 1·19 | 0·92 | 1·14 | 1·28 | | | | | | | | | | |
| Gd | 3·11 | 3·11 | 2·60 | 3·00 | 3·90 | | | | | | | | | | |
| Dy | 2·91 | 2·91 | 2·30 | 2·80 | 3·80 | | | | | | | | | | |
| Ho | 0·71 | 0·67 | 0·49 | 0·60 | 0·77 | | | | | | | | | | |
| Er | 1·61 | 1·81 | 1·30 | 1·70 | 1·90 | | | | | | | | | | |
| Tm | 0·25 | 0·23 | 0·19 | 0·21 | 0·26 | | | | | | | | | | |
| Yb | 1·41 | 1·50 | 1·20 | 1·30 | 1·60 | | | | | | | | | | |
| Lu | 0·20 | 0·21 | 0·20 | 0·19 | 0·24 | | | | | | | | | | |

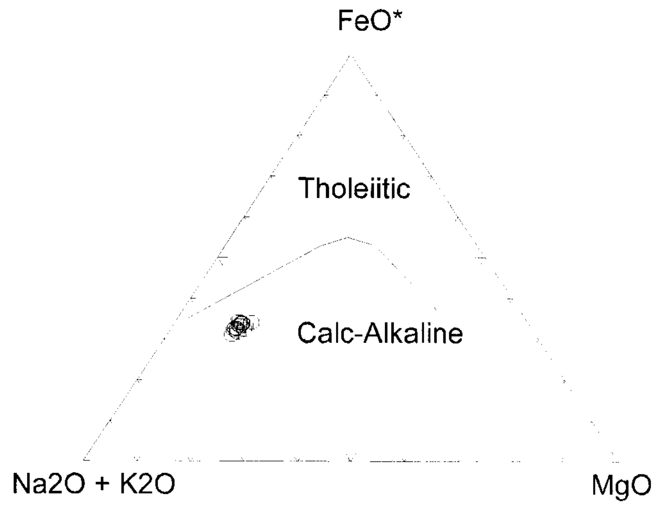


Figure 2. Plot of AFM diagram where alkaline and subalkaline fields are from Irvine and Baragar (1971)

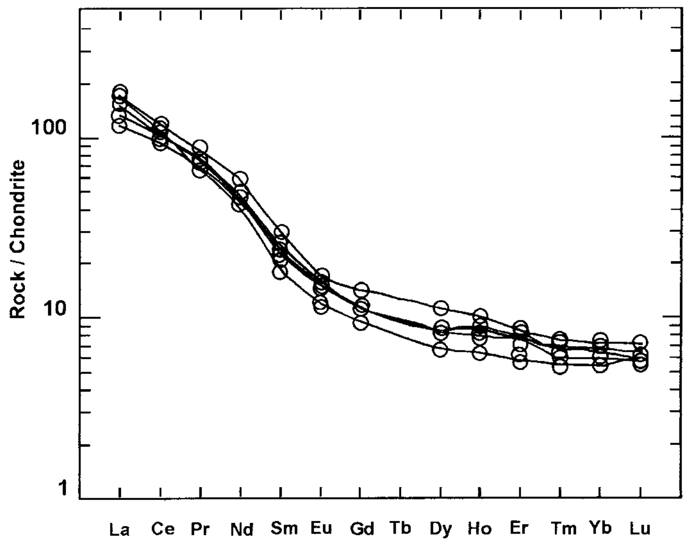


Figure 3. Chondrite-normalized REE diagram. Normalizing values are from Sun (1982)

Table 2. K-Ar isotope analyses of the Terlemez quartz monzonite samples

| No. | Mineral | K(%) | $^{40}$Ar(mol/g × $10^{-11}$) | $^{40}$Ar(%) | $^{40}$Ar/$^{36}$Ar × $10^2$ | $^{40}$K/$^{36}$Ar × $10^4$ | Age (Ma) |
|---|---|---|---|---|---|---|---|
| T-1 | K-Feldspar | 9·75 | 115·62 | 87·6 | 23·83 | 52·53 | 67·1 ± 1·3 |
| T-2 | K-Feldspar | 10·15 | 125·722 | 82·17 | 16·57 | 32·81 | 70·1 ± 1·5 |
| T-2 | Amphibole | 0·98 | 14·176 | 77·5 | 13·13 | 20·99 | 81·5 ± 1·9 |

The K-Ar isotopic determinations for the Terlemez quartz monzonite yielded ages that range from 81·5 ± 1·9 to 67·1 ± 1·3 Ma. The analytical data are given in Table 2.

The K-Ar hornblende age (*c.* 81·5 ± 1·9) Ma) is interpreted as the formation age of the hornblende and thus the intrusion age of the Terlemez quartz monzonite . The K-feldspar K-Ar ages between 71·1 ± 1·5 and 67·1 ± 1·3 Ma, on the other hand, are in accordance with the K-Ar mineral ages obtained from other CAG.

 

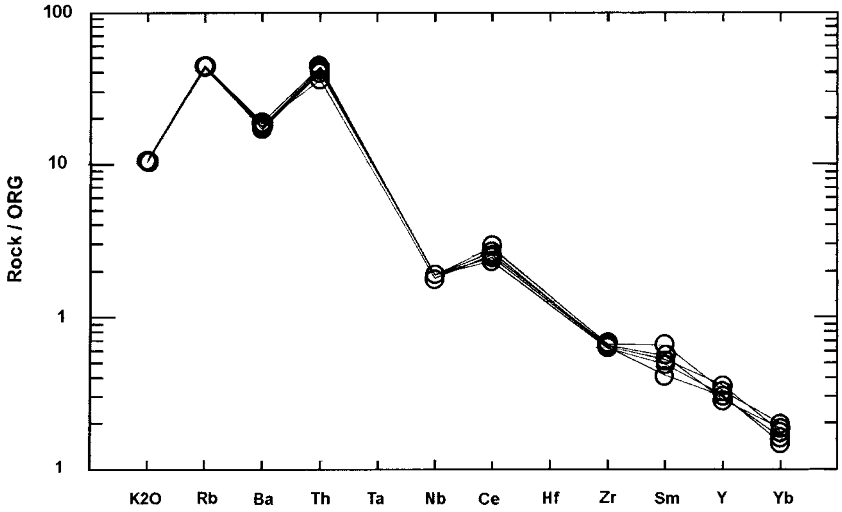


Figure 4. Ocean ridge granite (ORG)-normalized spider diagram. Normalizing values are from Pearce *et al.* (1984)

Ataman (1972) reported from Cefalıkdağ granitoid a Rb-Sr biotite–whole-rock age of 71 ± 1 Ma, and interpreted this date as a cooling age. From the micaschists, Erkan (1981) found K-Ar biotite and hornblende ages that range from 70·3 ± 1·6 to 69·0 ± 1·7 Ma and 74 Ma, respectively. The authors suggest that the average age of *c.* 71 Ma does not reflect the age of the metamorphic event but represents the cooling age of the metamorphic rocks subsequent to the intrusion of the granitoids. Thus we interpret the K-feldspar ages of around 69 Ma as the cooling age of the Terlemez quartz monzonite.

## 3. GEOLOGICAL IMPLICATIONS

The tectonic setting of the Terlemez quartz monzonite is presented in the trace element classification diagrams of Pearce *et al.* (1984) (Figure 5).

It is important to note that application of this diagram does not necessarily indicate that suggested tectonic setting or classification schemes are accepted by the authors. The samples from the Terlemez quartz monzonite fall within syn-collisional granite (syn-COLG) + volcanic arc granite (VAG) field of the Nb versus Y diagram (Figure 5A), but they clearly fall within the VAG field of Rb versus Y + Nb diagram (Figure 5B). Furthermore, none of the field, petrographic and geochemical features, including (a) the presence of mafic minerals, K-feldspar megacrysts and mafic microgranular enclaves and (b) the metaluminous nature, are consistent with those of the granitoid rocks that can be classified by syn-COLG.

From the above discussion, it is clear that the Terlemez quartz monzonite is not the product of syn-COLG type magmatism. Nevertheless, it is not clear whether these rocks are products of VAG or post-collisional granite (post-COLG) type magmatism. By considering the other H-type granitoid intrusions of the Central Anatolian Crystalline Complex, it is possible to suggest that the Terlemez quartz monzonite is post-COLG and may represent a mature stage of the post-collisional magmatism in the Central Anatolian Crystalline Complex which is characterized by mafic magma underplating of the lower crust as a result of lithospheric delamination following crustal thickening (Aydin *et al.* 1998).

This suggestion is of critical importance for the ophiolite emplacement in Central Anatolia and hence the geodynamic evolution of the Central Anatolian Crystalline Complex. It is generally accepted that ophiolitic rocks in Central Anatolia are intruded by granitoids (Ketin 1959; Seymen 1982; Göncüoğlu 1986; Koçak and Leake 1994; Yılmaz-Şahin and Boztuğ 1997). It is further documented by Göncüoğlu and Türeli (1994) and Yalınız and Göncüoğlu (1998) that granitic intrusions cross-cut not only the ophiolites but also the

 

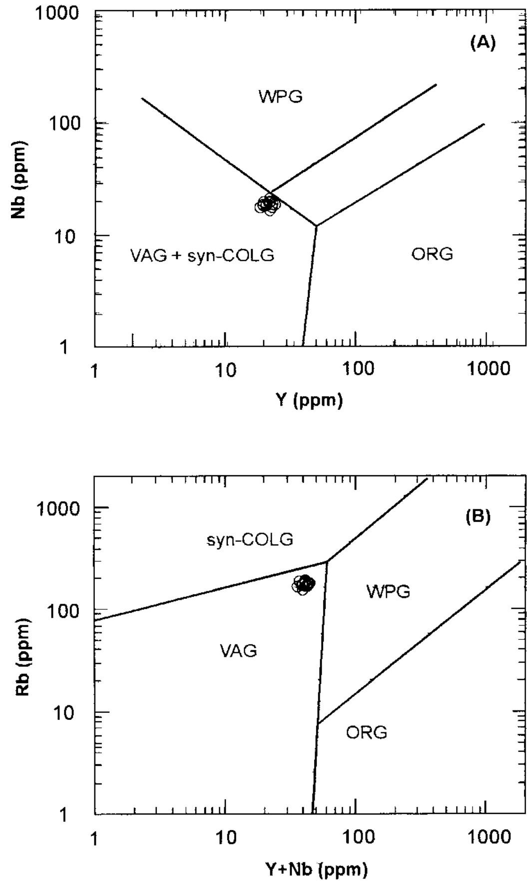


Figure 5. Tectonic discrimination diagrams of (A) Nb versus Y and (B) Rb versus Y + Nb (after Pearce *et al.* 1984)

structurally underlying Central Anatolian Metamorphics and the thrust plane between them. These field data clearly indicate that granitoid intrusion post-dates ophiolite emplacement. However, the scarcity of radiometric data on the age of the Central Anatolian Granitoids, as well as limited geochemical data on both ophiolitic and granitic rocks, has prevented a better reconstruction of the geological events in the Central Anatolian Crystalline Complex.

Before reaching a conclusion about the geological constraints for the evolution of Central Anatolian Crystalline Complex, it is important to summarize the data obtained by this study. (a) The supra-subduction type Sarıkaraman Ophiolite, similar to other ophiolitic rocks in Central Anatolia, overthrusts the Central Anatolian Metamorphics which represent the passive margin of the Tauride–Anatolide platform. Palaeontological studies from the associated sediments indicate an Early middle Turonian to Early Santonian formation age for the oceanic crust. (b) The Terlemez quartz monzonite cross-cuts the Sarıkaraman Ophiolite and its associated sediments. (c) The Terlemez quartz monzonite is of H-type and shows post-COLG character. (d) K-Ar mineral data indicate an Early Campanian intrusion age and a Late Maastrichtian cooling age. (e) The earliest post-granite transgressive cover of the Central Anatolian Crystalline Complex is represented by uppermost Maastrichtian–lowest Palaeocene marine–lacustrine sediments dominated by granitic detritus.

The significant regional implications of these observations are as follows: (1) similarly to the small Neotethyan supra-subduction zone (SSZ) type ophiolities in the southern branch of Neotethys (e.g. Troodos, Mersin–Antalya–Hatay, Baer–Bassit, Zagros and Oman), the Central Anatolian Ophiolites of the Vardar–

 

İzmir–Ankara–Erzincan (VIAE) ocean were created due to intra-oceanic subduction. During Early middle Turonian–Early Santonian, away from the passive margin of the Tauride–Anatolide platform, and due to the northward subduction of the VIAE oceanic lithosphere, the Sarıkaraman Ophiolite formed above this subduction as a fore-arc ophiolite (Yalınız *et al*. 1994, 1996). (2) The obduction of the ophiolitic nappes onto the northern margin of the Tauride–Anatolide platform was realized in two successive events. (a) The initial obduction of the older MORB-type oceanic assemblages onto the Tauride–Anatolide margin resulted in depositing of an ophiolite-bearing olistostrome within a flexural foreland basin formed in front of the ophiolitic nappes. The obduction of these ophiolitic nappes caused deep burial and metamorphism of the platform-margin units together with the ophiolitic olistostromes. This event pre-dates the emplacement of the SSZ-type ophiolites. (b) The obduction of SSZ-type ophiolites was between Early Santonian and Early Campanian. Structural data indicate that the obduction was towards the SSW. These data are in good accordance with the emplacement ages of further ophiolitic units onto the passive margin of the Tauride–Anatolide platform further west in Turkey (e.g. Ricou 1971; Özgül 1976; Göncüoğlu *et al*. 1992). (3) The intrusion of the post-collisional H-type Central Anatolian Granitoids and the formation of extensional basins during latest Maastrichtian clearly post-date ophiolite emplacement. As is the case for many SSZ-type ophiolites in the Eastern Mediterranean ophiolites, the time interval between the formation and emplacement ages of the Central Anatolian Ophiolites is very limited, which seems to be a typical feature for the fore arc-type oceanic lithosphere.

A further regional implication of this study is that the SSZ-type oceanic crust formation in the Turkish part of the VIAE ocean is definitely younger than in the Carpato–Balkan region, which was suspected in previous studies (e.g. Robertson and Dixon 1985).

## ACKNOWLEDGEMENTS

Funding for the geochemical studies by NATO grant CRG 960549 and the Scientific and Technical Research Council of Turkey (TÜBİTAK) (code no: YDABÇAG-85) is gratefully acknowledged. Logistic support in the field was given by Turkish Petroleum Corporation (TPAO). The authors acknowledge Dr P. A. Floyd, Department of Earth Sciences, Keele University, and Professor Dr R. Chessex, University of Geneva, for providing the laboratory facilities for the analytical and isotope data. We also acknowledge the constructive advice of Dr Q. Crowley and Dr G. Rowbotham.

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