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Geochemistry of the Esence granitoid (Göksun-Kahramanmaraş), SE Turkey

Esence granitoyidinin (Göksun-Kahramanmaraş) jeokimyası, GD Türkiye

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ABSTRACT

The Esence granitoid intruded into the Paleozoic-Mesozoic Malatya metamorphics and Late Cretaceous Göksun ophiolite in the area between Göksun and Afşin, to the north of Kahramanmaraş. It is represented by granodiorite and microgranite. The granodioritic rocks contain amphibole-bearing mafic microgranular enclaves (MME) ranging in size between 5 cm and 30 cm whereas the microgranites comprise number of aplitic dykes. These rocks present granular, microgranular porphyric and micrographic textures, respectively. On the basis of geochemical observations, the intrusive rocks are interpreted as I-type, calcalkaline granitoids. ORG-normalized spider diagram shows LIL element (K, Rb, Ba, Th) enrichment and HFS element (Hf, Zr, Sm, Y) depletion, suggesting subduction related setting for the granitoid rocks. Tectonomagmatic discrimination diagrams also confirm their volcanic arc setting. All the geochemical data combined with the field observations suggest following evolutionary scenario for the Esence granitoid rocks. The ophiolites and related metamorphic rocks were formed in a suprasubduction zone environment in southern branch of Neotethys in Late Cretaceous. These units were then accreted to the base of the Malatya-Keban platform. Finally all the former units were intruded by the Esence granitoid in volcanic arc setting in Late Cretaceous.

Key Words: Aplitic dike, granitoid, mafic microgranular enclave, volcanic arc.

ÖZ

Kahramanmaraş'ın kuzeyinde Göksun-Afşin arasındaki bölgede yeralan Esence granitoyidi Paleozoyik-Mezozoyik yaşlı Malatya metamorfitleri ve Geç Kretase yaşlı Göksun ofiyolitini kesmektedir. Esence granitoyidi, granodiyorit ve mikrogranitlerle temsil edilmektedir. Granodiyoritik kayaçlar boyları 5-30 cm arasında değişen amfibolce zengin mafik mikrogranuler enklavlar (MME) içerirken, mikrogranitler ise çok sayıda aplitik dayk içermektedir. Bu kayaçlar sırasıyla granüler, mikrogranüler porfirik ve mikrografik dokular sunmaktadırlar. İntruzif kayaçlar, jeokimyasal incelemelere dayanarak, I tipi kalkalkalen granitoyid olarak yorumlanmıştır. Granitoyide ait kayaçlar, okyanus ortası sırtı granitlerine (ORG) göre normalize edilmiş örümcek diyagramında, yüksek iyon yarıçaplı (LIL) elementler (K, Rb, Ba, Th) bakımından zenginleşme ve HFS elementler (Hf, Zr, Sm, Y) bakımından tüketilme göstermekte ve dalma batma ile ilgili bir ortamı işaret etmektedir. Ayrıca tektonomagmatik ayırtlama diyagramları da Esence granitoyidinin volkanik yay ortamında oluştuğunu doğrulamaktadır. Arazi gözlemleriyle birleştirilmiş tüm jeokimyasal veriler, Esence granitoyidi için aşağıdaki oluşum evrimini önermektedir. Ofiyolitler ve bunlarla ilişkili metamorfik kayaçlar Geç Kretase'de Neotetis'in güney kolunda bir yitim zonu üzerinde oluşmuşlardır. Daha sonra tüm bu birimler nap hareketleri sırasında Malatya-Keban platformunun tabanına tektonik olarak yerleşmişler ve Geç Kretase'de volkanik yay ortamında oluşan Esence granitoyidi tarafından kesilmişlerdir.

Anahtar kelimeler: *Aplitik dayk, granitoyid, mafik mikrogranüler enklav, volkanik yay.*

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INTRODUCTION

Granitoids of Mesozoic and Cenozoic in age are extensively observed as intruding the metamorphic massifs, platform units, ophiolites and post-Mesozoic (Early Tertiary) rocks as a result of closure of Neotethyan ocean basins throughout Anatolia. In relation to these activities, the Pontide belt comprises Late Eocene granitoids (Çoğulu, 1975; Karslı et al., 2002). The magmatism in this belt is represented by calc-alkaline, I-type subduction-related granitoids in the eastern region (Şengör and Yılmaz, 1981; Aydın et al., 2003; Karslı et al., 2002). The intrusive associations in Central Anatolia are characterized by (a) syncollisional S-type, (b) post-collisional I-type and (3) post-collisional A-type granitoids (Akıman et al., 1993; Boztuğ et al., 1994, 1997; Göncüoğlu and Türeli, 1994; Erler and Bayhan, 1995; Erler and Göncüoğlu, 1996; İlbeyli and Pearce, 1997; Alpaslan and Boztuğ, 1997; Ekici and Boztuğ, 1997; Boztuğ, 1998; Tatar and Boztuğ, 1998; Aydın and Önen, 1999; Yalınız et al., 1999; Gençalioğlu-Kuşçu et al., 2001; İlbeyli et al., 2004). The northwest Anatolia comprises volcanic arc (Güçtekin et al., 2004) to post-collisional (Genç and Yılmaz, 1997) granitoids of Middle-Late Eocene in age (Delaloye and Bingöl, 2000).

The granitoids in the southeast Anatolian orogeny are of Carboniferous and Late Cretaceous in age. The Carboniferous intrusive rocks are seen within the high grade metamorphic schists and gneisses of the Bitlis and Pötürge massifs (Yılmaz, 1971, 1978; Helvacı and Griffin, 1983). The Late Cretaceous granitoids are widespread in Kahramanmaraş, Malatya and Elazığ regions and seen as intruding into the platform carbonates (i.e. Malatya, Keban metamorphics), ophiolites (Göksun, Berit, İspendere and Kömürhan ophiolites) and volcanic arc units (Yüksekova/Elazığ magmatics) of the southeast Anatolia (Tarhan, 1986; Yazgan and Chessex, 1991; Parlak and Rızaoğlu, 2004). This paper presents major and trace element geochemical data on the granitoid rocks of the Esence (Göksun-Kahramanmaraş) region (Figure 1) to interpret its importance in the regional geology of the southeast Anatolia.

REGIONAL GEOLOGY

In the north of Kahramanmaraş region, the southeast Anatolian orogeny comprises three distinct, approximately E-W trending tectonic elements, which are separated from one another by major north dipping thrust faults (Figure 2). From north to south these are the nappe zone,

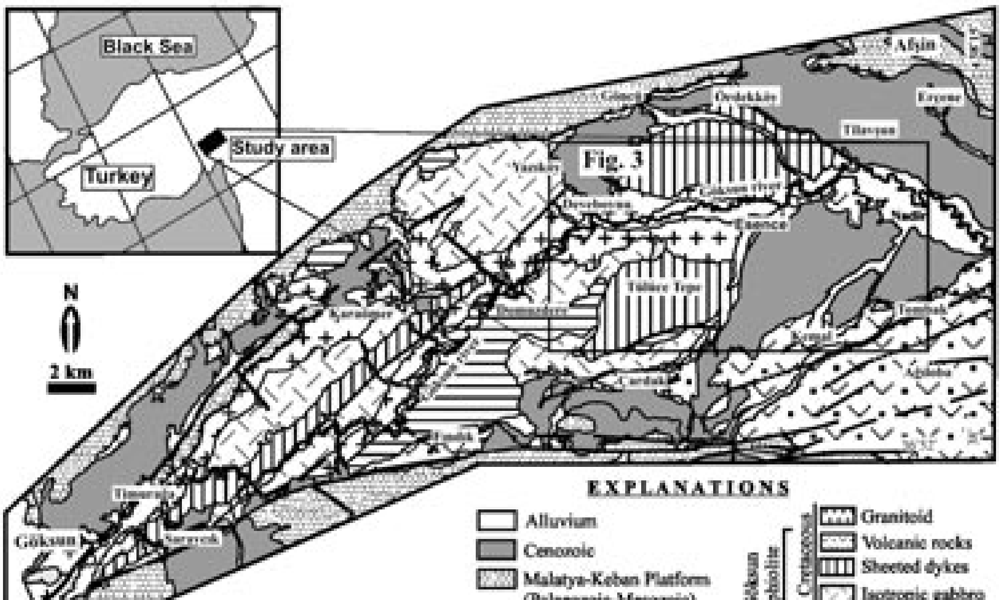

Figure 1. Location map of the study area (modified from Perinçek and Kozlu, 1984).
Şekil. 1. Çalışma alanının yerbulduru haritası (Perinçek ve Kozlu 1984' ten değiştirilerek alınmıştır).

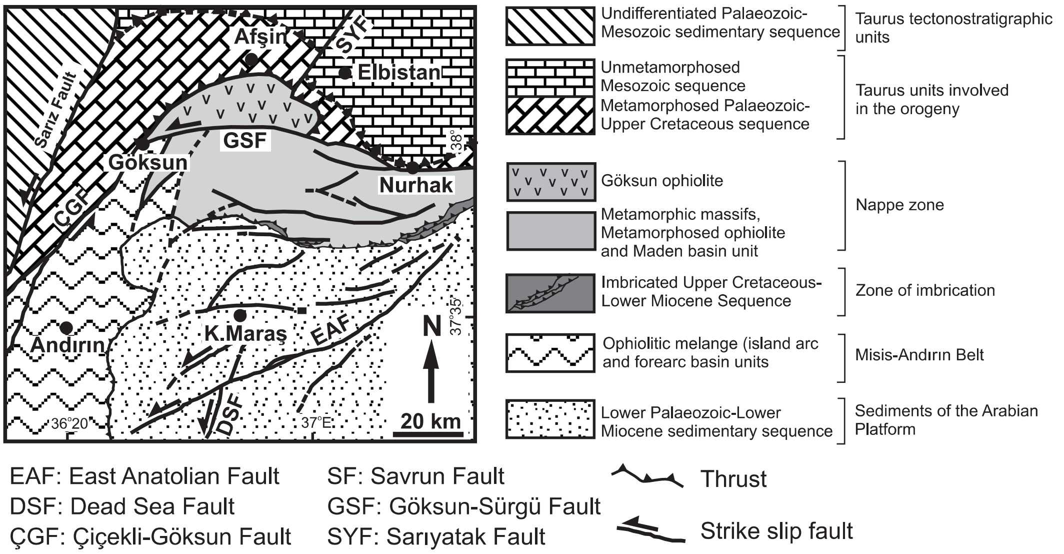

Figure 2. Tectonic units and structural features of the Kahramanmaraş-Elbistan region (Simplified after Yılmaz, 1993).

Şekil 2. Kahramanmaraş-Elbistan bölgesinin tektonik birlikleri ve yapısal özellikleri (Yılmaz, 1993'ten basitleştirilerek alınmıştır).

the zone of imbrication and the Arabian platform (Yılmaz, 1990, 1993; Yılmaz et al., 1993). The nappe zone forms, morphologically, the highest tectonic unit which consists of two large nappe stacks, the lower and the upper nappes (Yılmaz, 1993). The lower nappe is mainly characterized by the variably metamorphosed ophiolitic units and the Maden Group whereas the upper nappe is represented by the metamorphic massifs (Bitlis, Pütürge, Malatya, Keban, Engizek and Binboğa) of southeast Anatolia (Ketin, 1983; Yılmaz, 1993). The imbrication zone is a narrow E-W trending belt which was squeezed between the nappe region to the north and the Arabian platform to the south (see Figure 2). The zone of imbrication is represented by a number of north dipping thrust slices with southerly vergence (Yılmaz et al., 1987; Yılmaz, 1990; Karig and Kozlu, 1990). The rock units in the imbricated thrust sheets range in age from Late Cretaceous to Early Miocene (Yılmaz, 1993). Further to the west-southwest, the rock units of the imbrication zone is traced along the Misis-Andırın Mountain belt (Yılmaz et al., 1987; Yılmaz, 1990; Kelling et al., 1987). Yılmaz et al., (1993) suggested that the Misis-Andırın Mountain belt is an escaped zone between the nappe zone and the Arabian platform (see Figure 2). The Arabian platform comprises autochthonous and parautochthonous sedimentary units deposited since Early Paleozoic time as seen in Figure 2 as well as Upper Cretaceous ophiolite nappes and their sedimentary cover (Yılmaz, 1993).

The granitoids related to the evolution of the southern Neotethys in the southeast Anatolia are observed at three localities, namely the Göksun-Afşin (Kahramanmaraş), Doğanşehir (Malatya) and Baskil (Elazığ) regions as intruding the tectonostratigraphic/magmatic units of the nappe zone (Yılmaz, 1993). The most important point at these localities is that the granitoids are seen as intruding both into the Malatya-Keban platform, ophiolites and related metamorphic units, suggesting that the Malatya-Keban platform and ophiolitic units had been tectonically juxtaposed before the intrusions took place in Late Cretaceous.

The Esence granitoid crops mainly up along the Göksun River (Figure 3). It has an intrusive contact relations with the ophiolitic units and is overlain by the Plio-Quaternary cover sediments (Figure 4). Although, in the study area granitoid and the Malatya-Keban platform are not in contact, the intrusion of the Esence granitoid into the Malatya-Keban platform is mentioned by Parlak and Rızaoğlu (2004) elsewhere in the region. The Esence granitoid is represented by

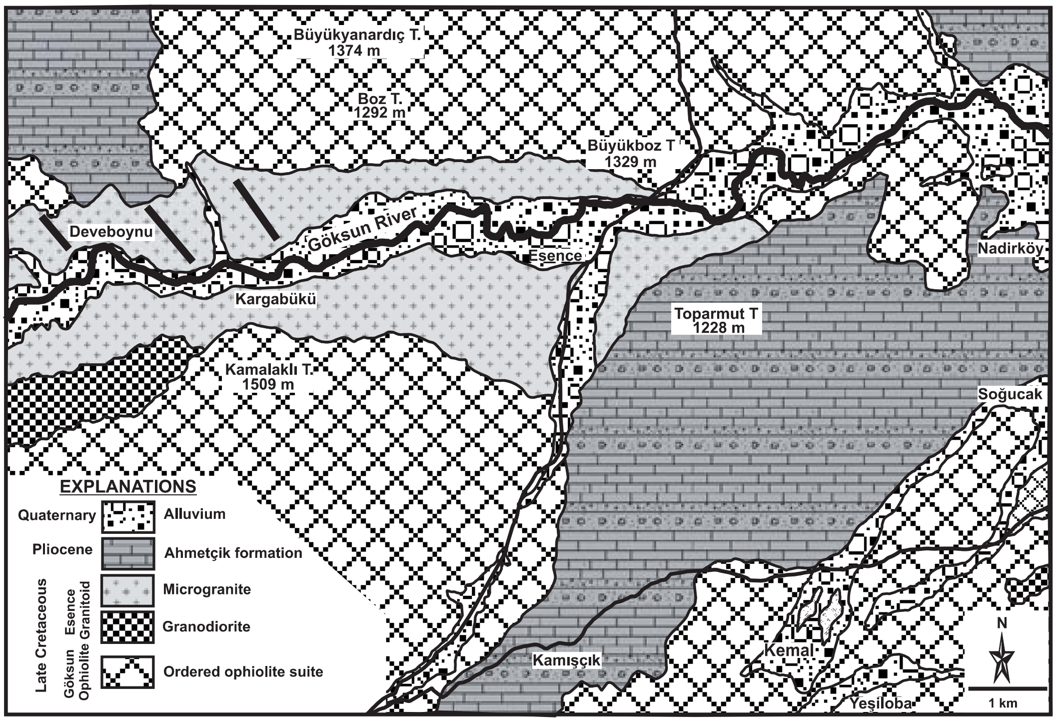

Figure 3. Geological map of the study area.
Şekil 3. Çalışma alanının jeoloji haritası.

granodiorites and microgranites (see Figures 3 and 4). The granodiorites are very fresh and contain amphibole bearing mafic microgranular enclaves (MME) ranging in size between 5 cm and 30 cm. The microgranites show extensive arenatization, and are cut by aplitic dykes.

PETROGRAPHIC FEATURES

The Esence granitoid is located along the Göksun River in the vicinity of Deveboynu- Kargabükü and Esence villages in the study area (see Figure 3), and is represented by granodiorites containing mafic microgranular enclaves (MME), microgranites and aplitic dikes.

The medium to coarse grained granodiorites are light gray and have amphibole bearing mafic microgranular enclaves (MME) (Figure 5a). They present granular texture (Figure 5b) and are mainly composed of quartz (25-30%), plagioclase (50-55%), orthoclase (10-15%), hornblende (3-4%) and biotite (3-4%). Titanite and iron-oxide minerals are the accessory phases. The plagioclase is the most common felsic mineral, and shows polysynthetic twinning and zo-

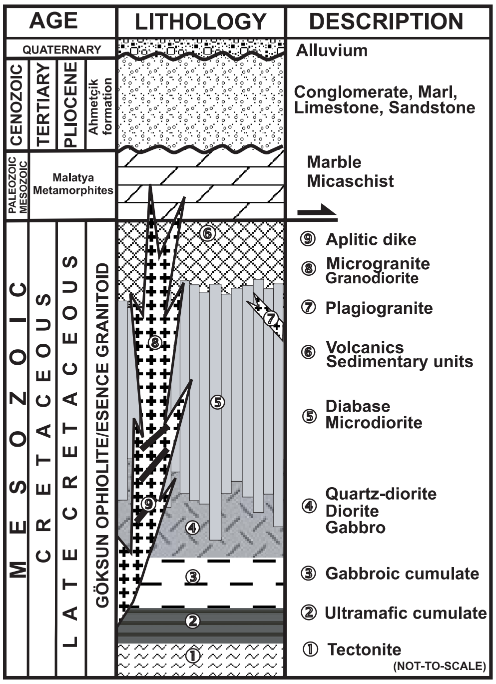

Figure 4. Stratigraphic column showing the relations of the Göksun ophiolite, Esence granitoid, Malatya platform and sedimentary units.
Şekil 4. Göksun ofiyoliti, Esence granitoyidi, Malatya platformu ve sedimanter birimler arasındaki ilişkiyi gösteren kolon kesit.

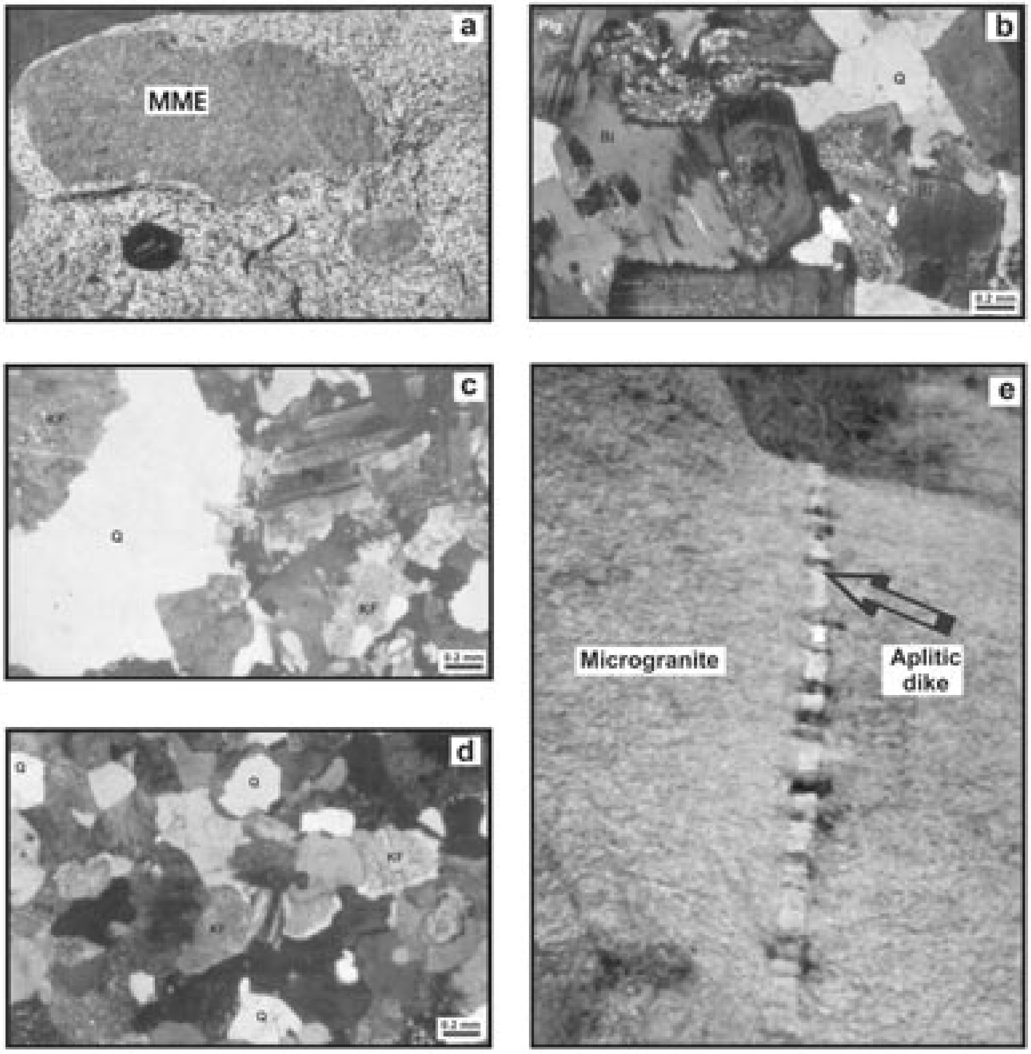

Figure 5. (a) Field view from the granodiorite and mafic microgranular enclaves (MME), (b) microscopic view from granodiorite (XPL), (c) microgranite, and (d) aplitic dike, (e) field view from the aplitic dike and microgranite. (Q:Quartz, Plg: Plagioclase, KF: K-feldspar, Bi: Biotite).

Şekil 5. (a) Granodiyorit ve mafik mikrogranüler enklavların arazi görünümü, (b) granodiyoritin, (c) mikrogranitin ve (d) aplitic daykların mikroskopik görüntüleri (Çift Nikol), (e) Aplitik dayk ve mikrogranitlerin arazi görünümü (Q:Kuvars, Plg: Plajiyoklas, KF: K-feldspat, Bi: Biyotit).

ning (see Figure 5b). The quartz is the second common felsic mineral, and occurs as xenomorphic grains. The K-feldspar displays perthitic texture and Carlsbad twinning. The hornblende is more abundant mafic mineral and encloses plagioclase and biotite minerals. The biotite is characterized by its dark to pale brown pleochroism (see Figure 5b). Prehnite is seen as secondary mineral in veins. The granodiorite displays variable degrees of low temperature alteration minerals including kaolinite, sericite, calcite and chlorite. Mafic microgranular enclaves (MME) are diorite in composition. They present microgranular texture and are mainly composed of plagioclase (50%), hornblende (35%), K-feldspar (7-8%), quartz (1-2%), and iron oxide minerals. The plagioclase is the most common felsic mineral which presenting polysynthetic twinning and zoning. The main ferromagnesian mineral of the mafic microgranular enclaves (MME) is hornblende which xenomorphic and sub-automorphic in shape. K-feldspars are seen as medium grained xenomorphic crystals. The size of mafic microgranular enclaves (MME) ranges from 5 to 30 cm in diameter, and most of the mafic microgranular enclaves (MME) have sharp contacts with the immediate surrounding granodiorite host (see Figure 5a).

The medium grained microgranites are pinkish and yellowish in color and present wide spread arenatization in the study area (Figure 5e). The microgranites exhibit both microgranular porphyric and micrographic textures, and are mainly composed of quartz (40-45%), plagioclase (10-15%), orthoclase (30-35%), biotite (3-4%) and hornblende (1-2%) (Figure 5c). The quartz is the most common felsic mineral of the microgranites and present as phenocrystals and microgranules. Some of the quartz crystals corroded magmatically, and lost their regular shapes. The second common felsic mineral, K-feldspar, is present as phenocrystals and microgranules. Some of the K-feldspars exhibit perthitic texture and Carlsbad twinning. The microgranites include plagioclase as both microgranules and phenocrystals in microgranular porphyric texture (see Figure 5c). The biotite and hornblende are the mafic minerals of the microgranites. Kaolin, sericite, prehnite and calcite are secondary phases in the rocks.

The microgranites are cut by pinkish colored aplitic dykes which have different thickness and orientation (see Figure 5e). They present micrographic and aplitic textures and are composed of quartz (35-40%), orthoclase (25-30%), plagioclase (25-30%), biotite (1-2%), muscovite (1-2%) and iron-oxide minerals (Figure 5d).

GEOCHEMISTRY

A total of 15 samples from the granodiorites, microgranite and aplitic dikes were analysed for major and trace element contents. Major and trace element analyses were carried out at the University of Geneva. Major elements were determined by XRF spectrometer (PW2400 with a Rhodium Tube from the Company of Pananalytical) on glass beads fused from ignited powders to which $Li_2B_4O_7$ was added (1:5), in a gold-platinum crucible at 1150 ºC. Trace elements were analysed on powder pressed-pellets by the same method. The analytical precision for major elements is 0.3 % for SiO_2, 0.03 % for TiO_2, 0.2 % for Al_2O_3, 0.1 % for FeO*, 0.015 % for MnO, 0.15 for MgO, 0.15 for CaO, 0.15 % for Na_2O, 0.06 % for K_2O, 0.02 % for P_2O_5. Detection limit for the trace elements is 1 ppm for Nb, 1 ppm for Zr, 1 ppm for Y, 1 ppm for Sr, 1.5 ppm for U, 1 ppm for Rb, 2 ppm for Th, 2 ppm for Pb, 1 ppm for Ga, 2 ppm for Zn, 2 ppm for Cu, 2 ppm for Ni, 2 ppm for Co, 2 ppm for Cr, 2 ppm for V, 3 ppm for Ce, 4 ppm for Nd, 9 ppm for Ba, 4 ppm for La, 1 ppm for Hf, 2 ppm for Sc.

Whole rock major and trace element analyses of the granodiorites, microgranites and aplitic dikes are presented in Table 1. The granodiorites are characterized by high amount of TiO_2 (0.28-0.43 wt %), Al_2O_3 (15.24-16.19 wt %), FeO (3.22-5.44 wt %), MgO (0.89-2.01 wt %), CaO (2.77-4.99 wt %), P_2O_5 (0.09-0.11 %), Zr (87-136 ppm), Sr (190-232 ppm) and low amount of SiO_2 (64.48-69.77 wt %) and K_2O (2.13-4.55 wt %) compare to microgranites and aplitic dikes (see Table 1), corresponding to their modal mineralogy. The major element Harker (1909) diagrams are shown in Figure 6. Overall Al_2O_3, TiO_2, MgO, FeO, CaO, MnO and P_2O_5 decrease by following linear trend with increasing SiO_2 wt %. These linear trends may indicate that these three rock types may be originated from same parental magma with fractional crystallization. Two samples (TR-13 and TR-14) in granodiorite suite are plotted away from the others and represented by lower content of SiO_2 and higher contents of other elements in the diagram (Figure 6). However these two samples remain on same line with the other samples, suggesting that there is a compositional gap which could be due to insufficient sampling for geochemical work.

The granodiorite, microgranite and aplitic dikes in the Esence granitoid show subalkaline character in total alkali-silica (TAS) diagram of Irvine and Baragar (1971) (Figure 7), and exhibit typical calcalkaline character as seen in Figure 8. In the Maniar and Piccoli (1989) diagram, the granodiorites and microgranites exhibit metaluminous to peraluminous character whereas the aplitic dikes show metaluminous character (Figure 9). "The Ocean Ridge Granite (ORG)-normalized multi element spider" diagram of the Esence granitoid displays selective enrichment in large ion lithophile (LIL) elements such as Rb, Ba, Th and depletion in high field strength (HFS) elements such as Nb, Zr, Hf, Sm, Y (Figure 10). The field of plutons from modern volcanic arc settings is shown for comparison (Pearce et al., 1984). The multi-element patterns of the granitoid rocks show similarity to the volcanic arc gra-

Table 1. Results of the major and trace element analyses of the rocks from the Esence granitoid.
Çizelge 1. Esence granitoyidine ait kayaçların ana ve iz element analizlerinin sonuçları.

	Microgranite					Aplitic dike				Granodiorite					
	TR-4	TR-6	TR-7	TR-20	TR-21	TR-5	TR-8	TR-9	TR-10	TR-13	TR-14	TR-15	TR-16	TR-17	TR-18
SiO_2	76.23	73.63	75.48	74.39	73.75	76.63	76.65	76.52	75.59	65.04	64.48	67.89	68.06	69.37	69.77
TiO_2	0.04	0.10	0.08	0.10	0.11	0.04	0.06	0.05	0.03	0.43	0.43	0.34	0.30	0.28	0.28
Al_2O_3	13.26	14.06	13.66	14.03	14.31	13.12	12.97	12.68	13.12	16.19	15.98	15.41	15.44	15.24	15.34
FeO*	0.93	1.77	1.56	1.39	2.02	0.80	1.23	1.33	0.81	5.44	5.37	4.02	3.58	3.45	3.22
MnO	0.02	0.03	0.02	0.04	0.04	0.01	0.03	0.03	0.06	0.09	0.09	0.05	0.04	0.06	0.05
MgO	0.06	0.26	0.20	0.30	0.33	0.07	0.12	0.10	0.05	1.95	2.01	1.26	1.06	0.98	0.89
CaO	0.41	1.19	1.30	1.12	1.09	0.32	0.69	0.82	0.53	4.94	4.99	2.93	2.85	2.77	2.88
Na_2O	3.78	3.93	3.78	3.93	4.16	3.32	3.09	3.19	3.86	3.28	3.27	3.16	3.12	3.66	3.45
K_2O	4.79	4.43	4.06	4.25	3.92	5.65	5.32	5.09	4.95	2.21	2.13	4.10	4.55	3.43	3.55
P_2O_5	0.03	0.05	0.04	0.05	0.05	0.03	0.03	0.03	0.03	0.10	0.11	0.11	0.10	0.10	0.09
LOI	0.30	0.86	0.20	0.46	0.41	0.26	0.27	0.16	0.19	0.62	0.66	0.74	0.61	0.98	0.67
Total	99.84	100.31	100.38	100.06	100.19	100.24	100.45	100.00	99.23	100.27	99.51	100.00	100.25	100.31	100.18
Nb	9	9	8	10	11	15	8	6	18	7	7	9	9	11	10
Zr	41	65	58	62	65	45	45	57	29	103	87	135	122	136	126
Y	27	23	17	17	19	35	23	34	9	15	17	19	19	22	16
Sr	15	69	123	103	108	16	48	44	28	232	231	192	190	200	228
U	6	5	4	10	9	7	7	6	7	4	4	6	6	7	5
Rb	154	147	135	134	131	113	160	154	270	89	84	162	161	126	128
Th	19	21	14	21	17	23	25	14	18	8	9	16	16	14	16
Pb	37	33	31	33	36	32	38	40	33	14	12	25	14	18	15
Ga	13	13	12	13	13	15	11	11	14	16	16	18	17	17	18
Zn	10	14	11	12	13	11	12	12	10	33	32	28	21	23	22
Cu	9	9	9	4	12	8	11	12	9	12	14	573	44	12	12
Ni	5	5	6	2	5	2	5	7	4	10	11	9	10	9	8
Co	2	3	2	2	3	2	2	2	2	14	13	8	7	7	6
Cr	23	27	35	13	26	20	24	28	24	60	48	36	42	36	51
V	6	10	9	13	14	5	10	8	7	95	90	55	53	43	39
Ce	17	23	25	20	22	25	28	24	9	30	24	45	43	45	43
Nd	4	6	7	5	7	7	9	9	4	18	9	17	20	19	20
Ba	143	571	853	891	724	125	274	181	156	571	547	751	840	696	770
La	11	14	11	14	11	7	15	13	10	7	10	23	22	18	21
Hf	8	6	8	7	6	6	7	7	8	6	6	8	6	6	6
Sc	2	2	3	4	3	3	2	2	2	15	14	8	7	5	5

Total Fe is expressed as FeO*

nites (Figure 10). Moreover distinctly negative Nb anomaly is typical of magmas derived from a subduction-modified mantle (Wilson, 1989). Tectonomagmatic discrimination diagrams of Pearce et al. (1984) based on immobile elements are effective at discriminating between tectonic environments in granitoid material. Figure 11 presents Nb versus Y and Rb versus Y+Nb diagrams for the granitoid rocks from the Esence region. The Nb versus Y diagram separates VAG+Syn-COLG and WPG (Figure 11a). The samples are mainly plotted in the VAG+Syn-COLG field. To separate volcanic arc granites from syncollisional granites, a Rb versus Y+Nb diagram is used in Figure 11b. It is evident that the granitoid rocks plot within the VAG field. The rocks from the Esence granitoid plot in the Syn-COLG field in the R_1-R_2 diagram of Batchelor and Bowden, (1985) (Figure 12), resulted from an ongoing collisional process between ensimatic island arc (Göksun ophiolite) and continent (Malatya-Keban platform) in the southern branch of Neotethyan oceanic basin (Yılmaz, 1993; Yılmaz et al., 1993; Parlak and Rızaoğlu, 2004).

DISCUSSION AND CONCLUSIONS

There are number of tectonomagmatic units that are important in understanding the geological

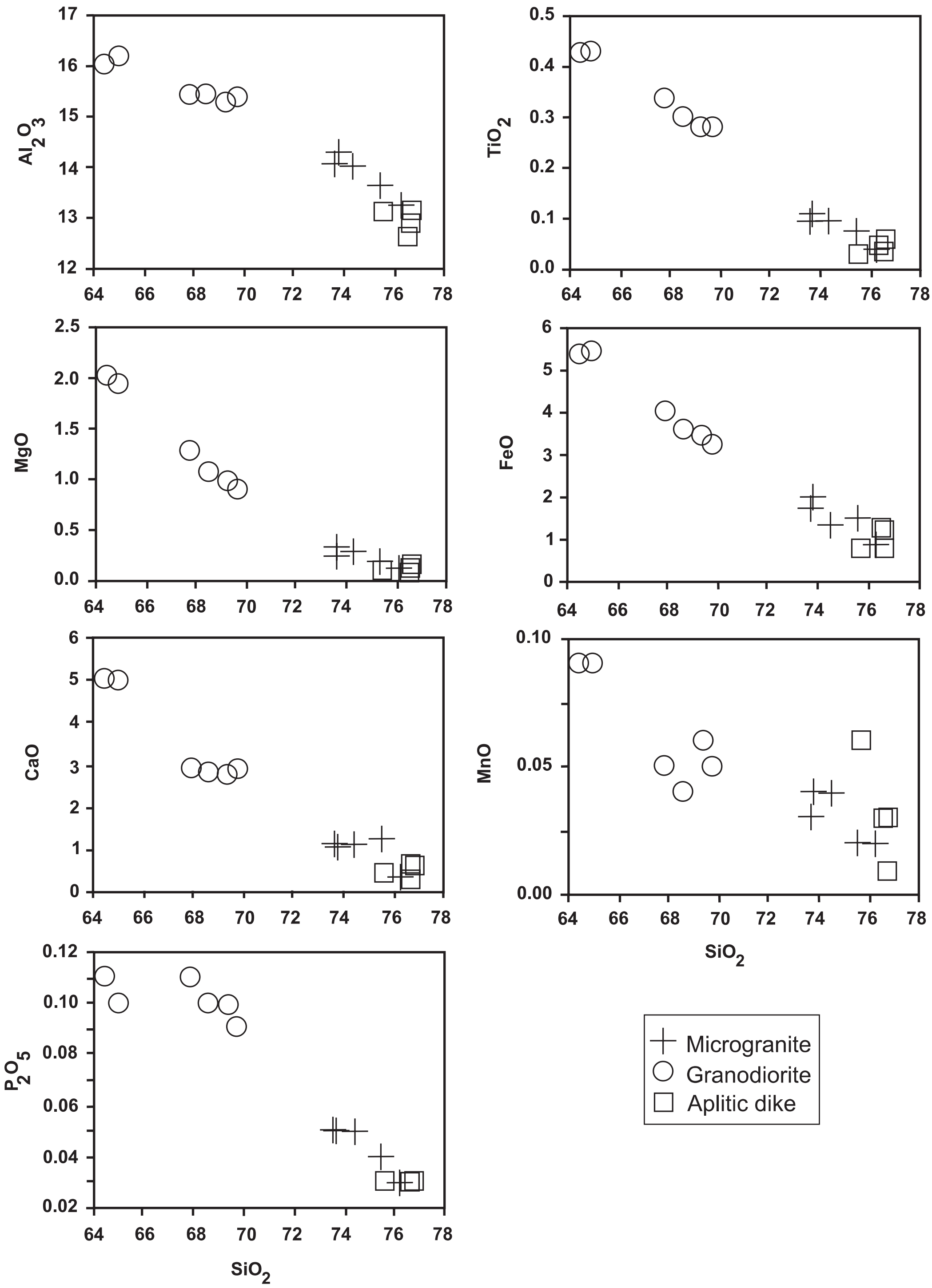

Figure 6. Harker type (Harker, 1909) variation diagrams for the rocks from the Esence granitoid.
Şekil 6. Esence granitoyidine ait kayaçların Harker tipi (Harker, 1909) diyagramları.

evolution of the region during the Late Cretaceous in southeast Anatolia. These units are (a) the granitoids, (b) the ophiolites, and (c) the ophiolite-related metamorphic rocks. The granitoids are located in Göksun-Afşin (Kahramanmaraş), Doğanşehir (Malatya) and Baskil (Elazığ) regions (Aktaş and Robertson, 1984; Yazgan and Chessex, 1991; Beyarslan and Bingöl,

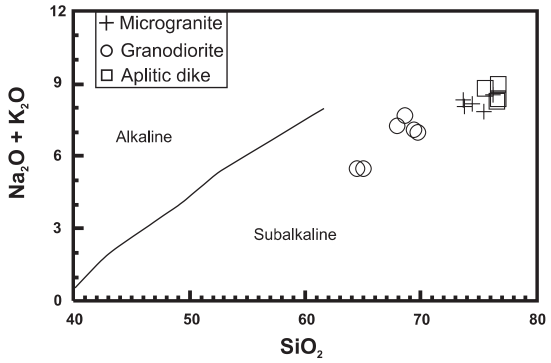

Figure 7. Total alkali-silica diagram for the rocks from the Esence granitoid (after Irvine and Baragar, 1971).

Şekil 7. Esence granitoyidine ait kayaçların toplam alkali-silis diyagramındaki (Irvine ve Baragar 1971'den) konumları.

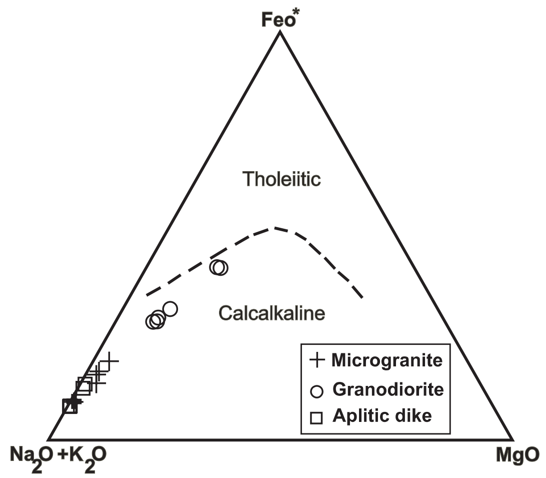

Figure 8. Distribution of the rocks from the Esence granitoid on AFM diagram (after Irvine and Baragar, 1971).

Şekil 8. Esence granitoyidine ait kayaçların AFM (Irvine ve Baragar 1971'den) diyagramında dağılımı.

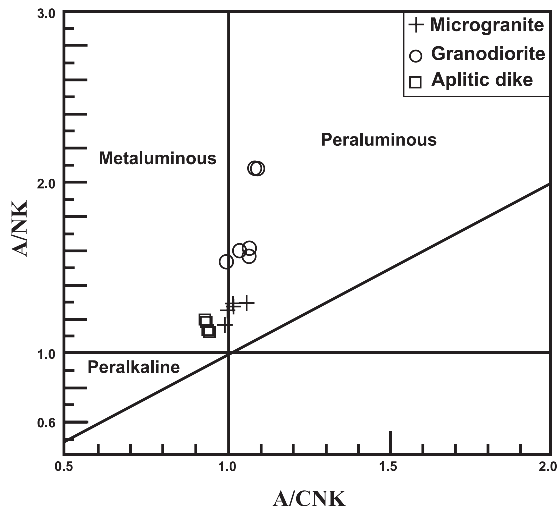

Figure 9. A/NK versus A/CNK diagram for the rocks from the Esence granitoid (after Maniar and Piccoli, 1989).

Şekil 9. Esence granitoyidine ait kayaçların A/NK-A/CNK (Maniar ve Piccoli, 1989'dan) diyagramı.

2000). The granitoid rocks intrude the Malatya-Keban platform, ophiolites and related metamorphic rock units in these regions. The Late Cretaceous ophiolitic bodies of the southeast Anatolia are represented by the Göksun (Kahramanmaraş), İspendere (Malatya) and Kömürhan-Guleman (Elazığ). These ophiolites were formed above north dipping subduction zone some time during Late Cretaceous in the southern branch of Neotethys (Robertson, 2002; Parlak et al., 2004; Beyarslan and Bingöl, 2000). These ophiolites are interpreted as to have been originated as single vast Late Cretaceous thrust sheet that was dispersed between the metamorphic massifs during the ongoing orogenic system between Late Cretaceous and Late Miocene (Şengör and Yılmaz, 1981; Yazgan and Chessex, 1991; Yılmaz et al., 1993; Beyarslan and Bingöl, 2000; Robertson, 2002; Parlak et al., 2004). The ophiolite-related metamorphic rocks are observed in the Doğansehir (Malatya) and Elazığ regions in tectonic contact with overlying ophiolitic units; they display inverted metamorphic zonation from pyroxene-granulite facies to epidote-amphibolite facies (Parlak et al., 2002). These metamorphic units are also interpreted as being the equivalent of the Berit metaophiolite (Perinçek and Kozlu, 1984; Genç et al., 1993) to the north of Kahramanmaraş region.

The granitoids in the region were intruded through the ophiolites, related metamorphic rocks and Malatya-Keban platform. The Malatya-Keban platform is thrust over the ophiolitic units in the region. This suggests that the Malatya-Keban platform, ophiolites and related metamorphic units had been tectonically juxtaposed before the intrusions took place in Late Cretaceous.

The K-Ar age obtained from the granitoid in Göksun-Afşin (Kahramanmaraş) region display

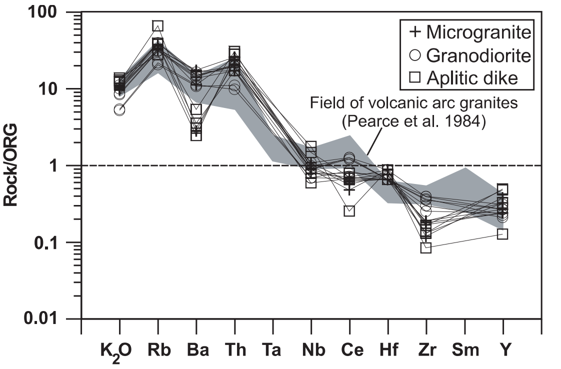

Figure 10. ORG-normalized spider diagram for the rocks from the Esence granitoid (normalizing values are from Pearce et al., 1984).

Şekil 10. Esence granitoyidine ait kayaçların ORG'ye göre normalize edilmiş örümcek diyagramı (ORG değerleri Pearce vd., 1984'ten alınmıştır).

an age range from 85 to 70 Ma (Parlak and Rızaoğlu, 2004). The formation age of the metamorphic soles and oceanic crust is thought to be contemporaneous and constrained approximately as 90-92 Ma (Parlak and Delaloye, 1999; Dilek et al., 1999). This shows that the intrusion of granitoid exceeds the formation of the ophiolites in time.

The geochemical and field data for the Esence granitoid are in agreement with the following scenario: The ophiolites in the southeast Anatolia were formed above a north dipping subduction zone between the Arabian platform and the Tauride platform in Late Cretaceous (~90-92 Ma) (Parlak et al., 2004). During this intraoceanic subduction, the oceanic crust and sea floor sediments were fragmented and accreted to the base of the hanging wall to form the metamorphic sole in subduction zone. Following this event, the ophiolites and related metamorphic units were then accreted to the base of the Malatya-Keban platform during the progressive elimination of the southern Neotethyan oceanic basin. The thrusting of the Malatya-Keban platform over the ophiolites and related metamorphic rocks were followed by the intrusion of a volcanic arc granitoids (88 to 85 Ma) along the Tauride active continental margin.

The geochemistry and geochronology of the granitoids in the SE Anatolian orogen is very important because they restrict the ensimatic island arc-continent collision in space and time.

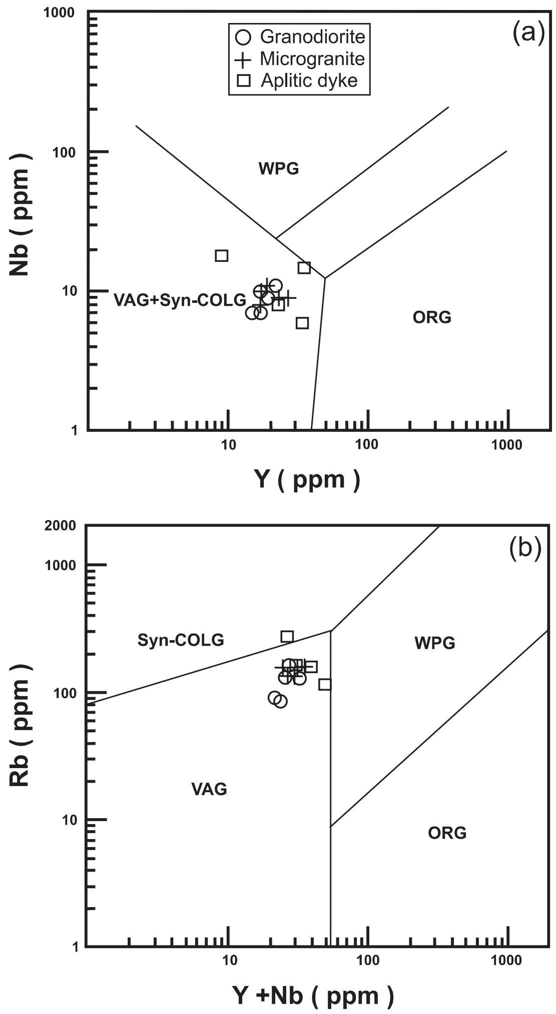

Figure 11. Tectonomagmatic discrimination diagrams based on Rb vs Y+Nb (a) and Nb vs Y (b) for the rocks from the Esence granitoid (after Pearce et al., 1984).

Şekil 11. Esence granitoyidine ait kayaçların Rb - Y+Nb (a) ve Nb - Y (b) tektonomagmatik ayırtman diyagramlarındaki dağılımı (Pearce vd., 1984'ten).

The Esence granitoid, which is one of the granitoid bodies in the SE Anatolian orogen between Kahramanmaraş and Elazığ, has not been studied in detail. This work simply presents preliminary geochemical data for a limited part of the Esence granitoid and future studies are needed for a detail geochemical work. The petrography and major-trace element geochemistry of the Esence granitoid rocks suggests that they are I-type, calcalkaline and formed in a subduction related environment (volcanic arc) during the collision of the Tauride continent and the Gök-

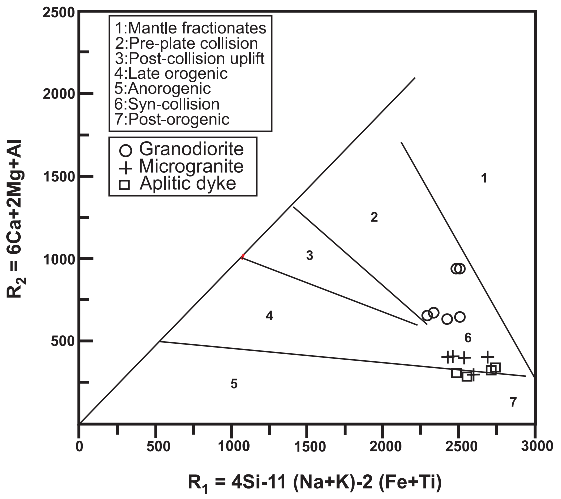

Figure 12. R_1 vs R_2 diagram for the rocks from the Esence granitoid (after Batchelor and Bowden, 1985).

Şekil 12. Esence granitoyidine ait kayaçların R_1 - R_2 diyagramındaki dağılımları (Batchelor ve Bowden, 1985'ten).

sun ophiolite in the Late Cretaceous. The metaluminous to peraluminous nature of the granitod rocks is consistent with an evolution involving contamination of mantle-derived magmas by continental crust.

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