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Investigation of feldspar raw material potential of alkali feldspar granites and alkali feldspar syenites within Central Anatolia

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ABSTRACT

Alkali feldspar granites represent one of the major sources that provide raw materials for glass and ceramics industry because of their high feldspar and quartz contents. In addition, also alkali feldspar syenites have potential to become raw material due to their high feldspar and feldspathoid contents. For this reason, alkali feldspar granites within Ağaçören Intrusive Suite (AIS) (Kalebalta, Yıldırımlı, Çerkezuşağı, Çatalçeşme, İbrahimbeyli, Deliler, Ekecik, Sipahiler, Camili, Yaylak, Namlıkışla), Hacılı Suite (Sarıhacılı), Cefalık, Behrekdağ, Terlemez and alkali feldspar syenites within Bayındır, Hamit and İdişdağı Suites are investigated. This study aims to investigate possible potential of alkali feldspar, plagioclase and quartz minerals within these rocks in glass and ceramic industry as raw materials. These rocks have high alkaline element content and relatively high Fe_2O_3 values compared to world granites. Fe_2O_3 values depend on mafic and independent Fe minerals such as magnetite. Feldspars have high K_2O (> %14) and low FeO (< %0.05), thus have high feldspar potential in ceramic industry. Alkali feldspar granites within AIS have promising potential as feldspar raw material, they have low reserve due to their occurrence as dykes. Hacılı, Cefalık, Behrekdağ, Terlemez, Bayındır, Hamit and İdişdağı Suites have both good quality and high reserve for feldspar potential.

1. Introduction

Alkali feldspar granites represent rocks with the highest content of quartz and alkali feldspar in the granitoid family. In general, alkaline feldspar granites are mainly light-colored plutonic rocks containing quartz (20-60%) and alkali feldspar (40-80%) and plagioclase amount ranging between 0-10%. Although their felsic (light color) mineral contents are high, they have very low mafic (dark color) mineral contents. In terms of their mineralogical composition, they can be divided into two groups as single and double micaceous. The proportion of mafic minerals (biotite, etc.) in alkaline feldspar granites is generally below 5%. Such rocks represent products crystallized from residual silicon (Si) and potassium (K) rich melts in the last stages of the magma. Therefore, mafic minerals are observed in a small proportion in the products formed due to the depletion of iron (Fe) and magnesium (Mg) in these melts. They are generally beige-pink in color and have fine crystalline granular texture and their thickness may range between cm to hundreds of meters. Alkali feldspar granites are geologically formed in two forms. The most common formation is the aplitic dykes consisting of the last residual products of the granitoid magma and located along the articular direction of the main mass. The second formation is mostly the pre-collisional magmatism and partial melting event resulting from thrust faults in the upper crust. In addition, they may also form as lenses in metamorphics in small thicknesses and distributions due to high temperature. They may exhibit sharper and higher topography due to the mineral composition they contain. Besides, they can be in alkaline feldspar

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syenite composition as quartz-free or quartz poor rocks can be crystallized in syenitoid magma-based products. Alkali feldspar syenites are light colored plutonic rocks, which contain high alkaline feldspar (80-100%), plagioclase between 0-10%, and quartz below 20%. Alkali feldspars [(K, Na) $AlSi_3O_8$], which are observed in rocks, are generally in orthoclase and microcline ($KAlSi_3O_8$) composition. These minerals have been used as raw materials in the production of glass and ceramics for many years as they contain 0.80-8.44% Na_2O, 3.29-15.60% K_2O, 19.10-20.23% Al_2O_3, 63.66-65.76% SiO_2 and very small amounts of Fe (0.08-0.40% Fe_2O_3) (Deer et al., 1992; Öbelik, 2011). From the viewpoint of operability, in which the rocks K and Na containing minerals are mostly available, with which Fe-Mg-containing mafic minerals they are present, at what ratios these mafic minerals are contained and where the rocks are located have a great significance. In addition, the grain size of mafic and/or accessory minerals released during enrichment of feldspars is also very important.

There have been carried out several studies related to the determination, enrichment and management of the feldspar deposits in Turkey (Şahin, 1989; Uğur, 1990; Akkoyuncu, 1994; Kalyon, 2003; Erdinç, 2007; Nizamoğulları, 2007; Demirbaş, 2010). On the other hand, there are also other studies related to the development of magnetic separation and flotation methods in the differentiation of such undesirable minerals, which have coloring properties such as amphibole, biotite and muscovite in the form of inclusions within feldspar minerals (Bayraktar et al., 1997; 1999; Şahin Kılavuz, 2000; Demir, 2001; Doğu, 2002; Kalyon, 2003; Kademli, 2004; Gülsoy, 2005; Erdinç, 2007; Özün, 2012). Although the quartz, which is one of the major minerals of the alkali feldspar granite rocks, does not form any problem in terms of color and brightness, it can increase the fragility due to their hardness. Therefore, the quartz ratio is also important in the prescriptions produced. Apart from these, there are also other studies on the effects of feldspar on ceramics or frit (Töre, 1999; Kula, 2003; Daday, 2012). Feldspars are not only used in ceramic bodies as melts but they can also be used in glasses, glass and porcelain enamel (Kadıoğlu, 2001; Özcan, 2002; Yeşilbaş, 2002). The 70% of feldspars are generally used in glass production, while 30% are used in ceramics and other products (Potter, 1996). Feldspars with high sodium (Na) content have lower viscosity and glazing temperature than feldspars with high potassium (K) content (Ryan, 1978; Köprülü, 1997; Tayçu, 2009). Besides, they are more susceptible to shrinkage during the cooking process (Ryan, 1978). As seen, almost all of the feldspar group minerals can be used for different purposes in the production of glass and ceramics. This situation shows that alkali feldspar granites have a high importance in the production of ceramic raw materials and these rocks have a significant place in ceramics produced for different purposes.

The main feldspar producers are Norway, Switzerland, Russia, United States (USA), Canada, Germany, Italy, France, Spain, Japan, Thailand, Finland, Mexico, Romania, South Africa, Czech Republic and Poland (Ryan, 1978; Ariffin, 2003; Lewicka, 2010). Feldspar deposits in Turkey are mainly located in Çanakkale, Balıkesir, Aydın (Akçaova, Çine), Manisa (Demirci, Gördes), Kütahya (Simav), Bilecik (Söğüt), Bitlis (Bölükyazı–Hizan) and Afyon (Geredeli, 1990; Sümer, 1994; Yalçın, 1995; Ermiş, 1996; Oyman, 1996; Bayraktar et al., 1999; Gürsoy, 1999; Akkurt, 2001; Karagüzel, 2001; Güven, 2002; Kaya, 2002; Oyan, 2004; Demirbaş, 2010; Çelik and Denizhan, 2016). Turkey is quite rich in terms of intrusive rocks with high feldspar content (mainly alkali feldspar granite). These rocks were selected as the study area because they have wide spreads in the Central Anatolia Region (Figure 1).

The alkali feldspar granites in the Central Anatolian Crystalline Complex (CACC) (Göncüoğlu et al., 1991, 1992, 1993) are mainly located in the Granite Supersuite and Monzonite Supersuite, and the alkali feldspar syenites are located in the Syenite Supersuite (Kadıoğlu et al., 2006). These rocks are exposed in large masses or in the form of aplitic dykes in all intrusive assemblages in the CACC. However, the masses with high economic reserves are seen in limited areas. Alkali feldspar granites in the Granite Supersuite outcrops in the Ağaçören Intrusive Suite (AİT), Behrekdağı Suite, Sulakyurt-Balışeyh Suite, Hacılı Suite, Akdağmadeni Suite and Karakeban Suite, however the Monzonite Supersuite outcrops in the Cefalık Suite, Baranadağ Suite, Akçakent Suite and Murmano Suite. The alkali feldspar syenites in the Syenite Supersuite are observed in the İdişdağı Suite, Devedamı Suite, Hayriye Suite, Bayındır Suite, İğdişdağı Suite, Akçakent Suite and in the Ömerli Suite. In this study, samples were taken from Sarıhacılı-Hacılı (Hacılı Suite-Yozgat) and from different locations of AIT (Granite Supersuite: Hacılı, Kalebalta, Yıldırımlı, Çerkezuşağı, Çatalçeşme,

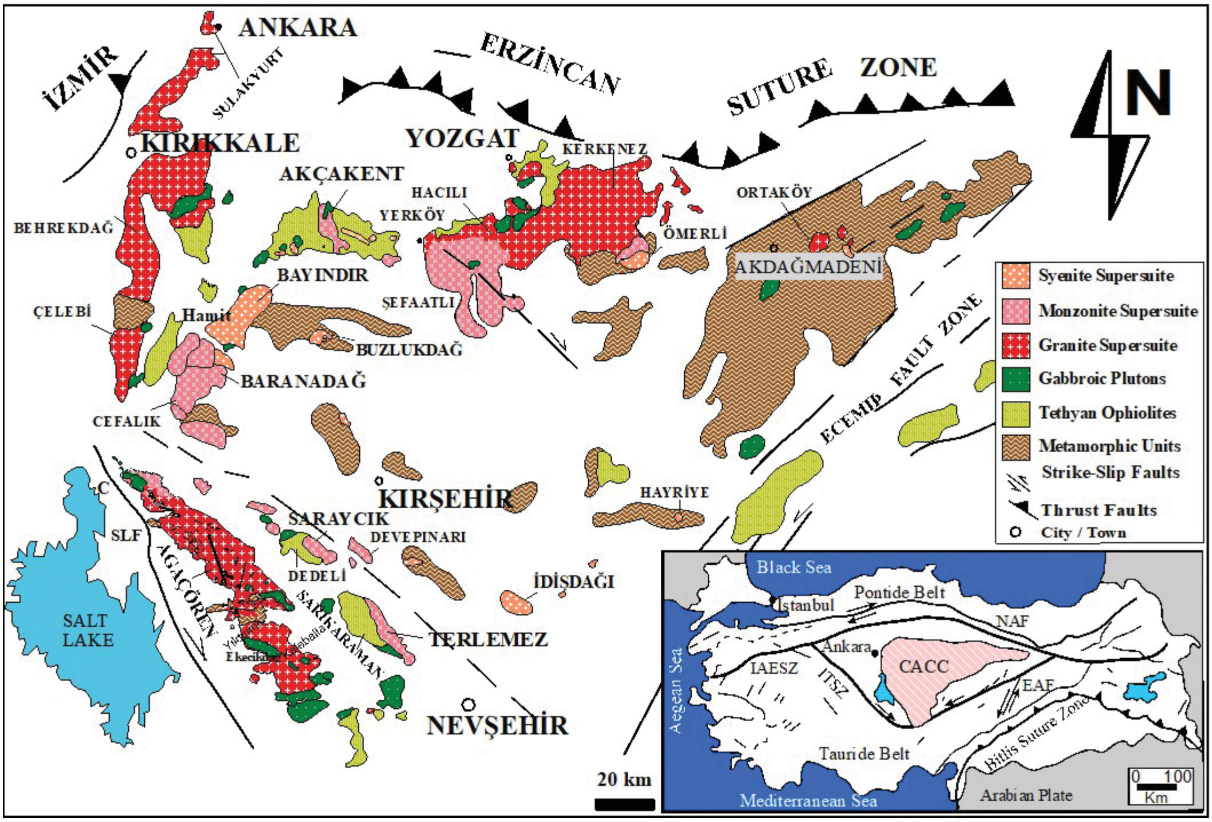

Figure 1- Simplified geology map of CACC (NAF: North Anatolian Fault; EAF: East Anatolian Fault; CACC: Central Anatolian Crystalline Complex; ITSZ: Intra Tauride Suture Zone) (simplified from Kadıoğlu et al., 2006).

İbrahimbeyli, Deliler, Ekecik, Sinandı, Sipahiler, Camili, Yaylak, Namlıkışla Sub-Suits), Monzonite Supersuite (Cefalık, Behrekdağ, Terlemez Sub-Suites) and from the Syenite Supersuite (Bayındır, Hamit and İdişdağı Sub-Suites).

In this study, the potential of being a raw material in terms of Na (albite-$NaAlSi_3O_8$) or K-rich feldspar (orthoclase-$KAlSi_3O_8$) were targeted comparing the geology, mineralogy, petrography and geochemistry of rocks and sampling from different locations where alkali feldspar granites and alkali feldspar syenites in Central Anatolia Region were exposed. In addition, the operability of them in the form of by-product as were also investigated as these rocks have high silica content. While evaluating the results of the assessment, interpretation was made by comparing the chemical compositions of alkali feldspar granite and alkali feldspar syenite rocks in different parts of the world. In the scope of the study, mechanical tests such as the strength, color and firing shrinkage, which should be determined for the raw materials used in the glass and ceramics industries, were not performed and the regional feldspar potential were revealed by using the whole rock and mineral chemistry data. In doing so, the attention was drawn to alternative deposits that could contribute to the economy of the country.

2. Material and Method

As a result of the field study carried out in different places of the CACC alkali feldspar granite and alkali feldspar syenite rock samples were collected and detailed mineralogical and petrographical investigations were carried out in the thin sections. By doing so, their mineralogical compositions, microscopic textural features and the alteration types were studied. The observations were made on the Leica DMLP model polarizing microscope. In order to reveal the normative mineralogical compositions of the alkaline feldspar granite and the alkali feldspar syenite samples, calculations were made based on the norms of Cross, Iddings, Pirsson and Washington (CIPW) (1931) by using chemical composition.

For the major oxide and trace element geochemical analyzes samples were broken in a Retsch Brand jaw crusher and then milled using a Tungsten carbide mill in a FRITSCH brand mill. The 4 g ground sample was mixed with 0.9 g of binding material (Wachs) and compressed under hydraulic pressure into a press-paste (powder pellet) then major and trace element analyzes were carried out using X-LAB 2000 model of Polarized Energy Dispersive X-Ray Fluorescence Spectrometer (PEDXRF). Analyzes were performed based on the GEO-7220 method and the instrument was calibrated using K02-GSR-09 and G01-GS-N-Granite standards for plutonic rocks (granite, granodiorite etc.) of USGS.

In addition, the chemistry of the feldspar (alkali feldspar) minerals were determined from selected rock samples by using the Electron Probe Micro Analysis (EPMA) method. Thin sections were coated with carbon using Quorum brand Q150T ES device and the major oxide compositions of feldspar minerals were determined on polished thin sections using JEOL brand JXA 8230 device under 20 kV voltage and 15 nA current. Chemical analysis results are given in table 5. During all studies carried out throughout the study, laboratories and equipment of the Earth Sciences Application and Research Center (YEBİM) of Ankara University were used.

All the data obtained from the literature, field and laboratory studies were evaluated, compared with some samples in the world and making interpretations related to the usage of alkali feldspar granites and alkali feldspar syenites in the glass and ceramic industries the potential deposits were revealed in Central Anatolia Region.

3. Regional Geology

The CACC, which is also known as the Kırşehir Massif (Seymen, 1982), Central Anatolian Massif (Ketin, 1955), Kırşehir Block (Görür et al., 1984), Kırşehir Complex (Lünel, 1985) or Kırşehir Microplate (Erler et al., 1991) is restricted by the İzmir-Ankara-Erzincan Suture Zone (IAESZ) in the north, Tuz Lake in the west and Intra Tauride Suture Zone (ITSZ) in the east. The region consists of four rock groups, namely Central Anatolian Metamorphics (CAM), Intra Anatolian Ophiolites (IAO), Central Anatolian Felsic Intrusives (CFI) and mantle-derived mafic rocks (Göncüoğlu et al., 1991, 1992; Kadıoğlu and Güleç, 1996; Özsan, 1997; Kadıoğlu et al., 2003).

AIT mainly consists of granite, monzonite and gabbroic rocks and cutting by alkali feldspar granite in the shape of small dykes (Kadıoğlu, 1991; 1996; Kadıoğlu and Güleç, 1996) (Figure 2).

Intrusive rocks located around Yozgat are mainly composed of granite, monzonite and syenite (Ekici, 1997; Tatar, 1997; Akçe, 2003, 2010; Akçe and Kadıoğlu, 2005; Aydoğdu, 2010; Tiryaki, 2012; Tüvar, 2015). The Hacılı Suite, which is one of the regions with the largest spread in terms of felsic masses, is located in the vicinity of Sarıhacılı village in the east of Yozgat (Figure 3). It is light pink in color and exhibits phaneritic texture as it is leucocratic in character and mainly rich in quartz and alkali feldspar (Akçe, 2010).

Cefalık, Behrekdağ and Terlemez Suites are composed of rocks in the monzonitic composition (Ataman, 1972; Seymen, 1982; Bayhan, 1987; Erler et al., 1991; Geven, 1992; İlbeyli, 1998, 2005; Yalınız et al., 1999; Tatar, 2003; İlbeyli et al., 2004; İlbeyli and Pearce, 2005; İlbeyli and Kibici; 2009, İlbeyli et al., 2009; Kadıoğlu et al., 2006; Köksal et al., 2013). The Cefalık Suite was distinguished as monzodiorite, quartz monzonite and the alkali feldspar granite and reported that they were cut by aplitic, pegmatitic, mafic and leucite phonolitic dykes (Geven, 1992; İlbeyli, 1998; Kadıoğlu et al., 2006). It was defined that Behrekdağ Suite was in quartz monzonite and granite composition (Bayhan 1986, 1989; Yadete, 1990, İlbeyli et al., 2004). The Terlemez Suite is composed of quartz monzonite, medium-coarse crystalline rocks and consists of 3 cm x 10 cm K-feldspar megacrystals (Yalınız et al., 1999).

Bayındır, Hamit and İdişdağı Suites represent the latest products of Late Cretaceous-Early Cenozoic magmatism in CACC and have syenitic composition (Seymen, 1982; Akıman, 1985; Bayhan, 1988; İlbeyli, 1998; Köksal, 1996; Köksal and Göncüoğlu, 1997; Köksal et al., 2001). The Bayındır Suite consists of quartz syenite and feldspathoid syenite (Bayhan, 1988). The Hamit Suite was named as feldspathoid bearing monzosyenite and they are dark gray, medium crystalline, porphyritic textured rocks (İlbeyli, 1998). İdişdağı Suite was defined as the syenite rich in quartz syenite and alkali feldspar (Köksal et al., 2001). Porphyritic texture can be observed locally in the medium-fine crystalline rock.

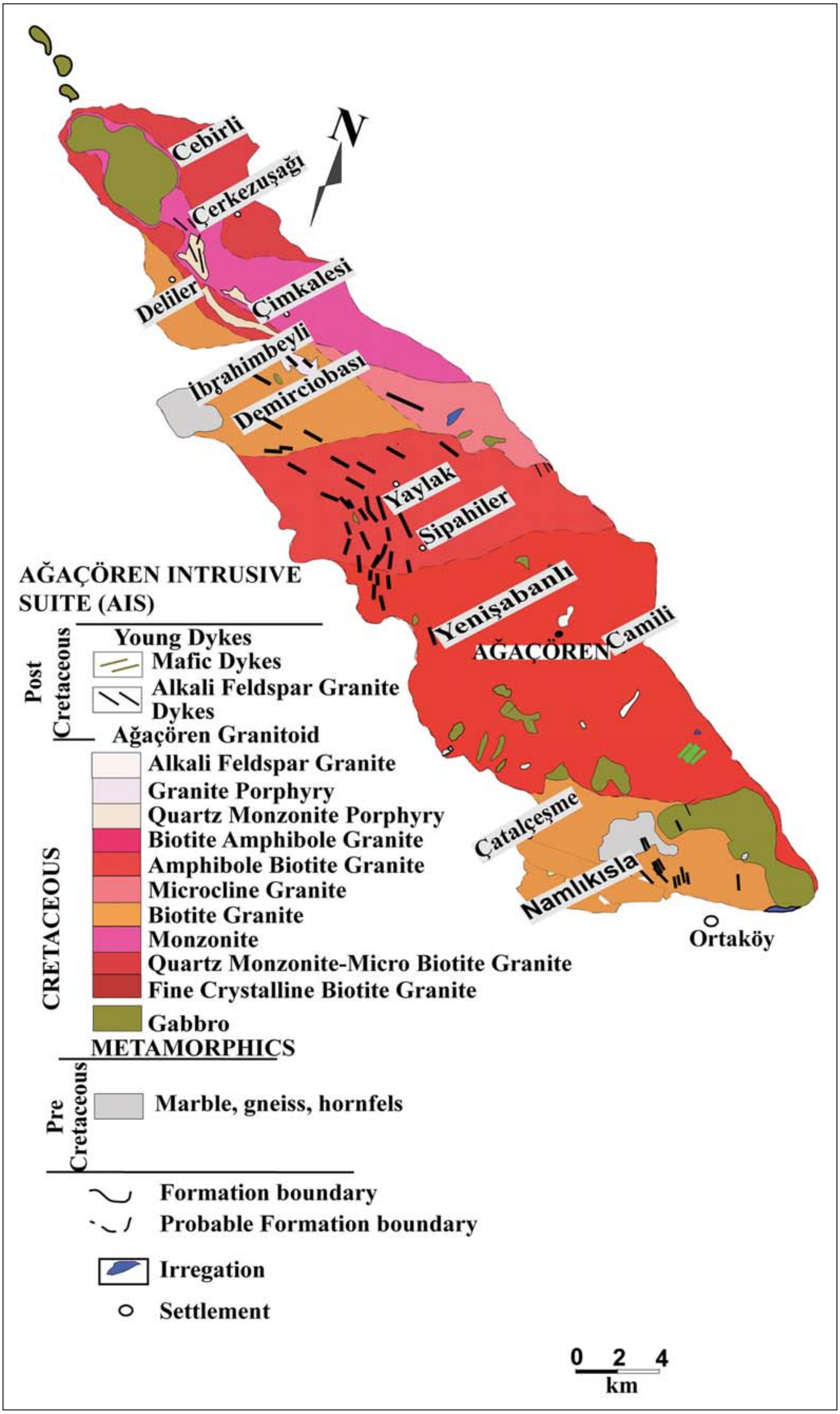

Figure 2- Geology map of the Ağaçören Intrusive Suit (AIT) (simplified from Kadıoğlu et al., 2006).

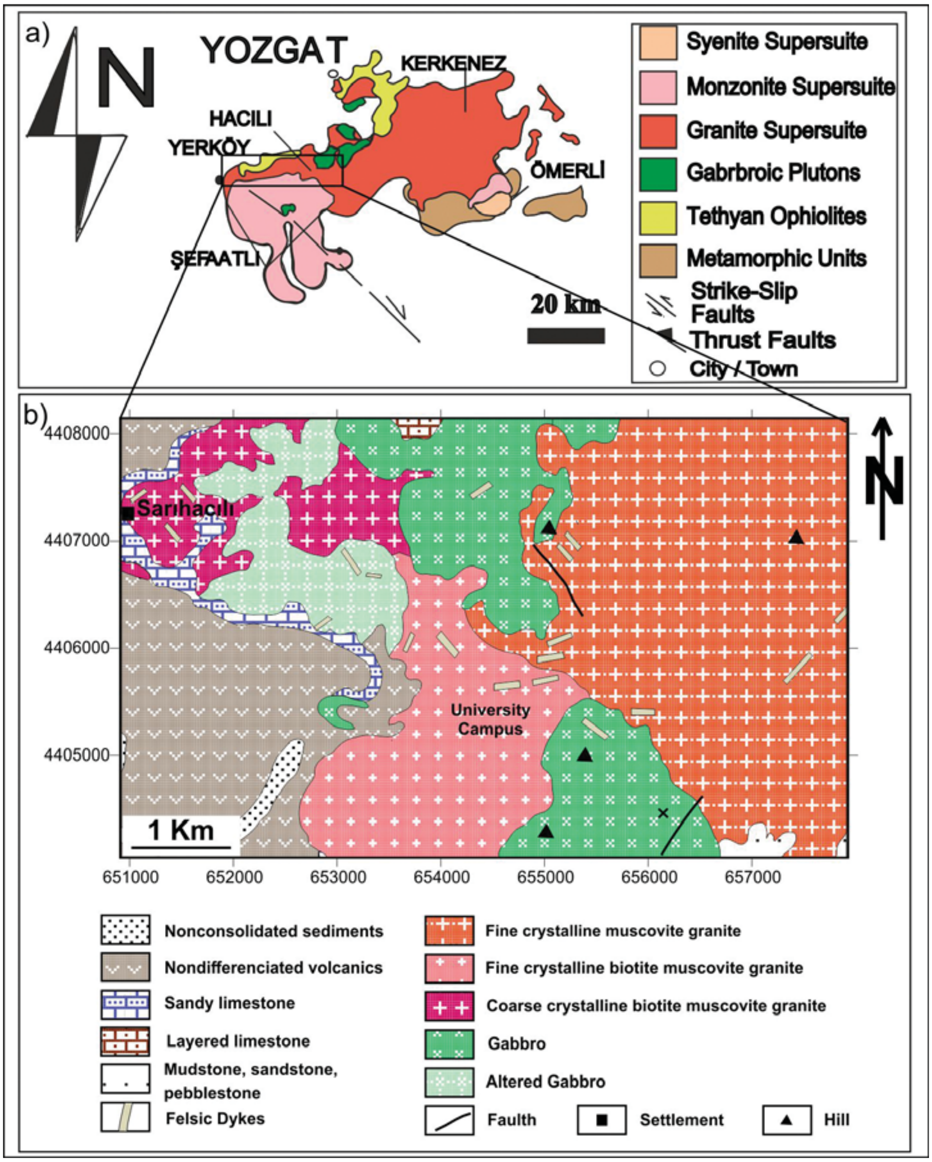

Figure 3- a) Simplified geology map of the Hacılı Suit (simplified from Kadıoğlu et al., 2006), b) Geology map of the Sarıhacılı vicinity (from Akçe and Kadıoğlu, 2005).

4. Mineralogy and Petrography

CACC; alkali feldspar containing rocks are divided into two main groups as; non feldspathoid containing (granitic-silicate-saturated) and feldspathoid-bearing (syenite-silica unsaturated) (Kadıoğlu et al., 2006). The felsic, mafic and accessory mineral contents of the Central Anatolian alkali feldspar granites and alkali feldspar syenites are given in Table 1. Alkali feldspar granites are fine-crystallized, holocrystalline hipidiomorph granular texture, and are composed of plagioclase minerals with equi-dimensional, sub-hedral quartz, alkali feldspar, biotite and muscovite (Figure 4a, 4b). Alkali feldspars have 0.5-5 mm in grain size and mostly orthoclase and microcline in composition, and plagioclases are 0.3-3 mm in size and mainly in oligoclase and locally in albite composition (An_{10-35}%). Mica group minerals consist of wedge and leafy biotite and muscovite with dimensions of 0.1-2 mm (Figure 4). In some alkaline feldspar granites (Hacılı and Kalebalta) garnet minerals are observed as secondary minerals. Within the orthoclase, cuneiform like quartz are observed and exhibit typical graphic and myrmekitic textures. In some of the orthoclases and plagioclases within rocks, argillization and sericitization are observed as a result of surficial effects (Figure 4). Fe bearing magnetite and ilmenite minerals in the form of accessory with dimensions ranging

Table 1- Felsic, mafic and accessory mineral contents of the Central Anatolian alkali feldspar granites and syenites.

Intrusion Name	Supersuite		Felsic Minerals	Mafic Minerals	Isotrope Minerals	Accessory Minerals
Kalebalta	Granite	AİT	Quartz, orthoclase, plagioclase	-	Grossular, andradite	Magnetite, ilmenite
Agaçören			Quartz, orthoclase, plagioclase, muscovite	Chlorite, epidote	-	Magnetite
Yıldırımlı			Quartz, orthoclase, plagioclase	-	-	Magnetite, hematite
Çerkezuşağı			Orthoclase, plagioclase	Amphibole, biotite, chlorite, epidote	-	Magnetite, ilmenite
Çatalçeşme			Quartz, orthoclase, plagioclase	Biotite, Amphibole, chlorite, epidote	-	Magnetite, ilmenite, hematite
İbrahimbeyli			Quartz, orthoclase, plagioclase	Biotite, Amphibole, chlorite, epidote	-	Magnetite
Deliler			Quartz, orthoclase, plagioclase	Biotite, Amphibole, chlorite, epidote	-	Magnetite
Ekecik			Quartz, orthoclase, plagioclase	Biotite, Amphibole, chlorite, epidote	-	Magnetite, ilmenite
Sipahiler			Quartz, orthoclase, plagioclase	Amphibole, biotite, chlorite, epidote	-	Magnetite
Camili			Quartz, orthoclase, plagioclase	Amphibole, biotite, chlorite, epidote	-	Magnetite
Yaylak			Quartz, orthoclase, plagioclase	Amphibole, biotite, chlorite, epidote	-	Magnetite
Cefalık	Monzonite		Orthoclase, plagioclase	Amphibole, biotite, chlorite, epidote	-	Magnetite, ilmenite
Behrekdağ			Orthoclase, plagioclase	Amphibole, biotite, chlorite, epidote	-	Magnetite, ilmenite
Terlemez			Orthoclase, plagioclase	Amphibole, biotite, chlorite, epidote	-	Magnetite, ilmenite
Bayındır	Syenite		Nepheline, orthoclase, plagioclase	Biotite, Amphibole	Melanite, fluorite	Magnetite, ilmenite, hematite
Hamit			Nepheline, orthoclase, plagioclase	Biotite, Amphibole	Melanite, fluorite	Magnetite, ilmenite
İdişdağı			Nepheline, orthoclase, plagioclase, quartz, muscovite	Amphibole, biotite,	Melanite, fluorite	Magnetite, ilmenite
Sarıhacılı	Granite		Quartz, orthoclase, plagioclase, muscovite	Biotite, chlorite, epidote	Grossular, andradit	Magnetite

from 0.1 mm to 0.4 mm are freely and independently located in the rock.

Some of the rocks in alkali feldspar granite cut other rocks in the region in the form of dykes and are largely found in AIT. They are mainly composed of orthoclase, quartz and in few amounts plagioclase and muscovite. Within the alkaline feldspar granite dykes around Yaylak in the AIT, the biotites are located within the rock, forming the magma segregation enclaves (Figure 4i, 5).

Cefalık, Behrekdağ, Terlemez Sub-Suites are monzonitic in composition (Akıman et al., 1993; Yalınız et al., 1999; Tatar, 2003; İlbeyli et al., 2004; İlbeyli, 2005; İlbeyli and Pearce, 2005; İlbeyli and Kibici, 2009; 2009; Kadıoğlu et al., 2006; Köksal et al., 2013). The coarse crystalline monzodioritic rocks in the Cefalık Suite are porphyritic texture as they contain feldspar megacrystals reaching up to 10 cm. The rocks are mainly composed of plagioclase, alkali feldspar, biotite and amphibole minerals and their mafic mineral ratios are higher than other felsic rocks (Kadıoğlu et al., 2006). The rocks in monzonitic composition are gray and coarse crystalline. The mafic mineral composition of these porphyritic rocks is composed of biotite, amphibole and few pyroxenes. Terlemez monzonites are mainly composed of K-feldspar, plagioclase, hornblende, biotite and rarely pyroxene minerals. Epidote minerals up to 3% in Terlemez monzonites are observed as a result of alteration.

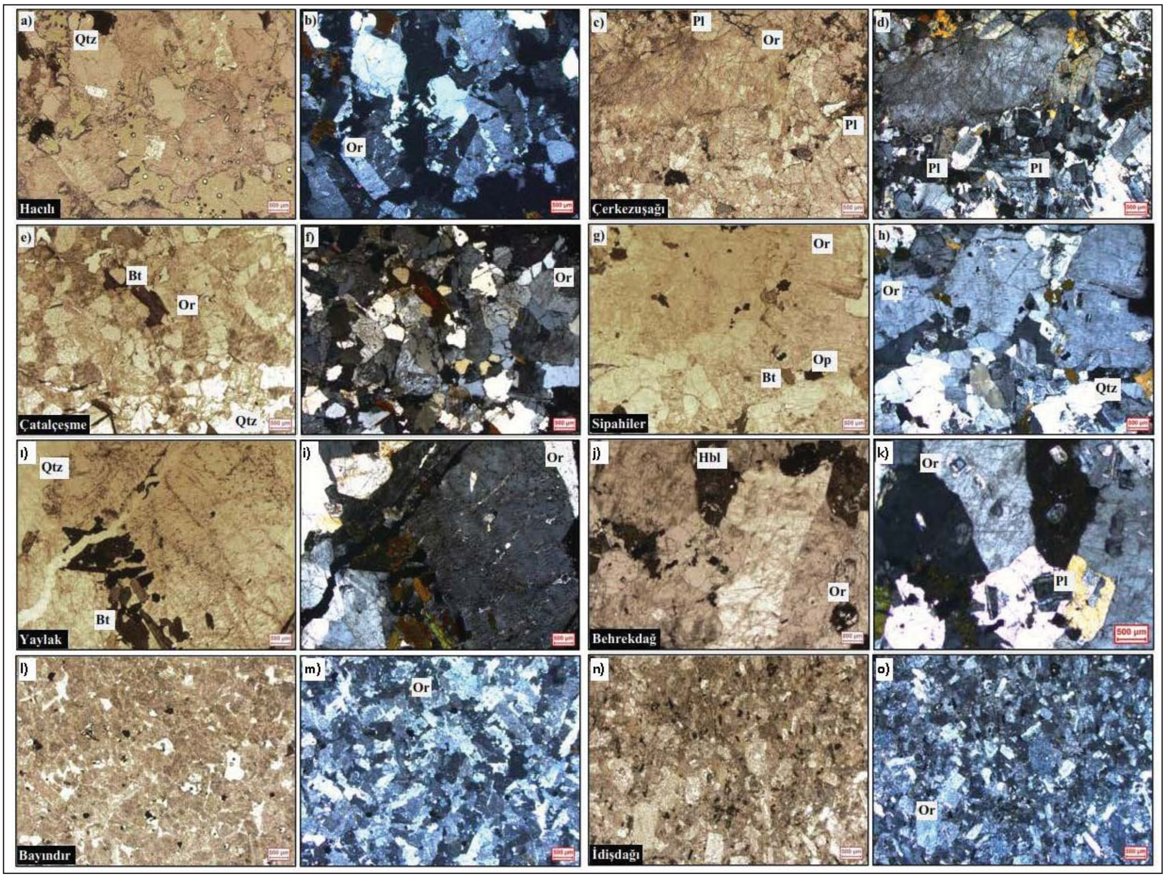

Figure 4- Thin section photos of some alkali feldspar granites and syenites in the study area (a, b) Hacılı, (c, d) Çerkezkuşağı (AIT), (e, f) Çatalçeşme (AIT), (g, h) Sipahiler (AIT), (ı, i) Yaylak (AIT), (j, k) Thin section photo of orthoclase minerals within Behrekdağ alkali feldspar granite, (l, m) photo of İnce crystalline Bayındır alkali feldspar syenite, (n, o) thin section photo of the İdişdağı alkali feldspar syenite.

Bayındır, Hamit and İdişdağı Sub-Suites represent the syenite silica unsaturated rock groups, and the felsic dykes that cut them are also in alkaline feldspar syenite composition (Kadıoğlu et al., 2006). Alkali feldspar syenites are generally have holocrystalline granular textures consisting mainly of alkaline feldspar, nepheline, plagioclase, amphibole, rare biotite and clinopyroxene, as well as secondary minerals such as titanite, zircon, apatite and accessory minerals and secondary minerals such as epidote, chlorite and calcite (Figures 5n, 5o). The most characteristic feature of alkali feldspar syenite is that they contain feldspathoid minerals like nepheline. Therefore, the alkali feldspar (orthoclase, microcline, anorthoclase) minerals of these rocks cause K and Na ratios to be higher than the alkaline feldspar granites due to the presence of nepheline.

CIPW norm values based on the chemical composition of rocks were calculated to determine the type and proportion of felsic minerals and accessory minerals in each locality studied (Table 2). According to this, it was seen that accessory minerals within the rocks were formed by ilmenite, magnetite, hematite and rutile minerals (Table 2). The rocks in AIT (Kalebalta, Yıldırımlı, Çerkezuşağı, Çatalçeşme, İbrahimbeyli, Deliler, Ekecik, Sipahiler, Camili, Yaylak and Namlıkışla) constitute mainly hematite (0.28-1.66%), ilmenite (0.06-0.51%) and rutile (0.02-0.20%). The Hacılı Suite samples on the other hand constitute accessory minerals in ilmenite (0.11-0.13%) and rutile (0.34%) compositions (Table 2). Accessory minerals in Cefalık, Behrekdağ, Terlemez Suites are in combination with ilmenite (0.06-0.15%), hematite (2.83%) and rutile (0.14-0.23%) (Table 2). Bayındır, Hamit and İdişdağı Suites contain ilmenite (0.30-0.39%), magnetite (0.12%) and hematite (0.38-0.43%) (Table 2). As quartz contents in the rocks increase, feldspar (plagioclase and orthoclase) contents decrease whereas mafic mineral contents increase (Table 2).

Table 2- CIPW normative values of the Central Anatolian alkali feldspar granites and syenites.

Sample Number	Location	Quartz	Plagioclase	Orthoclase	Diopside	Corundum	Wollastonite	Hypersthene	Apatite	Sphene	İlmenite	Magnetite	Hematite	Rutile	Nepheline	Akmite
Kaleb-1	Kalebalta	26.02	28.25	40.72	0.54	0.00	0.78	0.00	0.12	0.42	0.51	0.00	1.66	0.00	0.00	0.98
Kaleb-2	Kalebalta	24.56	28.18	40.89	0.32	0.00	0.10	0.00	0.14	0.24	0.73	0.00	0.00	0.00	1.56	3.27
Kaleb-3	Kalebalta	39.29	20.05	34.63	0.00	1.49	0.00	1.44	0.21	0.00	0.85	0.20	1.86	0.00	0.00	0.00
Kaleb-4	Kalebalta	41.14	28.69	23.64	0.00	2.11	0.00	2.22	0.07	0.00	0.23	0.57	1.33	0.00	0.00	0.00
Kaleb-5	Kalebalta	23.32	30.84	41.54	1.65	0.00	0.00	1.03	0.07	0.00	0.36	0.23	0.97	0.00	0.00	0.00
Kaleb-6	Kalebalta	37.04	28.00	28.48	0.00	2.80	0.00	1.67	0.07	0.00	0.62	0.00	0.83	0.47	0.00	0.00
Agac-1	Agaçören	33.16	29.02	33.80	0.00	1.23	0.00	1.74	0.09	0.00	0.28	0.15	0.51	0.00	0.00	0.00
Agac-2	Agaçören	36.05	24.12	33.33	0.00	3.08	0.00	2.32	0.05	0.00	0.19	0.00	0.85	0.03	0.00	0.00
Agac-3	Agaçören	36.53	28.51	29.08	0.00	2.63	0.00	2.39	0.05	0.00	0.25	0.37	0.19	0.00	0.00	0.00
Agac-4	Agaçören	34.78	29.11	29.19	0.00	3.65	0.00	2.34	0.12	0.00	0.21	0.53	0.08	0.00	0.00	0.00
Yıld-1	Yıldırımlı	43.95	24.89	26.06	0.00	3.11	0.00	1.27	0.09	0.00	0.17	0.00	0.36	0.10	0.00	0.00
Yıld-2	Yıldırımlı	36.70	34.68	25.23	0.00	1.27	0.00	1.44	0.12	0.00	0.17	0.00	0.29	0.10	0.00	0.00
Yıld-3	Yıldırımlı	28.79	22.19	44.20	0.21	0.00	1.42	0.00	0.16	0.19	0.21	0.00	0.00	0.00	1.95	0.64
Yıld-4	Yıldırımlı	28.64	24.27	43.49	0.00	0.00	0.00	1.59	0.37	0.61	0.19	0.00	0.65	0.16	0.00	0.00
Cerk-1	Çerkezuşağı	24.23	18.41	46.69	1.85	0.00	0.00	1.58	0.21	0.46	0.19	0.00	0.00	0.00	5.97	0.41
Cerk-2	Çerkezuşağı	33.08	26.65	37.17	0.00	0.50	0.00	1.20	0.42	0.00	0.19	0.00	0.94	0.08	0.00	0.00
Cerk-3	Çerkezuşağı	32.46	27.42	36.64	0.00	1.04	0.00	1.54	0.39	0.00	0.19	0.00	0.28	0.05	0.00	0.00
Nkisla-1	Çatalçeşme	23.55	28.12	41.13	0.74	0.00	0.00	1.37	0.30	0.65	0.06	0.00	0.00	0.00	3.00	1.07
Nkisla-2	Çatalçeşme	26.66	25.34	42.49	2.14	0.00	0.00	1.10	0.32	0.04	0.21	0.00	0.00	0.00	0.88	0.81
İbrah-1	İbrahimbeyli	35.95	19.88	40.78	0.00	1.55	0.00	0.62	0.30	0.00	0.21	0.00	0.78	0.04	0.00	0.00
İbrah-2	İbrahimbeyli	38.42	24.67	31.56	0.00	1.59	0.00	1.97	0.30	0.00	0.15	0.00	0.91	0.44	0.00	0.00
Delil-1	Deliler	48.80	21.83	24.05	0.00	3.02	0.00	1.10	0.28	0.00	0.15	0.00	0.68	0.09	0.00	0.00
Delil-2	Deliler	39.36	29.69	25.53	0.00	2.61	0.00	1.67	0.37	0.00	0.06	0.00	0.56	0.15	0.00	0.00
Delil-3	Deliler	39.42	27.74	26.00	0.00	3.13	0.00	2.14	0.37	0.00	0.17	0.00	0.93	0.09	0.00	0.00
Ekeck-1	Ekecik	40.60	26.31	26.36	0.00	3.18	0.00	1.89	0.42	0.00	0.15	0.00	0.62	0.47	0.00	0.00
Ekeck-2	Ekecik	37.07	34.68	23.93	0.00	2.86	0.00	0.25	0.14	0.00	0.13	0.00	0.73	0.21	0.00	0.00
Ekeck-3	Ekecik	28.16	26.71	41.78	1.15	0.00	0.00	0.36	0.28	0.89	0.15	0.00	0.53	0.00	0.00	0.00
Siph-1	Sipahiler	17.01	39.04	39.42	1.15	0.00	0.00	1.01	0.16	0.25	0.17	0.00	0.00	0.00	1.62	0.17
Siph-2	Sipahiler	27.29	39.32	29.96	0.00	1.45	0.00	1.39	0.21	0.00	0.11	0.00	0.12	0.15	0.00	0.00
Siph-3	Sipahiler	23.23	28.34	45.92	0.83	0.00	0.00	0.91	0.14	0.23	0.13	0.00	0.00	0.00	0.15	0.12
Cefalık-1	Cefalık	22.52	24.04	47.10	1.67	0.00	0.00	0.82	0.23	0.20	0.15	0.00	0.00	0.00	2.98	0.29
Cefalık-2	Cefalık	27.45	31.27	37.35	0.00	0.50	0.00	2.52	0.16	0.00	0.15	0.00	0.36	0.22	0.00	0.00
Cefalık-3	Cefalık	31.90	19.85	43.26	0.00	1.96	0.00	0.67	0.76	0.00	0.11	0.00	1.37	0.12	0.00	0.00
Cefalık-4	Cefalık	37.28	31.53	25.59	0.00	2.82	0.00	0.95	0.12	0.00	0.11	0.00	1.52	0.09	0.00	0.00
Behrek-1	Behrekdag	17.14	30.14	47.40	0.00	0.00	0.00	2.39	0.19	0.00	0.15	0.00	0.00	0.23	1.20	1.27
Behrek-2	Behrekdag	13.51	31.48	46.63	1.25	0.00	0.00	1.88	0.16	0.32	0.13	0.00	0.00	0.00	4.36	0.29
Behrek-3	Behrekdag	15.91	34.12	42.02	2.40	0.00	0.00	1.11	0.19	0.47	0.15	0.00	0.00	0.00	1.20	2.46
Behrek-4	Behrekdag	27.79	37.22	29.37	0.00	2.34	0.00	2.44	0.16	0.00	0.17	0.00	0.46	0.03	0.00	0.00
Behrek-5	Behrekdag	18.07	38.01	40.19	0.00	0.00	0.00	2.57	0.21	0.00	0.19	0.00	0.38	0.19	0.00	0.28

Table 2- continued.

Sample Number	Location	Quartz	Plagioclase	Orthoclase	Diopside	Corundum	Wollastonite	Hypersthene	Apatite	Sphene	İlmenite	Magnetite	Hematite	Rutile	Nepheline	Akmite
Behrek-6	Behrekdag	28.06	38.99	26.77	0.00	2.45	0.00	1.59	0.16	0.00	0.02	0.00	1.75	0.19	0.00	0.00
Terlm1	Terlemez	27.32	31.08	31.79	0.00	2.57	0.00	3.86	0.35	0.00	0.06	0.00	2.83	0.14	0.00	0.00
Terlm2	Terlemez	31.71	30.88	31.97	0.47	0.00	0.60	0.00	0.07	0.00	0.04	0.00	0.00	0.00	1.81	2.46
Cam-1	Camili	29.77	41.68	25.71	0.00	1.79	0.00	0.25	0.25	0.00	0.02	0.00	0.50	0.03	0.00	0.00
Cam-2	Camili	34.88	34.90	28.96	0.00	0.22	0.00	0.20	0.05	0.00	0.04	0.04	0.71	0.00	0.00	0.00
Cam-3	Camili	27.78	29.51	34.63	0.63	0.00	0.00	0.41	0.12	0.00	0.02	0.00	0.00	0.00	4.75	2.17
Yaylak-1	Yaylak	25.63	41.17	30.43	0.00	1.61	0.00	0.32	0.32	0.00	0.21	0.00	0.28	0.02	0.00	0.00
Yaylak-2	Yaylak	43.48	19.72	28.48	0.00	6.73	0.00	0.37	0.28	0.00	0.21	0.00	0.77	0.04	0.00	0.00
Yaylak-3	Yaylak	42.75	24.41	25.35	0.00	5.64	0.00	0.45	0.30	0.00	0.15	0.00	0.90	0.04	0.00	0.00
Yaylak-4	Yaylak	43.05	30.21	23.87	0.00	1.33	0.00	0.35	0.28	0.00	0.15	0.00	0.68	0.09	0.00	0.00
Hacılı-9	Yozgat	28.41	27.77	35.93	1.98	0.00	0.00	0.28	0.30	0.55	0.13	0.00	0.00	0.00	0.25	4.43
Hacılı-10	Yozgat	34.17	26.16	32.56	1.71	0.00	0.00	0.28	0.35	0.59	0.13	0.00	0.41	0.00	0.00	3.64
Hacılı-11	Yozgat	34.38	22.76	34.10	0.00	1.02	0.00	4.36	1.20	0.00	0.15	0.00	1.67	0.39	0.00	0.00
Hacılı-12	Yozgat	32.90	25.79	32.56	0.00	0.31	0.00	4.98	1.00	0.00	0.17	0.00	1.86	0.45	0.00	0.00
Hacılı-13	Yozgat	30.11	23.01	38.41	0.14	0.00	0.00	2.20	0.51	0.72	0.13	0.00	0.00	0.00	0.35	4.43
Hacılı-14	Yozgat	31.44	19.98	39.77	0.45	0.00	0.00	1.98	0.46	0.74	0.17	0.00	0.00	0.00	1.60	3.38
Hacılı-15	Yozgat	29.24	22.56	40.36	1.30	0.00	0.00	1.74	0.51	0.71	0.15	0.00	0.05	0.00	0.00	3.38
Hacılı-16	Yozgat	31.66	28.61	37.70	0.00	0.00	0.00	0.62	0.14	0.10	0.04	0.00	1.07	0.05	0.00	0.00
Hacılı-17	Yozgat	32.23	23.16	38.47	0.00	0.00	0.00	1.84	0.49	0.00	0.11	0.00	0.00	0.34	1.29	2.14
Hacılı-18	Yozgat	40.72	22.93	31.50	0.00	1.88	0.00	0.80	0.95	0.00	0.26	0.00	0.84	0.53	0.00	0.00
Hacılı-19	Yozgat	41.23	22.59	30.67	0.00	2.92	0.00	0.35	1.02	0.00	0.26	0.00	0.84	0.54	0.00	0.00
Hacılı-1	Yozgat	38.65	25.13	31.91	0.00	1.71	0.00	0.45	1.02	0.00	0.26	0.00	0.75	0.54	0.00	0.00
Hacılı-2	Yozgat	39.24	22.09	34.10	0.00	2.45	0.00	0.47	1.07	0.00	0.17	0.00	0.32	0.50	0.00	0.00
Hacılı-3	Yozgat	41.22	21.07	32.68	0.00	3.06	0.00	0.40	1.02	0.00	0.28	0.00	0.23	0.49	0.00	0.00
Hacılı-4	Yozgat	39.97	23.02	32.62	0.00	2.59	0.00	0.45	0.90	0.00	0.24	0.00	0.13	0.50	0.00	0.00
Hacılı-5	Yozgat	32.99	6.35	58.45	0.00	0.00	0.00	0.05	0.07	0.00	0.04	0.00	0.00	0.04	1.23	0.78
Hacılı-6	Yozgat	27.79	28.25	40.66	0.00	0.00	0.00	0.62	0.21	0.21	0.02	0.00	0.00	0.08	1.62	0.52
Hacılı-7	Yozgat	24.26	29.93	40.19	0.00	0.00	0.00	0.40	0.16	0.59	0.04	0.00	0.00	0.05	3.97	0.41
Hacılı-8	Yozgat	39.27	18.02	38.71	0.00	2.82	0.00	0.42	0.37	0.00	0.02	0.00	0.17	0.25	0.00	0.00
Bayınd-1	Bayındır	19.70	50.82	25.65	0.00	1.54	0.00	1.42	0.07	0.00	0.30	0.12	0.38	0.00	0.00	0.00
Bayınd-2	Bayındır	8.57	48.39	32.38	5.27	0.00	0.94	0.00	0.16	0.00	0.08	0.44	0.18	0.00	0.00	3.59
Bayınd-3	Bayındır	4.33	49.50	36.29	0.58	0.00	3.75	0.00	0.07	0.00	0.23	0.00	0.00	0.00	1.65	3.59
Bayınd-4	Bayındır	3.77	46.50	32.92	3.71	0.00	0.62	0.00	0.07	2.32	0.45	0.00	0.00	0.00	2.57	7.09
Hamt-1	Hamit	7.54	51.37	30.26	3.87	0.00	1.19	0.00	0.25	0.17	0.39	0.00	0.43	0.00	0.00	4.54
Hamt-2	Hamit	6.11	49.07	36.11	5.16	0.00	0.58	0.00	0.21	0.29	0.34	0.00	2.14	0.00	0.00	0.00
Hamt-3	Hamit	7.54	55.99	24.76	4.83	0.00	0.85	0.00	0.21	0.00	0.32	0.00	0.00	0.00	0.74	4.77
idis-1	İdişdağı	7.41	50.30	26.53	5.33	0.00	0.00	0.04	0.16	0.00	0.32	0.00	0.00	0.00	0.05	9.84
idis-2	İdişdağı	19.32	41.63	32.03	0.00	0.54	0.00	2.29	0.05	0.00	0.32	0.00	2.85	0.97	0.00	0.00
idis-3	İdişdağı	9.76	32.19	43.14	4.71	0.00	0.00	1.35	0.07	0.00	0.32	0.16	0.45	0.00	0.00	7.87
idis-4	İdişdağı	5.97	59.81	25.18	2.96	0.00	0.66	0.00	0.07	0.44	0.53	0.00	3.93	0.00	0.00	0.46

5. Geochemistry

The major oxide % element contents of alkali feldspar granite and alkali feldspar syenites examined in the study are given in table 3. The results of the geochemical analysis were interpreted by comparing with some of the alkaline feldspar granites in the literature (Junggar-Mongolia, Changyi-China, Alvand-Iran, Katharina-Egypt, Scotland, Klipberg-Africa) (Table 4) (Data were taken from Scheepers and Schoch, 1988; Murphy et al., 1998; Katzir et al., 2007; Geng et al., 2009; Aliani et al., 2011; Lan et al., 2015).

Alkaline feldspar granites outcropping in the form of dykes in the vicinity of Kalebalta, Yıldırımlı, Çerkezuşağı, Çatalçeşme, İbrahimbeyli, Deliler, Ekecik, Sipahiler, Camili, Yaylak and Namlıkışla in the AIT have values of 71.05-78.84% (average 74.64%) SiO_2, 11.56-15.70% (average 13.28%) Al_2O_3, 3.92-7.78% (average 5.58%) K_2O and 2.11-6.22% (average 3.48%) Na_2O (Table 3). It is seen that the rocks have very low amounts of Fe_2O_3 (0.04-1.99%), MgO (0.04-0.98%) and TiO_2 (0.01-0.79%). This situation is due to the low ratios of accessory minerals such as the mafic and magnetite and ilmenite in the rocks.

There are observed slight differences in the contents of some elements in the case of two micaceous alkali feldspar granites and muscovite alkali feldspar granites in the Hacılı Suite (Sarıhacılı) located to the east of Yozgat province (Table 3). The SiO_2 and Al_2O_3 contents of the rocks are almost similar, but there are differences in Na_2O, K_2O, Fe_2O_3, MgO and TiO_2 contents. Na_2O contents of the two micaceous alkali feldspar granites are 2.67-4.02%, the K_2O contents 5.43-6.84%, the Fe_2O_3 contents 1.06-1.83%, the MgO contents 0.25-1.97% and the TiO_2 contents 0.11-0.53%. On the other hand, the contents of these oxides vary between 1.48-5.58%, 5.15-9.90%, 0.13-0.84%, 0.02-0.74% and 0.06-0.68%, respectively. Muscovite alkali feldspar is high in K_2O ratio in granites, because of the high ratio of muscovite. Moreover, the reason for the high Na_2O ratio is due to the fact that some of the feldspar minerals are in albite composition. Similarly; since the two micaceous alkali feldspar granites contain both muscovite and biotite minerals, Fe and Mg values are higher than those of muscovite granites. Moreover, TiO_2 value due to the observation of accessory titanites in free state in two-micaceous granites is found to be higher than TiO_2 content in muscovite granites. (Figure 5).

When the chemical compositions of the alkali feldspar granites located around Cefalık, Behrekdağ and Terlemez are compared with AIT and the Hacılı Suite (Sarıhacılı), it is seen that SiO_2 and TiO_2 contents are low, but Al_2O_3, Fe_2O_3, MgO, Na_2O and K_2O contents are relatively high (Table 3, Figure 5). SiO_2 and TiO_2 contents of these rocks are between 68.80-76.40 (average 72.37%) and 0.02-0.30% (mean 0.19%), respectively (Table 3). Elements and their amounts with average values are as follows; MgO 0.08-1.53% (average 1.00%), Na_2O 2.21-5.90% (average 4.13), K_2O 4.33 to 7.91 (average 6.28%), Al_2O_3 11.86-15.35% (average 14.04%), Fe_2O_3 0.10-2.79% (average 14.09%) (Table 3).

The alkali feldspar syenites outcropping in Bayındır, Hamit and İdişdağı Suites were chemically compared with the alkali feldspar granites, and it was seen that Al_2O_3 (14.07-16.81%, average 15.30%), Fe_2O_3 (0.46-3.99%, average 2.25%), Na_2O (4.19-7.64%, average %6.19) and TiO_2 (0.04-1.16%, average 0.41%) were relatively high, however; SiO_2 (64.11-68.56%, average 66.13%) content was low (Table 3). On the other hand, K_2O (4.16-7.25%, average 5.28%) values are close to each other (Figure 5c-d, Figure 7). There is observed a positive correlation between the amounts of Na_2O and K_2O and the amounts of Fe_2O_3 and TiO_2 in these samples (Figure 5).

Klipberg (Africa) alkali feldspar granites contain 4.47-5.71% (average 4.92%) Na_2O, 4.40-5.27% (average 4.80%) K_2O, 0.35-3.08% (average 1.49%) Fe_2O_3 and 0-0.16% TiO_2 (Table 4). Junggar (Mongolia) alkaline feldspar granites consist of 0.93-3.40% Fe_2O_3 (average 1.96%), 0.08-0.42% TiO_2 (average 0.20%), 3.36-5.14% Na_2O (average 4.21%), 2.56-6.29% K_2O (Table 4). The contents of Fe_2O_3 (1.69-3.67%, 2.99% average) and TiO_2 (0.24-0.29%, 0.26%) are higher in the Changyi (China) alkali feldspar granites while Na_2O (2.86-6.56%, average 3.82%) and K_2O (0.29-5.14%, average 4.10%) contents are partially lower (Table 4). The Na_2O and K_2O contents are not very variable, but differences in Fe_2O_3 and TiO_2 contents are observed. The Katharina (Egypt) alkali feldspar granites have contents of 1.10-1.80% Fe_2O_3 (average 1.42%) and 0.07-0.09% TiO_2 (average 0.08%) (Table 4). The lowest Fe_2O_3 (0.41-1.13%, average 0.78%) and TiO_2 (0.02-0.05%, average 0.03%) contents are observed in Scottish granites. Alvand (Iran) granites have K_2O (6.12%) contents higher than Na_2O (2.41%) and Fe_2O_3 contents are 1.5% (Table 4).

Table 3- Major oxide geochemistry of the Central Anatolian alkali feldspar granites and alkali feldspar syenites.

Sample Number	Location	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	K_2O/Na_2O	Na_2O/K_2O
Kaleb-1	Kalebalta	72.67	12.86	1.99	0.10	0.70	3.45	6.84	0.44	1.98	0.50
Kaleb-2	Kalebalta	72.61	12.87	1.12	0.06	0.28	4.52	6.87	0.48	1.52	0.66
Kaleb-3	Kalebalta	75.24	11.56	1.97	0.57	0.09	2.33	5.78	0.44	2.48	0.40
Kaleb-4	Kalebalta	75.30	12.22	1.69	0.87	0.56	3.02	3.92	0.12	1.30	0.77
Kaleb-5	Kalebalta	71.64	13.64	1.11	0.71	0.72	3.44	6.93	0.19	2.02	0.50
Kaleb-6	Kalebalta	73.65	13.81	0.82	0.66	0.71	2.86	4.74	0.79	1.66	0.60
Agac-1	Agaçören	73.96	13.69	0.61	0.69	0.98	2.85	5.65	0.15	1.98	0.50
Agac-2	Agaçören	73.54	13.49	0.83	0.90	0.02	2.77	5.49	0.13	1.98	0.51
Agac-3	Agaçören	74.57	13.39	0.44	0.94	0.23	3.18	4.82	0.13	1.51	0.66
Agac-4	Agaçören	72.55	14.45	0.44	0.91	0.33	3.18	4.79	0.11	1.51	0.66
Yıld-1	Yıldırımlı	78.17	12.73	0.36	0.51	0.14	2.87	4.38	0.19	1.53	0.65
Yıld-2	Yıldırımlı	76.62	12.77	0.29	0.57	0.37	3.88	4.23	0.19	1.09	0.92
Yıld-3	Yıldırımlı	73.37	12.16	0.22	0.04	0.87	3.63	7.33	0.19	2.02	0.50
Yıld-4	Yıldırımlı	74.23	12.76	0.65	0.64	0.52	2.78	7.34	0.51	2.64	0.38
Cerk-1	Çerkezuşağı	72.20	12.10	0.14	0.98	0.73	5.25	7.88	0.29	1.50	0.67
Cerk-2	Çerkezuşağı	74.82	12.27	0.92	0.47	0.01	3.09	6.18	0.18	2.00	0.50
Cerk-3	Çerkezuşağı	75.02	12.92	0.28	0.61	0.20	3.20	6.12	0.15	1.91	0.52
Nkisla-1	Çatalçeşme	71.86	12.80	0.36	0.68	0.54	4.91	6.86	0.30	1.40	0.72
Nkisla-2	Çatalçeşme	73.67	12.60	0.28	0.83	0.74	3.52	7.13	0.13	2.03	0.49
İbrah-1	İbrahimbeyli	75.32	12.70	0.77	0.25	0.06	2.32	6.80	0.15	2.93	0.34
İbrah-2	İbrahimbeyli	76.29	12.06	0.90	0.78	0.18	2.88	5.30	0.52	1.84	0.54
Delil-1	Deliler	78.84	12.32	0.68	0.44	0.96	2.11	4.06	0.17	1.93	0.52
Delil-2	Deliler	76.81	13.15	0.56	0.67	0.38	3.40	4.31	0.18	1.27	0.79
Delil-3	Deliler	75.28	13.60	0.92	0.85	0.71	2.95	4.36	0.18	1.48	0.68
k-Ekeck-1	Ekecik	76.31	13.50	0.62	0.76	0.68	2.85	4.46	0.55	1.56	0.64
k-Ekeck-2	Ekecik	75.20	14.21	0.72	0.10	0.51	3.80	4.01	0.28	1.06	0.95
k-Ekeck-3	Ekecik	74.25	13.04	0.53	0.36	0.96	3.00	7.05	0.44	2.35	0.43
Siph-1	Sipahiler	71.05	14.70	0.06	0.62	0.46	5.42	6.62	0.19	1.22	0.82
Siph-2	Sipahiler	73.08	14.80	0.12	0.55	0.58	4.32	5.01	0.21	1.16	0.86
Siph-3	Sipahiler	73.01	13.80	0.04	0.52	0.36	3.41	7.70	0.16	2.26	0.44
Cefalık-1	Cefalık	72.10	13.20	0.10	0.64	0.62	4.36	7.91	0.16	1.81	0.55
Cefalık-2	Cefalık	73.78	14.11	0.36	1.01	0.87	3.25	6.34	0.30	1.95	0.51
Cefalık-3	Cefalık	74.13	14.07	1.38	0.27	0.70	2.21	7.37	0.18	3.33	0.30
Cefalık-4	Cefalık	75.47	14.01	1.52	0.38	0.52	3.46	4.33	0.15	1.25	0.80
Behrek-1	Behrekdağ	69.91	14.27	0.43	0.94	0.01	4.26	7.87	0.30	1.85	0.54
Behrek-2	Behrekdağ	68.80	14.50	0.10	0.98	0.50	5.90	7.80	0.20	1.32	0.76
Behrek-3	Behrekdağ	70.82	14.38	0.85	0.89	0.86	4.99	7.14	0.27	1.43	0.70
Behrek-4	Behrekdağ	72.80	14.87	0.45	0.97	0.21	4.28	4.91	0.12	1.15	0.87
Behrek-5	Behrekdağ	71.21	14.61	0.48	1.02	0.01	4.49	6.74	0.29	1.50	0.67
Behrek-6	Behrekdağ	72.67	15.35	1.75	0.64	0.55	4.35	4.54	0.20	1.04	0.96
Terlm1	Terlemez	69.85	14.75	2.79	1.53	0.79	3.27	5.31	0.17	1.62	0.62
Terlm2	Terlemez	76.40	11.86	0.85	0.08	0.45	4.90	5.41	0.02	1.10	0.91
Cam-1	Camili	75.06	14.99	0.50	0.10	0.53	4.72	4.37	0.04	0.93	1.08
Cam-2	Camili	77.36	12.66	0.74	0.08	0.41	3.90	4.91	0.02	1.26	0.79
Cam-3	Camili	74.86	12.13	0.75	0.28	0.23	6.22	5.88	0.01	0.95	1.06
Yaylak-1	Yaylak	72.83	15.60	0.28	0.13	0.74	4.52	5.13	0.13	1.13	0.88
Yaylak-2	Yaylak	75.32	15.70	0.77	0.15	0.06	2.32	4.80	0.15	2.07	0.48
Yaylak-3	Yaylak	76.29	15.06	0.90	0.18	0.18	2.88	4.30	0.12	1.49	0.67
Yaylak-4	Yaylak	78.84	12.32	0.68	0.14	0.96	3.11	4.06	0.17	1.31	0.77
Hacılı-9	Yozgat	76.08	11.57	0.74	0.74	0.21	3.69	6.52	0.40	1.77	0.57
Hacılı-10	Yozgat	77.06	12.06	0.84	0.32	0.12	2.70	5.31	0.67	1.97	0.51
Hacılı-11	Yozgat	76.28	12.84	0.83	0.14	0.15	2.65	5.15	0.68	1.94	0.51

Table 3- continued.

Sample Number	Location	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	K_2O/Na_2O	Na_2O/K_2O
Hacılı-12	Yozgat	76.20	12.33	0.74	0.18	0.17	2.94	5.35	0.67	1.82	0.55
Hacılı-13	Yozgat	76.35	12.92	0.32	0.19	0.18	2.60	5.74	0.59	2.21	0.45
Hacılı-14	Yozgat	76.16	12.98	0.23	0.16	0.13	2.46	5.46	0.63	2.22	0.45
Hacılı-15	Yozgat	76.85	12.98	0.13	0.18	0.09	2.71	5.50	0.62	2.03	0.49
Hacılı-16	Yozgat	76.29	11.95	0.27	0.02	0.03	1.48	9.90	0.06	6.69	0.15
Hacılı-17	Yozgat	74.62	12.87	0.18	0.25	0.18	4.21	6.84	0.18	1.62	0.62
Hacılı-18	Yozgat	73.08	13.11	0.14	0.16	0.26	5.58	6.77	0.31	1.21	0.82
Hacılı-19	Yozgat	76.54	13.33	0.17	0.17	0.16	2.12	6.51	0.26	3.07	0.33
Hacılı-1	Yozgat	75.00	12.04	1.54	0.48	0.84	4.02	6.11	0.29	1.52	0.66
Hacılı-2	Yozgat	79.03	11.43	1.73	0.44	0.84	3.70	5.70	0.32	1.54	0.65
Hacılı-3	Yozgat	74.11	11.60	1.66	1.74	0.63	2.67	5.72	0.47	2.14	0.47
Hacılı-4	Yozgat	73.40	11.28	1.83	1.97	0.74	2.90	5.43	0.53	1.87	0.53
Hacılı-5	Yozgat	74.32	11.42	1.52	0.90	0.53	3.46	6.45	0.36	1.86	0.54
Hacılı-6	Yozgat	74.86	11.13	1.17	0.88	0.59	3.62	6.70	0.39	1.85	0.54
Hacılı-7	Yozgat	74.73	11.80	1.22	0.94	0.83	3.12	6.84	0.37	2.19	0.46
Hacılı-8	Yozgat	74.60	12.88	1.06	0.25	0.73	2.98	6.32	0.11	2.12	0.47
Alkali Feldspar Syenite											
Bayınd-1	Bayındır	68.56	16.81	0.46	0.56	1.34	5.08	4.23	0.16	0.83	1.20
Bayınd-2	Bayındır	67.26	15.16	1.70	0.97	1.89	6.13	5.41	0.04	0.88	1.13
Bayınd-3	Bayındır	64.99	15.83	1.21	0.06	1.94	6.98	5.98	0.12	0.86	1.17
Bayınd-4	Bayındır	64.16	14.86	2.42	0.68	1.93	7.64	5.49	1.16	0.72	1.39
Hamt-1	Hamit	65.59	15.06	1.94	0.70	1.72	6.48	4.97	0.26	0.77	1.30
Hamt-2	Hamit	64.89	15.80	2.09	0.94	1.81	5.65	5.96	0.29	1.06	0.95
Hamt-3	Hamit	68.06	15.43	1.65	0.86	1.77	7.64	4.19	0.17	0.55	1.82
idis-1	İdişdağı	65.66	14.29	3.32	0.97	1.43	7.11	4.38	0.17	0.62	1.62
idis-2	İdişdağı	66.77	14.92	2.77	0.89	1.02	4.19	5.26	1.11	1.26	0.80

When the samples of some alkali feldspar granites (Junggar-Mongolia, Changyi-China, Alvand-Iran, Katharina-Egypt, Scotland, Klipberg-Africa) in different places of the world are compared with the chemistry of the studied samples, Fe_2O_3 and partly Na_2O values are high while K_2O values are lower (Tables 3 and 4) (Figure 5). TiO_2 contents have similar values with that of samples in the study area (except Yozgat-Hacılı samples) (Figure 5c-d).

6. Discussion

Although feldspar is a very common mineral, quartz, albite, accessory or iron-bearing minerals, which are in the form of inclusions, affect the feldspar's color, purity and the quality, and most of them cannot be used in the glass and ceramics industries. Therefore, when the accessory and iron bearing minerals in the alkali feldspar granites are removed by using techniques such as the magnetic separator and flotation they can be used as a raw material in ceramics and glass industries. As the reserve of alkaline feldspar granites increases, the proportion of minerals such as mafic minerals, magnetite and ilmenite also increases. The morphological features, mineralogical and petrographic characteristics of the alkali feldspar granite and alkaline feldspar syenites were evaluated together. Since the alkali feldspar granites in the AIT are in the form of dykes, the pertitizations in orthoclase minerals which they contain are not observed and quartz or iron bearing accessory minerals are not found as inclusions. On the other hand, due to the widespread exposure of alkaline feldspar granites in Hacılı and Kalebata, the presence of pertitization and poiklitic texture in alkali feldspar minerals can be partially observed. Similar situations in feldspars are more observed in Cefalık, Behrekdağ, Terlemez, Bayındır, Hamit and İdişdağı Suites.

Feldspar minerals are used for different purposes in the production of glass and ceramics according to their chemical compositions. The melting temperature of the orthoclase mineral in $KAlSi_3O_8$ composition is 1170°C, but it can be used largely in the ceramic sector as the melting temperature can even reach up to

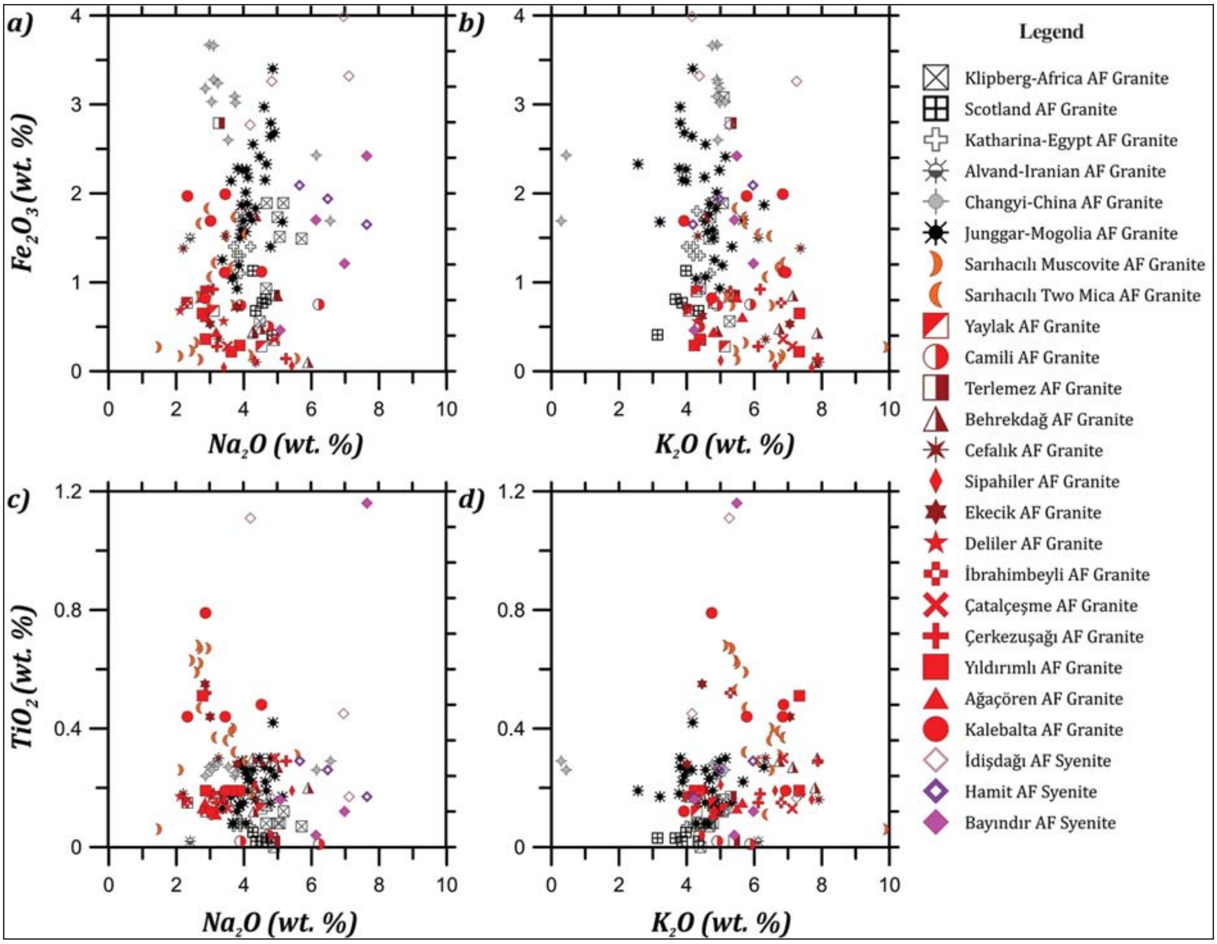

Figure 5- Fe_2O_3 and TiO_2 vs Na_2O and K_2O variation diagram of some alkali feldspar granites and alkali feldspar syenites from the Central Anatolia and the World (AF: Alkali Feldspar).

Table 4- Major oxide geochemistry of some alkali feldspar granites and alkali feldspar syenites from the Central Anatolia and the world.

Sample Number	Location	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	K_2O/Na_2O	Na_2O/K_2O
idis-3	İdişdağı	66.93	14.07	3.26	1.41	1.25	4.83	7.25	0.17	1.50	0.67
idis-4	İdişdağı	64.11	15.84	3.99	0.54	1.22	6.95	4.16	0.45	0.60	1.67
Junggar-Mongolia Alkali Feldspar Granite (from Geng et al., 2009)											
KM1	Junggar	74.80	12.20	2.28	0.36	1.13	3.82	3.78	0.18	0.99	1.01
KM9802-6	Junggar	74.90	12.60	2.33	0.47	1.51	4.67	2.56	0.19	0.55	1.82
KM2	Junggar	77.90	11.10	1.06	0.02	0.39	3.69	4.55	0.08	1.23	0.81
KM9918-3	Junggar	70.00	13.60	3.40	0.23	1.24	4.86	4.18	0.42	0.86	1.16
MG9951-1	Junggar	78.40	10.70	1.04	0.01	0.46	3.66	4.28	0.08	1.17	0.86
MG136-1	Junggar	73.10	14.40	1.68	0.23	1.70	5.14	3.21	0.17	0.62	1.60
MG9942-1	Junggar	74.30	12.70	2.27	0.38	1.28	4.08	3.98	0.26	0.98	1.03
MG9918-3	Junggar	76.40	11.70	1.69	0.04	0.41	3.99	4.55	0.15	1.14	0.88
MG106-2	Junggar	76.90	11.70	1.25	0.08	0.59	3.36	4.82	0.13	1.43	0.70
MG4*	Junggar	74.40	13.10	2.26	0.19	0.84	3.95	4.97	0.29	1.26	0.79
MG13*	Junggar	71.40	14.80	1.87	0.16	0.70	3.94	6.29	0.27	1.60	0.63
MG16*	Junggar	74.40	12.90	2.01	0.24	0.82	4.06	4.89	0.25	1.20	0.83
MG19*	Junggar	72.50	13.70	2.41	0.13	0.83	4.47	5.15	0.30	1.15	0.87
MG24*	Junggar	73.30	13.60	1.88	0.26	1.71	4.11	4.69	0.23	1.14	0.88
MG26*	Junggar	73.50	14.10	1.59	0.34	1.33	3.92	4.77	0.19	1.22	0.82

Table 4- continued.

Sample Number	Location	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	K_2O/Na_2O	Na_2O/K_2O
HONG4	Junggar	72.30	12.90	2.97	0.33	0.87	4.60	3.81	0.27	0.83	1.21
HONG5	Junggar	73.50	13.40	2.79	0.26	0.95	4.80	3.82	0.30	0.80	1.26
HONG2	Junggar	74.00	13.80	2.68	0.32	0.92	4.91	3.93	0.24	0.80	1.25
HONG1	Junggar	75.20	12.00	2.15	0.24	0.86	4.63	3.88	0.22	0.84	1.19
HONG3	Junggar	76.40	12.90	1.57	0.03	0.19	4.06	4.62	0.08	1.14	0.88
AK2-1	Junggar	71.50	13.70	2.55	0.45	1.05	4.27	4.56	0.26	1.07	0.94
AK2-2	Junggar	73.00	13.60	2.64	0.44	1.07	4.79	4.16	0.26	0.87	1.15
AK8	Junggar	75.20	12.80	2.18	0.26	0.78	4.12	4.53	0.19	1.10	0.91
AK1-3	Junggar	74.10	12.90	1.83	0.13	0.56	4.34	4.87	0.16	1.12	0.89
AK154-2	Junggar	76.50	11.70	1.50	0.02	0.55	3.88	4.79	0.14	1.23	0.81
AT6*	Junggar	73.00	14.30	1.76	0.29	1.07	4.16	4.66	0.23	1.12	0.89
AT14*	Junggar	76.50	12.60	1.19	0.03	0.38	3.85	5.06	0.14	1.31	0.76
AT19*	Junggar	71.60	14.90	1.70	0.26	0.96	4.24	5.67	0.22	1.34	0.75
AT20*	Junggar	76.80	12.50	0.93	0.01	0.42	3.80	4.98	0.12	1.31	0.76
AT22*	Junggar	72.80	14.40	1.40	0.08	0.61	4.79	5.34	0.15	1.11	0.90
Hatu	Junggar	76.60	11.00	2.14	0.11	0.45	3.62	3.98	0.17	1.10	0.91
KM1	Junggar	74.80	12.20	2.28	0.36	1.13	3.82	3.78	0.18	0.99	1.01
Alvand-Iran Alkali Feldspar Granite (from Aliani et al., 2011)											
AL	Alvand	75.60	12.90	1.50	0.08	0.42	2.41	6.12	0.02	2.54	0.39
Katharina-Egypt Alkali Feldspar Granite (Katzir et al., 2007)											
D97	Katharina	76.60	12.80	1.10	0.05	0.30	3.90	4.70	0.09	1.21	0.83
D54	Katharina	76.90	12.10	1.40	0.01	0.60	3.70	4.20	0.07	1.14	0.88
D59	Katharina	76.90	12.60	1.30	0.01	0.30	3.90	4.40	0.08	1.13	0.89
D93	Katharina	77.00	12.40	1.70	0.05	0.20	3.90	4.50	0.07	1.15	0.87
D100	Katharina	77.60	12.50	1.30	0.05	0.20	3.80	4.20	0.08	1.11	0.90
D43	Katharina	76.80	12.10	1.80	0.01	0.20	3.90	4.30	0.07	1.10	0.91
D40	Katharina	77.20	12.40	1.40	0.01	0.30	4.20	4.00	0.07	0.95	1.05
Scotland Alkali Feldspar Granite (Murphy et al., 1998)											
A1-2	Scotland	77.52	12.32	0.81	-	-	4.65	3.67	0.03	0.79	1.27
A1-4	Scotland	78.07	12.27	0.77	-	-	4.55	3.87	0.02	0.85	1.18
A1-7	Scotland	76.94	12.45	0.68	-	-	4.35	4.35	0.02	1.00	1.00
A1-8	Scotland	78.28	12.19	0.41	-	-	4.84	3.14	0.03	0.65	1.54
A1-10	Scotland	77.18	12.51	1.13	0.13	-	4.27	3.98	0.05	0.93	1.07
A1-15	Scotland	76.12	12.72	0.92	0.03	-	4.94	3.70	0.03	0.75	1.34
Klipberg-Africa Alkali Feldspar Granite (from Scheepers and Schoch, 1988)											
81-05	Africa	70.24	14.12	1.89	0.00	0.74	5.17	5.07	0.12	0.98	1.02
81-12	Africa	75.01	12.79	0.93	0.18	0.01	4.66	4.40	0.08	0.94	1.06
81-22A	Africa	74.24	13.24	0.56	0.18	0.06	4.47	5.27	0.07	1.18	0.85
81-34	Africa	73.66	13.45	1.51	0.14	0.00	5.06	4.78	0.08	0.94	1.06
81-35	Africa	75.97	13.02	0.35	0.13	0.00	4.89	4.41	0.00	0.90	1.11
81-36	Africa	72.88	13.66	1.73	0.15	0.40	5.33	4.70	0.08	0.94	1.06
81-51	Africa	71.77	13.79	3.08	0.00	0.17	4.68	5.09	0.16	0.15	6.48
81-14	Africa	71.49	13.56	1.89	0.12	0.29	4.88	4.78	0.14	1.02	0.98
81-25	Africa	72.52	13.40	1.49	0.14	0.02	5.71	4.67	0.07	0.82	1.22
Changyi–China (from Lan et al., 2015)											
CY2-49	China	76.00	12.00	3.28	0.26	0.73	3.11	4.89	0.28	1.57	0.64
CY2-75	China	76.30	11.90	3.67	0.24	0.64	2.98	4.90	0.27	1.64	0.61
CY2-76	China	76.60	11.60	3.09	0.23	0.58	3.73	4.88	0.24	1.31	0.76
CY2-77	China	76.60	11.70	3.02	0.21	0.62	3.75	4.98	0.25	1.33	0.75
CY2-78	China	76.70	12.00	2.60	0.17	0.57	3.54	4.92	0.27	1.39	0.72
CY2-79	China	76.40	11.80	3.66	0.26	0.75	3.10	4.76	0.28	1.54	0.65
CY2-80	China	76.60	11.90	3.03	0.20	0.53	3.05	5.14	0.26	1.69	0.59
CY2-86	China	76.40	11.80	3.24	0.22	0.69	3.23	4.93	0.28	1.53	0.66
CY2-92	China	77.40	11.60	3.18	0.23	0.39	2.86	4.97	0.24	1.74	0.58
CY2-43	China	78.30	12.30	1.69	0.39	0.57	6.56	0.29	0.29	0.04	22.62
CY2-44	China	77.90	12.00	2.43	0.58	0.70	6.15	0.44	0.26	0.07	13.98

1280°C. On the other hand, as the melting temperature of the albite in $NaAlSi_3O_8$ composition is 1120°C, it has high melting characteristics. For this reason, it is used in glaze phase (Önem, 1997; Gürsoy, 1999). The plagioclase minerals in the rocks can be used for making glazes in ceramics as types of plagioclase minerals are albite and oligoclase, and these minerals are rich in Na. Therefore, it is also important to determine the species of plagioclase minerals.

Because of the high amount of the quartz ratio as well as the feldspar amounts of the studied rocks, the quartz also seems to be a by-product in addition to the feldspar content. In addition to the quartz has also an important role in the production of ceramics. Quartz increases stiffness, prevents deformation, reduces capillary cracking as it reduces heat expansion, and increases the strength when added into glaze. However, secondary silica minerals, such as tridimite in SiO_2 composition formed at low temperatures also become a member of the undesired mineral group as the raw material. The tridimite mineral causes delamination as it easily decomposes, raises the melting temperature and increases water absorption and porosity in baked ceramics (Gürsoy, 1999). For this reason, it is formerly necessary to determine the ratio of the secondary silica minerals at low temperature.

The results of whole rock chemical analyzes are guiding for the feldspar minerals to be raw materials. In addition to this, the mineral chemistry of the feldspar minerals in the rock or the concentrated mineral feldspars obtained after the enrichment are very important in terms of being used in the industry. The chemical properties of feldspars (according to TS 11325) that can be used in the industry and the EPMA results of feldspar minerals taken at different locations from the study area are given in Table 5. According to point chemical analysis results, the alkali feldspars have values of 64.07-66.14% SiO_2, 18.20-19.09% Al_2O_3, 14.44-16% K_2O, 0.64-1.66% Na_2O and 0-0.05% FeO. The alkali feldspars are generally in orthoclase and microcline composition according to the results of point analysis (Figure 6). It was found that there was no significant change between edge and core measurements of alkali feldspar and it showed a more homogeneous composition (Table 5). On the other hand, the fact that the FeO content ratios are very low on the same measurements significantly increases the usability of these minerals in the ceramic industry. According to this, when the point chemical results of alkali feldspar and plagioclase minerals are compared with chemical properties that should be in the Class I, II and III feldspar raw material in the results of EPMA analysis, the K_2O content of alkali feldspar is higher than the minimum values (Tables 5 and 6). Therefore, it is seen that alkali feldspar minerals of rocks in the region can be used as class I alkali feldspar. In addition, the amounts of Fe and Ti, which represent the content of undesirable elements in the feldspar, are well below the desired maximum values (Tables 5 and 6). Although K_2O content of the feldspar to be used in the ceramic industry based on TS11325 standard seems to be the most important parameter, the feldspar minerals in different chemical composition can be used in different purposes at different stages of the production. For this reason, feldspar minerals in different composition in rocks can be used as raw materials for different purposes.

In high quality porcelains, the amount of Fe_2O_3 in the total product should not exceed 0.15% and the amount of TiO_2 should not exceed 0.05%, whereas the content of Fe_2O_3 in glass should be maximum 0.08% (Lewicka, 2010). As Fe contents of alkali feldspar granite and alkali feldspar syenites have low Fe contents, they are suitable raw materials for ceramic and glass making (Table 3, Figure 7). The high Fe contents of Hacılı alkaline feldspar granites with respect to other alkali feldspars can be reduced by appropriate magnetic separation and flotation. When we look at the world examples of alkali feldspar granites, it is seen that the Fe contents are higher than most of the studied granites. Therefore, it was revealed that the usage potential of alkali feldspar granites in the Central Anatolian Region had in the ceramic industry.

In modern fast cooking techniques, Na rich feldspar (K_2O / Na_2O <1) or nepheline syenite (Na_2O / K_2O ~ 2) because of strong melting behaviors is preferred due to strong solvent behavior (Lewicka, 2010). In all alkali feldspar granites, except for the Camili alkali feldspar, the K_2O / Na_2O is higher than 1 (Table 3) (Figures 8 and 9). This situation is related with the feldspars rich in K rather than Na in these rocks and the high orthoclase contents as clearly seen from normative mineral ratios (Table 2). It can be said that these rocks have suitable minerals and chemical compositions to be raw materials, but they are not suitable for rapid cooking techniques due to low Na. On the other hand, the K_2O / Na_2O ratio of alkali feldspar syenites of Bayındır, Hamit (except 1 sample) and İdişdağı (except for the sample 2) is less than 1 (Chart 3) (Figures 8 and 9). In this case, it seems that the fast

Table 5- Results of mineral chemistry of some feldspar minerals of rocks (EPMA).

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
	Core	Core	Rim	Rim	Core	Rim	Rim	Rim	Rim	Rim	Core	Rim	Rim	Rim
SiO_2	64.64	65.59	65.34	65.75	65.46	65.54	66.14	64.07	64.57	65.26	64.81	64.79	64.07	65.57
Al_2O_3	18.75	18.61	18.20	18.47	18.23	18.42	18.66	18.30	19.09	18.88	18.33	18.65	18.30	19.09
TiO_2	0.06	0.03	0.02	0.04	0.01	0.01	0.01	0.02	0.02	0.02	0.06	0.03	0.02	0.02
Cr_2O_3	0.01	0.01	0.00	0.04	0.02	0.04	0.04	0.02	0.00	0.03	0.04	0.04	0.03	0.00
FeO	0.01	0.00	0.02	0.05	0.05	0.04	0.03	0.01	0.04	0.00	0.02	0.05	0.01	0.04
MnO	0.01	0.00	0.01	0.01	0.03	0.03	0.02	0.02	0.01	0.01	0.03	0.03	0.02	0.01
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	0.06	0.02	0.00	0.04	0.02	0.01	0.02	1.43	0.43	0.23	0.01	0.03	1.43	0.43
Na_2O	1.43	1.28	1.10	1.37	1.35	1.07	1.29	0.86	1.66	1.26	0.64	1.58	0.86	1.66
K_2O	14.93	15.46	15.65	15.05	15.20	15.31	15.03	15.53	14.44	15.20	16.10	14.57	15.53	14.44
Total	99.90	101.00	100.34	100.82	100.37	100.47	101.24	100.26	100.26	100.89	100.02	99.76	100.27	101.26
Ions according to 32O														
Si	11.920	11.975	12.019	12.003	12.019	12.013	12.009	11.861	11.858	11.923	11.982	11.945	11.860	11.905
Al	4.076	4.006	3.947	3.975	3.946	3.980	3.994	3.994	4.133	4.067	3.995	4.054	3.994	4.086
Ti	0.008	0.004	0.003	0.005	0.001	0.001	0.001	0.003	0.003	0.003	0.006	0.003	0.003	0.003
Cr	0.001	0.001	0.000	0.006	0.003	0.006	0.006	0.003	0.000	0.004	0.006	0.006	0.004	0.000
Fe^{+2}	0.002	0.000	0.003	0.008	0.008	0.006	0.005	0.002	0.006	0.000	0.003	0.008	0.002	0.006
Mn	0.002	0.000	0.002	0.002	0.005	0.005	0.003	0.003	0.002	0.002	0.005	0.005	0.003	0.002
Mg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ca	0.012	0.004	0.000	0.008	0.004	0.002	0.004	0.284	0.085	0.045	0.002	0.006	0.284	0.084
Na	0.511	0.453	0.392	0.485	0.481	0.380	0.454	0.309	0.591	0.446	0.229	0.565	0.309	0.584
K	3.512	3.601	3.673	3.505	3.560	3.580	3.482	3.668	3.383	3.543	3.797	3.427	3.668	3.345
Estimated molecular percent values														
An	0	0	0	0	0	0	0	7	2	1	0	0	7	2
Ab	13	11	10	12	12	10	12	7	15	11	6	14	7	15
Or	87	89	90	88	88	90	88	86	83	88	94	86	86	83

frying technique can be applied to alkaline feldspar syenites. The excess Na content in such rocks is due to feldspatoid minerals such as nepheline it contains. The fact that the Na_2O / K_2O ratio of alkaline feldspar granite samples is not around 2 and even below this value indicates that the feldspars in these rocks do not have fast solvent behavior (Figure 3) (Figures 8 and 9). On the other hand, in most of alkaline feldspar syenite samples this ratio is close to desired value and these minerals contain normative nepheline based on CIPW normative which causes them to show solvent behavior (Figures 8 and 9). It is considered that rocks in the area where the ratio of K_2O / Na_2O is more than one are suitable for use by applying traditional cooking techniques (Figure 9).

As the plagioclase ratio increases the orthoclase ratio decreases in the rocks studied. Accordingly; K_2O contents decrease as Na_2O content increases (Tables 2 and 3) (Figure 10a). The total alkali (Na_2O + K_2O) amount decreases with increasing SiO_2 in all samples (Figure 10b). This situation is related to the decrease in the ratio of feldspar minerals with the increase of the quartz ratio in the rock. It is known that the melting temperature of ceramics changes with the content of free silica and alkali oxides. The orthoclase rate decreases as the plagioclase ratio in the rocks to be studied increases. Therefore, as Na_2O content increases, K_2O contents decrease (Tables 2 and 3) (Figure 10a). The total amount of alkali (Na_2O + K_2O) decreases with increasing SiO_2 in all samples (Figure 10b). This is related to the decrease in the ratio of

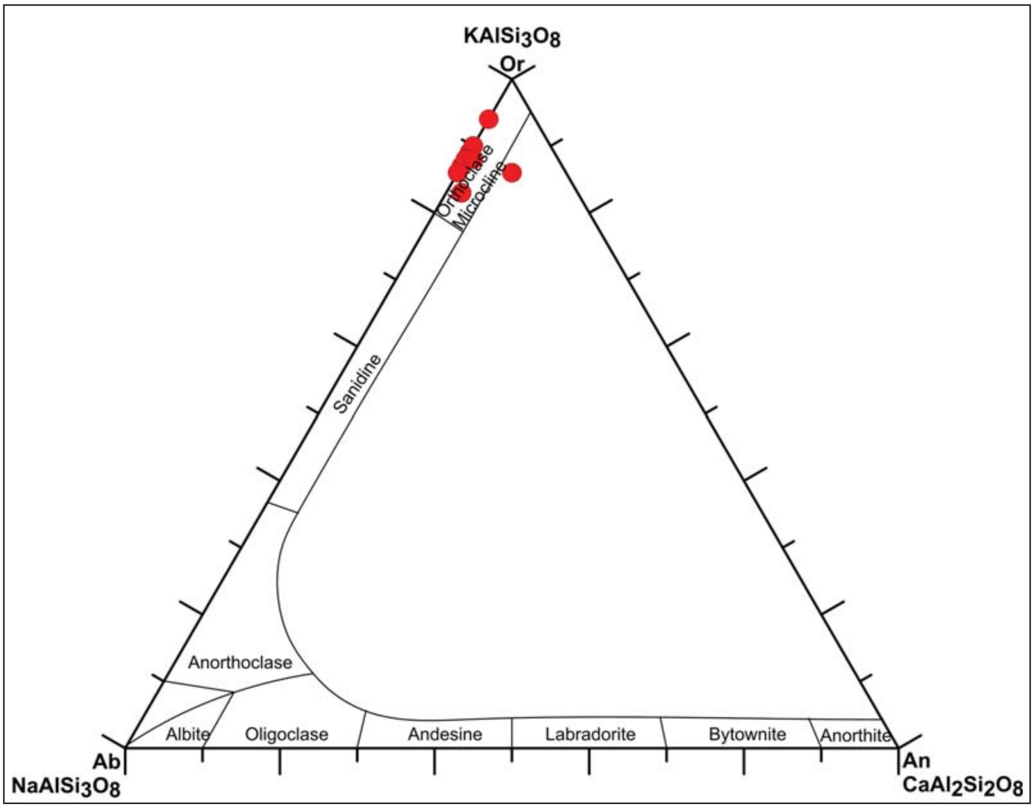

Figure 6- Ternary classification diagram of Ab-Or-An minerals.

Table 6- Required chemical compositions of feldspar classes in the Ceramic sector (TS 11325).

Feldspar Chemistry (%)	I. Class	II. Class	III. Class
Na_2O+K_2O	10.0	9.00	8.00
K_2O	9.00	7.00	-
Na_2O	3.00	3.50	-
Fe_2O_3	0.10	0.20	0.50
TiO_2	0.15	0.30	0.40
CaO+MgO	1.00	1.20	1.60
TiO_2+CaO+MgO	1.15	1.50	2.00

feldspar minerals with the increase of the quartz ratio in the rock. It is known that the melting temperature of ceramics changes with the content of free silica and alkali oxides. The melting temperature of the rocks will also decrease as the silica and quartz content decreases compared to the feldspar contents. It can be said that the melting temperatures of alkali feldspar granites are lower than those of alkaline feldspar syenites (Figure 10b). Besides, it seems impossible to operate the quartz mineral as a byproduct besides the feldspar minerals because of the absence or very little (0-5%) of quartz content in alkali feldspar syenites.

7. Conclusions

The need for quality raw materials, which do not contain particularly undesirable coloring minerals, has increased with the recent introduction of feldspar minerals as raw materials in many areas such as sanitary ware, refractory, cement, special glass, abrasive and superconductor. This requires the determination of new deposits in addition to known deposits with their specification. When geological, petrographical and geochemical data obtained in the study carried out in Central Anatolia Region for this purpose were evaluated together, it was determined that alkali feldspar granites in the AIT had good quality as feldspar raw materials but had relatively low reserves as they were not present in the form of dykes. On the other hand, it is possible to produce good quality feldspar with high reserve as it is not the same in other deposits (Hacılı, Cefalık, Behrekdağ, Terlemez, Bayındır, Hamit and İdişdağı). However, it seems possible to produce feldspar in the desired quality when considering that the coloring elements in the rocks are below the desired values as the availability of high quality feldspar is completely dependent on

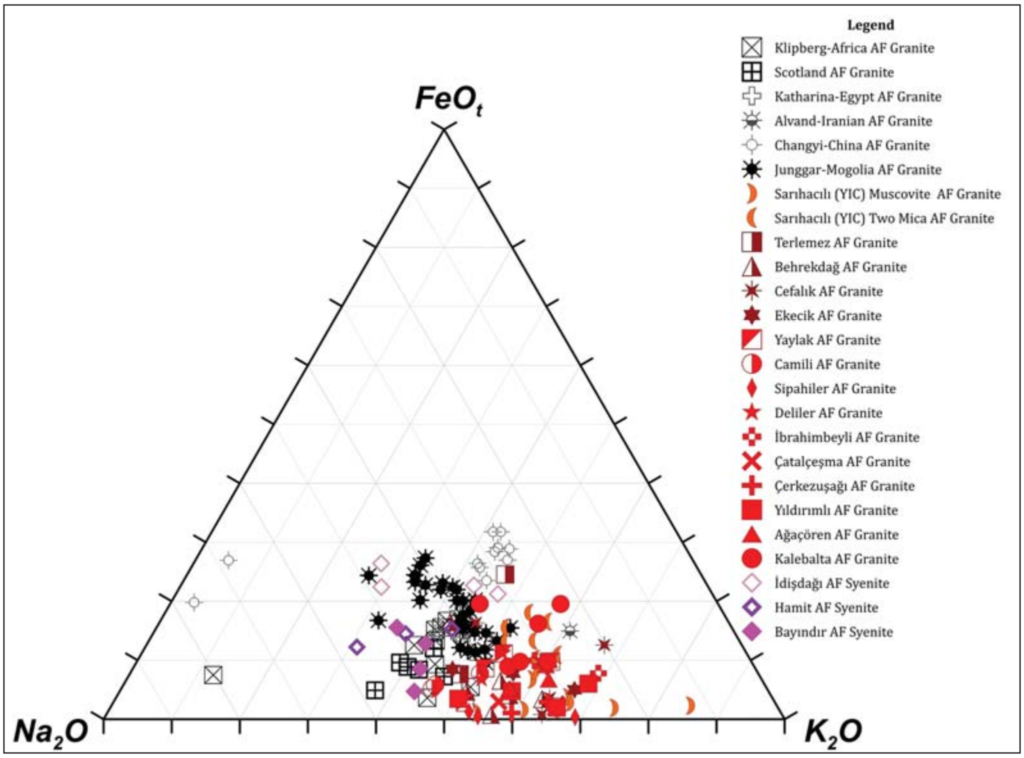

Figure 7- Na_2O–FeOt–K_2O ternary variation diagram of some alkali feldspar granites and alkali feldspar syenites from the Central Anatolia and the World (AF: Alkali Feldspar).

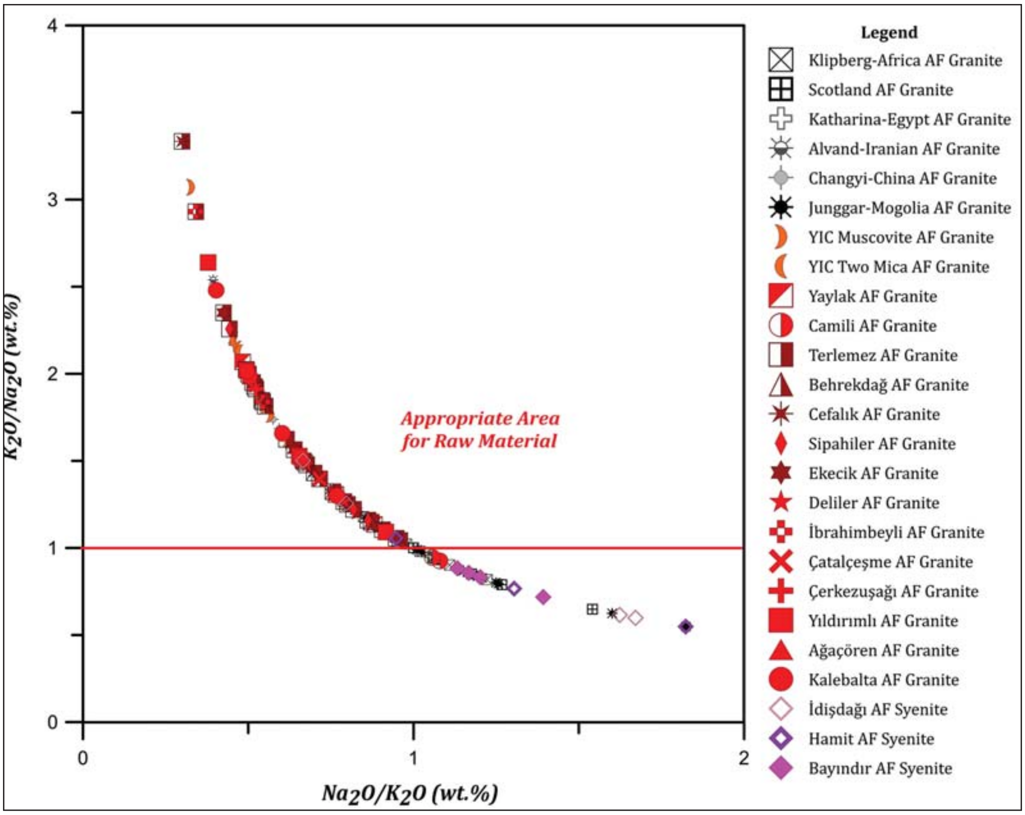

Figure 8- K_2O/Na_2O–FeOt–Na_2O/K_2O ternary variation diagram of some alkali feldspar granites and alkali feldspar syenites from the Central Anatolia and the World (AF: Alkali Feldspar).

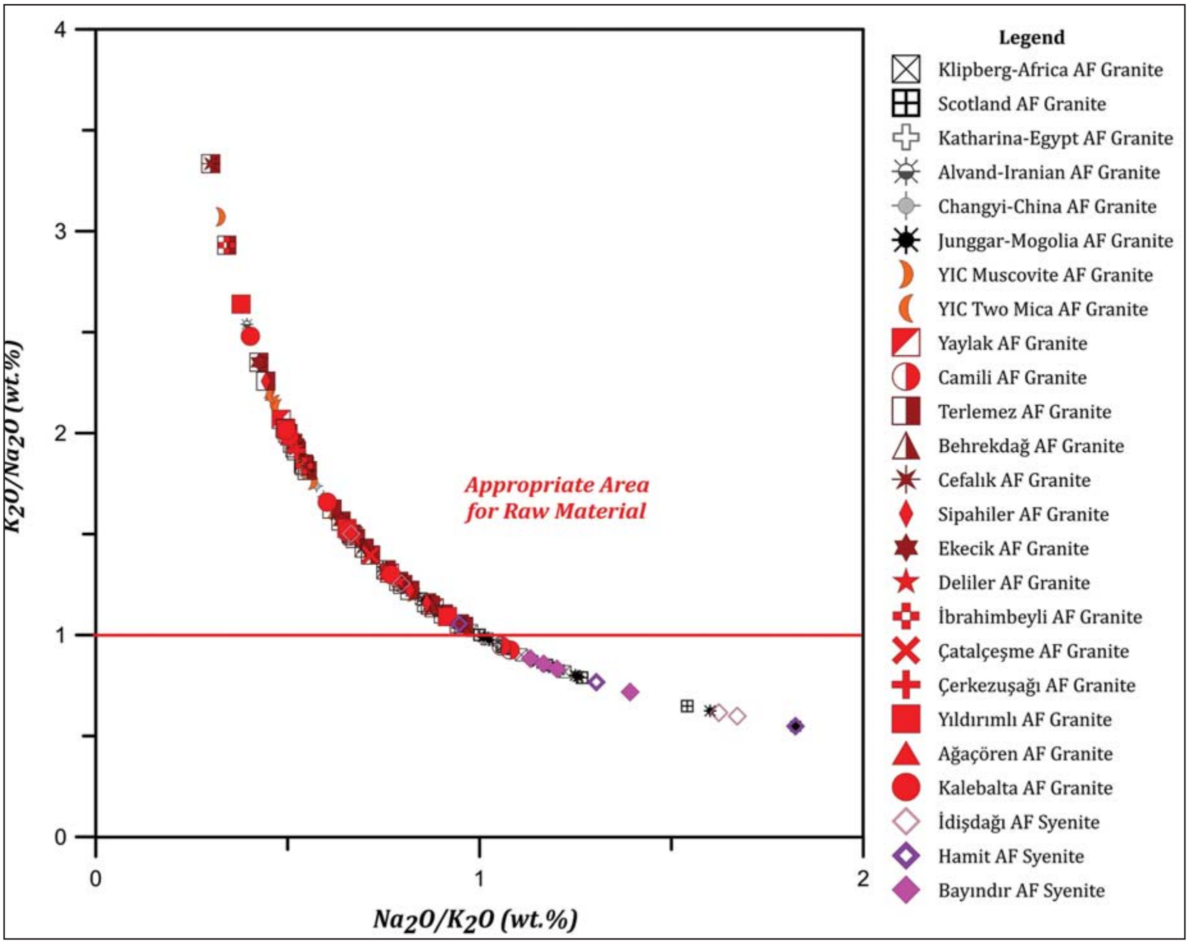

Figure 9- K_2O/Na_2O vs Na_2O/K_2O variation diagram of some alkali feldspar granites and alkali feldspar syenites from the Central Anatolia and the World.

the removal of undesired minerals by means of latest technologies. The lower proportion of color-forming oxides, such as Fe_2O_3, in the mineral and/or rock will lead to a reduction in the magnetic separation phases, thereby resulting in time and labor savings. Feldspar (especially K-feldspar) minerals, which are used as industrial raw materials in ceramic and glass industries in our country, are obtained from pegmatites and nepheline syenites (Çelik and Denizhan, 2016). In order to meet both the Na-feldspar and K-feldspar requirements, alternative rocks should be determined and their sources must be identified. In this study the feldspar raw material potential of the Central Anatolia alkali feldspar granites and alkali feldspar syenites were revealed by geological, petrographical and chemical data. Thus, it was determined that the feldspar formations in the sector constituted a great potential area for the ceramic industry.

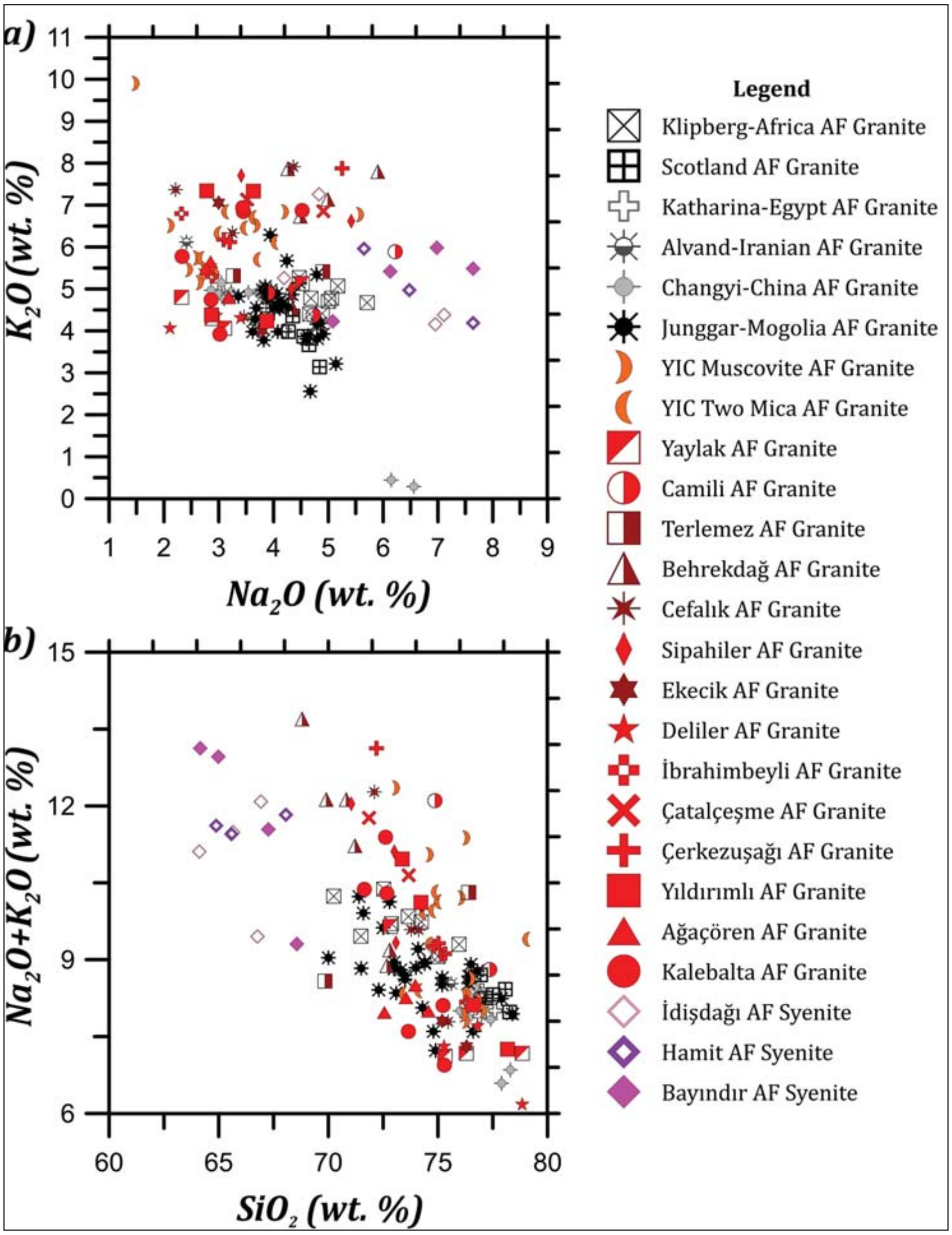

Figure 10- (a) Na_2O vs K_2O and (b) SiO_2 vs Na_2O+K_2O variation diagrams (AF: Alkali Feldspar).

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References

Aliani, F., Sabouri, Z., Maanijou, M. 2011. Petrography and Geochemistry of Porphyroid Granitoid Rocks in the Alvand Intrusive Complex, Hamedan (Iran). Australian Journal of Basic and Applied Sciences 5, 12, 2192-2199.

Akçe, M.A. 2003. Yozgat batolitinin kuzey bölümünün jeolojisi ve petrolojisi. Yüksek Lisans Tezi, Ankara Üniversitesi Fen Bilimleri Enstitüsü, 118s. Ankara (unpublished).

Akçe, M.A. 2010. Yozgat İntrüzif Kompleksinin Jeolojisi, Petrolojisi ve Orta Anadolu Kristalen Karmaşığındaki Zamansal ve Mekansal Konumu. Doktora Tezi, Ankara Üniversitesi Fen Bilimleri Enstitüsü, 255s. Ankara (unpublished).

Akçe, M.A., Kadıoğlu, Y.K. 2005. Yozgat Batoliti Kuzey Bölümündeki Lökogranitlerin Petrolojisi. Türkiye Jeoloji Bülteni 48, 2, 1-20.

Akıman, O., Erler, A., Göncüoğlu, M.C., Güleç, N., Güven, A., Türeli, T.K., Kadıoğlu, Y.K. 1993. Geochemical Characteristics of Granitoids along the Western Margin of the Central Anatolian Crystalline Complex and Their Tectonic Implications. Geol. J. 28, 371-382.

Akkoyuncu, H. 1994. Porselen hammaddelerinin zenginleştirilmesi. Yüksek Lisans Tezi, Eskişehir Osmangazi Üniversitesi, 52s. Eskişehir (unpublished).

Akkurt, İ. 2001. Çanakkale civarındaki alkalili hammaddelerin seramik yer karosu üretiminde kullanımı. Yüksek Lisans Tezi, Yıldız Teknik Üniversitesi, 107s. İstanbul (unpublished).

Ariffin, K.S. 2003. Feldspathic Minerals. EBS42573 Mineral Perindustrian, 1-16.

Ataman, G. 1972. Ankara’nın güneydoğusundaki granodiyoritik kütlelerden Cefalik Dağının radyometrik yasi hakkında ön çalışma. Hacettepe Fen ve Mühendislik Bilimleri Dergisi 2, 44-49.

Aydoğdu, B. 2010. Yozgat batoliti doğu kenarında (Sorgun Güneyi) yer alan plütonik kayaçların mineralojik-petrografik, jeokimyasal ve petrojenetik özellikleri. Yüksek Lisans Tezi, Cumhuriyet Üniversitesi, 132s. Sivas (unpublished).

Bayhan, H. 1986. Geochemical and genetic interpretation of the Celebi intrusion in the inner Anatolian granitoid belt (in Turkish). Jeoloji Muhendisligi 29, 27–36.

Bayhan, H. 1987. Cefalık ve Baranadağ plütonlarının (Kaman) petrografik ve kimyasal-mineralojik özellikleri. Jeoloji Mühendisliği 30, 3, 11-16.

Bayhan, H. 1988. Bayındır, Akpınar (Kaman) yöresindeki alkali kayaçların jeokimyası ve kökensel yorumu. Türkiye Jeol. Kur. Bült. 31, 59-70.

Bayhan, H. 1989. Petrographical and chemical-mineralogical characteristics of Keskin pluton (in Turkish). Hacettepe Yerbilimleri 15, 29–36.

Bayraktar, I., Ersayın,. S., Gülsoy, Ö.Y. 1997. Upgrading Titanium Bearing Na-Feldspar By Flotation Using Sulphonates, Succinamate And Soaps Of Vegetable Oils. Minerals Engineering I, 12, 1363-1374.

Bayraktar, I., Ersayın,. S., Gülsoy, Ö.Y., Ekmekçi, Z., Can, M. 1999. Temel Seramik ve Cam Hammaddelerimizdeki (Feldispat, Kuvars ve Kaolin) Kalite Sorunlan ve Çözüm Önerileri. Ş. Endüstriyel Hammaddeler Sempozyumu, 14-15 Ekim 1999, İzmir, Türkiye, 22-33.

Bolger, R.B. 1995. Feldspar and nepheline syenite. Industrial Minerals 332, 25-45.

Çelik, M.Y., Denizhan, T. 2016. Kınık-Dinar (Afyonkarahisar) Trakitlerinin K-feldispat Potansiyelinin İncelenmesi. AKÜ FEMÜBİD, 16, 035801, 747-758.

Daday Taykurt, M. 2012. Seramik sağlık gereçlerinde damar hatalarının giderilmesi. Yüksek Lisans Tezi, Anadolu Üniversitesi, 279 s. Eskişehir (unpublished).

Deer, W.A., Howie, R.A., Zussman, J. 1992. An Introduction to the Rock –Forming Minerals. 2nd Etition, Longman, 720 p.

Demir, C. 2001. Na-feldispatın K-feldispattan flotasyonla ayrılmasında inorganik tuzların etki mekanizması. Doktora Tezi, İstanbul Teknik Üniversitesi, 159s. İstanbul (unpublished).

Demirbaş, E. 2010. Kavşit (Çine-Aydın) yöresinin jeolojisi ve feldispat yataklarının incelenmesi. Yüksek Lisans Tezi, Selçuk Üniversitesi, 58s. Konya (unpublished).

Doğu, İ. 2002. Investigation of separation of dark colored minerals from feldspar by selective flocculation. Yüksek Lisans Tezi, Orta Doğu Teknik Üniversitesi, 121s. Ankara (unpublished).

Ehlers, E.G. 1972. The interpretation of geological phase diagrams. W.H. Freeman and Co, San Francisco, 492 p.

Ekici, T. 1997. Yozgat batoliti Yozgat güneyi kesiminin petrolojisi. Yüksek Lisans Tezi, Cumhuriyet Üniversitesi, 90s. Sivas (unpublished).

Erdinç A.Z. 2007. K-feldspar/kuvars ayrımında optimum flotasyon koşullarının belirlenmesi. Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi, 120s. İzmir (unpublished).

Erler, A., Akıman, O., Unan, C., Dalkılıç, B., Geven, A., Önen, P. 1991. Kaman (Kırşehir) ve Yozgat yörelerinde Kırşehir Masifi magmatik kayalarının petrolojisi ve jeokimyası. Doğa-Tr J. Of Engineering and Environmental sciences 15, 76–100.

Ermiş, İ.U. 1996. Determination of the processing parameters of Aydın Çine feldspar and recovering of rutile as a by product. Doktora Tezi, İstanbul Teknik Üniversitesi, 90s. İstanbul (unpublished).

Geng, H., Sun, M., Yuan, C., Xiao, W., Xian, W., Zhao, G., Zhang, L., Wong, K., Wu, F. 2009. Geochemical, Sr–Nd and zircon U–Pb–Hf isotopic studies of Late Carboniferous magmatism in the West Junggar, Xinjiang: Implications for ridge subduction?. Chemical Geology 266, 364–389.

Geredeli, A. 1990. Flotation of feldspar from Balıkesir district. MSc Thesis, Middle East Technical University, 103s. Ankara (unpublished).

Geven, A. 1992. Mineralogy, Petrography and Geochemistry of Cefalikdag Plutonic Rocks (Kaman Region-Central Anatolia). Ph.D. Thesis, Middle East Tehnical University, 165 pp. (unpublished).

Göncüoğlu, M.C., Toprak, V., Kuşcu, İ., Erler, A., Olgun, E. 1991. Orta Anadolu Masifinin Batı Bölümünün Jeolojisi, Bölüm 1-Güney Kesim. TPAO Rapor No. 2909, 140 s.(unpublished).

Göncüoğlu, M.C., Toprak, V., Kuşçu, İ., Erler, A., Olgun, E., Rojay, B. 1992. Orta Anadolu Masifinin Batı Bölümünün Jeolojisi, Bölüm 2: Orta Kesim. T.P.A.O. Rap.No:3155, 76 s.

Göncüoğlu, M.C., Erler, A., Toprak, V., Olgun, E., Yalınız, K., Kuşcu, İ., Köksal, S., Dirik, K. 1993. Orta Anadolu Masifi'nin Orta Bölümü'nün Jeolojisi, Bölüm 3: Orta Kızılırmak Tersiyer Baseni'nin Jeolojik Evrimi. TPAO Rap. No. 3313, 104 s.

Görür, N., Oktay, F.Y., Seymen, İ., Şengör, A.M.C. 1984. Paleotectonic evolution of the Tuzgölü Basin complex. central Anatolia (Turkey): Sedimentary record of Neo-Tethyan closure. Editors: Dixon JE, Robertson AHF. In the geological evolution of the eastern Mediterranean, Geological Society of London, Special publications 17, 467-482.

Gülsoy, Ö.Y. 2005. A Simple Model for the Calculation of Entrainment in Flotation. Korean J. Chem. Eng. 22, 4, 628-634.

Gürsoy, Y.H. 1999. Sarıkaya yöresi altere granitlerinden feldispatın kazanımı. Yüksek Lisans Tezi, Osmangazi Üniversitesi, 112s. Eskişehir (unpublished).

Güven, Z. 2002. Söğüt Çöplük feldispatının duvar karosu üretiminde kullanımı. Yüksek Lisans Tezi, Anadolu Üniversitesi, 58s. Eskişehir (unpublished).

Harben, P.W., Kuzvart, M. 1996. Industrial Minerals A global geology. Industrial Minerals Information Ltd., London, 462 p.

İlbeyli, N. 1998. Petrogenesis of Collision Related Plutonic Rocks, Central Anatolia (Turkey). Doctorate Thesis, University of Durham, 302p. Durham (unpublished).

İlbeyli, N. 2005. Mineralogical-geochemical constraints on intrusives in central Anatolia, Turkey: tectono-magmatic evolution and characteristics of mantle source. Geol. Mag. 142, 187-207.

İlbeyli, N., Pearce, J. 2005. Petrogenesis of igneous enclaves in plutonic rocks of the Central Anatolian Crystalline Complex, Turkey. International Geology Review 47, 78-97.

İlbeyli, N., Kibici, Y. 2009. Collision-related granite magma genesis, potential sources and tectono-magmatic evolution: comparison between central, northwestern and western Anatolia, Turkey. International Geology Review 51, 3, 252-278.

İlbeyli, N., Pearce, J.A., Thirlwall, M.F. and Mitchell, J.G. 2004. Petrogenesis of collision-related plutonics in Central Anatolia, Turkey. Lithos 72, 163-182.

İlbeyli, N., Pearce, J.A., Meighan, I.G., Fallick, A. 2009. Contemporaneous Late Cretaceous Calc-Alkaline and Alkaline Magmatism in Central Anatolia, Turkey: Oxygen Isotope Constraints on Petrogenesis. Turkish Journal of Earth Sciences 18, 529-547.

Kademli, M. 2004. Feldispat cevherinden spiral zenginleştirici ile mikanın uzaklaştırılması. Yüksek Lisans Tezi, Hacettepe Üniversitesi, 100s. Ankara (unpublished).

Kadıoğlu, H. 2001. Sert porselende değişik sır denemelerinin araştırılması. Yüksek Lisans Tezi, Dumlupınar Üniversitesi, 143s. Kütahya (unpublished).

Kadıoğlu, Y.K. 1991. Geology, petrography and geochemistry of Ağaçören (Aksaray) magmatic rocks. MSc Thesis, Middle East Technical University, 141p. Ankara (unpublished).

Kadıoğlu, Y.K. 1996. Genesis of Ağaçören Intrusive Suite and Its Enclaves (Central Anatolia): Constraits From Geological, Petrographic, Geophysical and Geochemical Data. PhD Thesis, Middle East Technical University, 242p. Ankara (unpublished).

Kadıoğlu, Y.K., Güleç, N. 1996. Mafic Microgranular Enclaves and Interaction Between Felsic and Mafic Magmas in the Ağaçören Intrusive Suite: Evidence from Petrographic Features and Mineral Chemistry. International Geology Review 38, 854-867.

Kadıoğlu, Y.K., Özsan, A. 1997. Sulakyurt granitoidindeki ofitik olmayan gabroların konumunun sondajlarla belirlenmesi. 50. Türkiye Jeoloji Kurultayı, Ankara, Türkiye, 14.

Kadıoğlu, Y.K., Dilek, Y., Güleç, N., Foland, K.A. 2003. Tectonomagmatic Evolution of Bimodal Plutons in the Central Anatolian Crystalline Complex, Turkey. The Journal of Geology 111, 671-690.

Kadıoğlu, Y.K., Dilek, Y., Foland, K.A. 2006. Slab break-off and syncollisional origin of the Late Cretaceous magmatism in the Central Anatolian crystalline complexs. Geological Society of America 409, 381-415.

Kalyon, D. 2003. Feldispat kuvars ayırımında kullanılan HF'siz flotasyon yöntemleri. Yüksek Lisans Tezi, Hacettepe Üniversitesi, 117s. Ankara (unpublished).

Karagüzel, C. 2001. Simav yöresi feldispatlarının seramik sanayinde kullanım olanaklarının araştırılması. Doktora Tezi, Dumlupınar Üniversitesi, 136s. Kütahya (unpublished).

Katzir, Y., Eyal, M., Litvinovsky, B.A., Jahn, B.M., Zanvilevich, A.N., Valley, J.W., Beeri, Y., Pelly, I., Shimshilashvili, E. 2007. Petrogenesis of a-Type granites and origin of vertical zoning in the Katharina pluton, Gebel Mussa (Mt. Moses) Area, Sinai, Egypt. Lithos 95,208–228.

Kaya G. 2002. Aydın Çine yöresi albit flotasyon ve triyaj atıklarının seramik bünyelerde kullanımının bünye özelliklerine etkisi. Yüksek Lisans Tezi, Anadolu Üniversitesi, 93s. Eskişehir (unpublished).

Ketin, İ. 1955. Yozgat bölgesinin jeolojisi and Orta Anadolu Masifinin tektonik durumu. TJK Bülteni C, VI, 1, 1-40,

Köksal, S. 1996. The Geological and petrological characteristics of the İdiş Dağı-Avanos area (Nevşehir-central anatolian). MSc Thesis, Middle East Technical University, 140p. Ankara (unpublished).

Köksal, S., Göncüoğlu, M.C. 1997. Geology of İdişdağı-Avanos Area (Nevşehir-Central Anatolia). Mineral Research and Exploration Bulletin 119, 41-58.

Köksal, S., Göncüoğlu, M.C., Floyd, P.A. 2001. Extrusive members of post collisional A-type magmatism in Central Anatolia: Karahıdır Volcanics, İdiş Dağı-Avanos area, Turkey. International Geology Review 43, 8, 683-694.

Köksal, S., Moller, A., Göncüoğlu, C.M., Frei, D., Gerdes, A. 2012. Crustal homogenization revealed by U–Pb zircon ages and Hf isotope evidence from the Late Cretaceous granitoids of the Ağacören intrusive suite (Central Anatolia/Turkey). Contrib Mineral Petrol 163, 725–743.

Köksal, S., Toksoy-Köksal, F., Göncüoğlu, M.C., Möller, A., Gerdes, A., Frei, D. 2013. Crustal source of the Late Cretaceous Satansari monzonite (central Anatolia/Turkey) and its significance for the Alpine geodynamic evolution. Journal of Geodynamics, doi: 10.1016/j.jog.2012.06.003.

Köprülü Tunç, F. 1997. Sintering kinetics of feldspar by the rising temperature technique. Doktora Tezi, Ege Üniversitesi, 46s. İzmir (unpublished).

Kula, S. 2003. Hammaddelerin firit özellikleri üzerine etkisi. Yüksek Lisans Tezi, Anadolu Üniversitesi, 67s. Eskişehir (unpublished).

Lan, T.G., Fan, H.R., Yang, K.F., Cai, Y.C., Wen, B.J., Zhang, W. 2005. Geochronology, mineralogy and geochemistry of alkali-feldspar granite and albite granite association from the Changyi area of Jiao-Liao-Ji Belt: Implications for Paleoproterozoic rifting of eastern North China Craton. Precambrian Research 266, 86–107,

Levin, E.M., Robbins, C.R., McMurdie, H.F. 1974. Phase diagrams for ceramists. The Amer. Cer. Soc., Columbus, Ohio, USA, 626 p.

Lewicka, E. 2010. Conditions of the feldspathic raw materials supply from domestic and foreign sources in Poland. Gospodarka Surowcami Mineralnymi 26, 4, 5–18.

Lünel, A.T. 1985. An approach to the naming. origin and age of Baranadağ monzonite of the Kırşehir intrusive suite. METU Journal of Pure and Applied Sciences 18, 385–404,

Murphy, J.B., Anderson, A.J., Archibald, D.A. 1998. Postorogenic alkali feldspar granite and associated pegmatites in West Avalonia: the petrology of the Neoproterozoic Georgeville Pluton, Antigonish Highlands, Nova Scotia. Can. J. Earth Sci. 35, 110–120.

Nizamoğulları, E. 2007. Kalsiyum içerikli feldispatların porselen bünyelerde kullanılabilirliği. Yüksek Lisans Tezi, Anadolu Üniversitesi, 88s. Eskişehir (unpublished).

Oyan, V. 2004. Bölükyazı-Hizan (Bitlis masifi) çevresindeki Na- feldispat oluşumlarının jeolojik özellikleri ve ekonomik önemi. Yüksek Lisans Tezi, Yüzüncü Yıl Üniversitesi, 126s. Van (unpublished).

Oyman, T. 1996. K-feldspar bearing pegmatities of Çine (Aydın) area, Menderes massif. Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi, 79s. İzmir (unpublished).

Öbelik, Y. 2011. Cam hammaddesi mineralojisi ve cam teknolojisi. Yüksek Lisans Tezi, Niğde Üniversitesi, 84s. Niğde (unpublished).

Önem, Y. 1997. Sanayi Madenleri, Ankara.

Özcan, Ö. 2002. Stoneware bünye ve sır kompozisyonlarında alternatif hammadde kullanımı. Yüksek Lisans Tezi, Anadolu Üniversitesi, 78s. Eskişehir (unpublished).

Özün, S. 2012. Flotation Characteristics of Minerals in Feldspar Ore. PhD Thesis, Middle East Technical University, 276s. Ankara (unpublished).

Potter, M.J. 1996. Feldspar and Nepheline Syenite: Minerals Yearbook, US Dept. Of Interior, US Geological Survey; (//minerals er.usgs.gov/minerals).

Ryan, W. 1978. Properties Of Ceramic Raw Materials. 2nd Edition, Pergamon Press, Londra, 123 p.

Scheepers, R., Schoch, A.E. 1988. Geology and geochemistry of the Klipberg alkali feldspar granite and associated hydrothermally altered rocks in the Darling batholith, southwestern Cape Province. S.-Afr. Tydskr. Geol. 91, 2, 212-225.

Selzer, S. 2000. Keeping the plates spinning—A European tableware focus. Industrial Minerals 397, 77-85.

Seymen, İ. 1982. Kaman dolayında Kırşehir Masifinin jeolojisi. Doçentlik Tezi, İstanbul Teknik Üniversitesi (İTÜ), İstanbul (unpublished).

Sümer, G. 1994. Aydın-Çine feldispatlarının özellikleri ve flotasyon yöntemi ile zenginleştirilmesi. Doktora Tezi, Eskişehir Osmangazi Üniversitesi, 160s. Eskişehir (unpublished).

Şahin, M. 1989. Feldispatların zenginleştirilebilirlik etüdü ve Türkiye feldispat potansiyelinin değerlendirilmesi. Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi, 73s. İzmir (unpublished).

Şahin Kılavuz, F. 2000. Feldispat-Kuvars flotasyonunda metal iyonlarının seçimliliğe etkisinin incelenmesi. Yüksek Lisans Tezi, Hacettepe Üniversitesi, 94s. Ankara (unpublished).

Tatar, S. 1997. Yozgat batoliti Şefaatli kuzey kesiminin (Güney Yozgat) petrolojik incelenmesi. Yüksek Lisans Tezi, Cumhuriyet Üniversitesi, 94s. Sivas (unpublished).

Tatar, S. 2003. Behrekdağ Batoliti'nin Kırıkkale ili-Hirfanlı barajı arasında kuzey-guney yönlü bir jeotravers boyunca petrolojik incelenmesi. Doktora Tezi, Cumhuriyet Üniversitesi, 259s. Sivas (unpublished).

Tayçu, A. 2009. Seramik sağlık gereçleri pişirim koşullarının incelenmesi. Yüksek Lisans Tezi, Anadolu Üniversitesi, 194s. Eskişehir (unpublished).

Tiryaki, C. 2012. Yozgat batolitini oluşturan lökogranitlerin ve yozgat volkanitlerinin petrolojisi. Yüksek Lisans Tezi, Cumhuriyet Üniversitesi, 135s. Sivas (unpublished).

Töre, İ. 1999. Siyenit hammaddesinin seramik bünyelere etkilerinin incelenmesi. Yüksek Lisans Tezi, Anadolu Üniversitesi, 82s. Eskişehir (unpublished).

TS11325, Türk Standartları, 1994, Feldispat Seramik Sanayinde Kullanılan, TSE, Ankara.

Tüvar, O. 2015. Yozgat-Yerköy doğusunun mineralojik, petrografik ve jeokimyasal incelenmesi. Yüksek Lisans Tezi, Cumhuriyet Üniversitesi, 112s. Sivas (unpublished).

Uğur, G. 1990. Feldispatların manyetik yolla zenginleştirilmesi. Yüksek Lisans Tezi, Anadolu Üniversitesi, 67s. Eskişehir (unpublished).

Yadete, H.M. 1990. Rock Geochemical Exploration in Intrusive Rocks of the Behrekdag Area (Celebi-Kirikkale). MSc. Thesis, Middle East Technical University, 120 pp. (unpublished).

Yalçın, A.H. 1995. Çine güneyi (Akçaova) pegmatitlerinin jeolojisi ve petrojenezi. Yüksek Lisans Tezi, İstanbul Üniversitesi, 107s. İstanbul (unpublished).

Yalınız, M.K., Aydın, N.S., Göncüoğlu, M.C., Parlak, O. 1999. Terlemez quartz monzonite of Central Anatolia (Aksaray-Sarıkaraman): age, petrogenesis and geotectonic implications for ophiolite emplacement. Geol. J. 34, 233-242.

Yeşilbaş Günsal, Y. 2002. Sodyum feldispat atıklarının çinko esaslı yumuşak porselen sırlarında değerlendirilmesi. Yüksek Lisans Tezi, Anadolu Üniversitesi, 77s. Eskişehir (unpublished).