Iğdır Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 11(3): 2079-2090, 2021
Journal of the Institute of Science and Technology, 11(3): 2079-2090, 2021

ISSN: 2146-0574, eISSN: 2536-4618

İnşaat Mühendisliği / *Civil Engineering* **DOI: 10.21597/jist.877230**

Araştırma Makalesi / *Research Article*

Geliş tarihi / Received: 09-02-2021 **Kabul tarihi / Accepted: 27-03-2021**

Atıf İçin: Horasan B.Y, Öztürk A, 2021. Features of Andesites Used in Buildings Around İncesu (Seydişehir) Region, Iğdır Üniversitesi Fen Bilimleri Dergisi, 11(3): 2079-2090.

To Cite: Horasan B.Y, Ozturk A, 2021. Features of Andesites Used in Buildings Around İncesu (Seydişehir) Region, Journal of the Institute of Science and Technology, 11(3): 2079-2090.

İncesu (Seydişehir) Çevresinde Yapılarda Kullanılan Andezitlerin Özelikleri

Bilgehan Yabgu HORASAN[1*], Alican ÖZTÜRK[2]

ÖZET: Doğal taşlar eski dönemlerden günümüze kadar artarak hayatımızın her alanında yer almıştır. İnsanlığın ilk zamanlarında kesme, delme, tarım aletleri ve takı gibi günlük hayatta kullanılmış, insanlık tarihinin gelişimine paralel olarak da her alanda kullanım alanı artmıştır. Özellikle yapı alanında önemli bir yer tutan doğal taşlar savunma yapılarından, büyük görkemli yapılar ile gücü, otoriteyi ve uzun ömürlüğü ifade eden anıtsal yapılar olarak karşımıza çıkmaktadır. Doğal taşlar yapılarda yalnızca dayanıklı olmasının yanı sıra renk ve doku özelikleri gibi dekoratif özeliklerinden dolayı da kullanılmıştır. İncesu (Seydişehir) ve çevresinde lokal olarak yapı malzemesi olarak kullanılan gül kurusu renkli doğal taşların (andesite), jeolojik, jeokimyasal, petrografik, fiziko mekanik ve ayrışma indisleri bakımından incelenmiştir. Jeolojik olarak İncesu mahallesi ve çevresinde gözlenen doğal taşlardan (andesite) alınan numuneler üzerinden yapılan kimyasal analiz sonuçlarındaki toplam alkaliye karşı silis (TAS) diyagramında andezit, alkali-subalkali ayırım diyagramında subalkali ve AFM diyagramında kayaçların tümü kalkalkali alanında yer almaktadır. Uzun yıllar atmosferik şartlar da bozunmaya ve yüksek dayanım özeliği ile bilinen andezitlerin fiziko mekanik test sonuçları TS 10835 standartları na göre de değerlendirilmiştir. Aşınmaya karşı direnç ve eğilme dayanımı limit değerler içinde kaldığı anlaşılmıştır. Ayrışma indislerine göre ise, hafif ayrışmış olduğu tespit edilmiştir.

Anahtar Kelimeler: Ayrışma İndeksleri, Seydişehir, andezit, jeoloji, ticari doğal taş

Features of Andesites Used in Buildings Around İncesu (Seydişehir) Region

ABSTRACT: Natural stones have taken place in all areas of our lives from ancient times to the present. In the early days of humanity, they were used in daily life such as cutting, drilling, and agricultural tools, and their usage area increased in parallel with the development of humanity. Especially, natural stones, which hold an important place in the field of construction, appear as monumental structures that express power, authority, and longevity from defense structures to grand magnificent structures. As well as being durable, natural stones were also used for their decorative features such as color and texture properties. Dusty rose-colored natural stones (andesite) which are used locally as building materials in İncesu (Seydişehir) and its surroundings were examined in terms of geological, geochemical, petrographical, physico-mechanical, and weathering indices. Geologically, in the chemical analysis results of the samples taken from the natural stones (andesite) observed in the district of İncesu and its surroundings, all of the rocks are located "andesite" area in the total alkaline versus silica (TAS) diagram, "sub alkaline" area in the alkaline-sub alkaline separation diagram and "calc-alkaline" area in the AFM diagram. The physico-mechanical test results of andesites, which are resistant to weathering under atmospheric conditions for many years and known for their high strength, were also evaluated according to standards. It was found that the abrasion resistance and bending strength (flexural strength) remained within the limit values. According to the weathering indices, it was found to be slightly weathered.

Keywords: Weathering Index, Seydişehir, andesite, geology, commercial natural stone

[1]Bilgehan Yabgu Horasan (**Orcid ID:** 0000-0003-1899-0041), Selçuk Üniversitesi Sarayönü Meslek Yüksekokulu, Çevre Koruma Teknolojileri Bölümü, Konya, Türkiye
[2] Alican Öztürk (**Orcid ID:** 0000-0003-2748-6322), Konya Teknik Üniversitesi, Mühendislik ve Doğa Bilimleri Fakültesi, Jeoloji Mühendisliği Bölümü, Konya, Türkiye

***Sorumlu Yazar/Corresponding Author:** Bilgehan Yabgu Horasan, e-mail: bilgehanyabgu@gmail.com

INTRODUCTION

Natural stones took part in cutting and drilling functions, control of fire, agricultural tools with the beginning of humanity, and parallel to the progress of humanity, their usage areas have expanded even more. Humanity has used natural stones in many areas from religious rituals to communication tools, from the manufacture of paint to stone structures. The use of natural stone has been a symbol of civilization and power, and natural stone was preferred in temples, amphitheaters, palaces, roads, bridges, libraries, fountains, baths, places of worship, and works of art in settled communities (Taslıgil et al., 2016).

Natural stones continue to be used as a sign of civilization and wealth. Today, it is quite common to use commercial natural stones used in building foundations and walls, exterior coatings, garden walls, park and garden arrangements, pavement, road and pedestrian pathways, restoration of historical artifacts, mosques, minarets, and hard ground landscaping works. According to TS 699-1987 commercial natural stones are divided into magmatic, sedimentary, and metamorphic according to their formation characteristics. Magmatic and metamorphic rocks are frequently preferred due to their physical strength, massive texture, and low slippery properties, especially in pavements and steps in aqueous environments. The andesites, which are the subject of this study, are used in a very wide area, especially in the facade of the building, from the restoration of historical buildings in the city landscape (Davraz et al., 2006).

In this study, mineralogical compositions, textural - geochemical properties, and decomposition indices, and structural properties of andesites used in structures within and near Incesu district in the northeast of Seydişehir were investigated according to the results of physicochemical tests recommended in the standards. The properties of trachyte, trachyandesite, and TS 10835 extracted in different regions of andesites, which are used as building materials by local people in and around the Seydişehir region, have been compared with some physical-mechanical parameters. In addition, in this study, the chemical properties of andesites in the region were evaluated according to the weathering indices of WIP, CIA, CIW, and PIA.

MATERIALS AND METHODS

The study area is located in the N27 b2 sheet on the 1/25000 map located in the northwest of Seydişehir (Konya) (Figure 1).

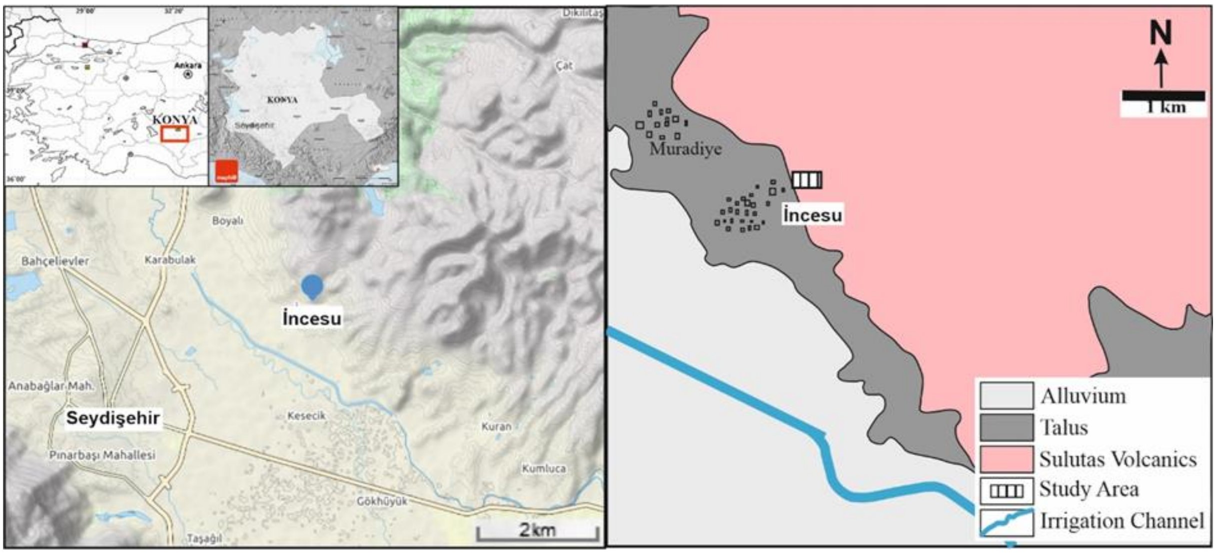

Figure 1. Location map of the study area

Samples were collected from andesites, which are frequently used as building materials, to define their geological, geochemical, mechanical, petrographic, and weathering properties. Mineralogical and petrographic examinations were also made on the samples taken, as well as macro studies. For XRF analysis of 9 samples randomly selected among 20 samples collected from the field for analysis, after each sample was ground to the size of 77-109 µm mesh in a ring mill, calcined for 2 hours in an oven at 1100 ^{o}C, the amount of heat loss of the sample weight was determined. 6.25 g of rock powder was taken and mixed homogeneously with 1.40 g of binding wax. The mixed sample powder was compressed under a pressure of 15-20 N/m into a tablet of 40 mm diameter and made ready for analysis. Specific bulk gravity of andesite samples, Schmidt hardness, surface wear by friction, apparent porosity were determined according to TS 699-1987 standard. TS EN 13755-2009 standards were used for water absorption tests. The dry and saturated water weights of andesite samples were determined and the water absorption amounts were defined as percentages. The uniaxial compressive strength test was made according to TS EN 13755-2009 standards. Cylindrical samples with a length (L) / diameter (D) 2.5 ratio were prepared on 6 selected samples and dried up to the fixed mass in an air-dried oven. After reaching room temperature by waiting in the desiccator, it was tested under a press at a constant speed of 0.5 MPa. In the magnesium sulfate test, samples were tested in the reference fraction range of 10 mm - 14 mm specified in the standard. Two test samples (500 g) from the 10-14 mm fraction range were taken and washed, dried in an air-dried oven at 110 ± 5 ºC for 24 ± 1 hours, and kept in the desiccator to reach room temperature. These suspended samples are weighed and recorded as the first weight. Then, for the beginning of the first cycle, it was immersed in a magnesium sulfate solution at a density of 1,292 ± 0,008 gr/ml. Samples that waited in the solution for 17 ± 0.5 hours are filtered for 2 ± 0.25 hours and then dried in an air-dried oven at 110 ± 5 ºC for 24 ± 1 hours. The samples taken out of the oven are allowed to cool in the desiccator for 5 ± 0.25 hours, and the first cycle is completed. This test, each cycle of which is 48 hours, at the end of 5 cycles, samples were washed and dried, and both samples subjected to the test were sieved through a finishing screen with 10 mm size. The test is concluded by weighing the samples remaining in the sieve separately. Magnesium sulfate test was applied according to ISRM, 2007. Sodium sulfate freeze loss test was performed according to TS EN 1367-2. In the freeze loss experiment, samples in a fraction of 5-40 mm were sieved into a sodium sulfate solution prepared by dissolving 350 g of anhydrous sodium sulfate salt (Na_2SO_4) in 1 liter of water, dried at a constant temperature of 110 ± 5 ºC in three groups to constant weight and weighed. Then, three groups of samples between 40-25 mm, 20-10 mm, and 10-5 mm were immersed in a bucket containing sodium sulfate solution in them. The sample was kept in the solution in this state for 18 hours. At the end of the immersion period, the samples were removed from the solution and dried to constant weight at 110 ± 5° C for a maximum of 4 hours. Cooled to room temperature, the samples were immersed in the solution bucket again. Immersion and extraction drying has been repeated a total of 5 times. At the end of the 5th iteration, the dried and cooled samples were washed with water. When the washing process is complete, the sample is dried to a constant weight at 110 ± 5 ºC and then the samples between 40-25 mm and 25-20 mm were sieved from the 20 mm aperture sieve; the samples between 20-10 mm were sieved from 10 mm aperture sieve and the samples 10-5 mm were sieved using a 5 mm aperture sieve and the part remaining on the sieve is weighed. It was sieved using a sieve and the remaining part on the sieve was weighed. The parts passing through these sieves are indicated as frost loss (Figure 2).

Figure 2. Experimental studies (Sample prepared for uniaxial pressure experiment and Na_2SO_4 experiment)

RESULTS AND DISCUSSION

General Geology

Sulutas volcanic observed in the area where the study was carried out generally consist of oyster white, gray, pink-colored andesite, and dacites and a small proportion of rhyodacite, rhyolite, and basaltic neck, dyke, and lava flows. It was named as "Sulutas andesite member" within "Dilekçi formation" by (Göğer and Kıral, 1973). In regional scale studies (Jung and Keller, 1972; Keller et al., 1977; Besang et al., 1977), these rocks were defined as andesite, dacite, rhyodacite, and rhyolite; these have been defined as andesite and dacite by (Ota and Dinçel, 1977) and these were defined as "Büyükgevelletepe andesite/dacite member" and "Doğuşalayayla basalt member" by Ozkan (2017) and Eren (1993) defined these lavas, which crop out mostly by cutting the other units, as Sulutas volcanic, and this denotation was adopted in this study. These rocks are seen on fresh surfaces as lava flows in pink, light gray, gray, color tones in some locations, and volcanic nails, neck, and dykes in some regions (Figure 3 a and b). Andesites are pink, gray, dark gray, locally red, and contain large quartz grains, amphibole, and feldspar crystals that can be seen by the eye (Figure 3 a and b).

Figure 3. a and b Appearance of andesites in the study area

Slope debris is an alluvial complex composed of an alluvial fan developed in the form of rubble and mudflows and possibly braided stream sediments, generally formed by the weathering of volcanic units. In the study area, it is observed in areas between the volcanic unit and alluvium. Besides, there are unattached red, brown, yellow sand, silt, and clays alluvium in and around the study area.

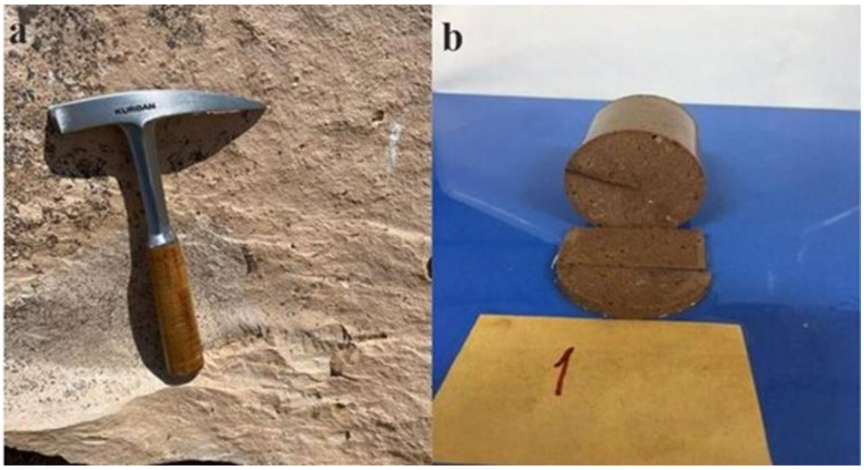

Figure 4. a and b Macro appearances of andesites

In the petrographic studies performed on the rocks, it was determined that the N1 sample was a porphyritic texture and contained plagioclase, amphibole, biotite, pyroxene, and opaque minerals as a phenocryst. Plagioclase shows idiomorph (euhedral) - hypidiomorph (anhedral), coarse-fine grained features; amphibole shows idiomorph (euhedral), allotriomorph (anhedral) coarse-fine grained features; biotite shows allotriomorph (anhedral), medium-fine grained features; pyroxene shows allotriomorph (anhedral), small-grained features and opaque minerals show allotriomorph (anhedral), small-grained features (Figures 4 c and d).

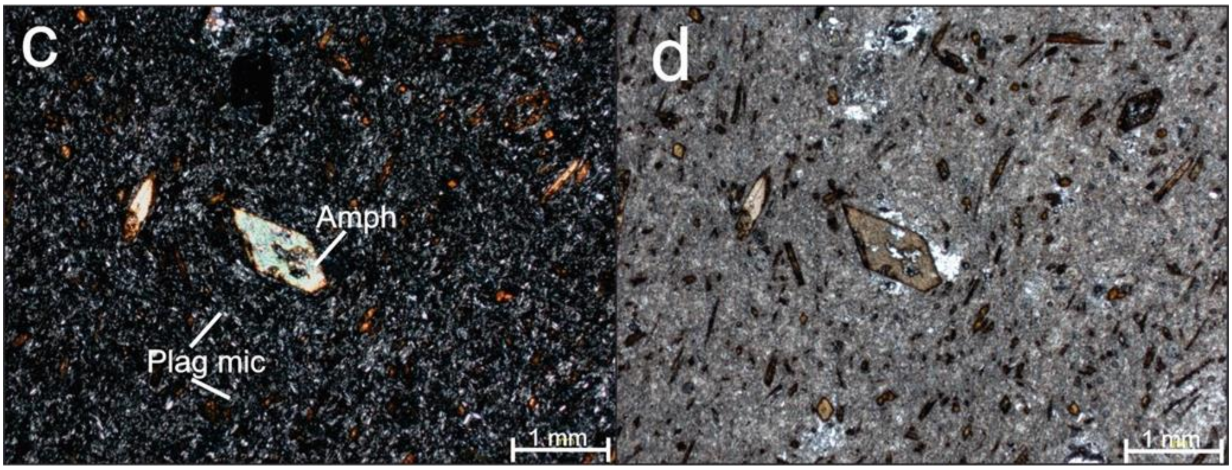

Figure 4.c and d Appearance of andesites under the polarizing microscope (c // Nikol and d / Nikol) (Plag mic = Plagioclase microlites, Amph = Amphibole)

Plagioclase, amphibole, biotite, pyroxene, and opaque minerals were observed with porphyritic texture. The paste is commonly composed of plagioclase microlites and other mineral microlites. Plagioclase has phenocrysts features and shows polysynthetic twinning with prominent zoned tissue. Plagioclase phenocrysts are generally altered and do not show polysynthetic twin lamellae. Amphibole and biotite phenocrysts are distinctly reddish-brownish in color and show cleavage marks and opacification along their edges. Besides, very few (2-3) small-grained pyroxene minerals were observed. Opaque minerals (allotriomorph, anhedral) are very common and show random distribution. The sample is named andesite according to its mineralogical composition and textural properties (Streckeisen, 1979).

Geochemical Properties of Andesites

Rock nomenclature (Figure 4 a) and geochemical evaluations were performed according to the main oxide and trace element concentrations of the studied andesites (Table 1).

Table 1. Chemical analysis results of andesite samples made with XRF device (%)

	N1	N2	N3	N4	N5	N6	N7	N8	N9
SiO_2	61.00	61.30	60.50	61.90	60.00	59.40	60.68	61	60.72
Al_2O_3	16.60	16.90	16.50	18.20	19.30	17.60	17.52	17.1	17.46
CaO	4.83	4.90	5.01	3.31	3.22	3.95	4.20	4.9	4.29
CO_2	4.55	4.45	5.25	4.61	5.87	5.10	4.97	5.4	5.03
Na_2O	3.91	3.75	3.65	3.55	3.24	3.45	3.59	3.2	3.54
Fe_2O_3	3.47	3.56	3.10	3.60	3.55	3.98	3.54	3.3	3.51
K_2O	2.96	3.01	2.98	2.56	3.04	3.10	2.94	2.95	2.94
MgO	1.44	0.91	1.20	0.90	0.654	0.78	0.98	0.855	0.965
Ti_2O	0.507	0.499	0.501	0.498	0.487	0.601	0.516	0.598	0.526
P_2O_5	0.245	0.230	0.241	0.278	0.209	0.263	0.244	0.223	0.242
SrO	0.124	0.105	0.113	0.138	0.0911	0.122	0.116	0.118	0.116
BaO	0.117	0.125	0.122	0.129	0.140	0.141	0.129	0.131	0.129
MnO	0.103	0.119	0.0985	0.0987	0.0668	0.0895	0.0959	0.0778	0.0937
ZrO_2	0.0196	0.0221	0.0229	0.0228	0.0227	0.0226	0.0221	0.0225	0.0222
SO_3	0.0177	0.0198	0.0185	0.0198	0.0215	0.0225	0.0200	0.0181	0.0197
Rb_2O	0.0083	0.0089	0.0091	0.0088	0.0092	0.0086	0.0088	0.0098	0.0089
ZnO	0.0083	0.0091	0.0071	0.0081	0.0064	0.0074	0.0077	0.0071	0.0077
NiO	0.0061	0.0068	0.0065	0.0051	0.0063	0.0064	0.0062	0.0054	0.0061
O	48.00	49.1	47.9	49.8	50	50.5	49.3	48.8	48.8
Si	28.70	28.62	29.10	27.90	27.60	28.15	28.1	27.40	28.10
Al	8.84	9.24	8.90	9.55	10.10	9.80	9.40	8.89	8.61
Ca	3.48	2.90	2.02	2.41	2.26	2.94	2.71	2.98	2.95
Na	2.91	2.25	2.60	2.46	2.39	2.64	2.56	2.81	2.56
K	2.48	2.47	2.30	2.30	2.47	2.58	2.49	2.56	2.92
Fe	2.45	2.34	2.55	2.30	2.43	2.51	1.95	2.19	2.25
C	1.25	1.21	1.41	1.60	1.58	1.62	0.91	0.65	1.25
Mg	0.871	0.952	0.510	0.445	0.390	0.410	0.419	0.519	0.95
Ti	0.306	0.301	0.321	0.278	0.286	0.299	0.284	0.308	0.30
P	0.108	0.0998	0.0795	0.0826	0.0897	0.0910	0.0856	0.0912	0.10
Sr	0.106	0.0825	0.0924	0.0882	0.0752	0.0806	0.0745	0.0780	0.08
Ba	0.105	0.0995	0.115	0.134	0.122	0.123	0.129	0.110	0.12
Mn	0.0807	0.0606	0.0710	0.0665	0.0506	0.0598	0.0745	0.0678	0.09
Zr	0.0147	0.0149	0.0158	0.0154	0.0164	0.0170	0.0154	0.0159	0.02
Cl	0.0097	0.0089	0.0135	0.0088	0.0153	0.0159	0.0153	0.0090	0.02
Rb	0.0077	0.0094	0.0089	0.0091	0.0082	0.0079	0.0095	0.0080	0.01
S	0.0071	0.0076	0.0086	0.0081	0.0084	0.0086	0.0112	0.0070	0.01
Zn	0.0067	0.0074	0.0054	0.0059	0.0050	0.0052	0.0061	0.0065	0.01
Ni	0.0049	0.0039	0.0047	0.0039	0.0048	0.0049	0.0056	0.0061	0.01

The distributions of the total alkaline versus silica (TAS) diagram based on rock naming are shown in Figure 5a. Accordingly, the samples are on the Traki andesite - andesite boundary and most of them are within the andesite area (Figure 5a). Volcanics (Cox et al., 1979) are located in the sub alkaline area in the alkali- sub alkaline separation diagram (Figure 5a). In the AFM diagram developed for sub alkaline rocks (Cox et al., 1979), all of the rocks are located in the calc-alkaline area (Figure 5b).

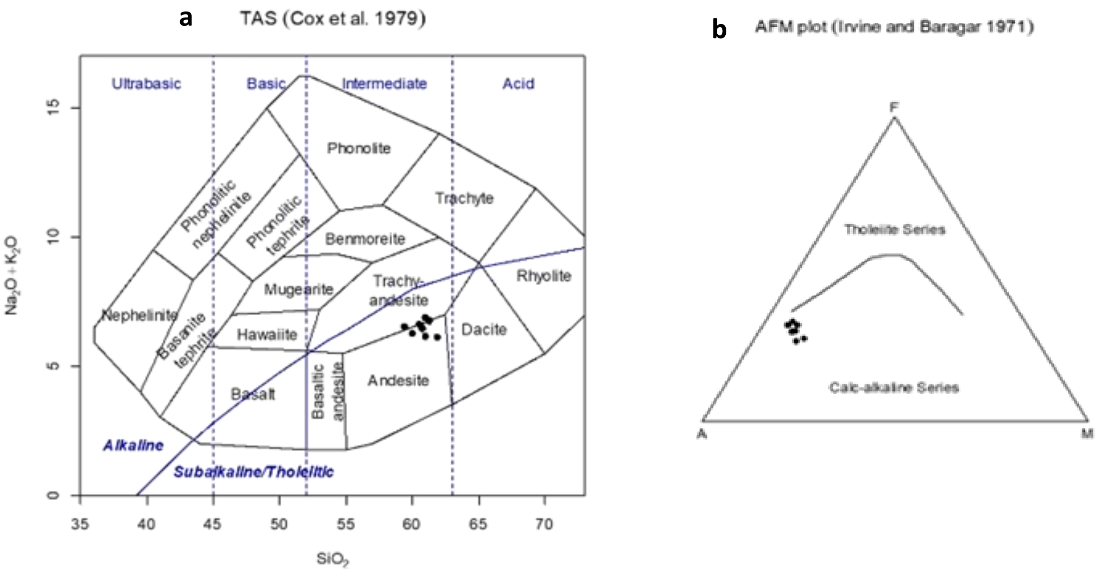

Figure 5. a. The distributions of the studied volcanic rocks in the total alkaline versus silica diagram in TAS (Cox et al., 1979) in the alkali sub alkaline diagram (Irvine and Baragar, 1971). b. The distribution of rocks in the AFM diagram of sub alkaline volcanic rocks (Cox et al., 1979)

Weathering Indices of Andesites

Andesites in the study area should be able to withstand atmospheric conditions for a long time and not easily decompose, since they are used locally in the study area and its immediate surroundings as building material (such as wall construction, pavement, paving stone and pavement, etc.). Changes in rock and/or mineral chemistry may occur during weathering processes. These changes that may occur that elements such as Na, Ca, Mg, K, Si, Fe, Al in the rock and/or mineral are sequentially removed from the environment (Koralay et al., 2014). Various weathering indices have been developed by different researchers using the chemical analysis results of the rocks (Table 2).

Table 2. Some weathering indices and formulas characterizing the degree of weathering in silicate rocks

Weathering Index	Formula	Value in Undissolved Fresh Rock	Value in Weathered Rock	Source
Weathering Index of Parker	$WIP = 100\,x\left(\frac{2Na_2O}{0.35}+\frac{MgO}{0.9}+\frac{2K_2O}{0.25}+\frac{CaO}{0.7}\right)$	>100	0	Parker 1970
Chemical Alteration Index	$CIA=100\text{ x }\left(\frac{Al_2O_3}{Al_2O_3+CaO+Na_2O+K_2O}\right)$	≤50	100	Nesbitt and Young 1982
Chemical Index of Weathering	$CIW\ =100\,x\left(\frac{Al_2O_3}{Al_2O_3+CaO+Na_2O}\right)$	≤50	100	Harnois 1988
Plagioclase Index of Alteration	$PIA=100\text{ x }\left(\frac{(Al_2O_3-K_2O)}{Al_2O_3+CaO+Na_2O-K_2O}\right)$	≤50	100	Fedo et al. 1995

The indices values (Table 3) calculated according to the results of the chemical analysis of andesites (Table 2) were determined.

The Parker Index (WIP) is used to evaluate the weathering intensity of magmatic/metamorphic rocks. WIP values are based on the ratio of alkaline and earth alkaline (sodium, potassium, magnesium, and calcium) elements in the rock. In igneous rocks, the WIP value varies between 0 and 100 (Price and Velbel, 2003). Low WIP values indicate severe chemical weathering, high WIP values indicate that the rock is not unweathered (Shao et al., 2012). The WIP values of the analyzed andesite samples are between 65-77, and it has been determined that they are compatible with the WIP value of the average andesite rock given in (Koralay et al., 2014; Blatt and Tracy, 1996) and partially weathered.

Table 3. Calculated weathering index values of andesite samples taken from the study area

	WIP	CIA	CIW	PIA
N1	77	48	53	47
N2	75	48	53	48
N3	75	48	53	47
N4	65	56	61	57
N5	65	58	64	59
N6	70	53	58	53
N7	71	52	57	52
N8	69	50	55	50
N9	71	51	57	52

The Chemical Index of Alteration (CIA) was first proposed in 1982 by (Nesbitt and Young, 1982) to determine the paleoclimatic properties of early Proterozoic deposits of the Huronian supergroup. CIA is widely used to determine the degree of chemical weathering of rocks. Generally, the CIA is interpreted as a measure of the conversion of feldspar minerals to clay minerals, and the CIA values increase in parallel with the increase of clay minerals in the rock (Price and Velbel, 2003; Shao et al., 2012). The CIA values of the andesite samples vary between 48-58 and are similar to the CIA value of the average andesite rock given in (Koralay et al. 2014; Blatt and Tracy 1996). CIA value is below 50 in igneous rocks that do not show weathering (Price and Velbel, 2003; Kontou 2012).

The Chemical Index of Weathering (CIW) proposed by (Harnois 1988) is also defined as the ratio of ACN. There are a great similarity and agreement between CIW and CIA values. As the Al_2O_3 values associated with K-feldspars may be high in K-feldspar rich rocks, whether weathered or not, K_2O values are not used when calculating the CIW values (Harnois 1988). The CIW value in igneous rocks varies between ≤ 50-100 (Koralay et al., 2014; Price and Velbel, 2003). The CIW values of andesite samples vary between 55-64 and it is thought that the rocks undergo chemical weathering at a very little rate.

The Plagioclase Index of Alteration (PIA) has been proposed as an alternative to the Chemical Index of Weathering (CIW) (Fedo et al., 1995). Plagioclase minerals, which are one of the main components of all igneous and metamorphic rocks, can dissolve relatively easily and turn into clay minerals during the weathering processes. For this reason, it can be used easily in evaluating the weathering degree of rocks. PIA values of andesite samples are between 47-59. In unweathered igneous/metamorphic rocks, the PIA value is ≤50, and this value increases with increasing weathering value (Koralay et al., 2014; Price and Velbel, 2003).

When the calculated weathering index values are compared with the limit values given by different researchers, it can be said that the analyzed andesite samples show a slightly weathered rock feature. In the ACNK triangular diagram prepared for this purpose, it was determined that andesite samples were located on the ACN line and fell on the slightly weathered rock separation line according to CIA values (Figure 6).

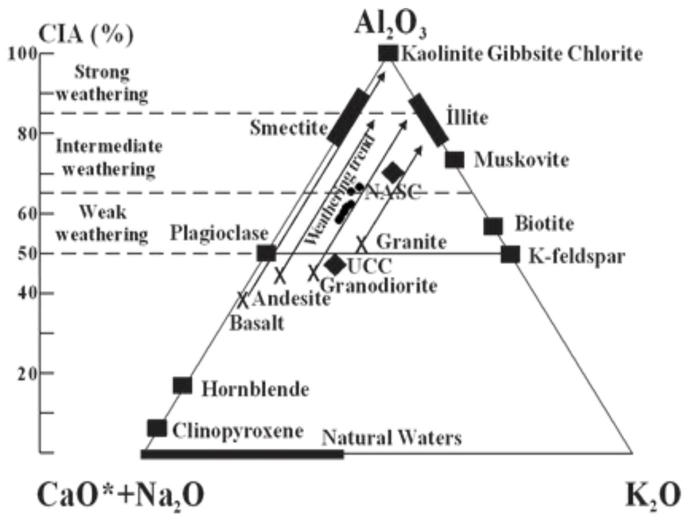

Figure 6. CIA evaluation according to Al_2O_3-CaO + Na_2O-K_2O diagram (Nesbitt and Young, 1982, 1996; Liu et al., 2009; Shao et al., 2012)

Evaluation of physico-mechanical tests

Dry unit weight, specific gravity, water absorption, apparent porosity, true porosity, Schmidt hardness, compressive strength, bending strength, frictional wear loss, sodium sulfate, and magnesium sulfate tests were performed on the samples taken (Table 4). These tests are given in Table 4 together with the Direkli trachyandesite (Davraz and Gündüz, 2006), Gönen trachyte (Sengun, et al., 2009) Elvan Pasa trachyandesite (Celik and Kavas[3], 2006) and Uşak Pink andesite (Tuncay at al. 2016).

Table 4. Comparison of Seydişehir andesites with some andesite types ([1]Davraz and Gündüz, 2006; [3]Celik and Kavas, 2006; [2]Sengun, et al., 2009; [4]Tuncay et a. 2016)

Feature		**TS 10835 Andesite**	**Direkli Trachyandesite[1]**	**Gönen Trachyte[2]**	**Elvan Paşa Trachyte Andesite[3]**	**Uşak Pink Andesite[4]**	**Seydişehir Andesite**
Color			Grey	White	Dusty Rose	Pink-Pinkish	Dusty Rose
Specific Bulk Density (kg/m^3)			2210	2296	2290	2700	2130
Specific gravity (kg/m^3)		>2550	2390	2611			2430
Water absorption (%)		<0.7	2.38		2.8	1.33	5.86
Apparent Porosity (%)			5.25	7.96			5.54
Total Porosity (%)			7.53	12.07	5.8	16.55	8.67
Schmidt Hardness			42.6	41.1		25.95	46.1
Pressure Resistance (MPa)	Endurance	98.1	120.4	81.1	69.23*/ 706 **	90.1	38.48
	Covering	58.8					
Flexural strength (MPa)/ kgf/cm^2	Endurance	7.8*/80**			8.3*/ 84**	11.90	16.7
	Covering	5.9*/60**					
Abrasion loss by friction (cm^3/50cm^2)	Laying	17			30	20.67	8.60
	Covering	28					
Na_2SO_4 (Sodium Sulphate Experiment) %							16
Mg_2SO_4(Magnesium Sulphate) %							64

Mpa *
kgf/cm^2 **

The physical, chemical, petrographic, and geochemical properties of andesites, which are used as building blocks in the Seydişehir region and its immediate surroundings (village) have been determined. In our country and other countries, natural stones have been used as building materials in buildings with historical and cultural characteristics, and today they are used by expanding the usage area of commercial natural stones. From past to present, natural stones are more robust and durable than other traditional building materials. The abundance of natural building stone reserves in the region of the structures to be manufactured also significantly affects this choice (Celik 2019). In addition to building materials, andesites are also preferred in the urban landscape in Europe and our country due to their durability for many years, and they are in increasing demand every year (Celik and Kavas, 2006; Ceylan 2019). In the samples taken from Seydişehir andesites, it is understood that the specific gravity and uniaxial compressive strength value according to TS 10835 are below the determined limit value. It has been determined that the uniaxial compressive strengths of andesites under uniaxial stresses and the stress values at the onset of fracture vary significantly with the ratio of amphibole and feldspar coarse crystals to the pulp material. In addition, opaque and altered minerals affect the compressive strength. When minerals are fresh, fracture development is not observed in them, but when they are opaque and altered, fractures may develop within the same minerals (Ündül and Aysal, 2016). The water absorption rate is above the determined limit, the abrasion loss due to friction and the bending strength remain within the limit determined by TS 10835. It was found to be 16% in the sodium sulfate (Frost Loss) test and 64% in the magnesium sulfate test. When evaluated together with trachyandesites in studies conducted in different regions at different times (Sengun, et al., 2009; Davraz and Gündüz, 2006; Celik and Kavas, 2006), it is understood that it complies with the standards in terms of abrasion resistance and bending strength.

Commercial natural stones that are considered for operation are generally determined for production by examining criteria such as block yield, broken crack gap, color-texture, strength. Commercial natural stone quarries, which require high investment costs to start the field, may have to leave the site after a negative parameter, which is not preferred (due to durability, weathering, segregation, etc.) due to a negative parameter encountered without detailed research. These situations cause not only direct economic and environmental problems but also cause social problems in the region. To prevent such damages, every detail and data should be evaluated in detail. For this reason, in addition to physico-mechanical testing, chemical analysis, petrographic identification, and investigations on the samples collected from the field with detailed geological study, the weathering indices of andesites according to the chemical analysis results were also evaluated according to WIP, CIA, CIW, and PIA. According to these results, it is thought that the rocks are slightly weathered.

CONCLUSION

The andesites seen in the Seydişehir region are frequently used by the local people in applications such as house construction, wall, gravestone, fountain road construction, due to their robustness and easy accessibility. Commercial natural stones should have high block yield, color and texture should have a commercial value, as well as provide standard values of other physical and chemical parameters. In the natural stone sector, the continuation of the quarry can remain open and operated as long as there is a sectoral demand (sales). For this reason, although many commercial natural stone quarries have provided the desired conditions in terms of reserve and block efficiency; their physical, chemical, petrographic, and mechanical strengths do not meet the necessary criteria and may result in their closure. It should be known that businesses that cannot succeed by making sufficient sales will have environmental and social impacts along with equity losses.

The andesite samples examined in this study were found to have resistance to abrasion (8.60 cm^3 / 50 cm^2) and flexural strength values (16.7 kgf / cm^2) from physical tests within the desired limits in TS 10835. The weathering index parameters were evaluated using the chemical analysis results. CIA values are between 48-58% and andesites are thought to have a slightly separated rock character. It has been determined that the samples taken are slightly decomposed. In this study, the properties of andesites used locally in the region were tried to be determined. Due to their color and texture, andesites, which are frequently used in urban landscaping in recent years, are thought to come to the fore with their decorative properties in building exterior and interior cladding.

ACKNOWLEDGEMENTS

The authors would like to thank Nihal Yılmaz, the Mining engineer working in Seydişehir Municipality, for whom she received assistance and support during the research process.

Conflict of Interest

The article authors declare that there is no conflict of interest between them.

Author's Contributions

The authors declare that they have contributed equally to the article.

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