International Journal of Environmental Trends (IJENT)
http://dergipark.gov.tr/ijent

International Journal of Environmental Trends (IJENT)
2020; 4 (2),110-123
ISSN: 2602-4160
Turkish JournalPark ACADEMIC

Research Article

Petrographic and Geochemical Properties of Basaltic Scorias Around Karapınar (Konya) Used as Sand-Gravel Quarry

Gürsel Kansun [1], Alican Öztürk[1] and Bilgehan Yabgu Horasan*[2]
[1] Konya Technical University, Geological Engineering Department, Selçuklu, Konya, Turkey
(ORCID Number:0000-0002-4581-6076), (ORCID Number: 0000-0003-2748-6322)
[2] Selçuk University Sarayönü Vocational High School Department of Environmental Protection and Control Konya,
(ORCID Number: 0000-0003-1899-0041)

Received
21 November 2020
Accepted
22 December 2020

Keywords
Scorias
Sand
Gravel
Basalt
Volcanism
Karapınar

Abstract

Sand has become the most used natural raw material after water in the century we live in. In parallel with the rapid population growth, the need for sand used in different areas, especially in the construction sector, is increasing. Sand consumption is increasing every year in the world and causes irreversible damage to lakes and stream beds. As in many areas, the world is rapidly consuming natural building materials and is looking for alternatives. For this reason, the properties of the raw materials that are used / can be used as an alternative should be known. Basaltic scorias used as sand-gravel quarries around Karapınar are used in the construction sector due to their lightness. In macroscopic samples of basaltic scorias in red and black color, very few phenocrysts of mafic minerals (olivine and pyroxene) are observed. Olivines are black colored, pyroxenes are greenish black and prismatic. The rock is very porous, low density, and its SiO_2 content is 44.40%. Considering the macro properties, the rock has an aphanitic porphyritic texture according to the grain state.

Kum – Çakıl Ocağı Olarak Kullanılan Karapınar (Konya) Civarındaki Bazaltik Cürufların Petrografik ve Jeokimyasal Özelikleri

Anahtar Kelimeler
Cüruf
Kum
Çakıl
Bazalt
Volkanizma
Karapınar

Özet
Kum yaşadığımız yüzyılda sudan sonra en çok kullanılan doğal hammadde durumuna gelmiştir. Hızla nüfusun artmasına paralel bir şekilde büyüyen şehirlerin, inşaat sektörü başta olmak üzere farklı alanlarda kullanılan kum ihtiyacı da artmaktadır. Dünya da her geçen yıl kum tüketimi daha da artmakta göllerde ve dere yataklarında geri dönüşümü olmayan tahribatlara neden olmaktadır. Dünya, birçok alanda olduğu gibi doğal yapı malzemelerini hızla tüketmekte ve bunlara alternatifler aramaktadır. Bu nedenle alternatif olarak kullanılan/kullanılabilecek ham maddelerin petrografik, jeokimyasal, fiziksel ve jeoteknik özelikleri bilinmelidir. Karapınar civarında Kum – Çakıl ocağı olarak kullanılan bazaltik cüruflar hafif olmaları nedeni ile inşaat sektöründe kullanılmaktadır. Kırmızı ve siyah renkli olan bazaltik cüruflar makroskobik numunelerde çok az miktarda mafik minerallere (olivin

ve proksen) ait fenokristaller içerir. Olivinler siyah renkli, proksenler ise yeşillimsi siyah renkli ve prizmatik şekillidirler. Bu kayaçlar bol gözenekli, düşük yoğunluklu ve SiO_2 içeriği % 44.30-44.50 'dir. Makro özellikleri gözönüne alındığında cüruflar, tane durumuna göre afanitik porfirik doku gösterirler.

International Journal of Environmental Trends, *4* (2), 110-123. DOI: not now possible

*2 Corresponding Author Email: bilgehanyabgu@gmail.com

INTRODUCTION

In the 21st century, sand has become the second most used natural raw material after water in the world. As a result of the rapid increase in population, cities that grow very quickly cause sand shortages in the world on a global scale. This situation suggests that with the political and economic crises that may occur on a global scale, there is very little time left for this famine to turn into a major environmental crisis. Sand is used in many areas in our daily life, from glass making to construction, from road and asphalt construction to the production of electronic devices, from marine filling to shale gas extraction. In addition to the general use, sand is required especially for paper, plastic, paint, cosmetic products, wine, toothpaste production. The very fine-grained sand found on beaches and deserts is of great use to human activities. The fact that the sand required for construction in Dubai is imported from abroad shows that the sand in the deserts is not very useful. Although approximately 4 billion tons of sand is formed every year in the world according to the characteristic rock and mineral properties of the region, a certain amount of it is available for needs. With the growth of cities, new buildings and construction sites are needed and 200 tons for a detached house, 3 thousand tons for a hospital, and 10 thousand tons of sand are needed for a 1 km highway. According to the data of the United Nations, 54 percent of the human population in the world lives in cities. It is thought that this rate will continue to increase rapidly and reach 66 percent by 2050. Since 2010, 15 billion metric tons of sand have been consumed every year in the world [1]. The amount of sand used by China only from 2011 to 2014 is equal to the total amount of sand used by the USA during the 20th century. This sand consumption in the world causes destruction that is difficult to recycle, especially in stream beds and lakes. Many countries in the world, especially China, import sand from various countries, especially Vietnam [1,2].

Karapınar is geographically located in Central Anatolia. Many polygenetic and monogenetic volcanoes developed in the region during the Upper Miocene-Quaternary as a result of the processes of convergence and collision of the Eurasian and Arabian plates in the Middle Miocene [3- 6]. This volcanic activity in Central Anatolia is represented between Karapınar (Konya) - Hasandağı (Aksaray) with basalt-andesite rocks, scoria cones, lava flows, and products in the form of maars [7].

In parallel with the growth of the construction sector, which is one of the dynamic sectors of our country, the demand for sand - gravel, stabilized and similar materials, which are the most important tools for the sector, has increased significantly in recent years [8]. For this reason, it is necessary to determine alternative sandpits and meet the demand for sand and gravel economically. Pyroclastics, which are used as sand-gravel quarries in the borders of the Karapınar (Konya) district, are used as an alternative and are highly demanded in the region. These are preferred in the construction sector as very light building materials due to their porosity [9]. In this study, the geochemical and petrographic properties of the samples taken from the borrow pit (Kesmez Quarry) in the region were investigated.

MATERIAL AND METHOD

Three black colored and three brownish Scoria deposites were taken from the area in the northwest of Kesmez Village (Karapınar-Konya) which is thought to be used as sand and gravel. Randomly selected one brownish-red and two black scoria samples were analyzed. These samples were taken from fresh, undissociated surfaces. Kesmez Quarry is located approximately 4 km northwest of Kesmez Village, south of Konya - Adana ring road (Figure

1). Thin sections for the petrographic examination of these rocks were made in the "Thin Section Laboratory of the Konya Technical University Faculty of Engineering and Natural Sciences Department of Geological Engineering" and they were examined under the Nikon brand Polarizing microscope., Whole-rock major oxite and some trace element analyzes were carried out in the "Middle East Technical University Central Laboratory"; XRD (X-Ray Diffraction) analyses, SEM-EDX images were carried out at the Selçuk University Advanced Technology Research Application Center.

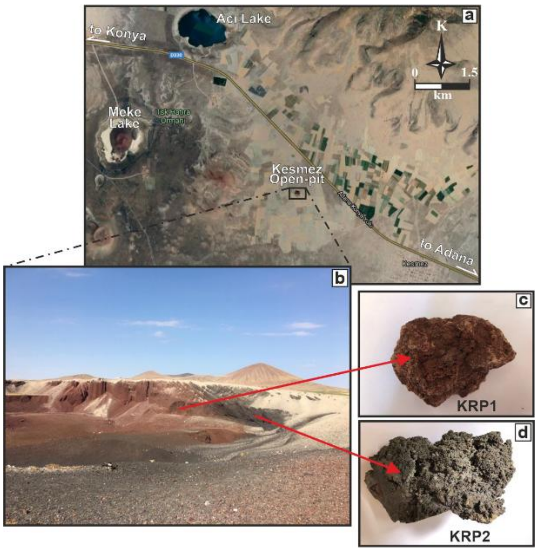

Figure 1. a) Location map of Kesmez quarry (The map is taken from Google Maps). **b)** View from Kesmez quarry. **c)** an example taken from the Kesmez quarry. **d)** KRP2 sample taken from the Kesmez quarry

RESULT AND DISCUSSION

General Geology

In the region, Cihanbeyli formation is located at the bottom, which is bedded close to the horizontal, and consists of light white-gray marl, clayey limestone, and tuff alternation in some areas (Figure 2). This formation presents quite wide-spreading in and around the study area. In the northeast of the study area, undifferentiated basalts and andesites belonging to the lower members of the Karacadağ volcanics lie over the Cihanbeyli formation. Young volcanics, which play an active role in the formation of the morphology of the region, mostly consist of basalt, andesitic basalt, trachybasalt, and pyroclastics. The units in the study area are covered with Quaternary alluvium [10].

Volcanics in the region are generally composed of basalt, basaltic andesite volcanics overlying pyroclastics that are not welded. Volcanics, which are partially observed as plains in large areas, present a porphyro-aphanitic texture. Dark gray-blackish colored and locally amygdaloidal texture is observed in the hand sample of basalts. Within these basalts, rock fragments of trachyte-trachyandesite composition varying in size from 0.3-4 cm are also observed. Another rock group presenting a porphyro-aphanitic textural feature in the study area and the surrounding area is andesites and trachyandesites. Andesites can be distinguished from other rock groups by the light pink color they show in the hand sample, and trachyandesites by their gray color and flow textures [7].

Describe and discuss the results here and/or the finding/contents of your study.

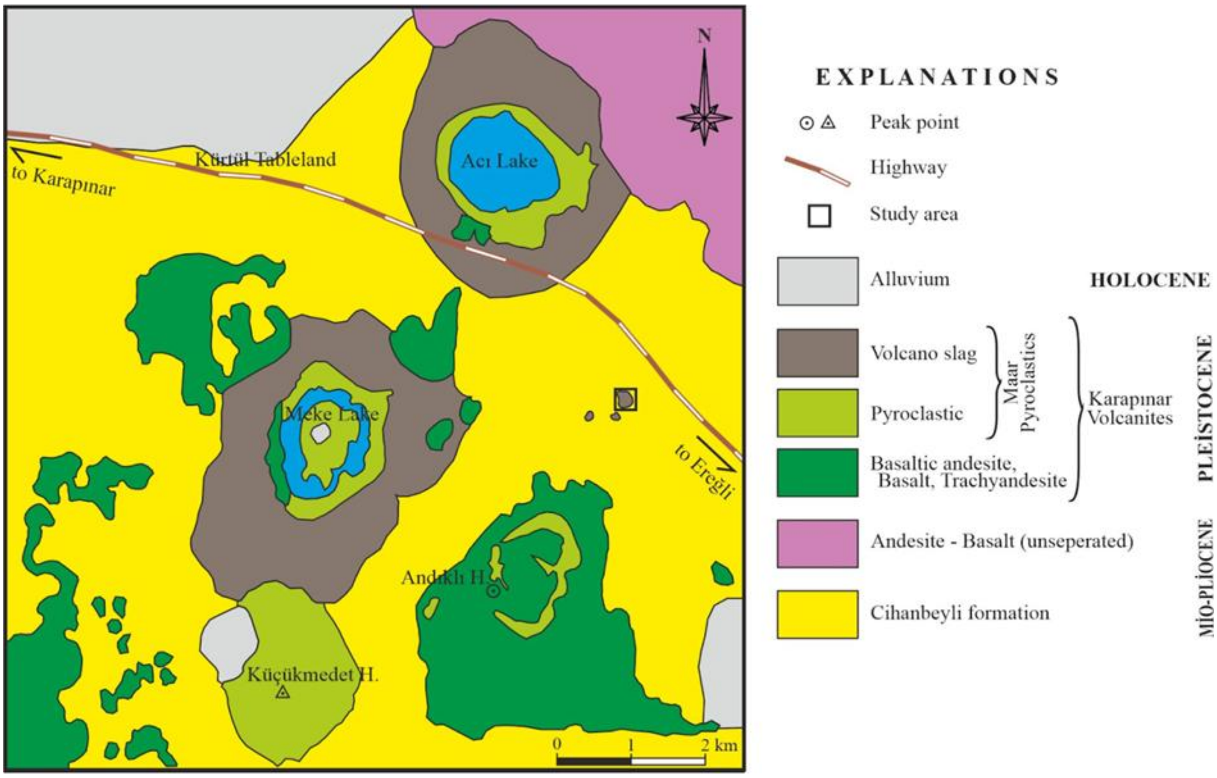

Figure 2. Geology map of the study area and its surroundings (partially modified from [7])

Petrographic and Geochemical Evaluation

Macroscopic Features

Red Scoria

The brownish red-colored scoria samples (Figure 1c) taken from the Kesmez quarry area of Karapınar District (Konya) Kesmez Village are mostly fine-grained. Very few phenocrysts of mafic minerals (olivine and pyroxene) are observed in these rocks. The fine-grained cut of the red scoria deposites is the "paste phase". These are very porous (Figure 1c, Figure 5 a, b, c, and d). Olivines, one of the mafic minerals rarely observed in these rocks, are black and prismatic. Pyroxene are greenish-black colored and prismatic. The SiO_2 content of red scoria deposites is 44.40%. With this feature, these rocks are of "basic" composition. They have a massive appearance and present a "porous structure" (Figure 1c). In addition, their density is low. Considering their macro properties, these rocks have"aphanitic porphyritic texture" according to grain state.

Black Scoria

The black-colored scoria samples (Figure 1d) taken from the sand-gravel pit in the Kesmez region are mostly fine-grained. Very few phenocrysts of mafic minerals (olivine and pyroxene) are observed in these rocks. The "paste phase" forms the fine-grained cut of black scoria with abundant pores. Olivines in black scoria are generally in the form of subhedral prismatic crystals and black in color. Pyroxene are prismatic in shape and greenish-black in color. These rocks are of "basic" composition according to their SiO_2 content (44.30% - 44.50%). These rocks have a massive appearance and porous structure (Figure 1d). These have a low density. Considering the macro properties, black scoria have"aphanitic porphyritic texture" according to grain state.

Microscopic and Geochemical Properties

Thin sections and geochemical analyzes (major oxite, some trace elements and XRD analyzes) were performed from the black scorias taken from the Kesmez quarry. Therefore, black scorias have been interpreted with the help of macro observations, thin sections, and geochemical analysis. As red scorias have a very soft and dispersible feature, thin sections of these samples could not be made, but geochemical analyzes (major oxite, some trace elements and XRD analyzes and SEM EDX analysis were made from these samples. Therefore, red scorias were interpreted with the help of macro observations and geochemical analysis.

The main element (major) and some trace element chemical analysis results of red scoria and black scorias are given in Table 1. According to the results of this analysis, the CIPW norm values of these rocks were calculated (Table 1).

Table 1. Major oxide and some trace element oxide amounts (%wt), major element and some trace element amounts (%wt), and CIPW norm values (%wt) of red scoria and black scoria.
Q: Quartz, A: Alkali feldspar, P: Plagioclase, F: Feldspatoid

Major Oxide and Some Trace Element Oxide Amounts (% Wt.)			
	Red scoria	**Black scoria**	**Black scoria**
	KRP1	**KRP2**	**KRP3**
SiO_2	44.4	44.5	44.3
Al_2O_3	18.0	18.7	18.5
CaO	11.5	11.5	11.7
Fe_2O_3(t)	9.84	9.66	9.77
MgO	6.04	5.86	5.43
MnO	0.233	0.189	0.164
K_2O	0.979	0.929	0.953
Na_2O	3.22	3.2	3.0
TiO_2	1.09	1.05	1.12
P_2O_5	0.284	0.3	0.283
Cr_2O_3	0.051	0.041	0.0431
ZrO_2	-	0.015	0.0166
SrO	0.085	0.086	0.0876
NiO	0.017	0.017	0.0141
ZnO	0.011	0.011	0.0094
CuO	0.007	0.007	0.0076
CO_2	4.18	3.87	4.58
Cl	0.047	0.062	0.0547
SO_3	0.031	0.01	0.0131
Total	100.015	100.006	100.046

Major Element and Some Trace Element Amounts (%wt.)				
	Red scoria	**Red scoria**	**Black scoria**	**Black scoria**
	KRP1	**KRP4**	**KRP2**	**KRP3**
O	46.8	52.29	46.5	47.0
Si	20.3	13.77	20.4	20.2
Al	9.33	6.83	9.74	9.63
Ca	7.97	8.95	8.04	8.07
Fe(t)	6.63	5.79	6.57	6.58
Mg	3.58	3.27	3.49	3.22
Mn	0.174	-	0.142	0.122
K	0.79	0.66	0.754	0.768
Na	2.36	3.07	2.35	2.19
Ti	0.631	0.59	0.612	0.649
P	0.121	-	0.128	0.12
Cr	0.0336	-	0.027	0.0285
Zr	-	-	0.011	0.0119
Sr	0.0685	-	0.07	0.0709
Ni	0.0129	-	0.013	0.0107
Zn	0.0085	-	0.008	0.072
Cu	0.0056	-	0.005	0.058
C	1.12	2.58	1.04	1.23
Cl	0.0461	-	0.061	0.0531
S	0.012	2.20	0.004	0.0051
Tot.	99.993	100.00	99.970	100.089

CIPW Norm values (%wt.)			
	Red scoria	**Black scoria**	**Black scoria**
	KRP1	**KRP2**	**KRP3**
Kuvars	-	-	0.02
Zirkon	-	0.01	0.03
Anortit	29	30.84	27.48
Hipersten	13.1	12.36	21.80
Albit	26.3	26.12	24.58
Sanidin	5.79	5.5	5.61
Olivin	7.61	7.71	-
Apatit	0.65	0.7	0.65
İlmenit	2.07	1.99	2.13
Korund	1.19	1.31	2.62
Magnetit	4.76	4.67	4.73
Kromit	0.07	0.06	0.06
Pirit	0.02	-	0.02
Halit	0.09	0.11	0.09
Tenardit	0.05	0.02	0.02
Kalsit	9.51	8.8	10.42
Total	100.24	100.21	100.26
Q	0	0	0.02
A	5.79	5.5	5.61
P	55.3	56.96	52.06
F	0	0	0

Red Scoria

As a result of the major and trace element analyzes made from sample no. KRP1, the CIPW norm values of this rock were calculated (Table 1). In addition, the result of the XRD analysis made from this rock is given in Figure 3. In the SEM analysis of these scoria samples, the hollow structure is seen (Figure 7). This hollow spongy structure is independent of each other and causes a low density. When these two chemical analysis results are evaluated together, as mineralogical composition in KRP1 numbered sample; Plagioclase, hypersthene, and enstatite (orthopyroxene), calcite, olivine, sanidine, biotite, clinochlore (chlorite) magnetite, ilmenite, corundum, apatite, halite, chromite, and pyrite are observed. The chemical analysis results of this sample can be found in [11] When evaluated in the TAS diagram [11] of, the sample KRP1 is in basalt composition (Figure 4a).

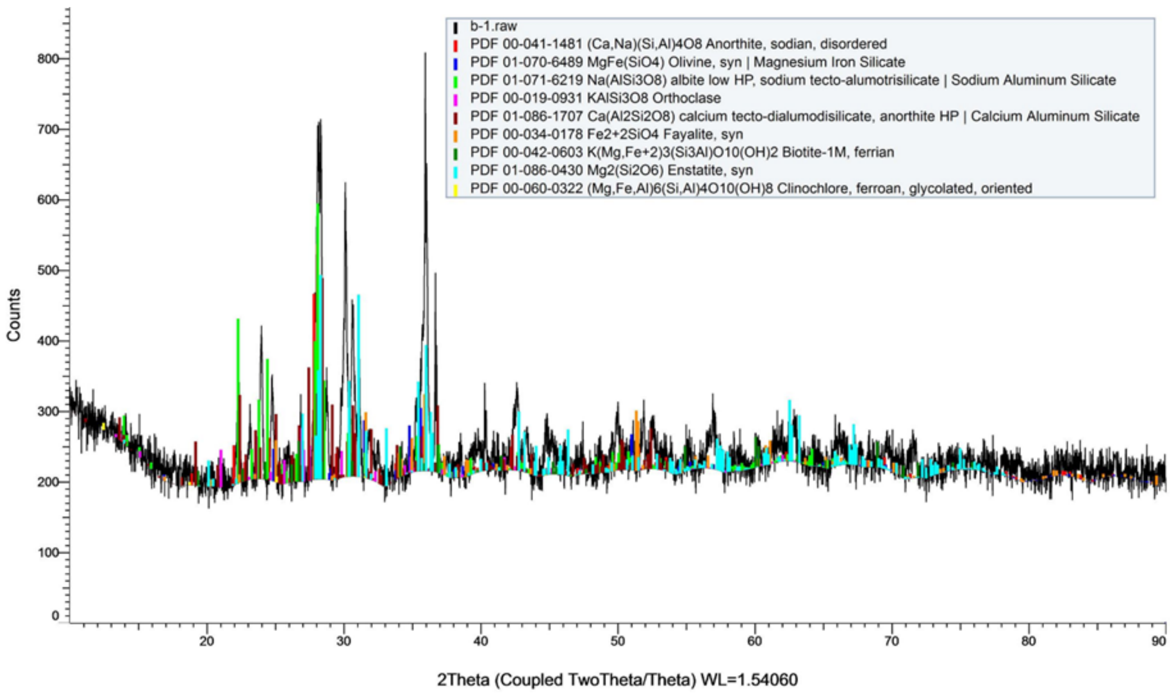

Figure 3. XRD result of KRP1

When this rock sample is reduced to the Q-A-P-F diagram [12] considering its mineralogical composition (Table 1), it is seen that it is again in basalt composition (Figure 4b). KRP1 according to the magma series when classified in R1 - R2 diagram [13], is seen that it has alkaline magma character (Figure 4c).

Sample no. KRP1 has dark (red) and basic composition (SiO_2: 44.4%). The rock is very light and has a low density. It also offers a porous structure (Figure 1c). These are the characteristics of scoria from pyroclastic rocks. Considering its chemical and mineralogical composition, the sample KRP1 is named basaltic scoria.

Black Scoria

As a result of examining the thin section made from the sample no. KRP2 under polarizing microscope, in the rock; orthoproxene (enstatite and hypersthene) (12%), olivine (7%), clinoproxene (diopside / augite) (3%), biotite (1%), chlorite (clinochlor) (1%), apatite (1%), plagioclase microliths (32%), sanidine microliths (4%), volcanic glass (20%), opaque mineral (2%) and porosity (17%) (Figure 5). Orthoproxenes in the rock show a prismatic shape and flat extinction (Figure 5). As a result of chemical analysis, it is seen that orthopyroxene in the rock is in the composition of enstatite and hypersthene. Clinopyroxene is occasionally octagonal and distinctly prismatic shaped crystals (Figures 5c and 5d). These clinopyroxenes, which have an oblique extinction between 43^o and 45^o, are probably of "diopside/augite" composition. Olivines are generally subhedral, flat extinct, and sometimes fractured (Figure 5). A very small amount of biotite is observed in the rock. Biotites are typical with their brown color and plate-like shapes. The paste phase of the rock is composed of plagioclase microliths and volcanic glass. Plagioclase microliths are distinctive with low birefringence, albite twinning, and prismatic shapes (Figure 5). Carbonation is observed in some plagioclases. Secondary calcite minerals were formed in the rock with this alteration.

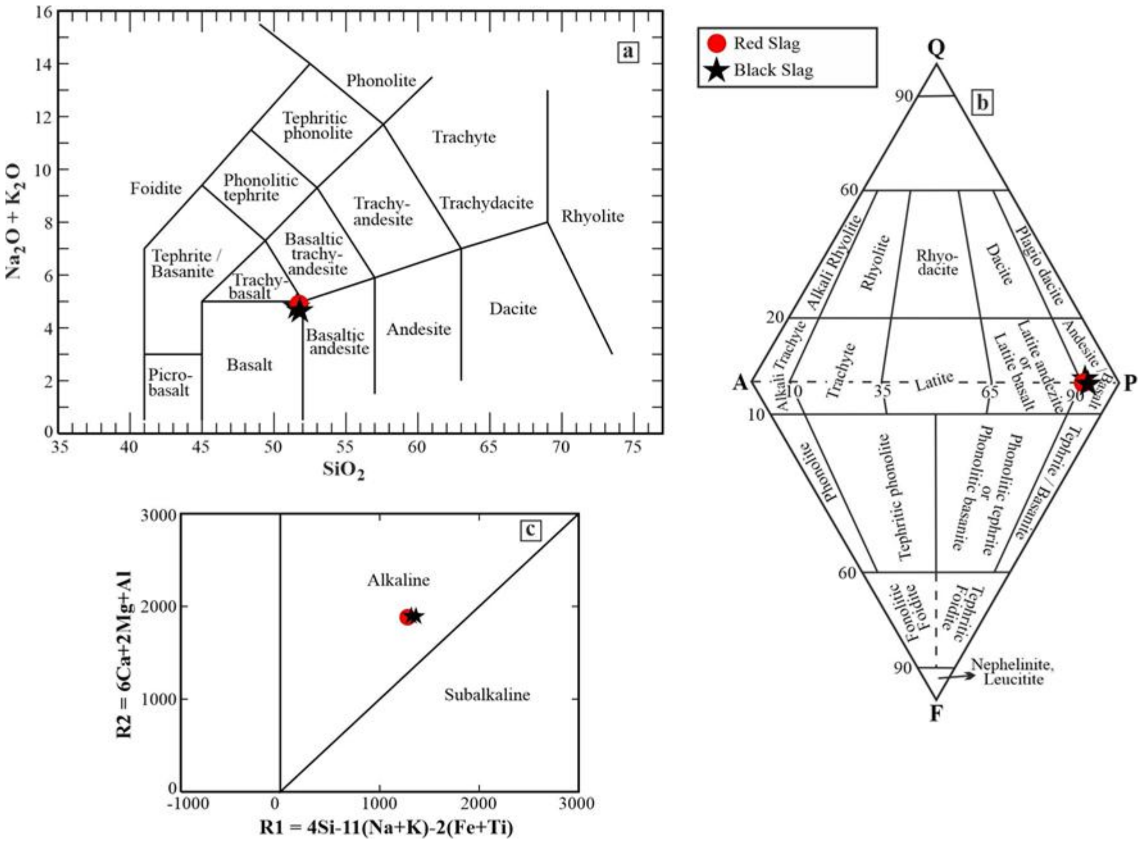

Figure 4. Classification of KRP1 and KRP2 samples in terms of chemical, mineralogical and magma series a) Chemical classification in TAS diagram [11] b) Mineralogical description in Q-A-P-F diagram [12], c) Magma series in R1 - R2 diagram [13]. Q: Quartz, A: Alkali feldspar, P: Plagioclase, F: Feldspatoid

KRP2 is composed of crystals and volcanic glass. Therefore, according to the degree of crystallinity rocks, "hypocrystalline tissue" is the line. Since the rock is made up of phenocrysts, microliths, and volcanic glass, it has a “porphyritic texture” according to grain condition. The paste phase consists of microliths and volcanic glass. Therefore, they also offer "hypocrystalline porphyritic texture". (Figure 5).

The CIPW norm values of the rock are shown in Table 1 as a result of the major and trace element analyzes made from sample no. KRP2. In addition, the result of the XRD analysis made from this rock is given in Figure 6. When these two chemical analysis results are evaluated together, as mineralogical composition in KRP2 numbered sample; plagioclase, hypersthene, and enstatite (orthopyroxene), calcite, olivine, sanidine, biotite, clinochlore (chlorite), magnetite, ilmenite, corundum, apatite, halite, and chromite are observed. Therefore, the chemical analysis results of this rock are highly compatible with thin section results. When chemical analysis results of KRP2 is evaluated in the TAS diagram [11], it is seen that this rock is in basalt composition (Figure 4a).When this rock sample is plotted to the Q-A-P-F diagram [12] considering its mineralogical composition according to both thin section observations and CIPW norms (Table 1), it is seen that the rock is again in basalt composition (Figure 4b).

When the sample KRP2 is classified in the R1 - R2 diagram [13]according to the magma series, it has an alkaline magma character (Figure 4c). KRP2 numbered sample is black and basic composition (SiO2: 44.5%). The rock is fairly light, so it has a low density. It also offers a porous structure (Figure 1d). All these features are characteristic of scoria from pyroclastic rocks. Considering the chemical and mineralogical composition of the rock, the sample KRP2 was named basaltic scoria.

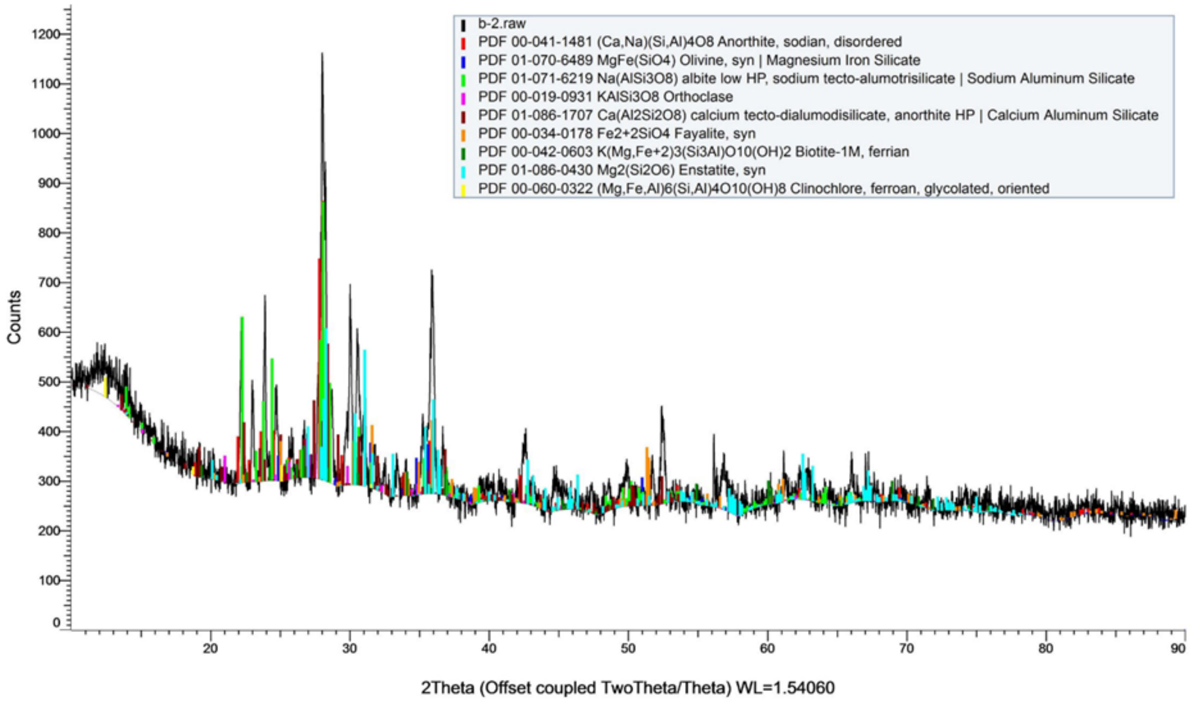

Figure 6. XRD result of KRP2

In the SEM analysis of these scoria samples, the hollow structure is seen (Figure 7). This hollow spongy structure is independent of each other and causes a low density.

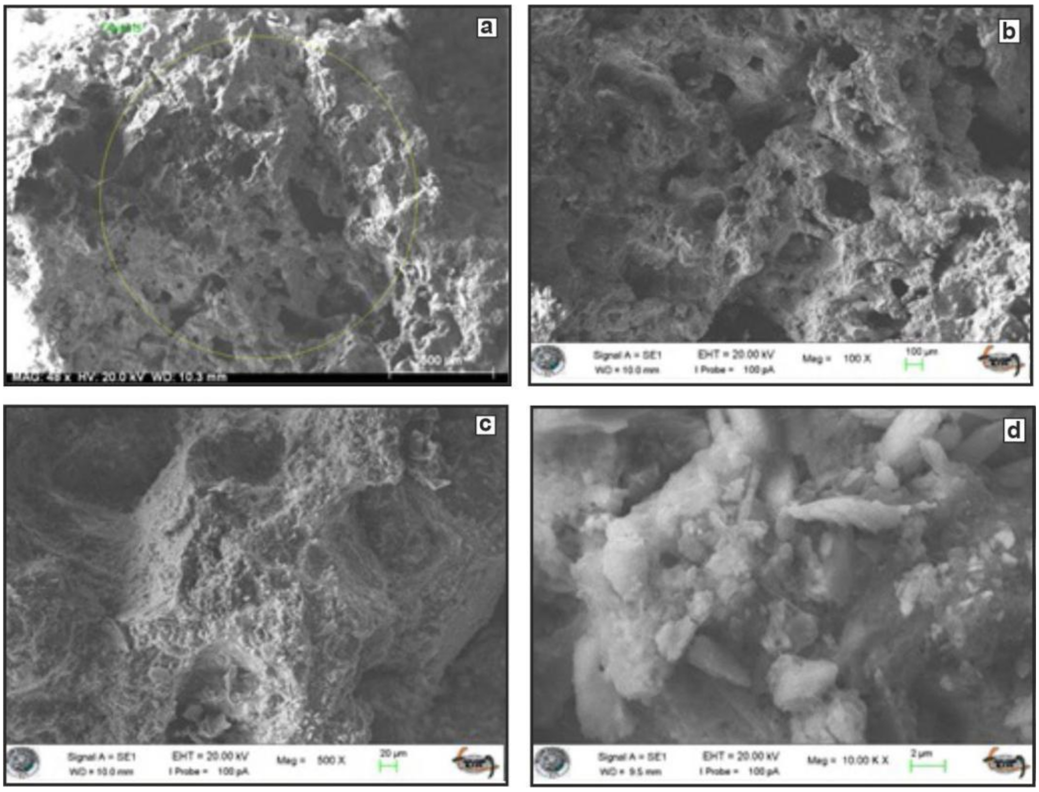

Figure 7: SEM-EDX images of KRP2

Sands are not only limited to the building sector according to their usage characteristics. Particularly, silica sands offer a wide range of use in the casting industry, treatment plants, pipe manufacturing in the glass industry, surface cleaning, as a filter in treatment plants, the chemical industry, and the agricultural sector [14]. Basaltic slags subject to this study are frequently used in the construction industry in the region. It is preferred in infrastructure and superstructure constructions due to its porosity feature. In recent years, it has been preferred in the agricultural industry around the region, in park, garden, and landscape work. Especially, red and black colored slags are used in park and garden arrangements as well as their visual use as well as their mud-preventing feature. Its differences from other sediments are that it prevents the growth of insects, fungi, and bacteria, reduces water consumption, prevents water accumulation in heavy rains, does not hold dust and prevents sludge formation, regulates the pH level of the soil and its decorative elasticity [15].

4. Results

Today, we are moving rapidly towards a century in which renewable alternatives will have to be created to replace the rapidly depleted natural resources. Alternative resources should be found by making good use of the natural resources we have and their characteristics should be determined very well in these resources. In this study, the region that can be operated as a sand and gravel quarry in the Karapınar (Konya) region was investigated. The quarry opened in the pyroclastic origin units is different from the quarries that are operated in the stream sands that we are used to seeing or by the fragmentation of carbonate units. Hollow spongy construction lightens the material. For this reason, the petrographic definition and geochemical properties of the raw materials used in many areas such as filling and stabilized materials, especially in the construction sector, have been determined. This raw material, which is defined as basaltic scoria, is found in pyroclastics frequently seen in the region and is used as an alternative sand-gravel quarry in the region.

Acknowledgments

The authors would like to thank the support of the Karapınar municipality and mining engineer Muhammed Toklu for this study.

Referance

[1] https://tr.euronews.com/2019/08/15/yeni-kuresel-kriz-kapida-dunya-kum-kitligina-girmek-uzere

[2] https://muhendishane.org/2019/11/16/sessiz-ve-derinden-gelen-bir-kriz-kum/

[3] Toprak, V., 1998 “Vent distribution and its relation to regional tectonics, Cappadocian volcanics Turkey”. Journal of Volcanology and Geothermal Research, 85(1), 55-67.

[4] Gencalioglu-Kuscu, G., Satvan, N., Atilla, C., 2004, “An example to Quaternary maar volcanism in Cappadocian Volcanic Province: Cora Maar, Central Anatolia, Turkey”. 2nd International Maar Conference, Kecskemet-Hungary, 15-29 September 2004.

[5] Aydın, F., 2009, “Development of Cappadocia volcanic province and the effects of volcanism on the region”. First Workshop on Medical Geology, Urgup, Nevsehir, Turkey, 30 October-1 November 2009.

[6] Gencalioglu-Kuscu, G., 2011, “Geochemical characterization of a Quaternary monogenetic volcano in Erciyes Volcanic Complex: Cora Maar (Central Anatolian Volcanic Province, Turkey)”. International Journal of Earth Science Geol Rundsch, 100 (8), 1967-1985.

[7] Güllü, B., Kadıoğlu, Y.K., 2019, The Petro-chemical properties of Meke and Acıgöl (Karapınar-Konya) volcanites, Pamukkale Univ Muh Bilim Derg, 25(3), 325-335. doi: 10.5505/pajes.2018.28159

[8] Apaydın, A., Taner, O., Kavaklı, T., Güner, B., 1997, Kum-çakıl ocaklarının doğal çevreye; özellikle yeraltısuyuna olumsuz etkilerine çarpıcı bir örnek: Mürted Ovası (Ankara), Jeoloji Mühendisliği, Sayı 50:2, 33-38. ISSN 1016-9172

[9] Kayhan, A.H., 2011, Haldenbilen, S., Aydın, Y., Uslu, A., Shved, O., The Effect of Mechanical Properties of Basalt Fiber Reinforcement Rods on the Behavior of Reinforced Concrete Elements, İMO Denizli Magazine, Issue 66, p. 44-48.

[10] Göçmez, G., Eren, Y., Aydın, Y. and Söğüt, A.R., 2001, “The newly formed pothole around Karapınar”. Konya-Karapinar Municipality Parliament's opening of the 80th Anniversary Symposium Proceedings Karapinar, Konya, Turkey on 17-18 May 2001.

[11] Le Bas, M.J., Lemaitre, R.W., Streckeisen, A. and Zanettin, B. 1986, A Chemical Classification of Volcanic-Rocks Based on the Total Alkali-Silica Diagram. Journal of Petrology, 27 (3), 745-750.

[12] Streckeisen, A., 1967, Classification and nomenclature of igneous rocks: Neues Jahrbuch fur Mineralogie Abhandlungen, 107, 144-240.

[13] De La Roche, H., Leterrier, J., Grandclaude, P., and Marchal, M., 1980, A classification of volcanic and plutonic rocks using R1R2-diagram and major element analyzes - its relationships with current nomenclature. Chemical Geology, 29,183-210.

[14] http://www.celiktassilis.com/kullanim-alanlari.html

[15] https://ankaracuruf.com/index#services