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Geochemical Characterization of Silica Sand in the Sidenreng Rappang Area Based on X-Ray Diffraction Analysis and X-Ray Fluorescence Analysis

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ABSTRACTS

In the framework of the implementation of regional autonomy which will soon take effect, local governments are encouraged to be independent in managing their regions. One of the mainstays of the region is mineral resources. One potential commodity that deserves attention is quartz sand or silica sand. Silica sand is one of the mineral materials whose existence in nature is very abundant and can be utilized in various applications. In the Sidenreng Rappang area of South Sulawesi, there are deposits of silica sand that are quite abundant. The existence of silica sand in this area is expected to provide new income contributions, both to the local community and to local revenue. The purpose of this research is to determine the geochemical composition of silica sand in the Sidenreng Rappang area using X-Ray Diffraction (XRD) and X-ray fluorescence (XRF). The research method was carried out by combining qualitative research with inductive research, namely combining field data and laboratory analysis data. The literature review stage is first carried out before the field data collection stage and the laboratory analysis stage so that conclusions are obtained from the results of the third analysis. Based on the results of XRD analysis of the sample, the average content of SiO2 carrier minerals including quartz minerals, and pyroxene while the average percentage results of the mineral content of the sample obtained (SiO_2) 69.14%; (Al_2O_3) 22.92%; (Fe_2O_3) 3.04; (K_2O) 2.55%; (CaO) 1.63% and minerals with levels below 1% (RuO_2; TiO_2; SrO; MnO; V_2O_5; Cr_2O_3; Rb_2O; and ZnO). It can be estimated that the main impurity minerals present in the sample are aluminum minerals and iron minerals.

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INTRODUCTION

In the framework of the implementation of regional autonomy which will soon take effect, local governments are encouraged to be independent in managing their regions. One of the mainstays of the region is mineral resources. The mineral resources or mining sector, especially industrial minerals, nationally the mining industry plays a very important role in the development of domestic industry (Galih, 2017; Prayogo & Budiman, 2012). If managed properly, the mining sector can even contribute more. Mining has a regional role or mission, namely to improve the regional economy, open new areas and minimize the gap in progress between regions (Langi et al., 2020).

However, the national mining sector is still fixated on traditional commodities that have been relatively the same for a long time, such as nickel, iron ore, gold and copper. With the development of the world, it is time for Indonesia to look at other potential mining commodities, according to the momentum of the direction of industrial development and the global market (Yusnidah, 2021).

One potential commodity that deserves attention is quartz sand or silica sand. Silica sand is one of the mineral materials whose existence in nature is very abundant and can be utilized in various applications (Rachman et al., 2012; Ratnawulan et al., 2018). Quartz sand is an excavation material consisting of silica crystals (SiO_2) and contains impurity compounds that are carried during the

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deposition process. Quartz sand also known as white sand is the result of rock weathering containing major minerals, such as quartz and feldspar (Saniah et al., 2014; Trianasari et al., 2017). This commodity has benefits that are needed by the modern industrial world. A number of entrepreneurs from China, South Korea and India who are engaged in the mineral processing industry have recently been eagerly and vigorously hunting for this one sand in several regions in Indonesia (Renty et al., 2018; Silahooy, 2020).

The use of quartz sand is widely used in the cement industry, glass, steel casting, ceramics and others. It can be estimated that the need for quartz sand will continue to increase in accordance with the growth of the above industries (Metungku et al., 2017; Muliawan, 2017). The largest quartz sand reserves are found in West Sumatra, other potentials are found in West Kalimantan, West Java, South Sumatra, South Kalimantan, Bangka and Belitung Island and Sulawesi Island (Mahmuda, 2019; Ukhtiyani et al., 2017).

In the Sidenreng Rappang area of South Sulawesi, there are abundant deposits of silica sand. The existence of silica sand in this area is expected to provide new income contributions, both to the local community and to local revenue. Before further mining is done, the character of silica sand needs to be known. Therefore, this study was conducted with the aim of knowing the geochemical composition of silica sand in the Sidenreng Rappang area using X-Ray Diffraction (XRD) X-ray fluorescence (XRF).

METHODS

The research was conducted by combining qualitative research with inductive research, namely combining field data and laboratory analysis data (Bakri et al., 2022; Firdaus et al., 2022) . The literature review stage was first carried out before the field data collection stage and the laboratory analysis stage so that conclusions were obtained from the results of the analysis of these three stages. Silica sand samples came from the western part of Sidenreng Rappang, South Sulawesi.

Silica sand sampling was carried out using the channel sampling method, taking samples in three different locations that were considered representative of the entire study area. Each was taken as much as 5 kg/sample and physically described. The sampling process can be seen in the figure below (Figure 1).

Figure 1. Sampling

Sample preparation was carried out at the UMI Mining Engineering Mining Materials Processing Laboratory. Preparation starts from weighing, size reduction and sieving. The three silica sand samples that passed the 200 mesh sieve were then reweighed before geochemical analysis. Geochemical analysis was carried out by X-Ray Diffraction (XRD) method to determine the mineral composition and X-ray fluorescence (XRF) to determine the level of mineral elements contained in the silica sand samples of the study area. The sample sieving process can be seen in the picture below (Figure 2).

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Figure 2. Sample sieving

XRD and XRF analysis of the three samples were conducted at the UNHAS Materials Processing Laboratory. The results of sample analysis, both by XRD method, and by XRF method were then processed and analyzed. The data obtained is made into tables and graphs so that it is easy to analyze. The results of the analysis are then made into a conclusion that can show the geochemical character of the sample.

RESULTS AND DISCUSSION

Physical Description

The three physical samples are generally blackish white, this is due to the color composition of impurity minerals that compose the silica sand of the study area. Sample 1 is darker than sample 2 and sample 3, the color difference is due to its location in the plantation area. It is thought to have been heavily contaminated with clay minerals from sediment weathering due to grass and plant roots. Hardness 7.0 on the mohs scale, specific gravity 2.63, white streaks, glassy gloss and conchoidal fragments. Physically, the three samples can be seen in the picture below (Figure 3).

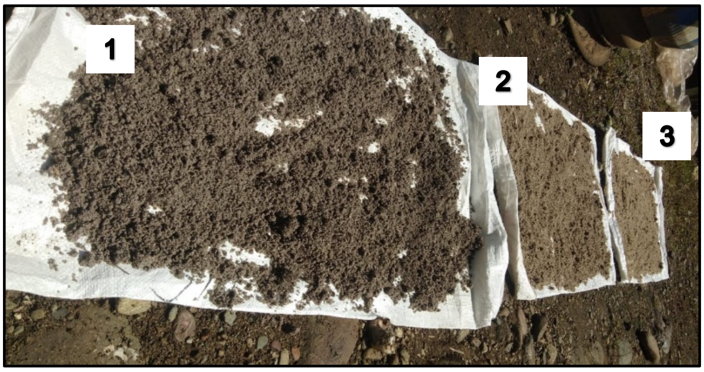

Figure 3. Physical color of sample 1, sample 2 and sample 3

X-Ray Diffraction (XRD)

The results of XRD analysis of sample 1 showed that the silica carrier minerals (SiO2) included quartz minerals of 59.29%; albit 23.20%; pyroxene 17.6%. Quartz minerals contain considerable silica compared to the other two minerals, namely albit and pyroxene minerals. The diffractogram analysis of sample 1 can be seen in the figure below (Figure 4).

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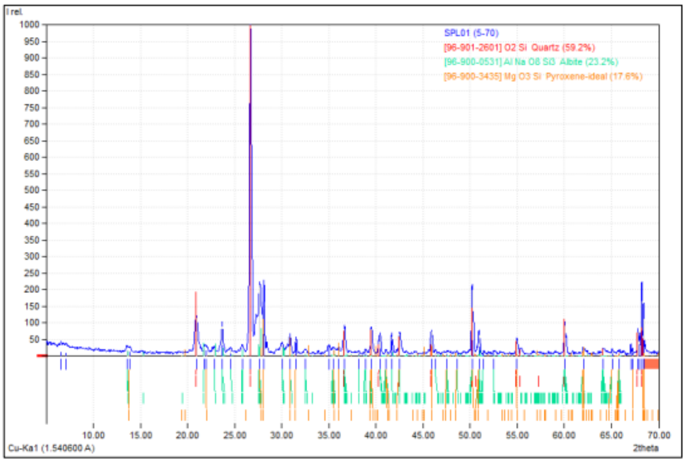

Figure 4. XRD results of sample 1

The results of XRD analysis of sample 2, also obtained silica carrier minerals (SiO2) including quartz minerals of 54.30%; albit 32.10%; pyroxene 13.5%. Quartz minerals contain considerable silica compared to the other two minerals, namely albit and pyroxene minerals. The diffractogram analysis of sample 2 can be seen in the figure below (Figure 5).

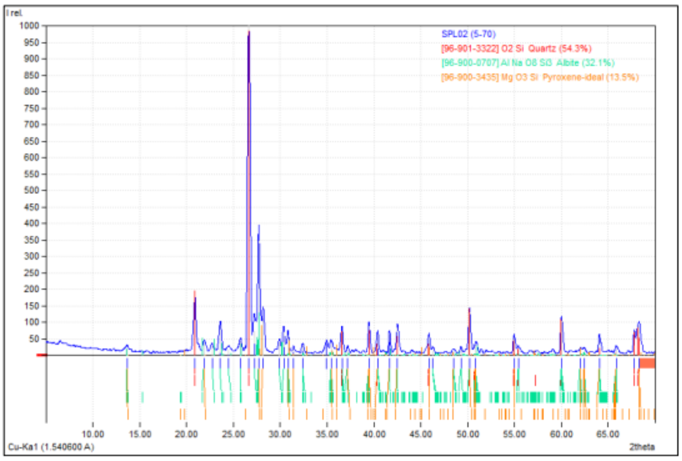

Figure 5. XRD results of sample 2

Sample 3 XRD results also obtained silica carrier minerals (SiO2) dominated by quartz minerals then followed by albit and pyroxene minerals with a percentage of 44.80% quartz; 38.20% albit; 17.00% pyroxene. The diffractogram analysis of sample 3 can be seen in the figure below (Figure 6).

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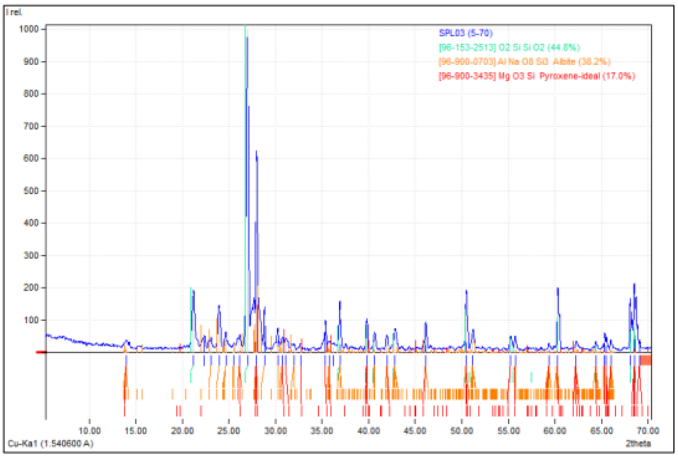

Figure 6. XRD results of sample 3

Sample 1 has a larger percentage of quartz minerals than sample 2 and sample 3, but the percentage of albit minerals in sample 1 is smaller than sample 2 and sample 3. The percentage of pyroxene minerals is almost the same between sample 1 and sample 3, but different in sample 2. Based on the results of XRD analysis of the three samples, the average content of SiO2 carrier minerals is obtained, including quartz minerals by 52.76; albit by 31.16% and pyroxene by 16.03%. The mineral composition of the three samples can be shown in the figure below (Table 1).

Table 1. XRD results of samples

Minerals	Chemical formula	Percentage (%)			Average (%)
		Sample 1	Sample 2	Sample 3	
Quartz	SiO_2	59.2	54.3	44.8	52.76
Albite	NaO_8Si_3	23.2	32.1	38.2	31.16
Pyroxene	MgO_3Si	17.6	13.5	17.0	16.03

X-ray fluorescence (XRF)

The XRF results of sample 1 obtained the percentage of mineral content, including (SiO2) 70.762%; (Al2O3); 20.991%; Fe2O3) 3.044%; (K2O) 2.834%; (CaO) 1.764%; (RuO2) 0.255%; (TiO2) 0.185%; (SrO) 0.057%; (MnO) 0.036%; (V2O5) 0.027%; (Cr2O3) 0.025%; (Rb2O) 0.013%; (ZnO) 0.006%. Sample 2 obtained the percentage of mineral content, including (SiO2) 69.001%; (Al2O3) 23.034%; K2O) 2.963%; (Fe2O3) 2.707%; (CaO) 1.619%; (RuO2) 0.255%; (TiO2) 0.153%; (BaO) 0.127%; (SrO) 0.060%; (Cr2O3) 0.032% (MnO) 0.027%; (Rb2O) 0.013%; (ZnO) 0.009%. Sample 3 obtained the percentage of mineral content, including (SiO2) 69.414%; (Al2O3) 22.701%; (K2O) 3.188%; (Fe2O3) 2.234; (CaO) 1.642%; (RuO2) 0.250%; (SO3) 0.145%; (BaO) 0.136%; (TiO2) 0.134%; (SrO) 0.063%; (Cr2O3) 0.038%; (MnO) 0.025%; (Rb2O) 0.014%; (ZnO) 0.009%; (CuO) 0.007%. The results of XRF analysis of the three samples are not much different from the XRD results, namely the SiO2 mineral as the dominant mineral composing the silica sand of the study area.

The average results of the percentage of mineral content of the three samples obtained (SiO2) 69.14%; (Al2O3) 22.92%; (Fe2O3) 3.04; (K2O) 2.55%; (CaO) 1.63% and minerals with levels below 1% (RuO2; TiO2; SrO; MnO; V2O5; Cr2O3; Rb2O; and ZnO). It can be estimated that the main impurity minerals present in the sample are aluminum minerals and iron minerals. The percentage of mineral content and its average can be shown in the table below (Table 2).

Table 2. XRF results of the samples

Chemical formula	Percentage (%)			Average (%)
	Sample 1	Sample 2	Sample 3	
SiO_2	69.00	69.00	69.41	69.14

Al_2O_3	23.03	23.03	22.70	22.92
Fe_2O_3	2.96	2.96	3.19	3.04
K_2O	2.71	2.71	2.23	2.55
CaO	1.62	1.62	1.64	1.63
RuO_2	0.26	0.26	0.25	0.25
TiO_2	0.15	0.15	0.15	0.15
SrO	0.13	0.13	0.06	0.11
MnO	0.06	0.06	0.04	0.05
V_2O_5	0.03	0.03	0.03	0.03
Cr_2O_3	0.03	0.03	0.01	0.02
Rb_2O	0.01	0.01	0.01	0.01
ZnO	0.01	0.01	0.01	0.01

Based on the above tables (Tables 1 and 2), it can be explained that silica is the main and dominant mineral that makes up the composition of silica sand while aluminum and iron are impurity minerals. The content of impurity minerals in silica sand is thought to be transported and deposited with valuable minerals, this is because they have almost the same specific gravity. Therefore, further research needs to be done, so that its utilization can provide added value to the economy and local revenue.

CONCLUSION

Based on the results of XRD analysis of the sample, the average content of SiO2 carrier minerals is obtained, including quartz minerals, and pyroxene, while the average results of the percentage of sample mineral content are obtained (SiO2) 69.14%; (Al2O3) 22.92%; (Fe2O3) 3.04; (K2O) 2.55%; (CaO) 1.63% and minerals with levels below 1% (RuO2; TiO2; SrO; MnO; V2O5; Cr2O3; Rb2O; and ZnO). It can be estimated that the main impurity minerals present in the sample are aluminum minerals and iron minerals.

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