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Morphology and Mineral Analysis of Coal in Senoni Village, Sebulu District, Kutai Kartanegara Regency Using SEM-EDS

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ABSTRACT

A scientific approach can be used to identify minerals in coal, namely SEM-EDS (Scanning Electron Microscope-Energy Dispersive Spectroscopy). In Senoni Village, coal mining is still minimal. To find out whether the coal in the area has good quality and by looking at the minerals contained in the coal. The first research stage is to take coal samples in the research area. Then the sample is prepared, namely making the sample in the form of chunks into granules with a size of 40 mesh. Furthermore, the SEM-EDS characterization test was carried out to determine the morphology and elemental content found in coal. The results obtained show that the minerals contained in coal are quartz, marcasite and calcite minerals. As well as the percentage of elemental content (C) 83.3%, (O) 16.0%, Na 0.1%, Al 0.2%, Si 0.1%, S 0.2% and Ca 0.1%. Based on the carbon content, this coal is classified as (good quality).

Keywords: *Coal, Elemental Content, Mineral, SEM-EDS*

ABSTRAK

Salah satu pendekatan ilmiah untuk mengidentifikasi mineral pada batubara dapat digunakan yaitu SEM-EDS (*Scanning Electron Microscope-Energy Dispersive Spectroscopy*). Di Desa Senoni, pertambangan batubara masih sangat minim dilakukan. Untuk mengetahui apakah batubara di daerah tersebut memiliki kualitas yang bagus dan memiliki prospek untuk ditambang, maka perlu dilakukannya uji kualitas batubara, yaitu dengan melihat mineral yang terkandung di dalam batubara tersebut. Tahapan penelitian yang pertama adalah mengambil sampel batubara di daerah penelitian. Kemudian sampel di preparasi yaitu menjadikan sampel yang berbentuk bongkahan menjadi butiran dengan besar 40 mesh. Selanjutnya dilakukan uji karakterisasi SEM-EDS untuk mengetahui morfologi dan kandungan unsur yang terdapat pada batubara. Hasil yang didapatkan diketahui mineral yang terkandung pada batubara adalah mineral kuarsa, markasit dan kalsit. Serta persentase kandungan unsurnya (C) 83.3%, (O) 16.0%, Na 0.1%, Al 0.2%, Si 0.1%, S 0.2% dan Ca 0.1%. Berdasarkan kandungan karbonnya batubara ini termasuk dalam klasifikasi batuminous (kualitas bagus).

Kata Kunci: Batubara, Kandungan Unsur, Mineral, SEM-EDS

1. INTRODUCTION

Coal is the most abundant alternative energy source in Indonesia, especially in East Kalimantan, both in terms of quantity and value. Coal in the future has better prospects and growth opportunities because the need for fuel oil and gas is increasing, while its reserves are increasingly limited. So that coal can be an alternative energy source in the near future (Avicenna, 2019).

Coal is formed the coalification process, which occurs along with increasing temperature, pressure, and time, causing the percentage of carbon in the coal-forming material to increase. Meanwhile, the hydrogen and oxygen content of coal decreases. This coalification process will produce coal with varying qualities depending on the level of organic maturity (Sira, 2022).

Coal quality parameters are influenced by the minerals contained in the coal. These parameters include ash content, sulfur (total sulfur), and calorific value (Annisa and Hafsari, 2017).

To identify minerals in coal, one of the scientific approaches can be used, namely SEM-EDS (Scanning Electron Microscope-Energy Dispersive Spectroscopy). SEM-EDS is a development of SEM which is used to obtain surface images or material features with very high resolution to obtain a display of the sample which is then computed with software to analyze the material components both quantitatively and qualitatively (Wahyuningsih, 2019).

In Senoni Village, coal mining is still very minimal. However, in one location in Senoni Village, there is a mining opening area. To find out whether the coal in the area has good quality and has prospects for mining, it is necessary to carry out a coal quality test, namely by looking at the minerals contained in the coal.

Research on mineral analysis in coal using SEM has previously been conducted by Avicenna (2019), namely the analysis of mineralogy and coal quality in Kadingeh Village, Baraka District, Enrekang Regency, South Sulawesi. This research has also been conducted by Fitrawan (2021), namely the analysis of coal mineralogy and its admixtures in Bulupoddo District, Sinjai Regency, South Sulawesi Province. The results of previous research their quality. Based on the explanation above, it is necessary to conduct research on the analysis of the morphology and minerals of coal in Senoni Village, Sebulu District, Kutai Kartanegara Regency. The results of this study are expected to provide information on the mineral content and quality of coal in the area.

2. MATERIAL AND METHOD

Scanning Electron Microscope is a type of electron microscope that images the surface of a sample using a raster scan pattern and a high-energy electron beam. Electrons interact with atoms in the sample, producing signals that provide information about the sample's surface topography, composition, and other properties such as electrical conductivity. Meanwhile, Energy Dispersive Spectrometry (EDS) is a complement to SEM that identifies chemical elements and their proportions on the mineral surface (% atoms). These elements are detected using X-ray energy produced by the surface of the material being tested (Annisa and Hafsari, 2017).

This study was conducted to analyze the morphology and minerals of Senoni Village coal, Sebulu District, Kutai Kartanegara Regency using SEM-EDS. The results are used to determine the quality of coal in the research area based on the element content obtained from the EDS test. The following are the stages carried out in this study:

1. Coal Sample Acquisition
   Conducting sampling at the research location
2. Coal Sample Preparation
   Sample preparation was carried out by grinding the coal into lumps into 40 mesh granules using a geological hammer and sieve.

3. SEM-EDS Characterization
After the sample has been refined, it is continued with mineral characterization using SEM-EDS. to find out the minerals contained in the coal.

3. RESULT AND DISCUSSION

3.1 Morphology of Coal Minerals Based on SEM Tests

The morphological characterization of coal minerals using SEM-EDS is an initial study that can provide information about the types of minerals found in rocks by knowing the element content and oxidation, as well as knowing the physical and chemical properties of the minerals (Julinawati, 2015).

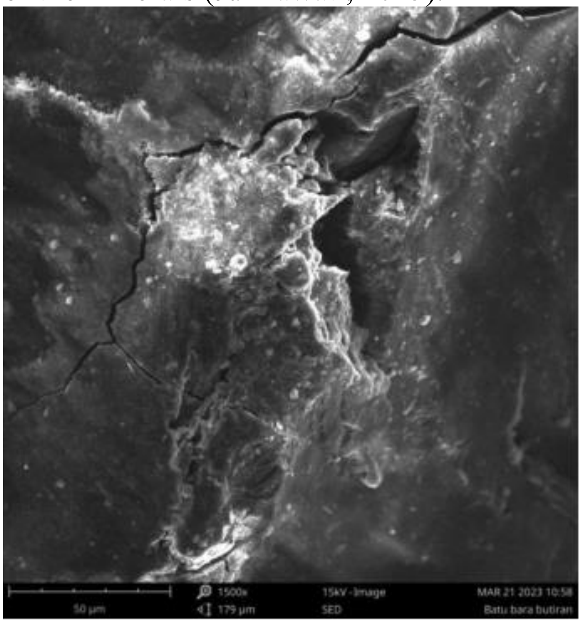

Figure 1: SEM Image 1500x Magnification 15kVCaption of Example Figure

Figure 1 shows the SEM image at 1500x 15kV magnification. It can be seen that in this image the surface of the sample is uneven and has holes and cracks, which means there are fractures or breaks in the mineral.

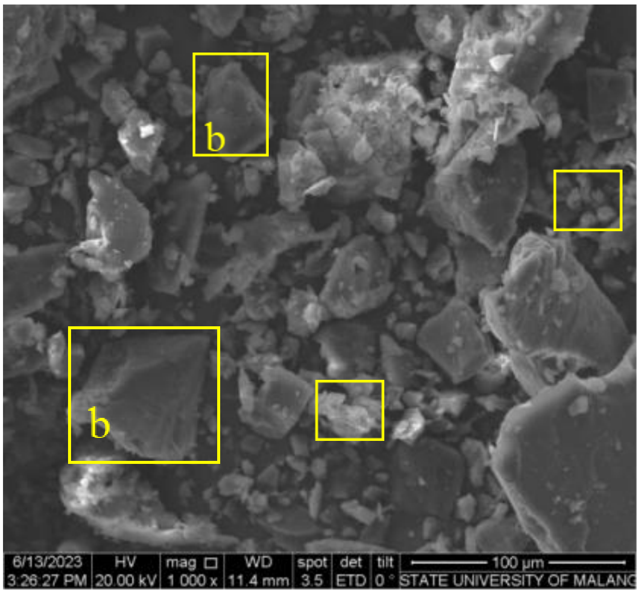

Figure 2: SEM Image 1000x Magnification 20kVCaption of Example Figure

Figure 2 shows the SEM image at 1000x 20kV magnification. In this image it is interpreted as mineral morphology (a) monoclinic quartz mineral fills almost the entire surface of the sample and (b) orthorhombic marcasite mineral.

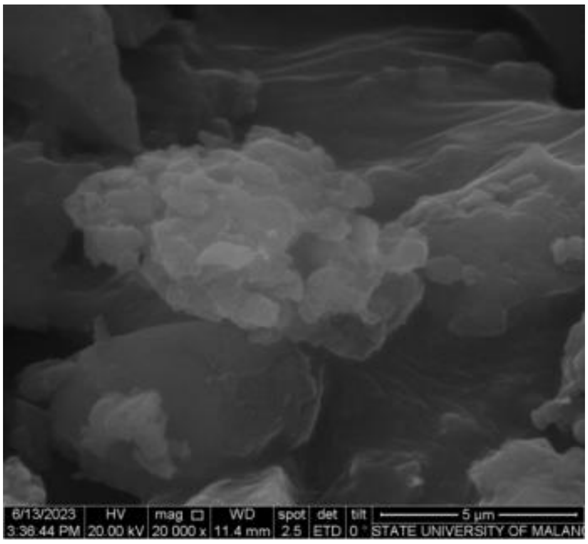

Figure 3: SEM Image 20000x Magnification 20kV Caption of Example Figure

Figure 3 shows the SEM image at a magnification of 20000x 20kV. In this image it is interpreted as the morphology of calcite minerals in the form of scalenohedral. The presence of minerals in coal with a certain amount will affect the quality of coal, especially the parameters of ash, sulfur and heat value so that it can limit the use of coal (Nursanto, 2013).

3.2 Coal Elemental Content Based on EDS Test

In EDS characterization, one coal sample was tested twice, where both results had different elemental content results even though they came from the same sample. Coal 1 is part of the first coal sample tested. Coal 2 is another part of the same coal sample. Analysis of the elemental content of Senoni Village coal using SEM-EDS obtained results in the form of a percentage of elements contained in the coal, which can be seen in the graph and table below:

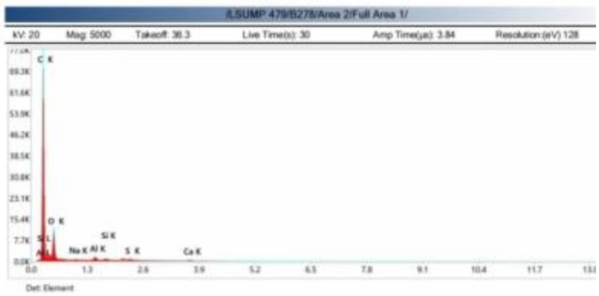

Figure 4: Coal EDS Test Result Graph

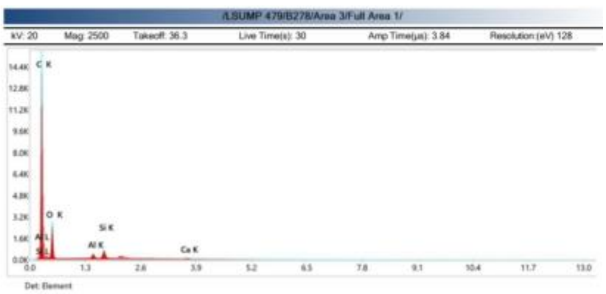

Figure 5: Coal EDS Test Result Graph

The graph in Figure 4 shows that the highest graph is in the carbon element (C) followed by the oxygen element (O), with other elements Na, Al, Si, S and Ca showing significant amounts.

The graph in Figure 5 shows that the highest graph is in the carbon element (C) followed by the oxygen element (O), with other elements Na, Al, Si, S and Ca showing significant amounts.

Table 1 Coal Element Content 1 Based on EDS Test

Element	*Weight%*	*Atomic%*
C K	83.3	87.2
O K	16.0	12.6
Na K	0.1	0.0
Al K	0.2	0.1
Si K	0.1	0.0
S K	0.2	0.1
Ca K	0.1	0.0

Table 2 Coal Element Content 2 Based on EDS Test

Element	*Weight%*	*Atomic%*
CK	80.6	84.9
O K	18.6	14.7
Al K	0.3	0.1
Si K	0.5	0.2
Ca K	0.1	0.0

The EDS test results provide information on the content of coal elements as seen in Table 1. Based on the EDS test results (Table 1), it is known that the constituent elements of coal 1 with the heaviest content are carbon (C) 83.3% and oxygen (O) 16.0%. In addition, there are several other constituent elements, namely Na with a weight of 0.1%, Al with a weight of 0.2%, Si with a weight of 0.1%, S with a weight of 0.2% and Ca with a weight of 0.1%.

The EDS test results (Table 2) provide information on the content of coal elements as seen in Table 2. Based on the test results, it is known that the constituent elements of coal 1 with the heaviest content are carbon (C) 80.6% and oxygen (O) 18.6%. In addition, there are several other constituent elements, namely Al with a weight of 0.3%, Si with a weight of 0.5%, and Ca with a weight of 0.1%.

3.2 Mineral Content of Coal

The morphology of minerals in each region has a different form depending on the area of formation. Based on the results of SEM morphological analysis, it is known how the morphological form of minerals contained in the coal of Senoni Village. Quartz minerals have a monoclinic morphology, marcasite minerals have an orthorhombic morphology and calcite minerals are scalenohedral.

Minerals are organic materials that are formed naturally have a regular atomic structure, with a certain chemical composition and provide specific physical properties. In nature there are more than 2000 types of minerals that have been known. only a few minerals are found as rock-forming minerals. So far, the determination of mineral types has only been based on their physical properties (Nasution, 2015). The presence of minerals in coal in certain amounts will affect the quality of coal, especially the parameters of ash, sulfur and heat value so that it can limit the use of coal (Nursanto, et al., 2015).

The quartz minerals contained in coal will affect the coal ash produced during combustion where the more quartz minerals contained in coal, the more ash will be produced (Nursanto, et al., 2015). Meanwhile, the marcasite minerals contained in coal indicate the presence of sulfur content in coal, where sulfur is one of the elements that form marcasite minerals (Zahar, 2021).

Coal ash affects the calorific value, if the calorific value is higher, the ash content will be lower because the amount of inorganic material (minerals) contained is high so that during the combustion process all organic substances will be oxidized into substances such as CO2 and H2O and produce heat while minerals will not undergo oxidation into steam, these minerals will precipitate so that they will not produce heat (Kurniawan and Huda, 2020). However, the ash content in coal cannot be seen at a glance based on the minerals contained in the coal alone, there is a special method used to see the ash content in coal.

EDS test to obtain mineral content in coal, was conducted twice for the same sample. Based on the results obtained from the two tests, the results obtained were generally the same percentage of element content, namely carbon (C) of 80.6% - 83.3%, oxygen (O) 18.6% -16.0%, Al 0.2% -0.3%, Si 0.1% -0.5%, Ca 0.1% and S 0.2%.

The content of elements in coal will affect the quality of coal. Where the elements in coal are related to the calorific value, water content and ash content in coal. Coal consists of several elements, namely carbon (C), hydrogen (H), and oxygen (O) as the main constituent elements. Sulfur (S) and Nitrogen (N) as additional elements and other elements that are rarely found in coal (Sira, 2022). The content of elements in coal can be used as one way to determine the quality of the coal. High quality coal has a high carbon content. Carbon is a very important element, because it is the largest producer of heat in the combustion process. The higher the carbon content, the higher the calorific value produced (Sepfitrah, 2016).

In this study, the carbon content is 80.6% and 83.3%. This shows that this coal has a content. So, we can predict that this coal is classified as good coal. In addition, coal with high carbon content can be classified into bituminous coal (good) or anthracite coal (very good).

Oxygen in coal is closely related to moisture content (water content) because oxygen tends to bind hydrogen so that water molecules increase. This causes the calorific value to decrease. Coal containing moisture during combustion, water will evaporate, reducing the calorific value of the coal (Zahar, 2021). The low oxygen content in the coal in this study will produce a high calorific value during combustion, because if the oxygen content is low, the moisture content will be low and the calorific value will be higher. So coal can be indicated as good coal in this study.

According to ASTM, coal quality is classified into several levels based on its carbon and water content, namely lignite as the lowest grade coal, sub-bituminous as medium grade coal, bituminous as good grade coal with a carbon content of 68-86% and anthracite as the best quality coal with a content of 86-98%.

Sulfur (S) in coal can be in the form of organic compounds or inorganic compounds such as pyrite, marcasite, and sulfate. Sulfur is a stable material and is evenly distributed in coal. The sulfur content in coal varies from very small amounts to more than 4% (Sira, 2022). The sulfur (S) content affects the quality of coal because it is an impurity (Zahar, 2021). In this study, the amount of sulfur content in coal was 0.2%. Coal that has a total sulfur content of 3% or more is called high sulfur coal, while coal that has a total sulfur content between 1% -3% is called moderate sulfur coal and coal that has a total sulfur content of less than 1% is called low sulfur coal (Avicenna, 2019). So, we can indicate that this coal has good quality because it has a low sulfur (impurity) value.

In this study, the carbon content obtained was 80.6% and 83.3%. In addition, the low oxygen content also indicates that the water content is low. if the water content is low, the coal calories are high. The low sulfur content in this coal also indicates that this coal has low impurities. Thus, it can be interpreted that the coal in this study is included in the category of bituminous coal (good quality). The largest use of bituminous coal is in power plants and the steel industry.

4. CONCLUSION

a. Based on the results of the Senoni village coal test using SEM-EDS, it can be seen what elements are contained in the coal. The elements contained in coal are carbon (C) of 80.6% - 83.3%, oxygen (O) 18.6% - 16.0%, Al 0.2% -0.3%, Si 0.1% -0.5%, Ca 0.1% and S 0.2%

b. The results of the SEM analysis show uneven and perforated mineral surface morphology and there are cracks in the minerals. In addition, there is a quartz mineral morphology in the form of monoclinic, marcasite minerals in the form of orthorhombic, and calcite minerals in the form of scalenohedral.

c. Based on the content of elements found in the coal of this study. It can be interpreted that the coal in this study is included in the classification of bituminous coal (coal with good quality). The conclusonshould state concisely the most important propositions of the papers as well as the author's views of the practical implications of the results.

5. ACKNOWLEDGMENTS

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