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Coal Characterization of Mallawa Formation in Mallawa Area, Maros Regency, South Sulawesi Province

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ABSTRACTS

The characterization of coal is very heterogeneous chemically and physically; even in one seam, there can be significant differences. Although some areas have coal, the characteristics of coal in one area are not necessarily the same as coal in other regions. This study was conducted to determine the coal perinkat based on calorific value and to determine the coal grade and characteristics of the Mallawa Formation. This research was carried out using a method of taking field data directly in the field in the form of coal samples, outcrop geometry data, which was then analyzed in the laboratory in the form of proximate, sulfur, and calorific tests, and analyzing the relationship between the total sulfur content in coal and the coal ash content. The results of the study found that the coal rating based on coal calories is sub bituminous (*low rank),* coal grade is very low grade coal, with an average moisture content of 7.78%, an average ash content of 39.99%, Volatile matter of 32.85% and an average fixed carbon of 19.39 cal/gr, and has a high sulfur content of 2.13%. There was a strong relationship between the ash and sulfur content in coal, with a value of R^2 = 0.8238.

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INTRODUCTION

Initial research on the characteristics of coal is essential to be carried out before exploiting it for its use. Because only by knowing the characteristics of coal can the type of coal used for a mine location be known. The characterization of coal is highly heterogeneous chemically and physically; even within one seam, significant differences can be observed (Anshariah et al., 2018). Coal is a type of sedimentary rock that has its uniqueness (Jiu, B., at. al., 2021). Apart from the formation process, which differs from that of sedimentary rocks that undergo typical sedimentation processes, coal plays a significant role as an energy source for various countries worldwide, including in Indonesia. Another uniqueness is that although some areas have coal, the coal in one area is not necessarily the same as the coal in other regions in terms of the characteristics of the coal found in the field. This can be caused by the difference in the sedimentation environment at the time the coal is formed. In other words, different settling environments will also have different characteristics of coal that will be formed (Anshariah, at. al., 2018; Widodo, S., 2008; Amijaya, 2005; Rahmat, at. al., 2012; Daulay, B., 1994). Coal quality tests are generally carried out using the proxy analysis method. Proximate analysis can provide information related to the characteristics of coal (Panda, L&Dash, S., 2020). Research on the characteristics of Mallawa Formation coal will be very useful in determining the quality of Mallawa Formation coal, which is related to its management and utilization. The quality of coal is largely determined by the needs and demands of the market or industry that uses it. Coal characterization is essential to obtain initial information related to coal quality in an area. For this reason, a study was carried out on the characteristics of the Mallawa Formation in the Mallawa Area, Maros Regency, South Sulawesi, so that the quality and proper handling can be known (Sukandarrumidi, 2009; Sigh, and. al., 2011; Arif., I., 2014).

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METHODS

This research was conducted in the Mallawa Area, Maros Regency, by going through several stages of research, such as: preparation stage: including literature study, journal review, mapping, and administration; the stage of field data collection includes the dimensions of the outcrop, field sampling, measurement of the position of the rock layer, and observation of geomorphological data; sample preparation: commination or reduction of mixtures (crushing and grinding), mixing and coning and quartering; laboratory tests in the form of proximate tests that include moisture content, ash content, volatile matter, and fixed carbon; The next stage is the research publication stage. Other laboratory tests carried out were sulfur and calorie tests on coal samples.

RESULTS AND DISCUSSION

The coal outcrops found in the Mallawa area show appearances consisting of lower layer coal outcrops, middle layer coal, and upper layer coal and are described as follows: 1). The MAL1 ply, which is the lower layer with a thickness of 50 cm, generally shows the physical characteristics of a black field with *a vitrous-subvitrous gloss* and shows the presence of a plating (*banded coal*)), and is classified as *bright coal (vitrain);* 2). Ply MAL2 which is the middle layer with a thickness of 55 cm generally shows the physical characteristics of a field that is black, vitreous-sub vitreous tmainly composed of *10% dull bands* with a size of less than 5mm (3mm*); 3). *Ply* MAL3 which is the middle layer with a thickness of 45 cm generally shows the physical characteristics of the field which is black, glossy vitreous-sub vitreous tespecially, composed of *dull bands* of 10% with *bright bands*. The appearance of coal in the research area can be seen in figure 1.

Figure 1. Field appearance from Mallawa coal (a). lower coal, (b) middle coal and (C) upper coal.

The results of the proximate test analysis showed varying results in the lower, middle and upper samples for moisture content, ash content, volatile matter and fixed carbon respectively (Table 1).

Table 1. Results of proximate test analysis of Mallawa Formation coal samples

Sample Code	Moisture Content (% adb)	Ash Content (% adb)	Volatile Matter (% adb)	Fixed Carbon (% adb)
MAL 1	6.85	42.77	32.84	17.54
EVIL 2	7.63	37.58	35.33	19.46
EVIL 3	8.85	39.62	30.37	21.16
Average	7.78	39.99	32.85	19.39

A proximal analysis graph of the bottom, middle and upper coal samples is presented in **Figure 2.**

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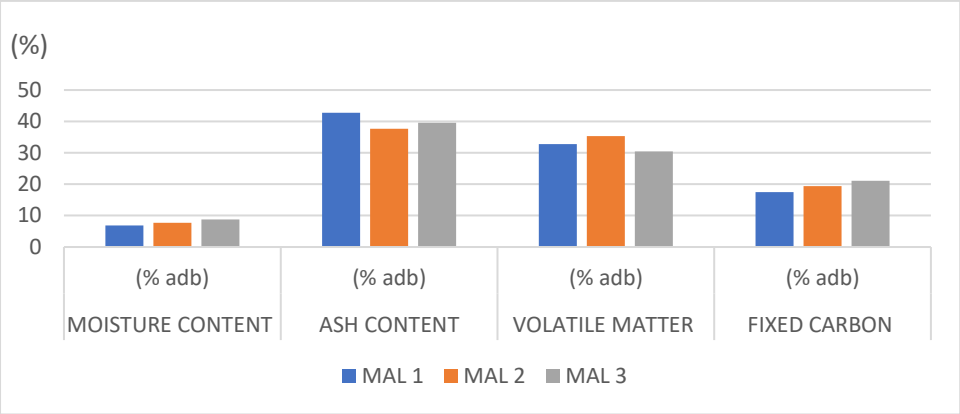

Figure 2. Chart of proximal analysis of Mallawa coal samples

The results of the sulfur and calorie content test on coal can be seen in Table 2 which is graphically illustrated in Figure 3.

Table 2. Results of analysis of total sulfur content and calories of Mallawa coal

Sample Code	Sulfur Total (% adb)	Caloric Value (cal/gr adb)
MAL 1	2,39	4127
EVIL 2	1,76	4344
EVIL 3	2,25	3800
Average	2,13	4090

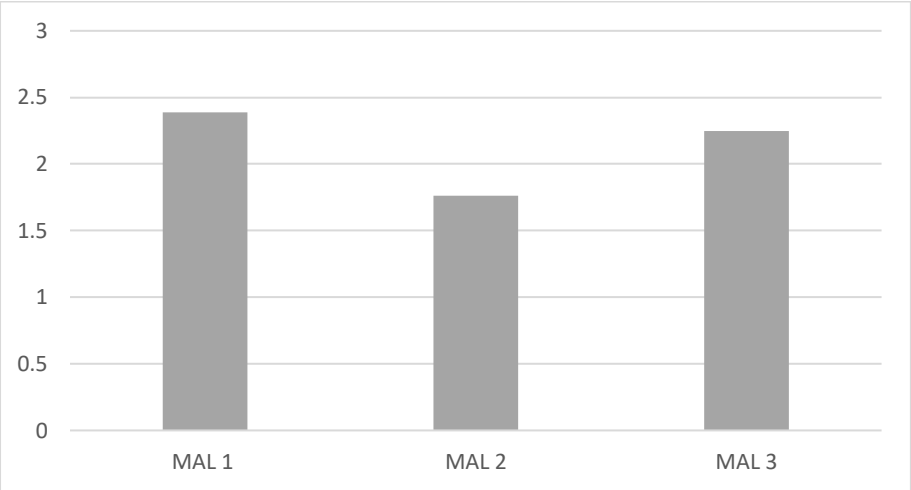

Figure 3. Comparison of total sulfur in each of the lower (MAL 1), middle (MAL 2), and upper (MAL 3) samples in the Mallawa Formation coal

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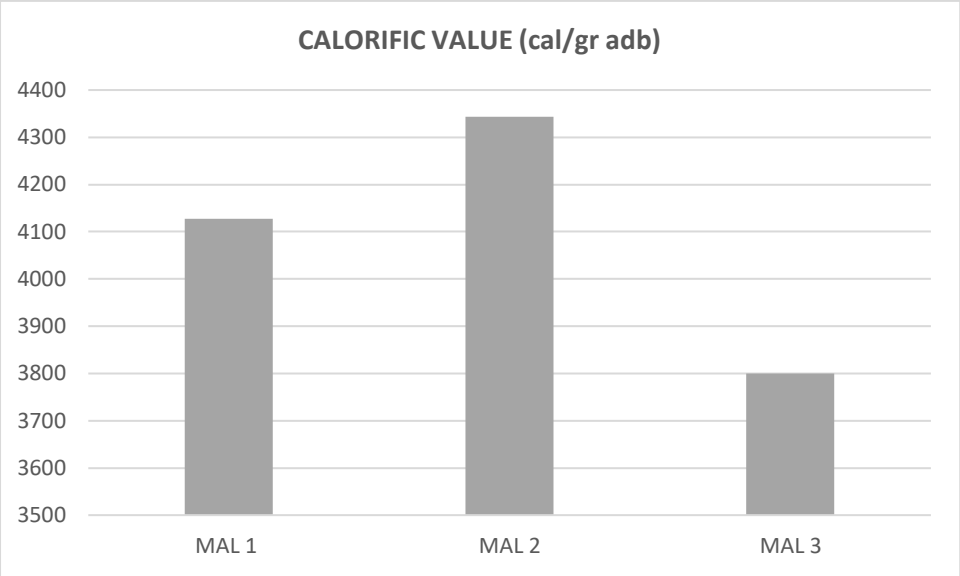

Figure 4. Comparison of calorific values in each of the lower (MAL 1), middle (MAL 2), and upper (MAL 3) samples in the Mallawa Formation coal

Comparison Of Ash And Sulfur Content

The ash content in coal is part of the residue of coal combustion, in the form of fine, amorphous particles. Ash is an inorganic material formed from changes in mineral matter due to the combustion process. Meanwhile, sulfur is one of the elements that form organic and inorganic materials in carbon. From the ash content analysis and Mallawa coal sulfur analysis in Tables 1 and 2, the relationship between ash and sulfur content can be made using linear regression diagrams.

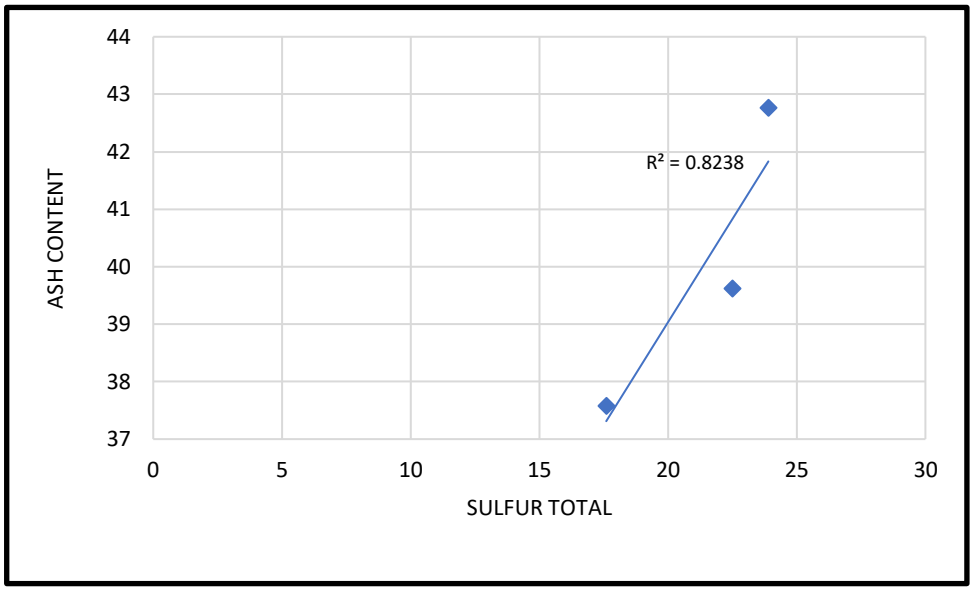

Figure 5. Linear regression graph between total sulfur and ash content in Mallawa Formation coal samples

The comparison graph of ash and sulfur content in Mallawa coal samples on the linear regression graph in Figure 3 shows a strong linear relationship between ash and sulfur content in Mallawa coal, where an increase in the amount of ash content in coal will also be accompanied by an increase in sulfur content. The value indicated on the chart for R^2 is 0.8238, which is close to the number 1. This value shows that 82.38% of the ash content can be explained by changes in total sulfur. In other words, an increase in total sulfur will increase the coal ash content.

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Coal ash is a manifestation of inorganic materials or minerals contained in coal. The average mineral content of the three samples can be calculated by Parr's formula equation.

Average Mineral Matter = 39.99 average *ash* + 2.13 average *sulphur*
= 42.12%

The Average *Ash Content* of the Proxy Analysis results is 39.99% (adb). To classify *the content of Ash* in the *Classification of in Seam Coal* (UN-ECE 1998), it is necessary to convert *Ash* from base (adb) to base (db). Here's how to convert *Ash* base (adb) to *Ash* base (db). Known; *Average Ash* = 39.99% (adb), *Moisture Air dried* (Mad) average = 7.78%, then mathematically it can be determined to average *Ash* in base.

Dry Base (db) as follows:
Avarage Ash (db) = % Average Ash (adb) x (100/(100-Mad))
= 33.99 (adb) x (100/(100-7.78))
= 43.36% (db)

The results of the above calculation reveal that the average ash content (% db) of the three lower, middle, and upper samples if plotted into *the Classification of in Seam Coal* (UN-ECE 1998), then the coal samples are included in very low grade coal.

Mallawa Coal Stage

The graph of the results of the proximate, sulfur and calorific analysis of the Mallawa coal sample showed the different variations that were studied, it was seen that the values of the parameters tested between the top, middle and lower samples showed relatively insignificant differences and did not show any specific patterns in each coal outcrop sample.

The average *Gross Calorific Value of* the three samples (top, middle and bottom) was 834.94 cal/gram (adb). To classify the coal according to the *Classification of in Seam Coal* (UN-ECE 1998), the caloric value base must be converted into *a moist base, ash free* (maf). Therefore, *Moisture Equilibrium* (EQM) or *Moisture Holding Capacity* (MHC) must be known, while in this study it does not determine EQM/MHC.

According to [17] EQM or MHC is a type of *Moisture* which is very difficult to determine because once the coal is taken or removed from the earth, the *Moisture*its (EQM/MHC) will change rapidly. Related to this, the coal outcrop in the research area is located in the seepage of the puddle so that the determination of EQM or MHC is very difficult to do because there has been an addition of water by the puddle. Therefore, the researchers used caloric values in the base *dry, ash free* (daf) in classifying the coal rating according to *Classification of in Seam Coal* (UN-ECE 1998) assuming the caloric value of the base *dry, ash free* (daf) approaching and will not be greater than the caloric value *moist, ash free* (maf). This assumption is based on the theory that the *moist* (water content) reduces the caloric value (MAF < DAF).

Here's how to convert the average calorie value (GCV) of the base (adb) to the base (daf). It is known that the average calorie value = 4090 kcal/kg (adb), *the average moisture air dried* (Mad) = 7.78%, then mathematically the average calorie value in the base (daf) can be determined as follows:

GCV Caloric Value (daf) = GCV Caloric Value (adb) x (100/(100-Mad-Aad))
= 4.090 kcal/kg x (100/(100 - 7.78 – 39.99))
= 4.090 kcal/kg × 1.914
= 7.831 kcal/kg or 32.81 MJ/Kg

The Mallawa coal rating is thus in sub-bituminous (*low rank)* in the 1998 UN-ECE classification.

CONCLUSION

The results that can be concluded in this study are the characteristics of Mallawa Formation coal in the Mallawa Area with an average moisture content of 7.78%, an average ash content of 39.99%, Volatile matter of 32.85% and an average fixed carbon of 19.39 cal/gr, which has a high sulfur content of 2.13%. There was a strong relationship between the ash and sulfur content in coal with a value of R^2 0.8238. Meanwhile, the coal rating based on coal calories is in sub bituminous (*low rank)* using the 1998 UN-ECE classification.

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