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Preface

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PREFACE

The 1st International Conference of Petroleum, Mining, Geology, Geoscience, Energy, and Environmental Technology (ICPMGET) 2024: *Empowering of Earth Resources for Sustainable Energy*

The 1st International Conference of Petroleum, Mining, Geology, Geoscience, Energy, and Environmental Technology (ICPMGET) 2024 is being organized by the Faculty of Earth Technology and Energy, Universitas Trisakti, Indonesia, and was held in a hybrid format on July 24-25, 2024, in Jakarta, Indonesia. The theme of the conference, *"Empowering of Earth Resources for Sustainable Energy,"* plays a part in shaping the future of energy. As the world confronts the dual challenges of meeting rising energy demands while ensuring environmental sustainability, it is important to explore new methods, technologies, and strategies to harness earth resources more efficiently and responsibly. This conference aims to create opportunities for academics, professionals, researchers, and students to collaborate, share, and discuss the innovations in resource management and environmental protection strategies that will drive the transition to a sustainable energy future.

The proceedings of ICPMGET 2024 capture the breadth and depth of the discussions that took place during the conference and peer-reviewed papers that cover a diverse range of topics:

- Earth natural resources and exploration
- Mineralogy and petrology
- Paleontology
- Vulcanology
- Water and Hydrology
- Geological science and engineering
- Geophysics and geochemistry
- Reservoir exploration
- Mining and metallurgical engineering
- Environmental and hazard mitigation
- Policy and energy sustainability.

The diversity of research showcased highlights the interdisciplinary nature of the challenges and solutions facing the energy and resource sectors. The conference was attended by more than 150 participants from Indonesia, South Korea, Japan, Vietnam, Australia, and Thailand and 78 contributed presenters. The output of the conference is well documented in the extended abstract of 66 reviewed papers. The conference proceeding can be beneficial for the authors, institutions, and worldwide scientific communities.

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We extend our deepest gratitude to the honorable speakers for their willingness to share the knowledge:

1. Prof. Shun Chiyonobu (Petroleum Geology, Akita University, Japan)
   Presentation topic: The Hydrocarbon Potential based on The Geological Analyses.
2. Prof. Kun Sang Lee (Petroleum Engineering, Hanyang University, South Korea)
   Presentation topic: Economic Analysis of CO2 Capture, Transportation, and Storage during Water Alternating Gas (WAG) Process.
3. Prof. Ir. Asep Kurnia Permadi, M.Sc., Ph.D (Petroleum Engineering, Institut Teknologi Bandung, Indonesia)
   Presentation Topic: The Potential of Integrated CO2 Enhanced Oil Recovery (EOR) and CCS/CCUS in Indonesia
4. Associate Prof. Dr. Hoai Nga Nguyen (Mining and Geology, Hanoi University and Mining Geology, Vietnam)
   Presentation Topic: Vision Zero and Sustainable and Responsible Mining in Southeast Asia
5. Associate Prof. Dr. Ir. Muhammad Burhannudinnur, M.Sc (Geological Engineering, Universitas Trisakti, Indonesia)
   Presentation Topic: Transition Energy – Leveraging the Opportunities of the Indonesian Oil and Gas Industry and Education.

We appreciate to all the authors, presenters, and participants contributions to sharing ideas and innovations. We also thank our sponsors and partners: BATM Trisakti, PT. Kideco jaya Agung, PT. Elnusa Tbk, PT. Cipta Kridatama, PT. Andamas Global Energi, Ikatan Alumni (IKA) Trisakti, Bank Negara Indonesia (BNI), and Bapak Silmy Karim (Chairman of IKA Trisakti). Special thanks go to the organizing committee, whose dedication and hard work ensured the smooth execution of the conference.

As the global demand for energy and resources rises, the need for continued innovation and sustainable practices has never been more urgent. We hope that the proceedings of ICPMGET 2024 will serve as an essential resource for researchers, professionals, and policymakers, inspiring continued collaboration and progress in the years ahead.

Sincerely,

Dr. Kartika Fajarwati Hartono
(Chairperson of ICPMGET 2024)

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Geochemical Characterization of Rocks to Analyze the Source of Acid Mine Drainage Generation

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Geochemical Characterization of Rocks to Analyze the Source of Acid Mine Drainage Generation

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Abstract. PT. Batubara Lahat, located in South Sumatra province, is a company that conducts coal mining using the open pit method. The open pit mining method creates a flow of water that has low pH properties commonly known as acid mine drainage and then becomes one in the lowest area of mining which is commonly called a sump. Acid mine drainage is water produced through oxidation of sulfide minerals in rocks by oxygen in the air in an aqueous environment. In good mining engineering regulations, companies must be responsible for overcoming the potential for the formation of acid mine drainage, one of which is by analyzing the quality of water that will be formed in testing as a first step by understanding the geochemical characterization of rocks on a laboratory scale. Geochemical characterization of rocks is determined by several laboratory tests, namely, static tests and kinetic tests, where in static tests are usually carried out by measuring total sulfur, paste pH, NAG pH, and Acid Base Accounting (ABA) methods, while in kinetic tests are usually carried out by the Free Draining Column Leach Test (FDCLT) method. The samples used in this study were the side rock samples of PT Lahat Coal, namely BL-A1, BL-A2, BL-B, BL-C, BL-D, BL-E and BL-F. Based on the results of this study, samples BL-A1, BL-A2 are categorized as potentially acidic rocks or PAF while samples BL-B, BL-C, BL-D, BL-E and BL-F are categorized as rocks that are not potentially acidic or NAF. The results of characterizing the geochemistry of these rocks can be a consideration for PT. Batubara Lahat in managing rock dumps in order to meet the environmental standards that have been set.

1. Introduction

Mining with open pit or open mine method are activities that can have a huge environmental impact. Environmentally, the existence of coal mining has an impact on landscape change, decreased soil fertility, threats to biodiversity, decreased water quality, decreased air quality and environmental pollution [1]. The mining industry in post operation also leaves mine pits and acid mine drainage [2]. The exposed area of the coal at the pit wall contacted with water creates low pH water or is called acid mine drainage [3], [4]. Acid mine drainage occurs as a result of the dissolution of sulfide minerals by water, air and microorganisms. Currently, the occurrence of acid mine drainage can damage the environment and pollute the water. Acid mine drainage that flows into waterways can become a pollutant that is toxic to organisms around the waters. Thus, acid mine drainage can also be a serious risk if not handled properly. Acid mine drainage will continue to occur even though mining activities have ceased [5].

Based on the significancy, it is necessary to study the efficient handling of acid mine drainage as a prevention step. One of the first steps is a geochemical study of rocks with laboratory-scale testing, one of which is static testing. Static test is the determination of the presentation of total sulfur and the amount of acid that can be neutralized by the rock by measuring total sulfur, paste pH, NAG pH and Acid Base (ABA), There are measurements of Acid Neutralizing Capacity (ANC), Maximum Potentially Acid (MPA), and Net Acid Producing Potential (NAPP). The static test alone could not be used to categorize the rock Potentially Acid Forming (PAF) or Non-Acid Forming (NAF). Additional tests need to be done to support static test. Static tests alone cannot be used to categorize rocks as Potentially Acid Forming (PAF) or Non-Acid Forming (NAF).

Additional tests need to be carried out to support the static test, namely continued with the kinetic test. kinetic test is a test of the kinetics of acid formation reactions in samples through a simulation of oxidation reactions in rocks and leachate water quality. Through this test, long-term weathering characterization can be predicted as a function of time. The measurements taken in the kinetic test are pH, Total Dissolved Solid (TDS), Oxidation Reduction Potential (ORP) and Electric Conductivity (EC). The purpose of this research can be a reference to prevent the potential formation of acid mine drainage.

Figure 1. The area where rock samples were taken

2. Method

2.1. Sampling

The research was conducted using experimental methods and quantitative approaches by conducting grab sampling in 7 locations that are considered representative of lithological and stratigraphic conditions that can be seen from the type of rock, composition and minerals in the sampling. it can be seen in the Figure 1, that there are several layers on the wall to the west with different colors of rock composition so that between the layers representative samples can be taken.

2.2. Laboratory Testing

The samples were prepared by drying, splitting, and comminution (crushing, grinding, and milling) in order to meet the required weight and size for the subsequent testing and analysis, which are Static and Kinetic Test. Static test as the first step in geochemical characterization studies on rocks, this test is assessed to obtain results between acid-forming components, namely sulfide minerals and acid-consuming components, namely carbonate minerals in the sample. The purpose of this static test is to provide an overview of the potential acidity that can be neutralized by the sample based on the composition of the rock sample and the results can be used to determine the rock category between PAF or NAF temporarily. In general, there are two categories of tests to determine the potential for acid formation, namely the acid- base calculation (ABA) test, namely the difference between the maximum acid potential and the acid neutralizing capacity and the NAG test which is carried out by adding strong acid (H2O2) [6] The static test is conducted based on SNI 6597: 2021 concerning rock characterization tests for determining the potential for acid mine drainage formation.

The kinetic test is a test that can be conducted in the laboratory where it aims to determine the kinetics of the acid formation reaction of the sample by simulating the oxidation reaction test on the rock. The information obtained from this kinetic test can provide validation of the potential for acid mine drainage formation, the amount of sulfur percentage and acid generation, the reduction in neutralization potential and determine the appropriate test strategy to evaluate acid mine drainage management. In this kinetic test, simulations are carried out using two conditions, namely wet watering conditions and dry conditions where the two conditions can be carried out with daily, weekly and even monthly cycles. In the wet cycle, distilled water are sprayed onto the surface of the rock sample with several variables of water volume in accordance with the ability of the rock to release leach water, then the leach water is collected in a container such as an erlenmeyer. Later, several parameters measured, namely pH, Total Dissolved Solid (TDS), Oxidation Reduction Potential (ORP), and Electrivity Conductivity (EC) [7]. The kinetic tests is conducted based on AMIRA 2002.

3. Results and Discussion

3.1. Static Test

Based on Figure 2 and Table 1, the geochemical classification results of the relationship graph between NAPP and pH NAG in rock samples can be explained as follows: Sample BL A1 with NAPP result (-13.90) Kg H_2SO_4/ton; pH NAG 6.37; Sample BL A2 with NAPP result (-25.75) Kg H_2SO_4/ton; pH NAG 11.76; Sample BL C rock with NAPP result (-9.17) Kg H_2SO_4/ton; pH NAG 6.08; and Sample BL D rock with NAPP results (-24.23) Kg H_2SO_4/ton; pH NAG 4.90. So that the four rock samples meet the requirements in rock classification by having NAPP results < 0 and NAG pH > 4.5 namely with Non-Acid Forming (NAF) rock types [8]. While the other three rock samples with the following results: BL B rock sample with NAPP results (-55.80) Kg H_2SO_4/ton; pH NAG 2.74; BL E rock sample with NAPP result (-21.97) Kg H_2SO_4/ton; pH NAG 3 and BL F rock sample with NAPP result (-30.57) Kg H_2SO_4 and pH NAG 3.53. Where these three samples have NAPP results < 0 but NAG PH < 4.5 this makes the two samples included in the Uncertain (UC) rock type. Because according to the rock classification requirements of the two types of rock classification, PAF rocks with NAG pH < 4.5 with NAPP > 0 while the type of NAF rock classification with NAG pH > 4.5 with NAPP < 0 [8].

The three uncertain rock samples can be determined again by looking at the pH paste test results so that the rock type can be identified. The pH paste results are as follows: BL B with a pH paste test result of 7.90; BL E with a pH paste test result of 7.3; and BL F with a pH paste test result

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of 7.3; Based on the pH paste results, the three samples can be classified into Non-Acid Forming (NAF) rock types. Apart from pH paste, data validation can be done by comparing ANC and MPA called Net Potential Ratio (NPR). From the NPR value in Figure 3, it has been determined that for the three uncertain samples, BL B, BL E and BL F have an NPR value > 2, which means that the rock samples are NAF. In the results of the tests carried out to determine indeterminate rock samples, namely from the measurement of pH paste and NPR, the material can be classified.

Table 1. Result of Static Test

Sample Name	TS (%)	MPA*	ANC*	NAPP*	NAG	pH Pasta	Type of Rock
BL-A1	0.48	14.56	28.46	-13.90	6.37	5.9	NAF
BL-A2	0.71	21.71	47.46	-25.75	11.76	5.6	NAF
BL-B	0.36	10.90	66.70	-55.80	2.74	7.9	UC
BL-C	0.63	19.29	28.46	-9.17	6.08	6.2	NAF
BL-D	0.97	29.64	53.87	-24.23	4.90	5.9	NAF
BL-E	0.75	22.93	44.90	-21.97	3.92	73	UC
BL-F	0.76	23.31	53.87	-30.57	3.53	7.3	UC

Note: *in Kg H_2SO_4 /ton, TS: Total Sulphure; ANC: acid-neutral capacity; NAG: Net Acid Generation; MPA: Maximum Potentially Acidity; NAPP: net acid production potential.

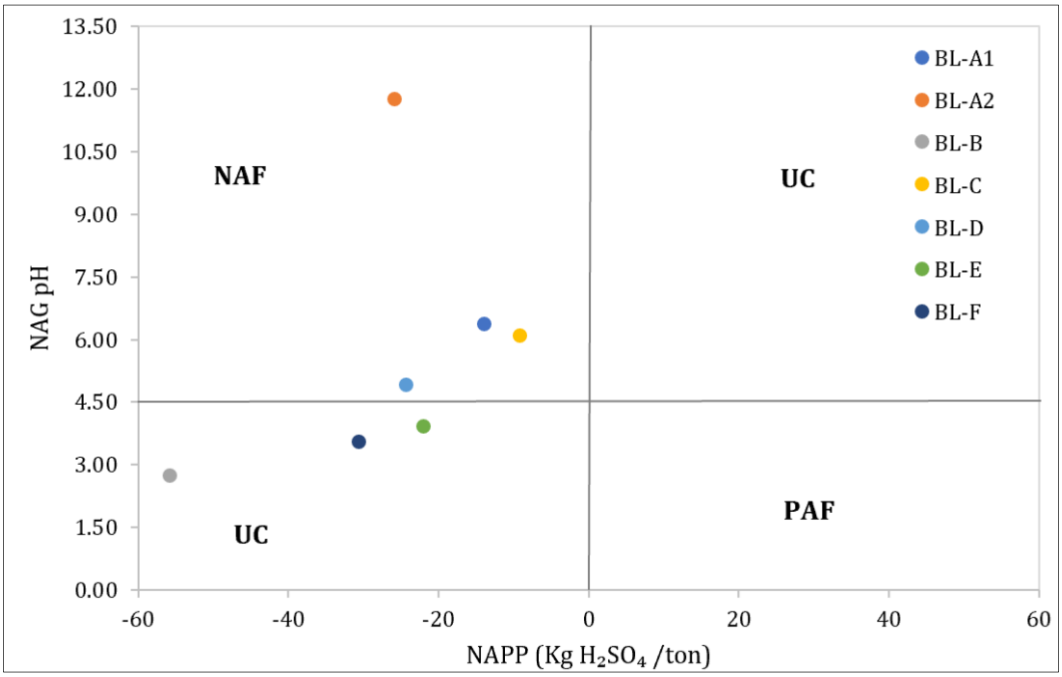

Figure 2. Graph of the Relationship Between NAPP and NAG pH

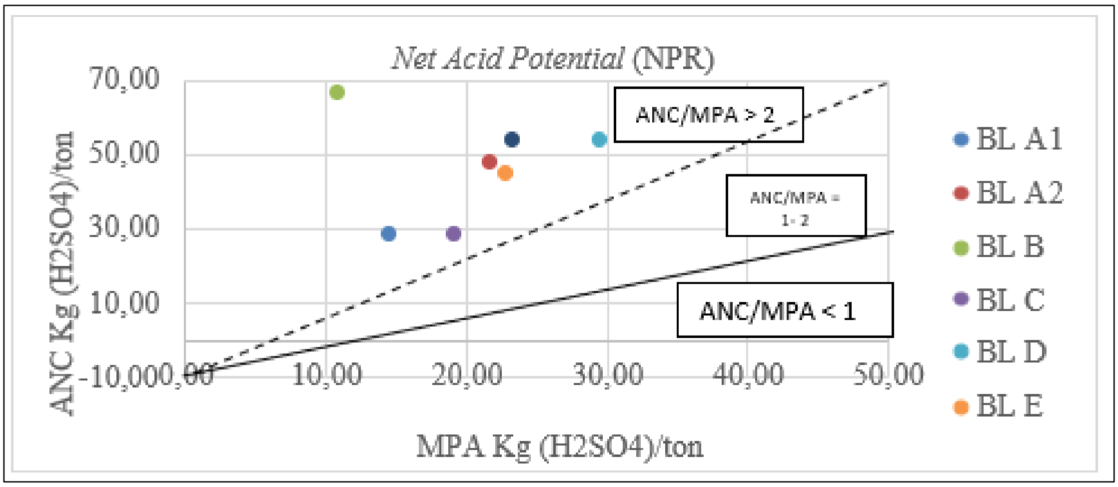

Figure 3. Comparison Chart of ANC Values with MPA

Table 2. Rock classification from the comparison results of pH paste and NPR

Sample	pH pasta	NPR	Rock Type
BL-B	7.9	> 2	NAF
BL-E	7.3	1-2	NAF
BL-F	7.3	> 2	NAF

3.2. Kinetic Test

Kinetic tests were conducted at the Rock Geomechanics Laboratory, Faculty of Earth and Energy Technology, Trisakti University. Tests that have been carried out with a daily cycle, namely with a daily period of 25 days using measurement parameters namely pH, Total Dissolved Solid (TDS), Oxidation Reduction Potential (ORP), and Electrivity Conductivity (EC). Based on the Table 3, samples BL A1 and BL A2 are classified as PAF rock types, although in the static test interpretation the two samples show the NAF rock type, but from the kinetic test results the two samples produce pH values that are in accordance with the pH requirements of AAT, namely < 4.5. Meanwhile, BL C and BL D are classified as NAF rock types both from the static test interpretation results and the kinetic test interpretation where the two samples are in accordance with those that are not classified as AAT. Furthermore, BL B, BL E and BL F in the static test interpretation results are classified as UC rocks but interpretation results the three samples are classified as NAF rock types because the results of the kinetic test are the process of oxidation and leaching of rocks whose processes are formed naturally in the field not mixed with climatic materials or reagents given or other treatments to the sample. So that the kinetic test is more confident in the accuracy of the results compared to the results of the static test [9].

Table 3. Geochemical Characterization of Rocks

Sample	Static Test Result	Kinetic Test Result	Classification of Rocks
BL-A1	NAF	PAF	PAF
BL-A2	NAF	PAF	PAF
BL-B	UC	NAF	NAF
BL-C	NAF	NAF	NAF
BL-D	NAF	NAF	NAF
BL-E	UC	NAF	NAF
BL-F	UC	NAF	NAF

3.3. Distribution of PAF and NAF

In the study that has been carried out supported by static test and kinetic tests, it can be concluded in accordance with table-3 above the results of the geochemical characterization of kinetic test rocks where the data is valid, as validation of data from static tests, then from the test results can be made the distribution of PAF and NAF areas in the western pit mining sidewall and mining seam. Based on Figure 4, the distribution of PAF and NAF areas on the side walls of the mining pit can be separated by colored lines based on lithology and rock stratigraphy. it can be explained that: Gray color line is Roof & Floor (BL A1 & BL A2) coal whose rock type is PAF; Gray-yellow color line is soil (BL B) whose rock type is NAF; Yellow-green color line is clay rock (BL C) whose rock type is NAF; Green color line is siltstone (BL D) whose rock type is NAF; and Blue and Aquamarine color lines are sandstone (BL E & BL F) whose rock type is NAF.

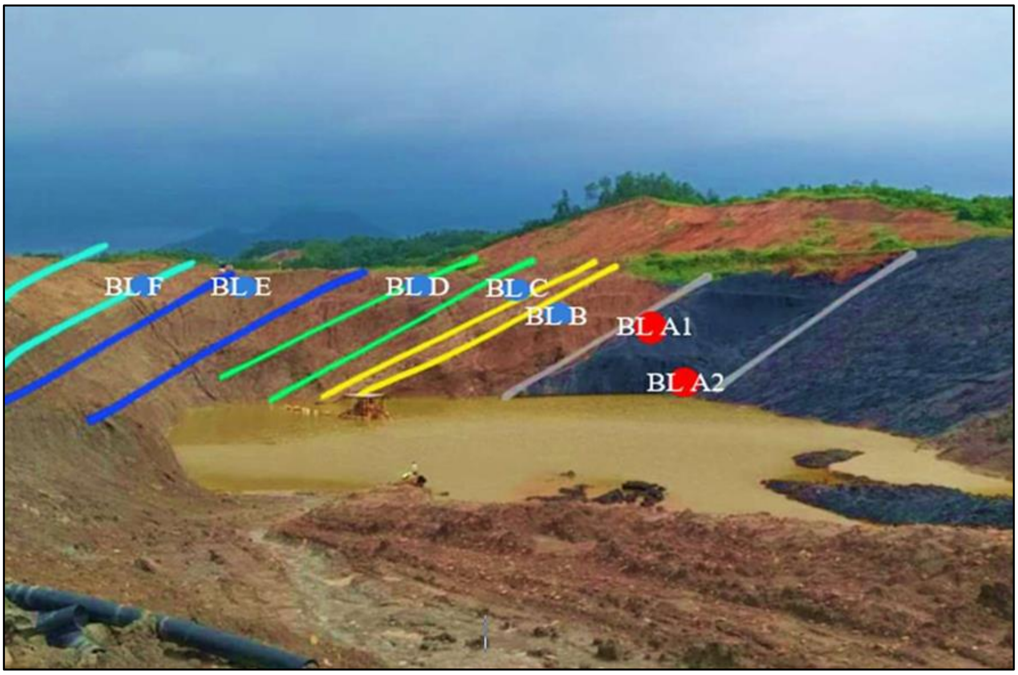

Figure 4. Distribution of PAF and NAF in the West Pit of PT Batubara Lahat

4. Conclusion

Based on the static tests conducted on a laboratory scale, the geochemical characterization of rocks in coal mining wall samples at PT Batubara Lahat can be concluded as follows: The geochemical characterization of rocks in side rock samples based on the static test, 4 samples are NAF, (BL A1, BL A2, BL C, and BL D), while for the other 3 samples are UC (BL B, BL E and BL); The results of the kinetic test verification resulted in 2 PAF samples, (BL A1 and BL) A2 and 5 other samples are NAF, (BL B, BL C, BL D, BL E, and BL F), and The results of geochemical characterization carried out in kinetic tests can represent the distribution of PAF and NAF at the PT Batubara Lahat coal mining site.

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by FTKE Ririn Yulianti

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Abstract. PT. Batubara Lahat, located in South Sumatra province, is a company that conducts coal mining using the open pit method. The open pit mining method creates a flow of water that has low pH properties commonly known as acid mine drainage and then becomes one in the lowest area of mining which is commonly called a sump. Acid mine drainage is water produced through oxidation of sulfide minerals in rocks by oxygen in the air in an aqueous environment. In good mining engineering regulations, companies must be responsible for overcoming the potential for the formation of acid mine drainage, one of which is by analyzing the quality of water that will be formed in testing as a first step by understanding the geochemical characterization of rocks on a laboratory scale. Geochemical characterization of rocks is determined by several laboratory tests, namely, static tests and kinetic tests, where in static tests are usually carried out by measuring total sulfur, paste pH, NAG pH, and Acid Base Accounting (ABA) methods, while in kinetic tests are usually carried out by the Free Draining Column Leach Test (FDCLT) method. The samples used in this study were the side rock samples of PT Lahat Coal, namely BL-A1, BL-A2, BL-B, BL-C, BL-D, BL-E and BL-F. Based on the results of this study, samples BL-A1, BL-A2 are categorized as potentially acidic rocks or PAF while samples BL-B, BL-C, BL-D, BL-E and BL-F are categorized as rocks that are not potentially acidic or NAF. The results of characterizing the geochemistry of these rocks can be a consideration for PT. Batubara Lahat in managing rock dumps in order to meet the environmental standards that have been set.

1. Introduction

Mining with open pit or open mine method are activities that can have a huge environmental impact. Environmentally, the existence of coal mining has an impact on landscape change, decreased soil fertility, threats to biodiversity, decreased water quality, decreased air quality and environmental pollution [1]. The mining industry in post operation also leaves mine pits and acid mine drainage [2]. The exposed area of the coal at the pit wall contacted with water creates low pH water or is called acid mine drainage [3], [4]. Acid mine drainage occurs as a result of the dissolution of sulfide minerals by water, air and microorganisms. Currently, the occurrence of acid mine drainage can damage the environment and pollute the water. Acid mine drainage that flows into waterways can become a pollutant that is toxic to organisms around the waters. Thus, acid mine drainage can also be a serious risk if not handled properly. Acid mine drainage will continue to occur even though mining activities have ceased [5].

Based on the significancy, it is necessary to study the efficient handling of acid mine drainage as a prevention step. One of the first steps is a geochemical study of rocks with laboratory-scale testing, one of which is static testing. Static test is the determination of the presentation of total sulfur and the amount of acid that can be neutralized by the rock by measuring total sulfur, paste pH, NAG pH and Acid Base (ABA), There are measurements of Acid Neutralizing Capacity (ANC), Maximum Potentially Acid (MPA) and Net Acid Producing Potential (NAPP). The static test alone could not be used to categorize the rock Potentially Acid Forming (PAF) or Non-Acid Forming (NAF). Additional tests need to be done to support static test. Static tests alone cannot be used to categorize rocks as Potentially Acid Forming (PAF) or Non-Acid Forming (NAF).

Additional tests need to be carried out to support the static test, namely continued with the kinetic test. kinetic test is a test of the kinetics of acid formation reactions in samples through a simulation of oxidation reactions in rocks and leachate water quality. Through this test, long-term weathering characterization can be predicted as a function of time. The measurements taken in the kinetic test are pH, Total Dissolved Solid (TDS), Oxidation Reduction Potential (ORP) and Electric Conductivity (EC). The purpose of this research can be a reference to prevent the potential formation of acid mine drainage.

Figure 1. The area where rock samples were taken

2. Method

2.1. Sampling

The research was conducted using experimental methods and quantitative approaches by conducting grab sampling in 7 locations that are considered representative of lithological and stratigraphic conditions that can be seen from the type of rock, composition and minerals in the sampling. it can be seen in the Figure 1, that there are several layers on the wall to the west with different colors of rock composition so that between the layers representative samples can be taken.

2.2. Laboratory Testing

The samples were prepared by drying, splitting, and comminution (crushing, grinding, and milling) in order to meet the required weight and size for the subsequent testing and analysis, which are Static and Kinetic Test. Static test as the first step in geochemical characterization studies on rocks, this test is assessed to obtain results between acid-forming components, namely sulfide minerals and acid-consuming components, namely carbonate minerals in the sample. The purpose of this static test is to provide an overview of the potential acidity that can be neutralized by the sample based on the composition of the rock sample and the results can be used to determine the rock category between PAF or NAF temporarily. In general, there are two categories of tests to determine the potential for acid formation, namely the acid- base calculation (ABA) test, namely the difference between the maximum acid potential and the acid neutralizing capacity and the NAG test which is carried out by adding strong acid (H2O2) [6]. The static test is conducted based on SNI 6597: 2021 concerning rock characterization tests for determining the potential for acid mine drainage formation.

The kinetic test is a test that can be conducted in the laboratory where it aims to determine the kinetics of the acid formation reaction of the sample by simulating the oxidation reaction test on the rock. The information obtained from this kinetic test can provide validation of the potential for acid mine drainage formation, the amount of sulfur percentage and acid generation, the reduction in neutralization potential and determine the appropriate test strategy to evaluate acid mine drainage management. In this kinetic test, simulations are carried out using two conditions, namely wet watering conditions and dry conditions where the two conditions can be carried out with daily, weekly and even monthly cycles. In the wet cycle, distilled water are sprayed onto the surface of the rock sample with several variables of water volume in accordance with the ability of the rock to release leach water, then the leach water is collected in a container such as an erlenmeyer. Later, several parameters measured, namely pH, Total Dissolved Solid (TDS), Oxidation Reduction Potential (ORP), and Electrivity Conductivity (EC) [7]. The kinetic tests is conducted based on AMIRA 2002.

3. Results and Discussion

3.1. Static Test

Based on Figure 2 and Table 1, the geochemical classification results of the relationship graph between NAPP and pH NAG in rock samples can be explained as follows: Sample BL A1 with NAPP result (-13.90) Kg H_2SO_4/ton; pH NAG 6.37; Sample BL A2 with NAPP result (-25.75) Kg H_2SO_4/ton; pH NAG 11.76; Sample BL C rock with NAPP result (-9.17) Kg H_2SO_4/ton; pH NAG 6.08; and Sample BL D rock with NAPP results (-24.23) Kg H_2SO_4/ton; pH NAG 4.90. So that the four rock samples meet the requirements in rock classification by having NAPP results < 0 and NAG pH > 4.5 namely with Non-Acid Forming (NAF) rock types [8]. While the other three rock samples with the following results: BL B rock sample with NAPP results (-55.80) Kg H_2SO_4/ton; pH NAG 2.74; BL E rock sample with NAPP result (-21.97) Kg H_2SO_4/ton; pH NAG 3 and BL F rock sample with NAPP result (-30.57) Kg H_2SO_4 and pH NAG 3.53. Where these three samples have NAPP results < 0 but NAG PH < 4.5 this makes the two samples included in the Uncertain (UC) rock type. Because according to the rock classification requirements of the two types of rock classification, PAF rocks with NAG pH < 4.5 with NAPP > 0 while the type of NAF rock classification with NAG pH > 4.5 with NAPP < 0 [8].

The three uncertain rock samples can be determined again by looking at the pH paste test results so that the rock type can be identified. The pH paste results are as follows: BL B with a pH paste test result of 7.90; BL E with a pH paste test result of 7.3; and BL F with a pH paste test result of 7.3; Based on the pH paste results, the three samples can be classified into Non-Acid Forming (NAF) rock types. Apart from pH paste, data validation can be done by comparing ANC and MPA called Net Potential Ratio (NPR). From the NPR value in Figure 3, it has been determined that for the three uncertain samples, BL B, BL E and BL F have an NPR value > 2, which means that the rock samples are NAF. In the results of the tests carried out to determine indeterminate rock samples, namely from the measurement of pH paste and NPR, the material can be classified.

Table 1. Result of Static Test

Sample Name	TS (%)	MPA*	ANC*	NAPP*	NAG	pH Pasta	Type of Rock
BL-A1	0.48	14.56	28.46	-13.90	6.37	5.9	NAF
BL-A2	0.71	21.71	47.46	-25.75	11.76	5.6	NAF
BL-B	0.36	10.90	66.70	-55.80	2.74	7.9	UC
BL-C	0.63	19.29	28.46	-9.17	6.08	6.2	NAF
BL-D	0.97	29.64	53.87	-24.23	4.90	5.9	NAF
BL-E	0.75	22.93	44.90	-21.97	3.92	73	UC
BL-F	0.76	23.31	53.87	-30.57	3.53	7.3	UC

Note: *in Kg H_2SO_4 /ton, TS: Total Sulphure; ANC: acid-neutral capacity; NAG: Net Acid Generation; MPA: Maximum Potentially Acidity; NAPP: net acid production potential.

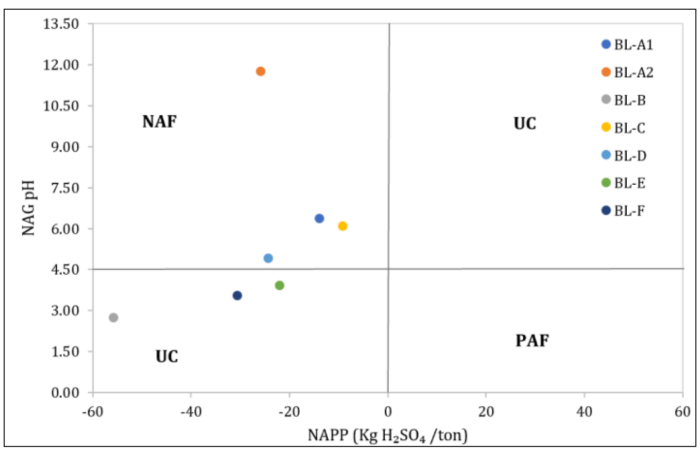

Figure 2. Graph of the Relationship Between NAPP and NAG pH

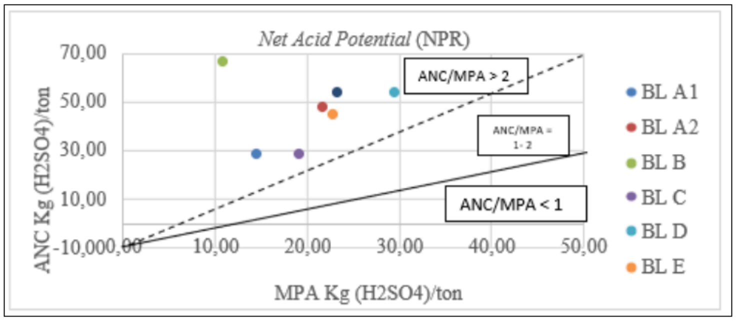

Figure 3. Comparison Chart of ANC Values with MPA

Table 2. Rock classification from the comparison results of pH paste and NPR

Sample	pH pasta	NPR	Rock Type
BL-B	7.9	> 2	NAF
BL-E	7.3	1-2	NAF
BL-F	7.3	> 2	NAF

3.2. Kinetic Test

Kinetic tests were conducted at the Rock Geomechanics Laboratory, Faculty of Earth and Energy Technology, Trisakti University. Tests that have been carried out with a daily cycle, namely with a daily period of 25 days using measurement parameters namely pH, Total Dissolved Solid (TDS), Oxidation Reduction Potential (ORP), and Electrivity Conductivity (EC). Based on the Table 3, samples BL A1 and BL A2 are classified as PAF rock types, although in the static test interpretation the two samples show the NAF rock type, but from the kinetic test results the two samples produce pH values that are in accordance with the pH requirements of AAT, namely < 4.5. Meanwhile, BL C and BL D are classified as NAF rock types both from the static test interpretation results and the kinetic test interpretation where the two samples are in accordance with those that are not classified as AAT. Furthermore, BL B, BL E and BL F in the static test interpretation results are classified as UC rocks but interpretation results the three samples are classified as NAF rock types because the results of the kinetic test are the process of oxidation and leaching of rocks whose processes are formed naturally in the field not mixed with climatic materials or reagents given or other treatments to the sample. So that the kinetic test is more confident in the accuracy of the results compared to the results of the static test [9].

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Table 3. Geochemical Characterization of Rocks

Sample	Static Test Result	Kinetic Test Result	Classification of Rocks
BL-A1	NAF	PAF	PAF
BL-A2	NAF	PAF	PAF
BL-B	UC	NAF	NAF
BL-C	NAF	NAF	NAF
BL-D	NAF	NAF	NAF
BL-E	UC	NAF	NAF
BL-F	UC	NAF	NAF

3.3. Distribution of PAF and NAF

In the study that has been carried out supported by static test and kinetic tests, it can be concluded in accordance with table-3 above the results of the geochemical characterization of kinetic test rocks where the data is valid, as validation of data from static tests, then from the test results can be made the distribution of PAF and NAF areas in the western pit mining sidewall and mining seam. Based on Figure 4, the distribution of PAF and NAF areas on the side walls of the mining pit can be separated by colored lines based on lithology and rock stratigraphy. it can be explained that: Gray color line is Roof & Floor (BL A1 & BL A2) coal whose rock type is PAF; Gray-yellow color line is soil (BL B) whose rock type is NAF; Yellow-green color line is clay rock (BL C) whose rock type is NAF; Green color line is siltstone (BL D) whose rock type is NAF; and Blue and Aquamarine color lines are sandstone (BL E & BL F) whose rock type is NAF.

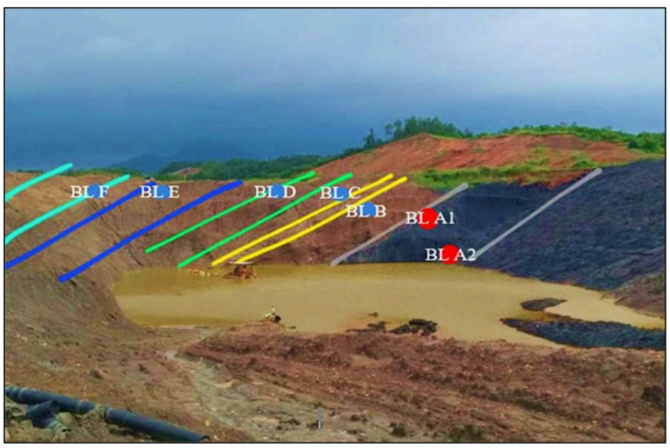

Figure 4. Distribution of PAF and NAF in the West Pit of PT Batubara Lahat

4. Conclusion

Based on the static tests conducted on a laboratory scale, the geochemical characterization of rocks in coal mining wall samples at PT Batubara Lahat can be concluded as follows: The geochemical characterization of rocks in side rock samples based on the static test, 4 samples are NAF, (BL A1, BL A2, BL C, and BL D), while for the other 3 samples are UC (BL B, BL E and BL); The results of the kinetic test verification resulted in 2 PAF samples, (BL A1 and BL) A2 and 5 other samples are NAF, (BL B, BL C, BL D, BL E, and BL F), and The results of geochemical characterization carried out in kinetic tests can represent the distribution of PAF and NAF at the PT Batubara Lahat coal mining site.

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