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# Analysis of overburden and interburden layer to predict acid mine drainage by use of Geo-Penetrating Radar Investigation

S Siti<sup>1\*</sup>, Erni<sup>1</sup>, V Frinsyah<sup>1</sup>, I Eddy<sup>2</sup>, S Dedi<sup>1</sup>, H M Faizal<sup>3</sup>

<sup>1</sup>Physic Department of MIPA Faculty, Sriwijaya University, Inderalaya, Ogan Ilir, Indonesia

<sup>2</sup>Mining Department of Engineering Faculty, Sriwijaya University, Ogan Ilir, Indonesia

<sup>3</sup>Chemical Department of Engineering Faculty, Sriwijaya University, Ogan Ilir, Indonesia

\*siti.sailah@unsri.ac.id

**Abstract.** In this study, the prediction of acid mine drainage was done by measuring dielectric contrast of sulphide mineral and its environment. It causes amplitude contrast of radar wave reflected by rock layer. This measurement was performed using electromagnetic method by use of Geo-Penetrating Radar or Georadar (GPR). The frequency of measurement was 250 MHz with perpendicular broadside antenna. It took place at pre-mining area whereas the surface soil was dry. GPR data was processed for enhancing data and amplification. The result of this research showed that the overburden and interburden layers were dominated by claystone or siltstone with little sandstone. The multiple that appear in the processed data looks relatively regular and evenly distributed in the layer, not spots which are characteristic of sulfide minerals.

## 1. Introduction

One of the many mining commodities being cultivated today, to meet the energy needs in Indonesia, is coal. The potential of Indonesian coal resources as of 1 January 2011 reached more than 120 billion tons consisting of nearly 28% of hypothetical resources, almost 30% of inferred resources, over 22% of estimated resources, and around 20% of measured resources [1].

On the other hand, coal mining in Indonesia is generally carried out by way of open mining, although there are some that use underground mining, so that it will have an impact on changes in the landscape, physical, chemical, and biological properties of the soil, and generally cause damage on the surface of the earth. This impact will automatically disrupt the ecosystem above it, including the water system [2]. This happens due to rock dissolution and oxidation process from mining waste material which will produce acid mine drainage (AMD) with low pH which is undesirable and dangerous for the environment.

Research based on the Geo-Penetrating Radar (GPR) method has been carried out by several researchers in an effort to map and investigate subsurface. The results of the study using the GPR and VES (Vertical Electrical Sounding) Geoelectric method show coherently the upper part of the contamination that moves laterally in the landfill site [3]. In 2005, GPR and other electromagnetic methods were successfully applied to map the internal structure and distribution of conductive rocks in New Mexico [4]. Three geological layers are identified and the infiltration test is monitored with a GPR that shows the flow path [5]. Zhang



(2012) has also shown a mathematical relationship between radar wave frequency, attenuation and water content in the soil [6]. But from all the studies using the GPR method, it cannot yet be proven that the GPR method is able to detect the presence of sulfide minerals as a major factor in forming acid mine drainage. Literature studies show that geophysical methods that are able to detect the presence of sulfide minerals are IP (Induced Polarization) and SP (Spontaneous Potential) methods. Therefore, this research tried to show whether the GPR method is able to indicate the presence of sulfide minerals or not.

## 2. Methodology

### 2.1. Site Description

This research was conducted in the western Banko mining area in Tanjung Enim. The West Banko mine area was chosen as the location of the study because this area still leaves a fundamental problem with acid mine water management. While on the other hand, according to the Research Center for Mineral and Coal Technology, West Banko is very potential to be developed because the slope is still stable and with a stripping ratio of "waste / coal ratio" ranging from 1.32 to 2.57. Location map of Banko barat is shown in figure 1.



**Figure 1.** Location Map of the Research

### 2.2. Equipment

The measurement tool used is a Geo Penetrating Radar (GPR) unit. The tool is an OKKO georadar tool with a frequency of 250 MHz AB as shown in figure 2. The dielectric permittivity input used is a sandstone permittivity of 4. The distance between the transmitter antenna and the fixed receiver (fixed offset) and the shielded frequency antenna (the transmitter and receiver antenna are already in one container).



**Figure 2.** Georadar OKKO with frequency of 250 MHz

### 2.3. Measurement

The measurement was performed by the surface reflection profiling method. The measurement direction (x direction) is perpendicular to the transmitter and receiver antennas (y direction). While the antenna configuration used is the perpendicular broadside method. Measurements were made in dry soil conditions assuming the surface layer is sandstone. This causes the dielectric permittivity input used is a sandstone permittivity of 4.

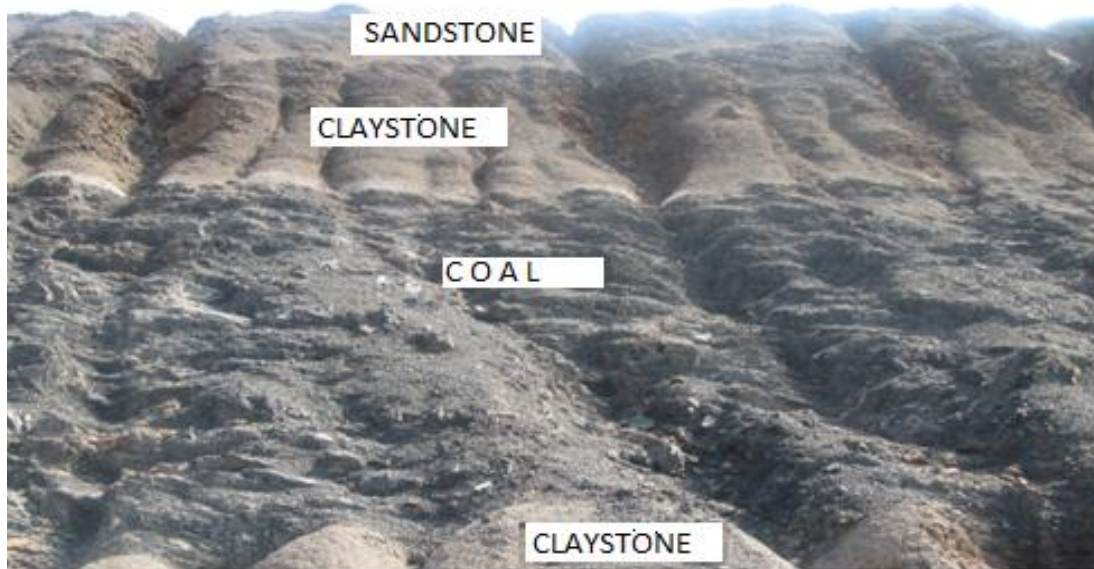
In principle, the transmitter antenna emits electromagnetic waves and is received by the receiver in the form of a radargram which in turn will show the electromagnetic properties of the rock layers beneath.

### 3. Result and Discussion

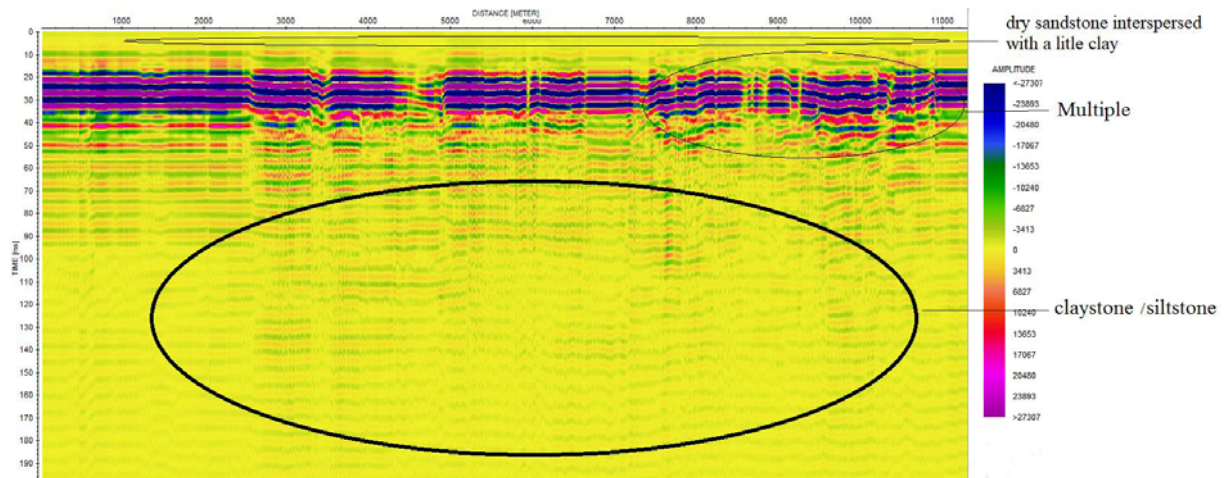
Physically outcrops in the study area showing several layers of overburden, interburden and coal as shown in Figure 3. Before interpretation, the GPR measurement results are processed first. Stages of data processing include Gain (signal amplification), DC Removal (reducing or even eliminating the effects of low frequency signals), Dewow (high pass filter), and band pass filter. The results of GPR data processing are shown in Figure 4.

The result of GPR data processing shows that there are multiple. The multiple basically arises due to the presence of strong reflectors so that the reflection on the GPR is repetitive and generally has a large amplitude contrast to the surroundings. These strong reflectors can be noise. Noise in coal seams is usually in the form of impurities. While the mineral sulphide (pyrite) in the form of spots is scattered irregularly and unevenly in the rock layer. In general, pyrite in nature is found in the form of veins or lenses with small sizes. These minerals can be in clay or coal layers which have high Fe and high sulfur content.

Contrast dielectric constant or relative dielectric permittivity of rocks will cause differences in wave propagation velocity and the difference in amplitude of the reflection signal. Based on differences in permittivity or dielectric constants that cause differences in the amplitude of the reflection signal, layers or lithology can be identified by the electromagnetic waves. GPR The layers of rocks that are found are clay rocks (claystone), intercalated coal, and a little siltstone.



**Figure 3.** Overburden and interburden outcrops



**Figure 4.** Results of GPR data processing

GPR measurements using electromagnetic wave propagation show the contrast of the dielectric permittivity. But the results of this study (Figure 4) show that multiple appears to indicate more noise that can accompany coal or other rock layers because the multiple is orderly and evenly distributed. This is not a characteristic of sulfide minerals. Beside that dielectric contrast caused by fluid saturated rock will produce electromagnetic impedance contrast between the saturated part and the unsaturated part. This will cause a difference in the reflection of the GPR pulse. Water that is conductive will cause strong and repetitive reflections (multiple). This fact is also shown in rock layers containing pyrite because pyrite is conductive and has a high dielectric constant like water while clay has a relatively low dielectric constant. This fact raises ambiguity in the interpretation of GPR data. Therefore, other supporting data is needed to produce the correct interpretation of the GPR.

#### 4. Conclusion

GPR measurement of 250 MHz frequency does not significantly indicate the presence of sulfide minerals. Multiple of the research result is dominantly caused by impurities like noise and not sulphide minerals. The multiple that appear looks relatively regular and evenly distributed in the layer, not spots which are characteristic of sulfide minerals. Therefore, application of GPR for mineral environmental problems related to acid mine drainage is more commonly used to detect the direction of mine acid water flow after it is formed, while the application of GPR to detect the presence of sulfide minerals should use the right frequency and antenna configuration.

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