



## Study of Physical Properties of Rocks and Acid Mine Drainage Potential at Banko Barat Tanjung Enim

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### ABSTRACT

One of the factors that generate acid mine drainage (AMD) is the presence of sulphide minerals in rocks because sulphide minerals will have oxidation with oxygen and water to generate AMD. Learning sulphide minerals in rocks can not be separated from the rocks themselves. Present paper is an attempt to study how the physical properties of rocks are and their influences in generating acid mine drainage. At Banko barat, especially at PIT 3 timur, the lithology of rocks is complex. It is assumed that the complexity of rocks will influence the complexity of formation of acid mine drainage. Thus by knowing the characteristics of each rock it is expected to be useful in identification of which rocks require special attention in the mine planning process.

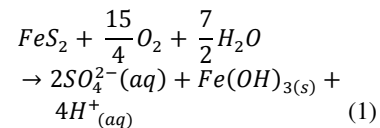
Keyword: acid mine drainage, rocks, physical properties of rock.

### 1. INTRODUCTION

One of coal mining problems is the presence of acid mine drainage waste. AMD becomes an environmental problem when natural forms of neutralization such as carbonate minerals are not available in sufficient quantities to neutralize the drainage. The metal rich, low pH effluent is highly toxic to life downstream of the waste rock pile, e.g. Barry et al. (2000), Soucek et al. (2001) [1,2]. Acid mine drainage is very dangerous for environment so that it is very important to identify factors affecting AMD formation.

Factors that control formation of acid mine drainage can be classified into two broad categories : 1) source characteristics/factors such as type, sulphide distribution and abundance, and other minerals with their acid neutralization capacity (ANC), rock texture and type, pore and interconnectivity (porosity and permeability), segregation and compaction degree, and 2) other environment factors such as climate, rainfall, air temperature, hydrogeology, waste volume and disposal method [3].

In general, pyrite (FeS<sub>2</sub>) is a sulphide mineral that is commonly found on the waste rocks and will have oxidation when exposed. The typical oxidation is in accordance with the following reaction [4] :



The characteristics of sulphide-bearing rocks play important role in formation of acid mine drainage. Consequently this study was particularly intended to understand characteristics of rocks especially their physical properties and acid mine drainage potential at Banko barat Tanjung Enim.

### 2. METHODS

In order to achieve the aims of the study, some core samples from different wells were used to be analysed. Samples consist of coal and non-coal lithologies of boreholes located in PIT 3 Timur Banko Barat Bukit Asam coal mining area. Goals of laboratory analysis are to determine some physical properties such as density and porosity; and while acid mine drainage potential was reviewed through literature study compared to physical properties results and secondary data (rock acidity analysis) from PT. BA analysis result.

Laboratory analysis was done by measuring rock parameters and mineralogy analysis with use of X-Ray Diffraction and SEM-EDS.

### 3. RESULTS

#### 3.1 Waste Rocks at Mine Site

Rock samples were obtained from PIT 3 timur and analysed using XRD. Result of overburden and interburden layer is shown by Figure 1 and 2.

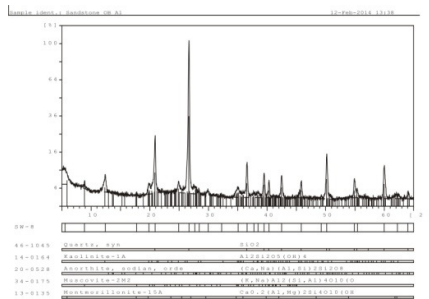


Figure 1. XRD Analysis of Sandstone of Overburden Layer

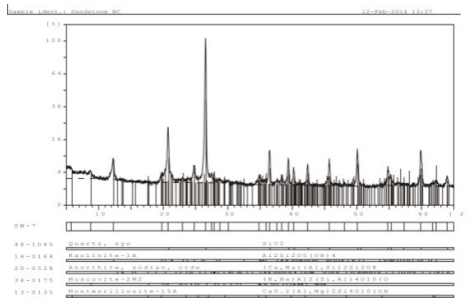


Figure 2. XRD Analysis of Sandstone of Interburden Layer

Results of overburden and interburden layer show that there is no indication of pyrite mineral. It is assumed that the condition of samples is no longer fresh caused by contamination from outside influences or the origin condition of samples itself. Because pyrite is basically not spread evenly on a rock.

Rock morphology and element content of rock from SEM-EDS analysis are shown by Figure 3 and Figure 4.

Sulfur (S) and Fe elements shown by SEM-EDS result below indicates that there is possibility of sulphide mineral of rocks. The sulphide minerals can be pyrite, pyrrhotite, marcasite or non-ferrous sulphides according to element content.

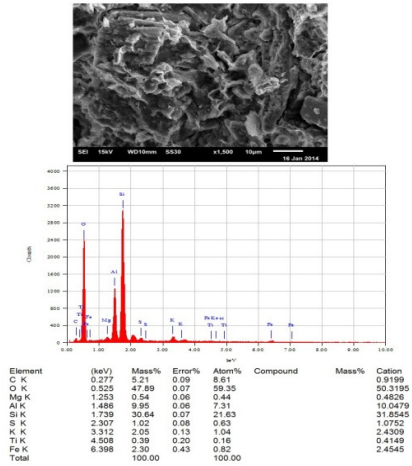


Figure 3. SEM-EDS Analysis of overburden layer

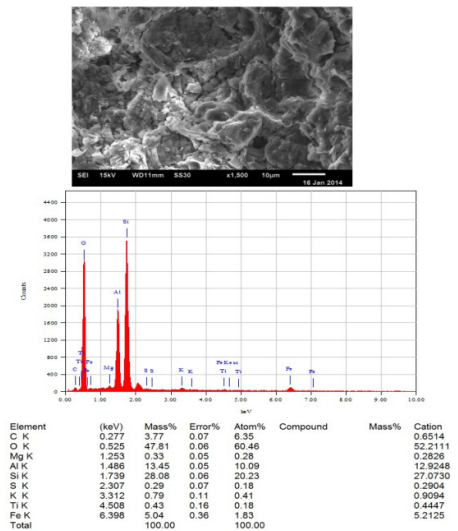


Figure 4. SEM-EDS Analysis of Interburden A1-A2

#### 3.2 Borehole Rocks at Pre-mining Area

Following results is several physical properties of borehole rocks at pre-mining area. Acid mine drainage is affected by characteristics such as pore size, particle size, permeability, and mineral composition of the materials being oxidized. The size of particles directly influences the surface area of rock exposed to weathering and oxidation. Particle size is inversely related to surface area. Therefore very coarse grain substances expose



less surface area; however, they have deeper crevices between particles. This characteristic may let air and water penetrate further, thereby exposing more substance to oxidation and ultimately generating more acid. Conversely, fine grain substances may prohibit air and water flow, but they also have more surface area exposed to oxidation.

In addition lithology or rock type also influences spoil and drainage quality. Physical characteristics of the rock, such as porosity, and accessory minerals can exert various constraints or enhancements to the overall chemical weathering process [5]. Argillaceous rocks tend to release their acid load over a longer period of time. Accessory minerals such as clays and other silicates may dissolve, form new minerals, or attenuate the acid and alkaline weathering products. Pyrite can occur in grain sizes ranging from invisible to the eye up to several inches. Framboids and other fine grained pyrites with a large surface area are much more chemically reactive than the coarser forms [6].

**Table 1. Results of Physical Parameters of several borehole rocks at Banko PIT 1 Barat**

| Borehole | Elevation |        | Lithology         | Stratigraphic Layer | Density                  |                          | Water Content (%) | Degree of Saturation (%) | Porosity (%) |
|----------|-----------|--------|-------------------|---------------------|--------------------------|--------------------------|-------------------|--------------------------|--------------|
|          | From      | To     |                   |                     | Wet (g/cm <sup>3</sup> ) | Dry (g/cm <sup>3</sup> ) |                   |                          |              |
|          | BKGT 28   | 6.00   |                   |                     | 9.20                     | Claystone                |                   |                          |              |
| BKGT 29  | 55.80     | 59.73  | Sandstone         | OB A1               | 0.255                    | 0.202                    | 18.279            | 69.863                   | 4.280        |
| BKGT 29  | 79.50     | 82.30  | Siltstone         | OB A1               | 0.351                    | 0.291                    | 15.618            | 75.490                   | 6.015        |
| BKGT 28  | 106.00    | 112.00 | Claystone         | IB A2A2             | 0.341                    | 0.272                    | 17.636            | 52.856                   | 8.934        |
| BKGT 29  | 198.90    | 199.30 | Claystone         | IB A2A2             | 0.359                    | 0.297                    | 16.947            | 56                       | 5.331        |
| BKGT 28  | 170.00    | 171.00 | Sandstone         | IB A2B1             | 0.351                    | 0.304                    | 24.73             | 16.279                   | 14.626       |
| BKGT 29  | 213.36    | 214.50 | Carbonaceous clay | IB A2B1             | 0.290                    | 0.251                    | 4.671             | 23.543                   | 3.941        |
| BKGT 27  | 178.00    | 184.00 | Carbonaceous clay | IB B2B2             | 0.245                    | 0.304                    | 22.455            | 66.982                   | 5.596        |
| BKGT 27  | 198.00    | 202.00 | Sandstone         | IB B2C              | 0.283                    | 0.149                    | 30.37             | 88.374                   | 13.451       |

**Table 2. Acidity Analysis of Borehole Core at Pre Mining Area in Banko PIT 1 Barat**

| Bore Series | Elevation |        | Lithology         | Layer      | Sulfur Total (%) | MPA (Kg H2SO4/ton) | ANC (Kg H2SO4/ton) | NAPP (Kg H2SO4/ton) | pHpaste  | pH NAG | pH NAG |        | TYPE |      |                  |                  |                   |          |        |        |      |
|-------------|-----------|--------|-------------------|------------|------------------|--------------------|--------------------|---------------------|----------|--------|--------|--------|------|------|------------------|------------------|-------------------|----------|--------|--------|------|
|             | From      | To     |                   |            | TS %             | PKM Kg H2SO4/Ton   | KPA Kg H2SO4/Ton   | PPAN Kg H2SO4/Ton   | pH PASTA | PAN pH | pH 4.5 | pH 7   |      |      |                  |                  |                   |          |        |        |      |
|             |           |        |                   |            |                  |                    |                    |                     |          |        |        |        |      | TS % | PKM Kg H2SO4/Ton | KPA Kg H2SO4/Ton | PPAN Kg H2SO4/Ton | pH PASTA | PAN pH | pH 4.5 | pH 7 |
|             |           |        |                   |            |                  |                    |                    |                     |          |        |        |        |      |      |                  |                  |                   |          |        |        |      |
| BKGT 27     | 178.00    | 184.00 | SANDSTONE         | IB B2 - C  | 0.59             | 18.07              | 21.34              | -3.27               | 6.44     | 2.61   | 8.95   | 21.96  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 27     | 184.00    | 190.00 | SANDSTONE         | IB B2 - C  | 0.64             | 18.60              | 23.58              | -3.98               | 6.39     | 2.78   | 8.54   | 21.56  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 27     | 190.00    | 196.00 | SANDSTONE         | IB B2 - C  | 0.94             | 28.79              | 24.19              | 4.60                | 6.49     | 2.67   | 13.42  | 29.28  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 27     | 196.00    | 202.00 | SANDSTONE         | IB B2 - C  | 0.71             | 21.74              | 27.44              | -5.70               | 6.95     | 3.87   | 8.54   | 22.78  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 27     | 202.00    | 205.00 | CARBONACEOUS CLAY | IB B2 - C  | 2.27             | 69.52              | 25.00              | 44.52               | 4.93     | 2.00   | 50.84  | 76.87  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 6.00      | 9.20   | CLAYSTONE         | OB A1      | 1.16             | 35.53              | 24.38              | 11.15               | 7.93     | 2.59   | 22.65  | 34.96  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 9.20      | 12.80  | SANDSTONE         | OB A1      | 0.38             | 11.64              | 42.69              | -30.96              | 8.55     | 3.71   | 5.91   | 15.27  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 20.80     | 26.80  | SANDSTONE         | OB A1      | 0.00             | 0.00               | 29.55              | -29.55              | 8.56     | 3.89   | 2.46   | 9.85   | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 26.80     | 30.00  | CLAYSTONE         | OB A1      | 0.55             | 16.84              | 31.27              | -14.43              | 9.07     | 3.13   | 4.92   | 10.34  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 30.00     | 36.00  | CLAYSTONE         | OB A1      | 0.66             | 20.21              | 30.78              | -10.57              | 9.14     | 2.76   | 11.82  | 22.16  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 36.00     | 43.50  | CLAYSTONE         | OB A1      | 0.91             | 27.87              | 43.58              | -15.71              | 8.80     | 2.53   | 18.71  | 32.50  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 43.50     | 48.00  | SANDSTONE         | OB A1      | 0.04             | 1.23               | 40.88              | -39.66              | 9.23     | 3.78   | 2.46   | 12.80  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 57.80     | 67.70  | SANDSTONE         | OB A1      | 0.01             | 0.31               | 24.87              | -24.56              | 7.32     | 3.42   | 2.95   | 10.83  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 77.00     | 79.00  | SANDSTONE         | OB A1      | 0.11             | 3.37               | 33.24              | -29.87              | 9.01     | 4.26   | 0.49   | 14.28  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 79.00     | 82.50  | CLAYSTONE         | OB A1      | 0.41             | 12.56              | 64.27              | -51.71              | 9.60     | 3.68   | 2.95   | 11.33  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 82.50     | 84.40  | SANDSTONE         | OB A1      | 0.09             | 2.76               | 34.47              | -31.71              | 9.20     | 5.33   | -      | 24.13  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 84.40     | 94.00  | CLAYSTONE         | OB A1      | 0.76             | 23.28              | 31.27              | -8.00               | 8.75     | 2.89   | 11.33  | 5.91   | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 94.00     | 100.00 | CLAYSTONE         | OB A1      | 1.92             | 58.80              | 24.13              | 34.67               | 6.60     | 2.97   | 43.83  | 58.60  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 100.00    | 106.00 | CLAYSTONE         | OB A1      | 1.20             | 36.75              | 48.12              | -11.37              | 7.23     | 3.06   | 12.47  | 24.94  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 106.00    | 112.00 | CLAYSTONE         | OB A1      | 0.66             | 20.21              | 60.09              | -39.88              | 8.15     | 4.39   | 1.50   | 6.98   | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 112.00    | 118.00 | CLAYSTONE         | OB A1      | 0.76             | 23.28              | 54.85              | -31.58              | 7.96     | 3.59   | 3.99   | 12.97  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 118.00    | 126.00 | CLAYSTONE         | OB A1      | 0.78             | 23.89              | 59.54              | -35.65              | 7.59     | 3.46   | 4.99   | 18.96  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 130.00    | 133.75 | CARBONACEOUS CLAY | OB A1      | 0.99             | 30.32              | 37.27              | -6.95               | 7.48     | 4.14   | 1.00   | 3.99   | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 145.00    | 145.60 | CARBONACEOUS CLAY | IB A1 - A2 | 0.70             | 21.44              | 24.06              | -2.62               | 6.68     | 2.47   | 67.34  | 112.23 | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 145.60    | 148.20 | SANDSTONE         | IB A1 - A2 | 0.17             | 5.21               | 26.55              | -21.34              | 8.23     | 4.25   | 1.00   | 10.97  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 149.00    | 152.74 | CLAYSTONE         | IB A1 - A2 | 0.00             | 0.00               | 40.88              | -40.88              | 8.36     | 4.59   | -      | 10.48  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 162.00    | 165.00 | CLAYSTONE         | IB A2 - B1 | 2.50             | 76.56              | 7.10               | 69.46               | 4.20     | 2.07   | 114.73 | 170.60 | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 165.00    | 169.00 | CLAYSTONE         | IB A2 - B1 | 1.38             | 42.26              | 21.66              | 20.60               | 5.56     | 2.75   | 26.44  | 42.90  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 170.00    | 171.00 | SANDSTONE         | IB A2 - B1 | 2.12             | 64.93              | 11.05              | 53.88               | 4.61     | 1.95   | 103.26 | 148.15 | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 171.00    | 175.40 | SILTSTONE         | IB A2 - B1 | 0.80             | 24.80              | 30.66              | -6.16               | 6.53     | 2.93   | 10.48  | 25.44  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 188.55    | 192.86 | CLAYSTONE         | IB B1 - B2 | 2.21             | 67.68              | 1.68               | 66.00               | 4.22     | 2.15   | 80.81  | 123.21 | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 196.00    | 198.00 | SANDSTONE         | IB B2 - C  | 1.18             | 36.14              | 2.92               | 33.22               | 4.89     | 2.34   | 35.42  | 50.38  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 28     | 198.00    | 200.00 | CLAYSTONE         | IB B2 - C  | 1.06             | 32.46              | 15.69              | 16.77               | 5.78     | 2.89   | 16.46  | 32.42  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 25.40     | 28.00  | CARBONACEOUS CLAY | OB A1      | 3.37             | 103.21             | 29.46              | 73.75               | 3.92     | 2.18   | 83.81  | 119.31 | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 28.00     | 36.00  | CLAYSTONE         | OB A1      | 1.08             | 33.08              | 30.38              | 2.69                | 7.08     | 2.92   | 13.80  | 29.09  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 36.00     | 42.00  | CLAYSTONE         | OB A1      | 1.28             | 39.20              | 26.19              | 13.01               | 7.16     | 2.86   | 20.71  | 35.99  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 42.00     | 48.00  | CLAYSTONE         | OB A1      | 0.71             | 21.74              | 53.61              | -31.87              | 8.22     | 3.94   | 2.96   | 13.80  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 48.00     | 55.80  | CLAYSTONE         | OB A1      | 0.74             | 22.66              | 32.35              | -9.69               | 8.62     | 3.48   | 6.41   | 15.28  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 55.80     | 59.73  | SANDSTONE         | OB A1      | 0.14             | 4.29               | 27.22              | -32.93              | 8.77     | 5.93   | -      | 1.97   | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 59.73     | 63.20  | CLAYSTONE         | OB A1      | 0.88             | 26.95              | 54.85              | -27.90              | 8.76     | 2.92   | 6.41   | 22.19  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 63.20     | 66.80  | SANDSTONE         | OB A1      | 0.30             | 9.19               | 27.42              | -18.24              | 8.51     | 2.94   | 1.48   | 6.41   | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 67.20     | 73.20  | SANDSTONE         | OB A1      | 0.03             | 0.92               | 56.32              | -55.41              | 8.97     | 5.47   | -      | 3.45   | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 73.20     | 79.50  | CLAYSTONE         | OB A1      | 0.65             | 19.91              | 60.76              | -40.85              | 8.51     | 3.25   | 4.93   | 12.82  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 79.50     | 82.30  | SILTSTONE         | OB A1      | 0.32             | 9.80               | 57.80              | -48.00              | 8.64     | 4.18   | 1.48   | 8.87   | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 82.30     | 91.00  | CLAYSTONE         | OB A1      | 1.08             | 33.08              | 38.09              | -5.01               | 8.04     | 2.77   | 32.54  | 44.37  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 91.00     | 93.90  | SANDSTONE         | OB A1      | 0.03             | 0.92               | 22.74              | -21.82              | 8.84     | 5.09   | -      | 3.45   | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 93.90     | 98.00  | CLAYSTONE         | OB A1      | 0.08             | 2.45               | 39.81              | -37.36              | 8.88     | 4.08   | 1.97   | 13.80  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 98.00     | 100.20 | CARBONACEOUS CLAY | OB A1      | 0.12             | 3.68               | 40.30              | -36.63              | 8.68     | 4.35   | 1.48   | 11.83  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 100.20    | 101.90 | CLAYSTONE         | OB A1      | 0.17             | 5.21               | 41.78              | -36.58              | 8.16     | 4.66   | -      | 5.92   | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 101.90    | 107.00 | SANDSTONE         | OB A1      | 0.18             | 5.51               | 43.26              | -37.75              | 6.81     | 3.31   | 4.44   | 15.28  | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 124.40    | 124.40 | CLAYSTONE         | OB A1      | 0.80             | 24.50              | 50.62              | -25.52              | 8.96     | 3.67   | 13.00  | 28.89  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 128.70    | 132.20 | CLAYSTONE         | OB A1      | 0.29             | 8.88               | 33.07              | -24.19              | 8.98     | 4.52   | -      | 7.22   | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 132.20    | 134.10 | SANDSTONE         | OB A1      | 0.07             | 2.14               | 33.07              | -30.93              | 8.68     | 7.01   | -      | -      | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 150.30    | 154.00 | CLAYSTONE         | OB A1      | 0.85             | 26.03              | 26.33              | -0.30               | 8.10     | 3.61   | 13.48  | 25.52  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 178.00    | 183.00 | SILTSTONE         | OB A1      | 0.71             | 21.74              | 19.25              | 2.50                | 7.01     | 3.65   | 9.63   | 23.59  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 183.00    | 185.40 | CARBONACEOUS CLAY | OB A1      | 1.54             | 47.16              | 16.22              | 30.94               | 3.66     | 3.06   | 67.88  | 99.65  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 197.20    | 198.10 | CARBONACEOUS CLAY | IB A1 - A2 | 0.74             | 22.66              | 238.78             | -216.12             | 8.30     | 2.92   | 50.07  | 87.62  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 198.10    | 199.30 | CLAYSTONE         | IB A1 - A2 | 0.09             | 2.76               | 31.87              | -29.11              | 8.43     | 5.63   | -      | 8.18   | NAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 213.36    | 214.50 | CARBONACEOUS CLAY | IB A2 - B1 | 1.81             | 55.43              | 29.80              | 25.63               | 5.71     | 3.33   | 36.11  | 75.10  | PAF  |      |                  |                  |                   |          |        |        |      |
| BKGT 29     | 214.50    | 219.70 | SILTSTONE         | IB A2 - B1 | 0.89             | 27.26              | -7.14              | 34.40               | 5.74     | 3.49   | 19.74  | 35.63  | PAF  |      |                  |                  |                   |          |        |        |      |

Source : PT. BA, 2013



Particle size is a fundamental concern since it affects the surface area exposed to weathering and oxidation: smaller particles have more surface area and therefore more reactive sites than larger particles. The relationships between particle size, surface area, and oxidation play a prominent role in acid prediction methods. This fact is shown by Table 2 indicating sandstone which has coarser grain size than claystone or siltstone or carbonaceous clay tends to cause NAF result in acidity analysis. In addition the silt and clay content in the rock influences the plasticity behaviors and will exhibit low permeability [7]. Permeability is directly proportional to the porosity so that claystone and siltstone porosity is less than sandstone porosity (Table 1).

Important mineralogical factors lead to formation of acid mine drainage are: type and quantity of sulphide minerals (pyrite, pyrrhotite, marcasite and non-ferrous sulphides), texture and morphology, degree of rock fracture, content of acid consuming minerals. These factors affect both the chemical rates of acid formation and neutralization [8].

Mineralogy and other factors affecting the potential for AMD formation are highly variable from site to site because of the difference of climate and parent rock type of each site and other condition. Thus the determination of the acid mine drainage from a particular site should be based on the physical characteristics (which include particle size, sorting and rock type) as well as the chemical characteristics of the rock mass.

#### 4. CONCLUSION

It is concluded that physical properties of rocks as well as chemical properties of rocks influence rate of formation of acid mine drainage. Physical characteristics such as grain size and rock type affect physical properties of rock such as porosity, permeability and density.

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