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Groundwater Quality Study of Bauxite Mining Area, Bintan Land – Riau Islands Province

Rusli, Nana Sulaksana, Lili Fauzielly
Faculty of Geological Engineering, Padjadjaran University, Bandung, Indonesia

ABSTRACT

The study area is located in the bauxite mining areas on the Bintan Land, Riau Islands Province. Geologically, the area consisted of pre-granitic rock such as clastic sedimentary rock of Triasic aged that consisted of shale and quartzite, granitic rock of jurasic aged that consisted of granite, granodiorite, aplit granite, granite-porphyry and rhyolite. These group of rock has intruded pre-granitic rock and caused hydrothermal procces and pneumatolitic contact as bauxite deposits origin rocks. It was known that the presence of Bauxite is associated with other elements. Because of its potentions, Bintan Land is also an catchment area that has potential as a source of clean water. So it will be very vulnerable to environmental pollution, especially pollution to the groundwater as a result of mining activities. It has become very important to environmentally assesment study due to its role of groundwater for society. The aims of study is to determined conditions of groundwater quality in bauxite mining area of Bintan Land based on chemical and physical data of groundwater taken in 3 wells located at midpoint to shoreline area. Based on laboratory analysis, it was found that sample of monitoring wells 1 and 2 declared as ineligible health, whereas in sample water of andesite mining still met with health requirements.

Keywords: Bintan, Bauxite, Groundwater Quality, Pollution

I. INTRODUCTION

Mining activity is harmful to the environment. The residue of mining activities were very vulnerable to pollution, especially in contributing to air and water pollution as well as in Bauxite mining of Bintan Land of Riau Islands province. At this time in Bintan Land there are about 989.1 ha of bauxite mines area with production capacity is about 1,237,006 tons/year (2001) and 1,283,485 tons/year (2002) (Anonymous, 2003).

Almost 60 years of bauxite mining, the bauxite washing process which is waste flowed into the settling ponds have produced tailings sand with a significant numbers, although there is no detailed data on tailings sand resource. The landfills tailing sand is utilized as a housing, schools, shops around town Kijang, because the condition of the sand is solid. (Lahar, et al: 2003).

In addition, the location of Bintan Island adjacent to the Batam Industrial development center and Singapore is a good potential in terms of economy, especially to meet clean water needs. This potential is supported by rainfall average of 3289 mm per year and 177 days of rain (Climatological Station Kijang, 2002).

Bauxite mined land is a critical area so that potential as a producer of clean water has not been possible to do although near from strategic location. One potentially of foreign exchange on the island of Bintan is a supplier of clean water to those regions. (Sembiring: 2008).
Bauxite existence is associated with other elements. Bauxite residue (originally Tayan, West Kalimantan) consists of alumina (Al_2O_3) and or silicate (SiO_2). Bauxite residue containing 25% Al_2O_3 and 3% (SiO_2) while pulp washing of bauxite containing 32% Al_2O_3 and 40% SiO_2 (Aziz, 2012). The washing process is carried out on the installation of washing that aims to separated the bauxite ore (in the form of Al_2O_3.xH2O) of impurities elements such as silica, iron oxide, titanium dioxide and other mineral impurities (Krishna, 2003).

Water Chemistry and Physics

Biological Oxygen Demand (BOD) is an empirical analysis that tries to approach globally the

microbiological processes that actually occur in water. BOD numbers is the amount of oxygen needed by bacteria to decomposed (oxidized) almost all the dissolved organic matter and some elements of organic material suspended in water.

Chemical Oxygen Demand (COD) is the amount of oxygen (mg O_2) is required to oxidize organic substances contained in 1 liter of water, where the oxidizing K2 CR2 O2 is used as an oxygen source. COD numbers is a measure of water pollution by organic substances that can naturally oxidized through microbiological processes, and lead to oxygen deprivation dissolved in water. (Alaerts, Santika 1984).

II. METHODS AND MATERIAL

The data used in this research are primary and secondary data. Secondary data were obtained from literature, while the primary data obtained through field observations for sampling groundwater. Then, physical and chemical analysis of groundwater used to determined the content of elements in groundwater and compared with the criteria under No. 197 / Menkes / SK / VII / 2002 dated July 29, 2002 On Drinking Water Quality Requirements. The object of this study is the groundwater, rocks and sediment influenced by bauxite. In Order to determined the quality of ground water and the factors that influence it.

III. RESULT AND DISCUSSION

1. Lithology Characteristics of Bintan Land

Lithology of Bintan Land and its surroundings can be classified into three groups as follows: (1) pre-granitic rocks consisted of clastic sedimentary rocks of Triasic aged such as shale and quartzite, (2) granitic rocks of Jurasic aged composed of granite, granodiorite, aplit granite, granite porphyry and rhyolite. These group of rock has intruded the pre-granitic rock and caused hydrothermal procces and pneumatolitic contact as bauxite deposits origin rocks, hornfels 3) tertiary sediment consists of sandstone and clay (esdm.go.id).

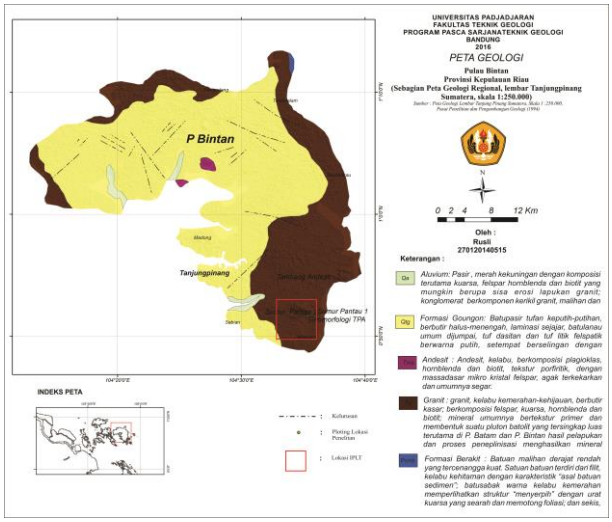

Figure 1. Geological Maps of Research area

2. Hydrogeology Bintan Island

Water bearing layers (aquifers) is the main study area is a shaly sand, sand and tuffaceous sandstones, which are generally loose to solid. Groundwater levels ranged from 0.4 to over 7 m below surface. The ground water flows from center to south and east. Affixes shallow groundwater area of 584.98 m² area that includes the District of Eastern Bintan and Mount Kijang is 212.57 million m^3/year. This rain water infiltration will mostly flow back to the surface to supply surface water (effluent stream).

The groundwater potention in Bintan (district, East Bintan, district. Mt. Kijang, district North Bintan. Gulf of Sebong and district Gulf of Bintan) has low quantity but the quality is good. Local ground water potential is classified as medium quality only present around Kangka Kawal - Karubi and around the mouth of S. Jago. Shallow groundwater around the beach and a few places in a marshy area in the interior indicates poor quality, because the content of chloride and iron that exceeded the permitted threshold, so that the necessary treatment carefully before being used as a clean water supply for the population (Dinas PU Provinsi Kepri, 2005).

Laboratory analysis Results showed that the groundwater in the study area has a high BOD5 and COD, with 49-202 mg/L of BOD and 60-251 mg/L of COD exceeds the limit specified quality. Chemical Oxygen Demand (COD) is the amount of oxygen (mg O2) is required to oxidize organic substances. COD Numbers is a measure of water pollution by organic substances. Therefore, COD and BOD5 values indicating of high pollution by organic substances in groundwater research area.

Water quality criteria based on the content of chemical elements (Fe, Mn, Cl, NO_3, NO_2, SO_4, pH,) and Physical properties can be divided into two criteria under No. 197/Menkes/SK/VII/2002 dated July 29 2002 About Drinking Water Quality Requirements, namely:
Good Quality, if the content of element/compound/ are contained below the maximum allowable levels
2. Bad quality, if the content of the element/compound contained/contained is above the maximum levels allowed.

Explanation :
(+) = good quality;
(-) = poor quality,
B6J2 (nature) = 6 elements/compounds good quality, two elements/bad compounds.

Based on that data, obtained two quality classes, namely
• 6 Good elements, 2 bad elements Chemical Properties (B6J2K) On Monitor wells 1).
• 8 Good Elements, 0 bad element Chemical Properties (B8J0K) at monitoring wells 2 and Mine Water of andesite.

Chemical characteristics of water in monitoring wells 2 and Mine Water of Andesite and monitoring wells 1 unfit or ineligible unfit for consumption because of the value of iron and chloride elements contained beyond the limits of the standard. A high iron content may be due to the interaction of water with rocks units of clay that contains mineral chlorite (MgFe) 6-x (Alfe) x Si4-x Alx (OH) 10 and an additional pH value which is not a neutral result in the properties of water that easily dissolve or substances path.

Besides of bauxite mining activities that generate residual iron oxide compound, when washing process can affect also. While, the content of chloride (Cl) can be caused due to the influence of sea water containing of high chloride element. Because the sampling position relatively close to the shoreline.

Quality (+) = good; (-) = Bad, B3J2, 3 physics characteristics of good quality.

Based on the data above water physics, got two quality classes, namely :
• 4 Good physical properties and 1 bad physical properties (B4J1F) On Monitor wells 1 and 2.
• 5 Good physical properties and 0 bad physical properties (B5J0F) On Water of andesite Mining.
From the quality classes can be stated that the class unfit for consumption for water samples of andesite mining and class unfit for consumption sampling monitoring wells 1 and 2.

Table 1. Water Chemistry Test

Parameter	Unit	Maximum limit	Well Test Result 1	Well Test Result 1	Methods
BOD	mg/L	30	**49**	**202**	Spectrophotometric
COD5	mg/L	50	**60**	**251**	Spectrophotometric
TTS	mg/L	50	0.006	0.021	Electrometric
Ph	mg/L	6.0-9.0	8.71	7.69	IK-M/04/PK-5,4/UPT LABES

Table 2. Table of Major Element

No.	Sample Code	Concentration (mg/l)							
		Fe	Mn	Cl	NO2	NO3	SO4	pH	Quality Class
1	Well Monitoring 1	1.05 (-)	0.21 (+)	289(-)	1.3 (+)	0.18 (+)	85 (+)	7.65 (+)	B6J2K
2	Well Monitoring 2	0.17 (+)	0.03 (+)	111 (+)	1.8 (+)	0.02 (+)	59 (+)	8.17 (+)	B8J0K
3	Water of Andesit Mining	0.12 (+)	0.03(+)	11(+)	1.8(+)	0.02(+)	65(+)	7.84(+)	B8J0K

Table 3. Water Physic Test

No.	Sample Codes	Physic Parameter					
		Odor	Color (PTCo)	Turbidity (NTU)	Taste	TDS(mg/L)	Quality Class
1	Well Monitoring 1	Odorless (+)	213.3 (-)	15.7(-)	tasteless (+)	691(+)	B4J1F
2	Well Monitoring 2	Odorless (+)	25.8 (-)	0.64 (+)	tasteless (+)	239(+)	B4J1F
3	Water of Andesite Mining.	Odorless (+)	0.6 (+)	0.44 (+)	tasteless (+)	52(+)	B5J0F

IV. CONCLUSION

The conclusion from the analysis of chemical data and physical groundwater are:

- Based on the value of COD and BOD5 samples of monitoring wells 1 and 2 have a value higher value of 49-202 mg/L of BOD and 60-251 mg/L of COD exceeded the maximum quality standard. So it does not meet unfit for consumption
- The main elements (Fe, Mn, Cl, NO_3, NO_2, SO_4) contained in groundwater showed that:
  - sample monitoring wells sample 1 have experienced contamination contains iron element 1:05 mg/L and 289 mg Cl/L. It is probably caused by the presence of interactions groundwater with clay that containing mineral chlorite (MgFe) 6-x (Alfe) x Si4-x Alx (OH) 10 or the influence of leaching of bauxite in form of compound impurities of iron oxide on bauxite itself. While the content of Chloride high possibility due to the influence sea water began intruded the area, because of the relative position of sample point that close to the beach.
  - The content of the main elements in samples monitoring wells 2 and water samples of Andesite quarry, everything is still below the quality standard, so it does not indicate any significant contamination.
- Based on the physical properties of water on groundwater research area acquired two quality classes, namely:
- Good quality classes on water samples monitoring wells 2 and andesite mining areas
- Bad quality classes on a sample monitoring wells 1
- So based on the results obtained by physical and chemical analysis of water that most excellent water quality in the area of andesite mining, while the water quality is very bad there at the point of

monitoring wells 1 and poor water quality were found in monitoring wells point 2.

The results of this study can be used as a starting point for the study of water conservation in the study area. Then, need for further studies to determine the effect of such pollution factor, facies analysis of groundwater and hydrogeological studies detail.

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