Trace Element Geochemistry and Environmental Impact of Rantau Coal, South-Kalimantan, Indonesia

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ABSTRACT

Warukin Formation has a lot potential as a coal-bearing formation in Rantau South Kalimantan, Indonesia. However, potential harmful to the environment posed by trace element needs to be examined. Because when the amount is above a specified threshold, it will be very dangerous because of its toxicity. Trace element in coal is dependent upon the chemical nature of the elements that are contained inside the coal.Trace element can be associated with elements of coal or mineral matter there. With the increasing emphasis on the trace element now routinely performed. The study was to determine the source and the impact caused by trace element. Eight examples of the coal seam have been taken for analysis: AAS, XRF and coal petrographic. Based on coal petrographic analysis, the average mineral matter composition was 2.4% consists of mineral oxide, pyrite and clay. The total amount of sulfur in the seam 0,14 %, it's much lowest. Most elements are positively correlated with the existing content in the ash for trace element that is: Cl, As, B,Hg, Se and F. The concentration of trace elements that are in the world average coal, thus indicating the absence of low-level hazard or danger to the environment.

***Keywords**: Warukin Formation, coal, environment, toxicity, chemical nature, mineral matter, sulfur,ash.*

INTRODUCTION

Coal is the largest source of energy in addition to oil and gas at Indonesia. Mining, coal-burning as well as organic material both an organic cause environmental impacts and human health, the impact of burning coal became an international problem on human health (Gulbin Gurdal, 2008). Characters of coal on combustion process depends greatly on the material constituting an organic and organic. Among coal quality parameters are the elements that rarely has a great impact to the environment, the economy, technology, and human health (Gulbin Gurdal, 2008). Finkelman (1995) in the 2007 Guurdal Gulbin explains that there are 25 elements rarely in coal potentially dangerous to the environment include: Sb, As, Ba, Be, B, Cd, Cl, Cr, Co, Cu, Hg, Pb, F, Mn, Ni, Mo, P, Se, Ag, Th, Ti, U, V, Sn, and Zn. The nature of the elements rarely during the combustion process, the utilization of coal washing, very in control by the concentration of elements rarely happens in coal. During this research about rare elements on coal very little done in Indonesia, therefore, information about the rare elements on coal very little. Environment impact from generally associated with trace element concentration, toxis, and mobility (Finkelman, et al, 1995 in Rouyu Sun, 2009). The main minerals in coal are silica, carbonate, and sulfate, generally trace elements present in minerals that are present in coal, while elements of Ge, Be, B, Br, Cl generally associated with organic elements.This research is conducted in the Rantau Area, Idamanggala, South Kalimantan, Indonesia (Fig.1) and the objective of the research is Seam M-10 (Fig. 2) to find out the origin and concentration of rare elements as well as knowing the possibility of environmental impacts and health due to the coal mining process.

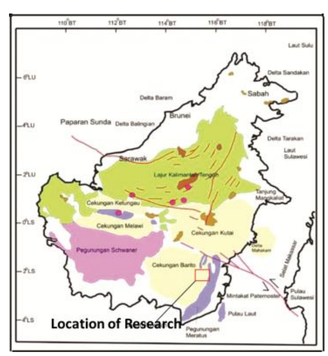

Fig. 1 The box is the location of the area carefully situations are located in the Rantau, Idamanggala, South Kalimantan.

Fig. 2 Seam M-10 Rantau Coal, Idamanggala, South Kalimantan.

SAMPLE AND METHODS

There are some samples taken from two layers of coal in the Rantau Area, Idamanggala, South Kalimantan, Indonesia, sampling is done by cannel sampling, sample in dry in sun on aerial dry, crushed, and before a blender is done the analysis. Proximate analysis was performed on 2 samples of coal, analysed using the procedure according to the standard ASTM (1991).

GEOLOGICAL SETTING

The research area is located in Barito Basin, South Kalimantan,. In regional geology according to Haryanto and Sanyoto (1994) this region belongs to the Warukin Formation. This formation is one of the abundant coal bearing formations.

Physiographically in the northern part of the Barito basin separated by the Kutai basin by the fault of the Adang while in the east it borders the Meratus Mount which extends from the southwest-northeast. In the south is an obscure boundary with the Java Sea and the western part borders the Schwaner Complex which is the basement.

The stratigraphic successions of the area may be divided into four megasequences including pre-rift, syn-rift, post-rift, and syn-inversion sequences (Satyana A and Silitonga P, 1994); (Fig. 3)

1. Pre-rift

The pre-rift basement of the eastern Barito Basin is composed of a variety of amalgamated terrains including; continental basement in the west (granitic) and accreted zones of Mesozoic and early Paleogene rocks (volcanics, metamorphics), in the east.

2. *Syn-rif*

Collision between the Indian subcontinent, Eurasian margin and the Western Pacific region at the beginning of the middle Eocene has made Barito Basin through rifting The synrift phase in the basin occurs in the middle Paleocene-Eocene, that is, on the deposition of the lower Tanjung Formation, which is the sediment deposited on the basement surface, Sediments consist of sandstone, silt, shale and conglomerate intercalations with coal.

3. Post-rift

subsidence occurred in the basin from the Middle Eocene to the middle of the Early Miocene, during the time of the Formation sediment, in which sediments from the Tanjung and Berai were deposited. This sediment is formed in the transgression phase. Significant changes in sediment character occur at the limit of the sequence of synrift and postrift. The subsidence of the continuous basin along the Oligocene and at mid Miocene has resulted in sediment tops up of the sequence.

4. *Syn-Inversion*

At the Middle Miocene there was a collision between the South China Sea Plate and North Borneo, which led to the formation of the Kuching Heights, at the same time the collision east of Sulawesi ended the rifting of Makasar Strait and the uplift of the Proto-Meratus Mountains. Both tectonic events resulted in the reactivation and inversion process of the old faults in the Barito Basin. The inversion process in the basin becomes stronger when there is a collision between the northwest Australian Plate with the Eurasian Plate at the time of the early Pliocene. The uplift of the Kuching Heights provides supply to the lower basins, and the Proto Meratus Proto-Ridge causes the Barito Basin to be separated by the marine environment, so that the previous transgression cycle of sedimentation changes into the regression cycle. This affects precipitation on the Warukin Formation and Dahor Formation. The synthesized syn-inversion Barito Basin consists of the upper Warukin Formation and Dahor.

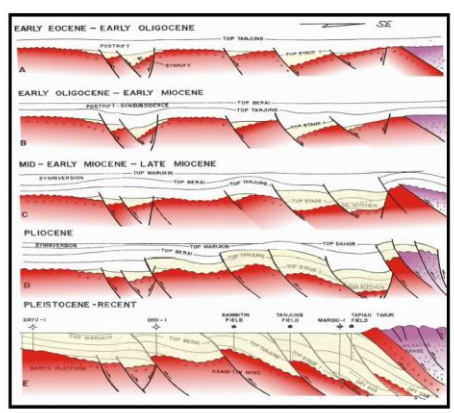

Fig. 3 Tectonostatigraphy Barito Basin (Satyana A and Silitonga P, 1994)

In the research area is made up of 3 formations and 3 rock units (Fig. 4). Here is the sequence of stratigraphic research area:

1. Claystone Tanjung Formation

Consists of interbeded claystone, sandstone, siltstone intercalations with coal. Claystone, hard, brown, masive. Siltstone, soft, brown. Sandstone, soft, gray ash, very fine sand - medium sand, subrounded - angular, open fabric, poor sortations. composed by quartz, litik, feldspar, plagioklas, mixed coal, masive and planar laminations, silica cement. coal, black, dull, hard, brown scratch, brittle, cleat, thickness 0,03 - 0,1meter.

2. Limestone Berai Formation

Consists of limestone. Compact, white, crystalline, monomineralic CaCO, masive.

3. Sandstone Warukin Formation

Consists of interbedded sandstone, siltstone, and claystone with coal intercalations. Sandstone, soft, bedded, gray ash, fine - coarse sand, subrounded - angular, open fabric, poor sortations. composed by quartz, litik, feldspar, plagioklas with coal mixed. masive, wavy laminations, planar laminations, flasher. Siltstone, soft, brown, masive. Claystone, soft, brown, with coal mixed. Coal, black, dull, compact, brown scratch, blocky, cleat, thickness 0.5 - 22 meter.

4. Alluvium

Consists of loose material sized clay-boulders with the composition of sand, crust, and loose boulders that are river deposits

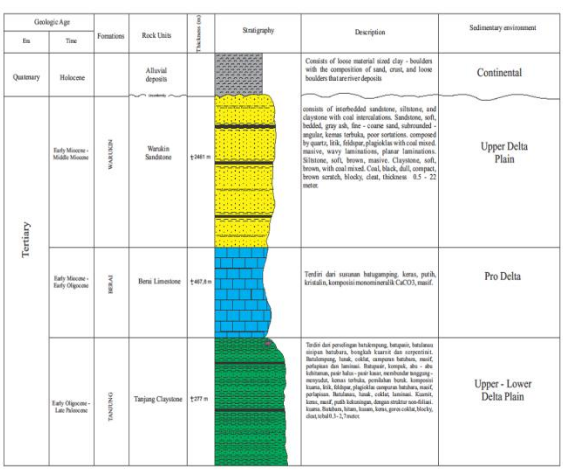

Fig . 4 Stratigraphy of Research Area.

RESULTS AND DISCUSSION: DEPOSITIONAL ENVIRONMENT

The result of the profile analysis obtained on the Warukin Formation deposited its settling environment at lower delta plains (Allen and Chamber, 1998) in obtaining lithology in the form of sandstone with clay stone, with sediment structure obtained that is coating, massive and graded bedding. with the pattern obtaining a coarsening upwards. See (fig.4) Whereas in the Warukin Formation in profil (fig.5) deposited its settling environment at the upper-lower delta plain (Allen and Chamber, 1998) seen from the lithology obtained sandstone, limestone, claystone, carbon claystone and coal with sedimentary structures obtained by flasher, laminated, and bedding.

Baron as an indicator of the level of salinity of the past in the form of coal environment (Swaine, 1990) The content of the coal Baron has a close relationship with depositional environment, the content Baron 50 s/d 110 mg/kg showed the limits depositional environments of freshwater and brackish, and the brackish sea.

The content of the research areas of the coal Seam M-10 of Rantau Coal ranges from 183-205 mg / kg, of the coal. Based on the analysis of coal maceral then generally depositional environment of coal Seam M-10 of Rantau Coal are telmatic located in the neighborhood, which is located between the environmental conditions and face to face ebb tide (Mukopadhay, 1986) or the condition of wetland located in the marshes (Diessel, 1986). This can be explained as a condition that is between flood water level until the normal water level, the processes are one of them will produce a precipitate overbank deposits, it is deposited in the flood plain as marshes as coal swamp, as well as a sludge carrier of coal seams on the system delta plain (Allen, et al., 1998) thus becoming partially nature brackish water (brackish).

CHARACTERISTICS OF MICROSOPIC COAL (COAL MACERAL)

Sampling is performed directly in the coal outcrops Seam M-10 of Rantau Coal by methods ply by ply. Observations show lithotype coal megaskopis Rantau namely: bright coal (vitrain), banded bright coal (vitrain) and banded coal (clarain). Based microscopy, the composition of the coal maceral Rantau to vitrinite ranging from 74.0% (Vol.) – 80.2% (Vol.); liptinite maceral composition ranges from 1.2% (Vol.) – 9.4% (Vol.); Inertinite maceral composition ranges from 16.2% (Vol.) – 22.8% (Vol.); mineral matter (pyrite, quartz) , ranging from 1.4% (Vol.) – 2.4% (vol.) with vitrinite reflectance value ranges 0.34% - 0.58%. Analysis of the results shows the reflectance of coal rank sub-bituminous coal for Rantau Area (Table 1; Figure 5)

Table 1. Composition maceral and mineral matter Rantau Coal (Basuki RAHMAD et al., 2017)

No. Sampel	Total Vitrinite (% vol)	Total Liptinite (% vol)	Total Inertinite (% vol)	Total Mineral Matter (% vol)	Reflektan Vitrinite (Rv) %
1	74,0	1,2	22,8	2,0	0,34
2	74,8	7,6	16,2	1,4	0,58
3	73,0	9,4	16,2	1,4	0,45
4	80,2	1,6	15,8	2,4	0,56

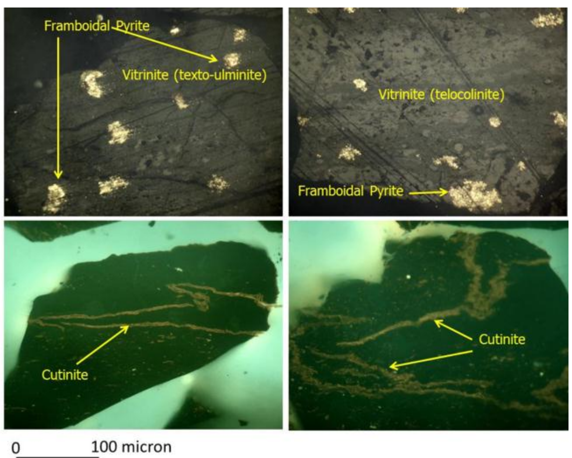

Fig. 5 The appearance of coal microscopic (maceral) Seam M-10, Rantau Coal, Idamanggala, South Kalimantan (Basuki RAHMAD et al., 2017)

The presence of pyrite in the coal mineral Rantau is framboidal shaped, indicating coal depositional environments of coal Seam M-10 of Rantau Coal by brackish water coming from seawater (Horne, 1978). According to William and Keith, 1963 (in Horne, 1978), especially in the form of pyrite material framboidal numerous in layers covered directly by marine stratum. Based on the research results, sulfur pyrite shaped framboidal resulting from the reduction of sulfur by microbial organisms found in marine environment to brackish water (Horne, 1978). High telovitrinite content of the coal seams and the coal Seam M-10 of Rantau Coal indicates that the area is located in the central part of the peat swamp with the highestwaterlevel.

Increased detrovitrinite will reflect the degree of degradation of vitrinite relatively high, this condition is caused by the rising water level maximum, thus causing overflow flooding (flood water level) followed by the erosional by channel, where the flood water level will be entered into the peat swamp , This will cause the accumulation and activity of the bacteria are becoming active, that can damage cell tissue structure of the plants (Teichmueller, 1982 and Diessel,1986).

The content inertinite contained in coal Seam M-10 of Rantau Coal derived from plants burning (charcoal) and partly due to the oxidation process of maceral vitrinite or process decarboxylation caused by fungi or bacteria (biochemical processes), eg from forest burning in the dry season in areas tropical, pross-process causes inertinite has a high oxygen content.

Inertinite attendance is low (<1%) of all samples of coal Seam M-10 of Rantau Coal, influenced by changes in depositional environment of telmatic until limno-telmatic, is reflected in declining water level. At the time of decreased water level reaches a minimum, such an area would be moist or relatively dry, so it will happen oxidation (burning). Gelovitrinite rising in line with increasing process gelifikasi under water (anaerobic conditions).

CHEMICAL CHARACTERISTICS OF THE COAL SEAM AND M10 BASED ON TEST PROXIMATE

Chemical characteristics of coal obtained in the study area based on the data cores Table 2 and 3.

ABUNDANCE ELEMENT

There are 5 trace element analysis, the amount of trace element content in coal seams Rantau area can be seen in Table 5.Based on the environmental impact of trace elements can be grouped into 2 (Swaine, 1990).

Group I element trace element that is sensitive to the environment (As, Hg, Se)

These elements include As, Hg and Se, which are easy-flying elements during coal burning, these are serious health and environmental problems (Zheng, 1999, in Basuki RAHMAD et al., 2016). The value of arsenic (As) on coal M10 has a value of 0.52 ppm, whereas in coal the content of this element has a value of 0.40 ppm. The number of elements of the and M10 coal trace elements is very small in comparison with the world's coal level (0.5-80 ppm). Mercury (Hg) content in M-10 coal is 0.06 ppm while mercury content in coal is 0.03 ppm. Hg content in coal M10 and falls into the low-level category compared to higher Hg levels in world coal (0.02-1 ppm). The level of Selenium (Se) in the M-10 coal layer is 0.17 ppm whereas in the coal layer that is 0.20 ppm has a low level compared to the Sea level in the world's coal (0.2 - 10 ppm) of the elements it can be concluded that trace element with elements of As, Hg and Se on coal layer M-10 and there is no dangerous threat to the environment

Group II are trace elements that have a significant impact on the environment.

This group includes (B, F, Ni, V, Zn), in this study there are only Boron (B) and fluorine (F) data obtained. The level of element B ranges from 31 ppm to M-10 coal layer while in the coal layer has the same value as the M-10 coal layer is 31 ppm. If in comparable level of element B in world coal (5-400 ppm) (Swain, 1990, In Basuki RAHMADet al., 2016) then the coal layers M-10 are classified as low. The value of fluorine (F) in M-10 coal layer has a level (23 ppm) while the value of coal layer is 18 ppm. Compared with the world's coal level (20-500 ppm) the content of fluorine (F) elements in M-10 and coal can be relatively low. (Table 4).

Tabel 2. Concentration ranges of the potential hazardous elements in the Seam-10 Rantau Coals, Iadamanggala, South Kalimantan

Trace Element	World coal (ppm)	Rantau Coal (ppm)
As	0,5-80	0,40 - 0,53
B	5-400	31
F	20-500	18 - 23
Hg	0,02 – 1	0,03 - 0,06
Se	0,2 – 10	0,17 – 0,20

Table 3. The average yield seam Proximate analysis Seam M-10.

Seam	TM(%)	IM (%)	Ash(%)	VM(%)	FC(%)	TS(%)	CV
M10	34.67	14.19	3.29	42.91	39.81	0.12	5480.13

Tabel 4. Results of analysis of the average Trace Elements seam M-10

Seam	Arsenic *(AS)* *ppm*	Boron *(B)* *ppm*	Mercury *(Hg)* *ppm*	Selanium *(Se)* *Ppm*	Flaurine *(F)* *ppm*
M-10	0,52	31	0,06	0.17	23

CONCLUSION

From the result of comparison of trace element on Seam M-10 coal layer with dangerous element concentration level on world coal, it can be said that trace elements in Seam M-10 to environment is not dangerous or does not pose a threat to the environment because the trace elements that are in the Coal Seam M-10 is relatively low in comparison with the world coal level.

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