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Geochemical prospecting of coal quality at Haya-Krusta-Sikari Area, Mamberamo, Papua

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Abstract: This study aims to determine the geological location, the distribution direction of coal layers and its quality at two locations; Haya-Crusta and Sikari. The coal oustcropt consist of two seams which are stratigraphically cut by several shear faults that are trending almost north-south. Petrographic properties of claystone, siltstone and sandstone are strong correlations of exposed coal deposit which are part of the pocket basin and thicken toward the northwest. Geological structure disturbance is correlated with the differences in the coal seam dip in the Haya-Crusta region which has a relatively better continuity than the Sikari coal seam. And the difference in sulfur content where precisely the Sikari coal seams are lower than the coal in the Haya area.

Keywords: project, cost, contract, dominant, Surakarta.

INTRODUCTION

Sedimentary rocks that were exposed at the study area, according to regionally stratigraphy are part of northern Papua basin rock formations. Where rock formations carrying the coal seams are the Arumi Formation and the Unk Formation which are the Mamberamo Formation group (Visser and Hermes, 1962; Mamengko et al, 2019).

The coal layers were exposed at the two research locations, namely: Haya-Krusta and Sikari, where both these locations have similarities and differences. The similarity is that both areas have continuity and discontinuity of coal seams and the difference is in the quality. The quality of coal is influenced by several factors, one of which is the content of sulfur. Sulfur in coal exists in both inorganic and organic forms. The inorganic form is usually sulfide and sulfate, with pyrite as the main inorganic sulfur contaminant in most coal (Chalkin, 1994).

Difficulties in field data collection and mapping are caused by dense vegetation on hilly topography, the abundance of river flow and swamp. So this study, is a prospecting stage that aims to determine the geological location, distribution direction of coal layers and its quality at two coal seams locations based on morphology, lithology and geochemistry.

RESEARCH AREA

Administratively the research Area is located at Rouffaer District in Haya-Kustra, Sikari area Mamberamo Regency, Papua Province (Figure 1). The research area is reached by using a motorized boat from the capital of Kasonaweja, Mamberamo Regency and continued on foot.

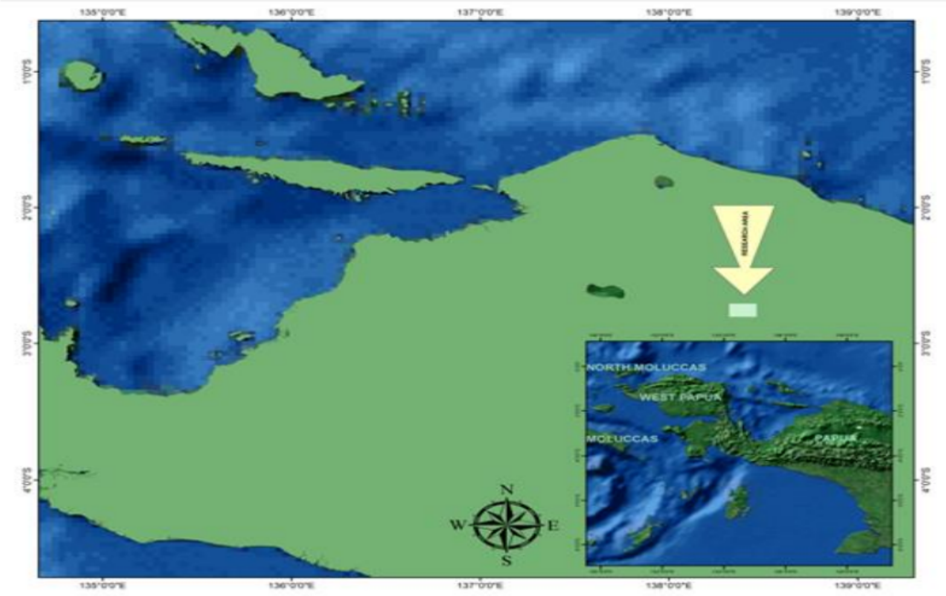

Figure 1. Map of research location

Regional Stratigraphy

Aurumi Formation (Late Miocene - Pliocene): sandstone and claystone, limestone layers, siltstone and carbonate claystone. Unk Formation (Late Pliocene - Plistocene): greywacke, siltstone, claystone and lignite layers. layered, soft, containing quartz, mica, feldspar, rock fragments, carbonates, layered structure, containing fossils of micro forams and mollusks. The Unk Formation can be compared to the Mamberamo Formation deposited on fluvial, deltaic to bathyal environment. The Mamberamo Formation consists of Member B: silt and shale; Member C: greywake, subgreywacke; Member D: claystone, sandy siltstone; Member E: subgreywacke, greywacke, siltstone and claystone with lignite (Visser and Hermes, 1962; McAdoo and Haebig, 1999).

METHOD

Field data collection, rock and coal sampling to complete the geological mapping method. Petrographic method uses four rock samples (claystone, siltstone, sandstone) which were first made in the form of thin sections and then observed under a polarizing microscope. Moreover, six(6) Coal samples from the Haya and three samples from Sikari are prepared for chemical analysis. Coal samples were examined at the chemical laboratory of the Mining and Energy of South Sulawesi Province, where for analytics it was finely crushed to the top size (ie. 95% particle size sieve) no more than 0.2 mm or -0.2 mm (-200 μm). The weight of the analytic sample will depend on what parameters will be determined in the sample.

RESULTS

Hills morphology is identical to the control of geological structures on the distribution of hills and slope. And lowland morphology is dominated by swamp deposits where erosion of claystone, siltstone causes coal seams to be exposed on the surface. Morphological classification follows the aspects of topographic elevation, as follows (Figure 2):

Lowland Morphology, located at an altitude of 100 m to 150 meters above sea level, slope of <8° with Exposed sandstone lithology. Sloppy Hill Morphology, sloppy hill morphology is unevenly distributed and located at an altitude approximately 150-500 m above sea level, slope between 5-50°. Exposed sandstone and claystone are encountered. Steep Hill Morphology, characterized by hills with elevations >600 meters above sea level. Its distribution is limited by the Sidurasi Mountain range (830 meters above sea level), 2160 meters for Gauttier Mountains (2160 m asl) and the Foya Mountains (2193 m asl).

Figure 2. (A) Sloppy hills and steep hills morphology (B) Lowland morphology

Geological Structure

Sinistral shear fault lineament generally in the north-northwest to south-southeast and southwest-northeast direction. The lineament pattern illustrates an anticline disturbance at the Sikari coal seam being discontinuous compared to the Haya-Krusta coal seam being more inclinely continous (Figure 3).

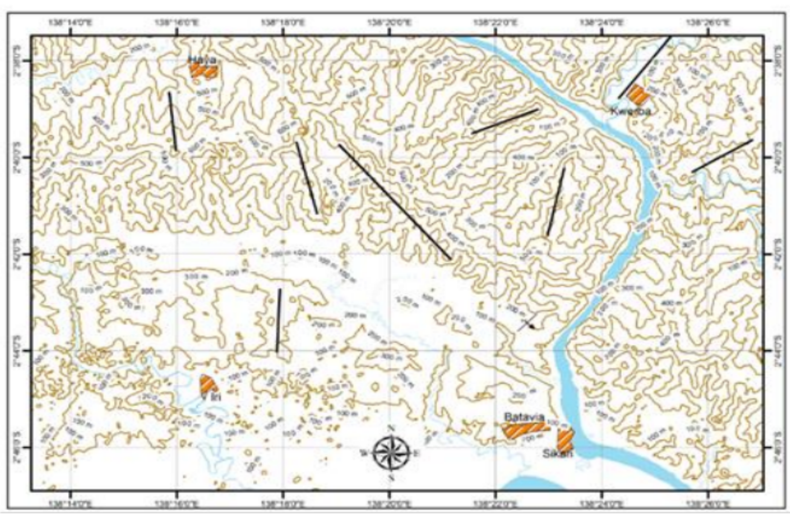

Figure 3. Geological structure Shear fault lineament pattern

Lithology

The megascopic appearance on claystone, siltstone and sandstone outcrops clamps the coal layers (Figure 4).

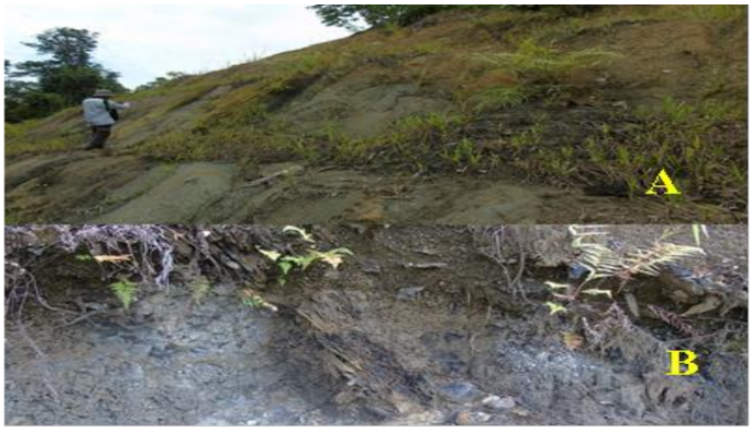

Figure 4. (A)Siltstone and sandstone outcrop (B)coal layers on claystone and siltstone

Petrographic analysis of claystone has a composition of constituent materials: quartz minerals (10-15%), biotite (15%), muscovite (5-20%), and clay minerals (80-85%). Siltstone consists of biotite minerals (10%) , quartz (10%), muscovit (5%), orthoclasts (10%), opaque (5%), clay minerals (60%). Sandstone consist of quartz mineral (5-25%), muscovite (20%), biotite (15-20%), Plagioclase (oligoclase) (10%), orthoclase (15-35%), clay mineral (10-20%), Graywacke and rock fragment of igneous rock origin (35%), orthoclase (15%), muscovite (20%), quartz (10%), carbonate mineral (20%), Lithic Arenite.

Petrographic composition of claystone, siltstone and sandstone is interpreted to be a shallow marine depositional environment. The presence of minerals; orthoclase, plagioclase, biotite and limitation of fossil contents shows that depositional process is influenced by igneous rock minerals and coal layers has variation in calorie grade.

Coal Layers (seams)

Coal layer on claystone is considered to be 1 seam which continuously distributed in northwest west to southeast east direction. Reconstruction of direction similarities shows that the continuation of this layer is a part of exposed coal at Haya-Krusta area (Haya-Krusta coal seam) and Sikari area.

Haya Seam (Seam 1). Field descriptions on a single layer of Haya coal are as follows: layer length 41 m, average thickness of 4.0 m, dip (10^{o} –20^{o}) spreading at north-northeast-southwest (Figure 5). Black, blackish brown, there wood content. The upper and lower flanking rocks of this layer are siltstone (Figure 6A).

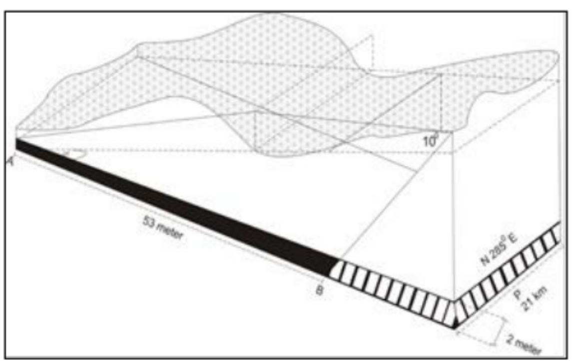

Figure 5; the distribution of Haya-Krusta coal layer

Sikari Coal Seams (Seam 1 and Seam 2). Sikari coal consists of two layers with the direction of distribution southeast-east-northwest-west. Field descriptions are as follows (Figure 6B):

The outcrop of the coal seams is 33.0 m, with an average thickness of 3.0 m, dip (35^{o}-40^{o}), black, blackish brown, flanked by siltstone and claystone; claystone as the top layer and siltstone as the bottom layer. The lateral continuity of this layer is not so good where some observation points outcrops show disappearing layers and are cut off by sandstones. The discontinuous layer of coal outcrops is thought to follow a siltstone lens. Besides being stratigraphically cut, this layer is also cut by faults.

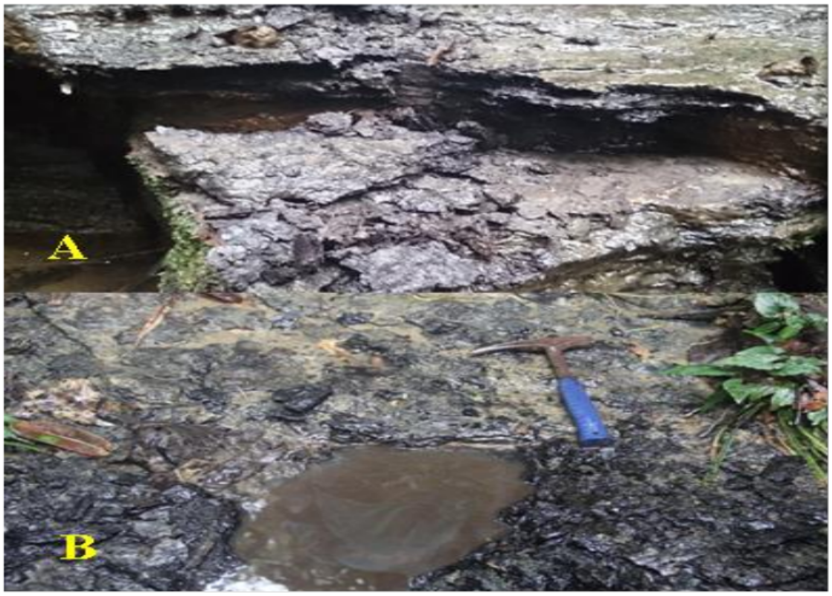

Figure 6. (A)Outcrop of Haya-Krusta coal seam (B) Outcrop of the Sikari coal seam

Geochemistry

Table 1, the percentage of sulfur content from five samples (0.27- <1.0%) derived from coal seams in the Haya-Crusta region which is referred to as low-sulfur (<1% S). Except for one sample which contained sulfur (1.45%) and included as medium sulfur content (1 to <3% S) (Chou, 2012). Increased calories of the lignite group accompanied by rising sulfur levels caused by the degree of aromatization of organic sulfur small molecules rises with increasing degree of coalification (Zhang et al, 2016).

Tabel 1. Coal chemistry of the Haya-Krusta area

	N	Median	Min.	Max.	Mean
Cal (Kal/g)	6	4800.30	3050.00	5930.00	4673.60
S Total (%)	6	0.70	027	1.45	0.73
Ash (%)	6	6.27	4.20	49.63	13.02
Moisture (%)	6	14.21	11.19	16.37	14.13
Volatile Matter (%)	6	45.88	23.98	55.47	43.68

While the results of chemical analysis from the Sikari area (Table 2) shows that the sulfur content of (0.75-1.0%) is a layer of coal in sandstone, silt and claystone intercalations.

Tabel 2. Coal chemistry of the Sikari area

	N	Median	Min.	Max.	Mean
Cal (Kal/g)	3	4960.79	4550.77	5000.00	4837.18
S Total (%)	3	0.76	0.75	1.00	0.84
Ash (%)	3	6.75	6.45	10.20	7.80
Moisture (%)	3	13.70	13.30	15.45	14.15
Volatile Matter (%)	3	43.89	43.25	46.20	44.44

Positive correlations (r = 0.025 and r = 0.25) sulfur and ash content are shown in the samples from Sikari (Figure 7). High levels of sulfur indicate that peat is connected to brackish water (Bustin and Lowe, 1987) or coated with marine sediments (Cohen et al, 1984).

Moderate to high ash levels and low sulfur levels <1% are interpreted to form in topogenous mud (freshwater/swamps) in a fluvial environment that contains autigenic minerals that were formed during peatification (Wiranata et al, 2019). It is interpreted that the difference in the quality of the coal seams in clay is better than the coal seams in siltstone, sandstone.

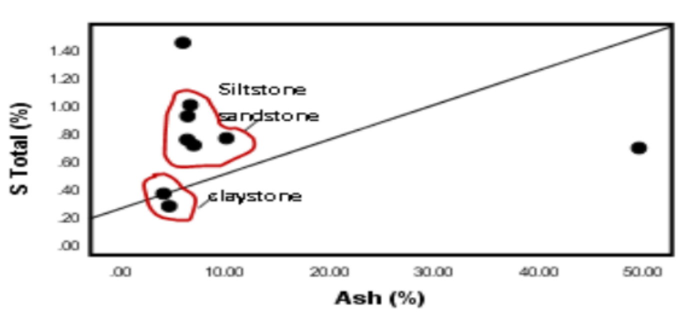

Figure 7. The correlation between ash and total sulfur

DISCUSSION

The coal layer consist of two seams which stratigraphically these layers were cut by several shear faults that are trending almost north-south. The petrographic nature of claystone, siltstone and sandstone is a strong correlation of exposed coal deposits which is a part of the the basin (pocket basin) distributed and thickens further toward the northwest.

Geological structure disturbance correlates with differences in the coal seam dip in the Haya-Crusta region which has a relatively better continuity compared to the coal outcrops of the Sikari Region. The differences in sulfur content precisely, the Sikari coal seam is lower than the Haya coal seam. Comparison of total sulfur and ash shows the level of depositional degradation. The uses aspect of coal researched lie in the uses for the cement industry, power plants and other industry uses.

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