Silicified coal characteristic and distribution at pt mitrabara adiperdana Tbk, north Kalimantan for efficient mine planning

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Abstract. Silicified coal is formed by the enrichment of mineral in the coal seam. Due to the very hard form, silicified coal interferes with the effectiveness of mining causing more time for excavation. The purpose of this study was to determine the characteristics and distribution of silicified coal in PT. Mitrabara Adiperdana Tbk, which is used as a reference for selective mining. This research has conducted mapping which includes surface and subsurface data collection and laboratory tests. Surface data includes geological structure, stratigraphy, distribution patterns and observations of megascopic characteristics of silicified coal inseam 3. Subsurface data include drill point and coal seam cross-sections in Sector Y. Laboratory analysis is carried out from the outcrop coal sample and overburden of seam 3. Silicified coal inseam 3 has two types, which are type A, which is more fragile, and type B which is harder. In general, silicified coal in the research area was formed on the coal layer that has direct contact with the tuffaceous sandstones. In fault areas, silicified coals are found along the fracture zone where coal seams come in contact with tuffaceous sandstones. Thus, the recommended mining area is based on the silicified coal distribution map.

1. Introduction

The presence of silica in the coal can form hard coal, called silicified coal [1]. The existence of silicified coal in the coal seam can disrupt the mining production, both the production and the coal quality [2]. Silicified coal can be classified into three diagenetic processes of wood silicification, namely detrital diagenetic, initial diagenetic and late diagenetic [3]. Detrital quartz which is a part of silica minerals generally has unclear boundaries (anhedral), un-uniform grain size, has a lot of clay mineral content, contains an inclusion of organic material and not fill the fracture [4]. Thin section of diagenetic quartz in petrographic analysis generally shows the euhedral subhedral form and uniform grain size forms lamination structure (fissure filling) and contains small clay mineral [4].

Pujobroto [5] explained the formation of silicification in coal. During the process of volcanic activity, peat will be covered by volcanic material. The sedimentation process causes the peat layer to experience pressure due to the volcanic material above it. The volcaniclastics is a material that is rich in silica, and when sedimentation happened to be above the peat layer, the silica content will be mixed with peat water. With the hydrogeological process, silica-rich water leaks into the peat layer. Precipitated silica water then replaces plant tissue. Coal silicification can begin during the initial stages of coalification or even the development stage of peat which forms diagenetic silica by the process of recrystallization of the saturated silica solution [6].

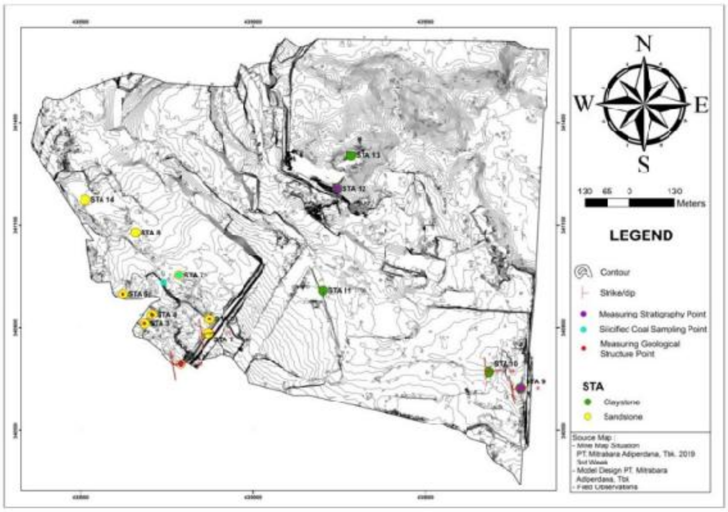

Figure 1. Location map of STA in the research area.

PT Mitrabara Adiperdana Tbk is one of the companies that are exploiting coal in the Langap Formation which contains volcanic material such as tuff [7]. During the exploitation activities, the company encountered the presence of silicified coal in Sector Y. This silicified coal is known to be the factor that can reduce the effectiveness of mining activities in one of its seams, especially seam 3. Thus, the study aims to determine the distribution of silicified coal based on the characteristics and patterns in Sector Y as the research area.

2. Methods

The study has conducted field mapping that includes surface and subsurface data collection and laboratory tests. There are 14 observation locations (STA) (Figure 1) within the research area that are used as a reference in the study. The data obtained from the surface are measured stratigraphy, structural geology measurements, three silicified coal of seam 3 samples and one sandstone sample. Samples are prepared for X-Ray Diffraction (XRD) test to determine the minerals and also prepared into thin sections for petrography analysis. The research is also supported by several secondary data, which are drill log data and mining topographic map.

3. Results and discussions

3.1. Stratigraphy of research area

Stratigraphy seam 3. The stratigraphy of Seam 3 from oldest to youngest consists of claystone, coal seam 3B, split layer between seam 3A and 3B which consists of claystone (1.5 m), tuffaceous sandstone (1 m), claystone (2 m), tuffaceous sandstone (20 cm) and claystone (1 m), then coal seam 3A, tuffaceous sandstone (Figure 2).

3.2. Stratigraphy seam 2.

The stratigraphy of Seam 2 from oldest to youngest consists of claystone, coal seam 2B, split layer of claystone, then coal seam 2A, claystone several interbedded sandstones (Figure 3).

3.3. Stratigraphy seam 1.

The stratigraphy of Seam 1 from oldest to youngest consists of claystone, coal seam 1C, inter burden layer of sandstone, seam 1B and there is a parting layer of sandstone, then inter burden layer of sandstone, coal seam 1A and claystone (Figure 4).

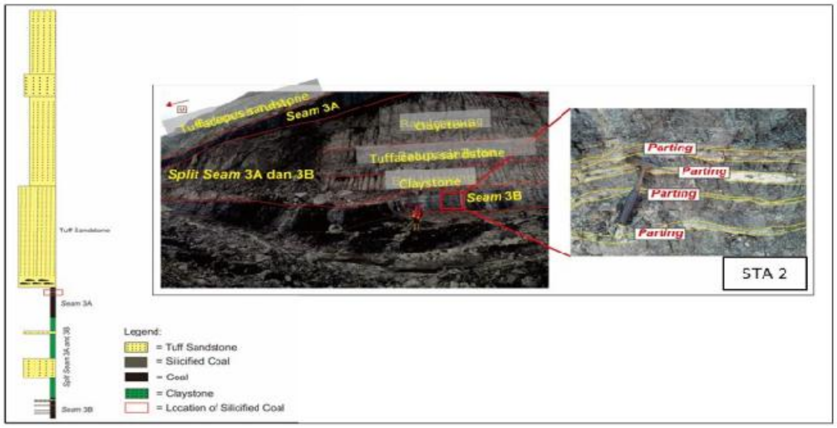

Figure 2. Measured stratigraphy of seam 3 coal-bearing formation. The roof of seam 3A has direct contact with tuffaceous sandstone.

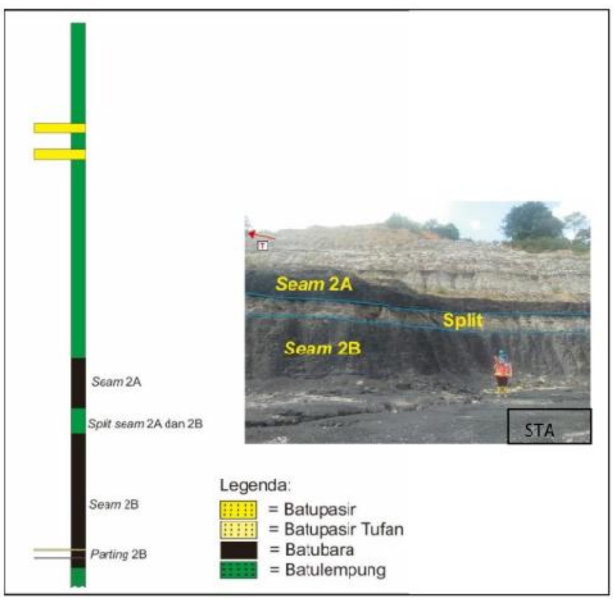

Figure 3. Measured stratigraphy of seam 2 coal-bearing formation. Vertically, seam 2 is separated by a split that thickens eastward, this split divided seam 2 into seam 2B and 2A.

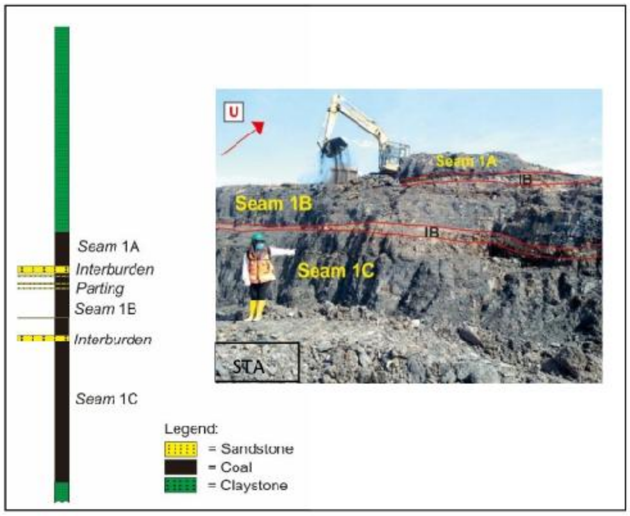

Figure 4. Measured stratigraphy of seam 1 coal-bearing formation. Seam 1 has two inter burden, thus separated into seam 1C (on the lowest part), seam 1B and seam 1A (on the upmost part).

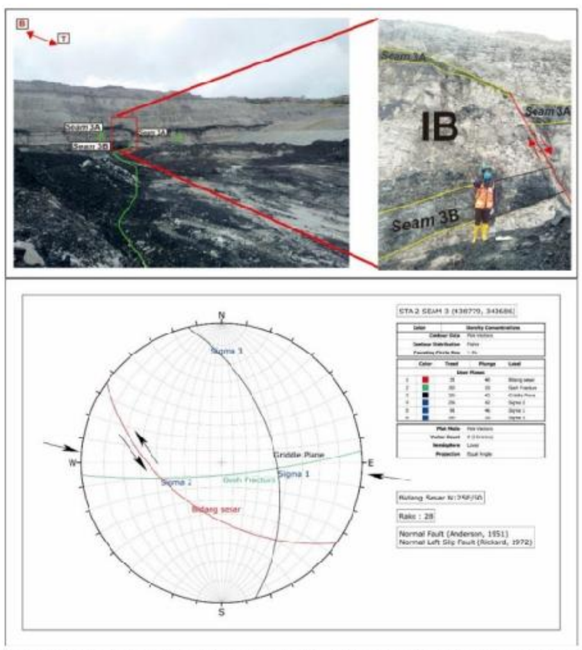

Figure 5. Fault plane measurement at STA 2 (upper). The analysis proved that it is at Normal Fault.

3.4. Structural geology of research area

Several fault features are found within the research area, especially faults that cut through seam 3. These faults were found in STA 2 (Figure 5), 3, 4, 5 and 6. All the fault planes have NNW-SSE direction, dipping WSW at 40° to 60°. Based on the field appearance and structural analysis, types of faults were normal faults.

3.5. Physical characteristic of silicified coal

Based on the physical properties of outcrop samples, the silicified coal in research area is divided into two types, which are type A and type B. Type A has a blackish color, abundant silica content in the form of veins, brittle, laterally distributed on the roof of seam 3A in the form of layers (Figure 5).

Type B has a grayish-black color, a small amount of silica vein, compact and hard and when exposed to sunlight the mineral composition will look shiny like glass (Figure 6). Generally spread within the body (under type A) and in the fractures of fault plane that cuts seam 3A. On the body of seam 3A, it is generally shaped lens with boulder size and in the fracture plane, it is shaped firmly following the fracture plane.

3.6. Microscopic characteristic of silicified coal

Under the microscope lens, type A (Figure 7) shows a massive structure, containing organic material and quartz minerals. The petrographic appearance of organic material, it is seen black on plane-polarized light and cross-polarized light, irregular shapes, some of which experience cracks filled with quartz. The composition of quartz minerals is around 58% and organic material about 42%.

Type B in the body of seam 3A in petrography analysis (Figure 8) shows clastic texture, laminated structure and matrix-supported. Its composition consists of organic material, quartz minerals and clays. Organic materials appear to have an irregular elongated flat shape. Quartz mineral in petrographic appearance is colorless on plane-polarized light and grey on cross-polarized light, with grain size <0.03-0.05 mm, present as microcrystalline granules (polycrystalline quartz), scattered or filling cavities in organic material.

The microscopic view of type B, from the fractures of fault plane at STA 6 that cut seam 3A (Figure 9), shows clastic texture, laminated structure and matrix-supported. Its composition consists of organic material, quartz minerals and clays. Organic material in petrographic appearance is brown in plane-polarized light and black in cross-polarized light. The organic material has many fractures filled with quartz minerals. Quartz mineral in petrographic view is colorless on plane-polarized light and grey on cross-polarized light, with grain size <0.02-0.05 mm, present as microcrystalline granules (polycrystalline quartz) scattered or filling cavities in organic material. Clay mineral in petrographic appearance is brownish in plane-polarized light, dark gray in cross-polarized light and found scattered in the body of silicified coral. The composition of organic material around 25%, quartz minerals around 40% and clay minerals 35%.

Clay mineral in petrographic appearance is brownish in plane-polarized light, dark gray in cross-polarized light and found scattered in the body of silicified coral. The composition of organic material around 24%, quartz minerals around 31% and clay minerals 45%. Based on XRD, it is known that silicified coal type A contains the same minerals as silicified coal type B, which are quartz, illite and paranatrolite.

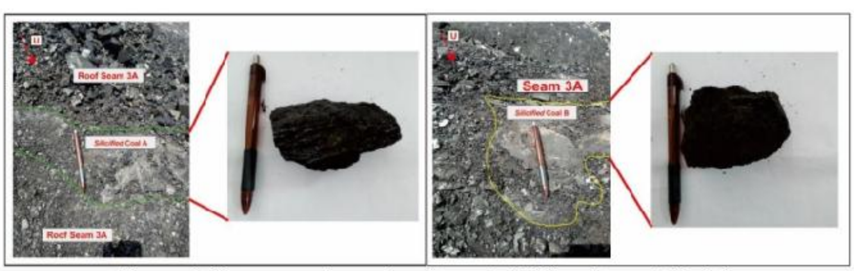

Figure 6. Outcrop and sample of type A (left) and type B (right).

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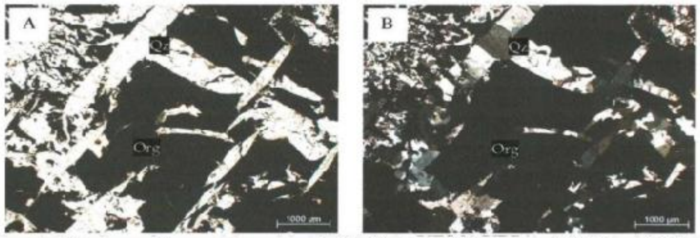

Figure 7. Petrographic appearance of silicified coal Type A; (A) Plane Polarised Light, (B) Cross Polarized Light (25 x magnification).
Note: Org = Organic Material, Qz = Quartz.

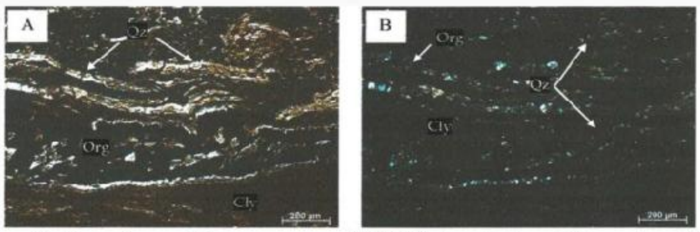

Figure 8. The petrographic appearance of silicified coal Type B (lens shape) (25x magnification) (A) Plane Polarised Light, (B) Cross Polarised Light
Note.: Org = Organic Material, Qz = Quartz, Cly = Clay Mineral.

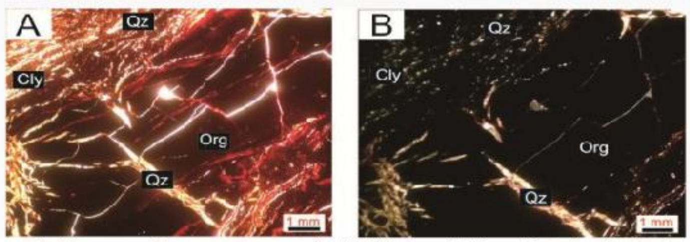

Figure 9. Petrographic appearance of silicified coal Type B at the fault plane of STA 6; (A) Plane Polarised Light, (B) Cross polarized Light (4x magnification).
Note.: Org = Organic Material, Qz = Quartz, Cly = Clay Mineral.

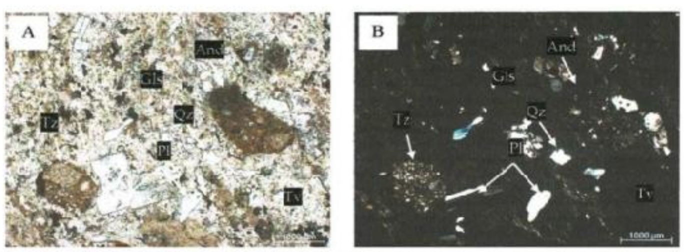

Figure 10. Petrographic appearance of tuffaceous sandstone; (A) Plane Polarised Light, (B) Cross Polarized Light (25 x magnification).
Note.: And = Andesit, Gls = Volcanic Glass, Pl = Plagioclase, Qz = QUartz, Tv = Vitric Ttuff, Tz = Zeolitic Tuff.

3.7. Characteristic of tuffaceous sandstone

Microscopic observations of tuffaceous sandstone (Figure 10) which become overburden on seam 3A (coal seam which contained silicified coal) has clastic texture, matrix-supported, and massive structure. The sample is composed of rock/ lithic fragments, plagioclase minerals, quartz and opaque minerals in the volcanic glass matrix which has been transformed into zeolites. The lithic composition consists of vitric tuff, andesite and zeolitic tuff. From XRD analysis, the tuffaceous sandstone composed of albite, clinoptilolite, cristobalite and quartz minerals.

3.8. The Distribution of silicified coal in research area

Stratigraphic correlation analysis and structural geology analysis at the research location were conducted to determine the distribution of the silicified. In order to build a map that covers the whole research area, stratigraphic correlations were controlled by the drill log data (Figure 11). There are five cross-sections: A-A' (Figure 13), B-B', C-C' (Figure 12), D-D' and E-E'.

The locations that have the potential to have silicified coal are at the area where coals with a roof that has direct contact with tuffaceous sandstones. It is marked in the red column areas of each geological cross-section. The sections show only seam 3 that stratigraphically overlain by tuffaceous sandstone above it. Seam 3A that most possibly has no silicified coal is distributed in the northeast part of the research area, whilst the high potential is distributed in the southwest part (Figure 14). The highest potential area with silicified coal form is along the fault planes, where the fractured coal is filled with minerals, especially silica.

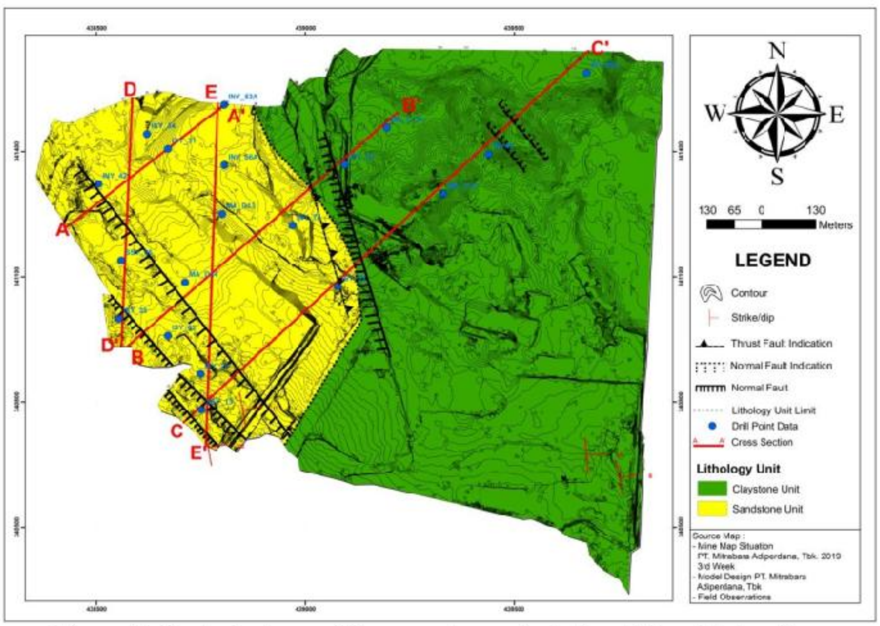

Figure 11. Geological map of the research area, including drilling data location.

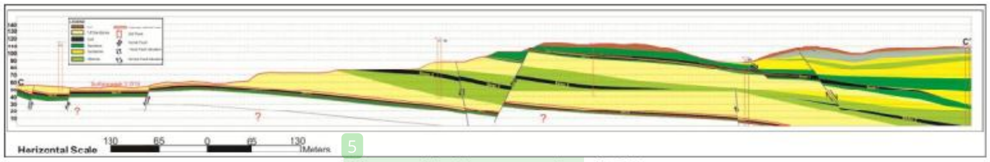

Figure 12. Cross-section C-C'.

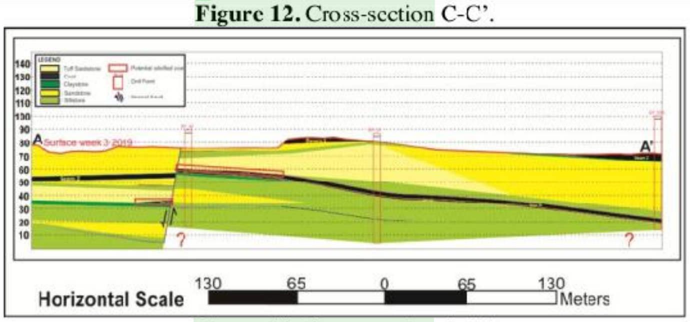

Figure 13. Cross-section A-A'.

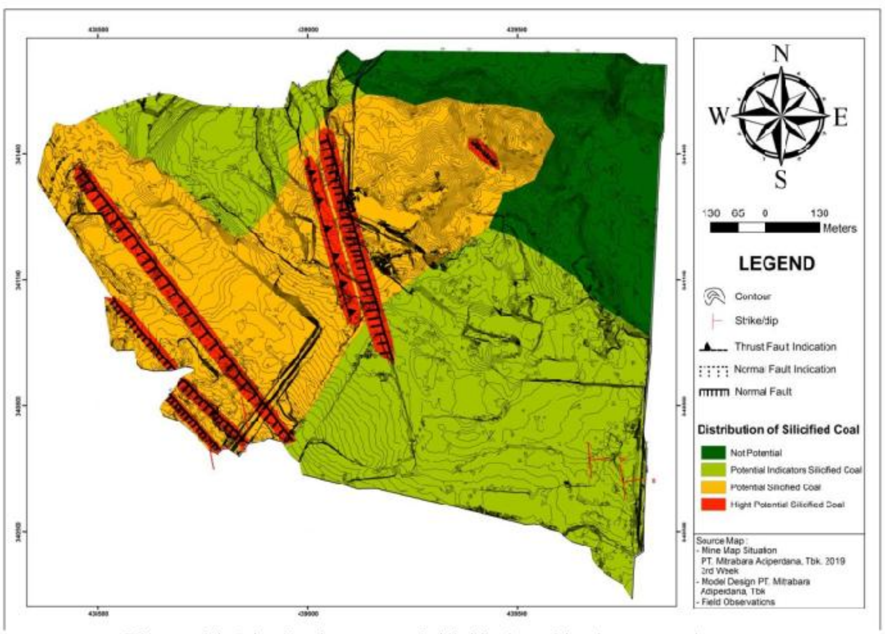

Figure 14. Distribution map of silicified coal in the research area.

4. Conclusion

Silicified coral in the research area is divided into two types of characteristics, which are type A and type B. Type A is harder than type B, spread evenly on the roof and slightly in the body seam 3 with layering and lens patterns. Based on the subsurface stratigraphic correlation, it is interpreted that silicified coal is widely spread on-seam 3A and is less likely to be found on other seams. Seam 3A that most possibly has no silicified coal is distributed in the northeast part of the research area, whilst the highest potential is distributed in the southwest part.

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