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International Symposium on Earth Science and Technology 2020

Greetings from Cooperative International Network for Earth Science and Technology (CINEST)

We are facing with global environmental problems with problems on resources depletion at behind. In particular, the rapid increases in mineral resources and energy consumptions have cast a shadow over the sustainability of human activities. The CINEST was founded in 2008 to enhance cooperative studies and activities by young researchers and engineers, because their boldly tackles must be keys and absolute foundation to solve problems found on the earth, especially in Asia and Africa. I would like to emphasize to young researchers that performing research "by hand" rather than "by manual" may develop their potential to find new solutions.

This international symposium started from 2008 cooperating with The JSPS International Training Program during 2008 to 2012, and has been supported by Mitsui-Matsushima Co., Ltd. from 2013. The important objective of the symposium is strong networking of young researchers to enhance international collaboration to solve both of global and domestic problems on mineral resource and environment.

Finally, I would like to sincerely thank all of the organizations and participants, and believe the symposium will provide fruitful successes for all.

Welcome to "International Symposium on Earth Science and Engineering 2020."

Kyuro Sasaki
CINEST Chair

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*"MITSUI MATSUSHIMA AWARD" will be given to Best Papers, Best Presentations and Best Posters at the Awards Ceremony

Contents

Characteristics of Cleat and Geometry Coal Seam of Keban Area, Lahat Sub-District, South Sumatera, Indonesia

Basuki RAHMAD[1], C. PRASETYADI[1], Fadhil ZUHDI[1], Indra DARMAWAN[1], Sugeng RAHARJO[1], EDIYANTO[1], Gerhana Prasetya PUTRA[1].

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ABSTRACT

Cleat is a term used for fractures in coal, there are two types of fractures which are a pair of face cleats and butt cleats. Cleat which is a component of coal has characteristics consisting of openings, spaces, length, frequency, orientation, and mineral fillers contained therein. Coal bearing formation in the research area is the Late Miocene - Pliocene included Muara Enim Formation. The coal depositional environmental of the Keban area and its surroundings is deposited in delta plain through a regression phase with the presence of multiple seam coal and the coal thickness between 3 - 10 meters. Regionally the study area belongs to the Syn Orogenic tectonic phase. The coal quality of the Keban Area: Caloric Value 5347-5504 kcal / kg, Inherent Moisture (23.6%), Ash (4%), Volatile Matter (32.1%), Fixed Carbon (40%), Total Sulphur (0.5%) including Sub-Bituminous Coal. The geometrical form of coal that developed in the study area is in the structure of the anticline fold Open Upright Gently Plunging Fold, with the axis of direction trending relatively eastern to western. The results of cleat analysis in the study area are endogenic cleats (macrocleats). There is a significant difference in the intensity of the cleats in the flank of folds which are steeply and the flanks of folds are gently sloping. Generally perpendicular to the bedding plane so that the plane of fracture tends to divide the coal layers into thin tabular fragments.

***Keywords**: coal, quality, anticline, fracture, endogeneous cleat, macrocleat*

INTRODUCTION

The research area is located in Keban Village, Lahat Regency, South Sumatra (Figure 1). South Sumatra Province is one of the provinces that has abundant natural resources. One of these natural resources is energy resources such as coal. Coal has been the main supporter of energy demand in Indonesia. However, the use of coal so far is still conventional. There is another potential that can be maximized from coal, namely methane gas trapped in coal which is called coal bed methane (CBM). The research area, which is located in Lahat Regency, holds quite large coal reserves, but there are not many researches that can be used as an initial step in the utilization of CBM. Therefore, the researchers conducted surface geological mapping and studies of the exposed coal cleats in the field, with the hope that this research will contribute to exploration and exploitation of coal bed methane at the research location and its surroundings in the future.

Cleat is a term used for fractures in coal, there are two types of fractures which are pairs, namely face cleat and butt cleat (Laubach et al., 1998). Cleats, which are one of the components of coal, have characteristics consisting of openings, spacing, length, frequency, orientation, and mineral fillers contained therein (Dwitama & Iskandar, 2014).

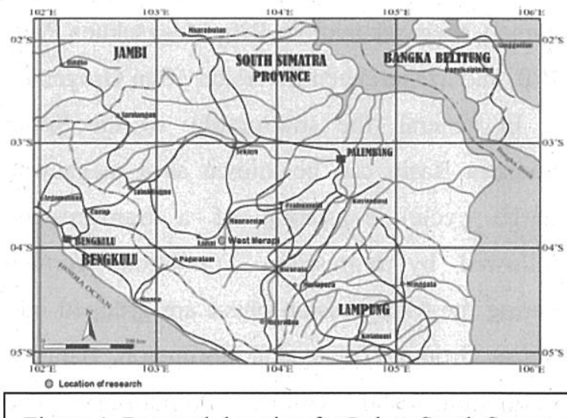

Figure 1. Research location for Lahat, South Sumatra

The cleat field functions as a pore cavity, a place for accumulation, and the passage of methane gas and water or as a main channel for the transfer of methane gas from a coal reservoir (Kuncoro, 2012).

The object of this study is to determine the characteristics of the cleats (openings, distance, spacing, and orientation) of the coal in the research area.

GEOLOGY REVIEW

The stratigraphy of the research area consists of the Muaraenim Claystone Unit which is based on the results of the palinological analysis including the Florschuetzia meridionalis zone with the Middle-Late Miocene age and is deposited in the lower deltaic plain environment with the tidal flat and marsh depositional environment (Rahmad, et.al., 2019). The Muaraenim tuffs unit is included in the papuan stenochlaenidites zone with the Late Miocene-Late Pliocene age which is deposited in the upper delta plain environment with the floodplain sub-environment. The geological structures that develop in the research area are anticline folds, burrows, and cleats.

According to Ginger & Fielding (2005), the history of the South Sumatra Basin is divided into three tectonic megasequences that form the structural framework of the South Sumatra Basin, namely Megasekuen Syn-Rift, Megasekuen Post-Rift, and Megasekuen Inversion / Syn Orogenic.

In general, the stratigraphy of the South Sumatra Basin can be known as a megacycle (large cycle) consisting of a transgression followed by regression. Formations formed during the transgression phase are grouped into Telisa Groups (Talangakar Formation, Baturaja Formation, and Gumai Formation). The Palembang group was deposited during the regression phase (Airbenakat Formation, Muara Enim Formation, and Kasai Formation), while the Lemat Formation and the older Lemat were deposited before the main transgression phase (Ginger & Fielding, 2005).

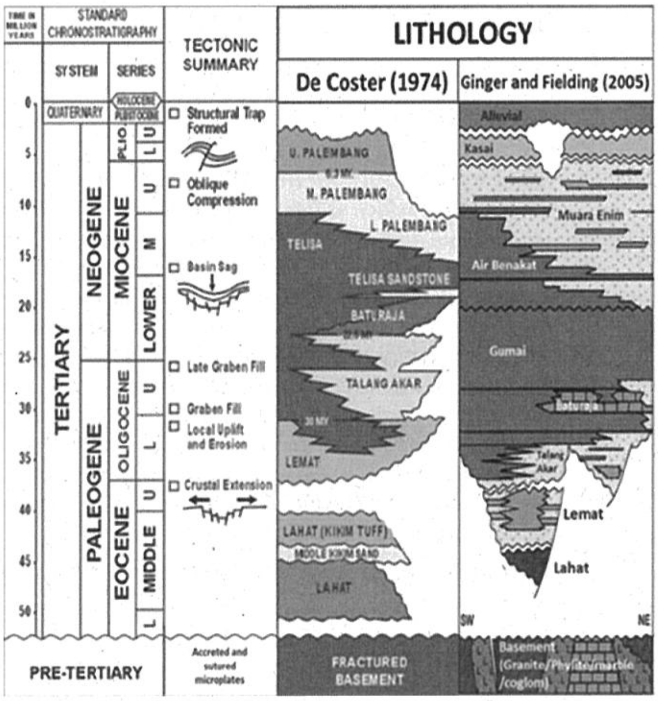

Figure 2. South Sumatra Basin Stratigraphy (Ginger & Fielding, 2005)

In the research area there are 3 coal seams, namely seam coal A (A upper and A lower), seam coal B, and seam coal C. Coal in the study area is included in the Subbituminous rank.

The major geological structure that was developed in the Keban Area is an anticline that has a relatively west-east direction with a north-south relative direction flank.

Based on the results of observations in the field, there are two geological structures in the study area, namely folds in the form of anticlines and fractures in coal or what are called cleats. However, the development of the geological structure has not yet reached the formation of faults, this is evidenced by the absence of faults found in the study area.

METHODE OF RESEARCH

The scope of this research is covered in several ways, namely observing coal outcrops and measuring and analyzing the data on the characteristics of the cleats in the coal seam in the Keban area, Lahat Regency, South Sumatra.

Cleat analysis was performed using attribute data and cleat orientation. The data is then analyzed to obtain the average value of each cleat attribute in the form of length, height, opening, cleat spacing and cleat orientation. This was done to determine the characteristics of the cleats on each fold limb (Figure 3).

Figure 3. Coal outcrops in the Keban area, Lahat, South Sumatra

Quoted from Laubach (1998) and Ryan (2003), a number of researchers stated that the cleat incidence in coal seams is influenced by dehydration, devolatilization, deposition mechanisms, coal macerals and lithotypes, coal rank, regional tectonics, geological structure, seam thickness, and activity. mine work (Ammosov, 1963; Jeremic, 1986). In other words, one of the cleat functions is the role of geological structures. Laubach et al (1998) in Kuncoro (2012), state that in measuring the characteristics of the cleat it consists of cleat attributes and cleat orientation. Measurement of cleat attributes is carried out by measuring data in the field in the form of cleat length, space / distance between cleats, cleat openings, and cleat fillers, while the measurement of cleat orientation is strike and dip. This was done to determine the comparison of cleat characteristics in each fold limb and genesa cleat.

According to Laubach (1988), a cleat is a natural fracture in the coal content with open characteristics, consisting of a face cleat and a butt cleat (Figure 4).).

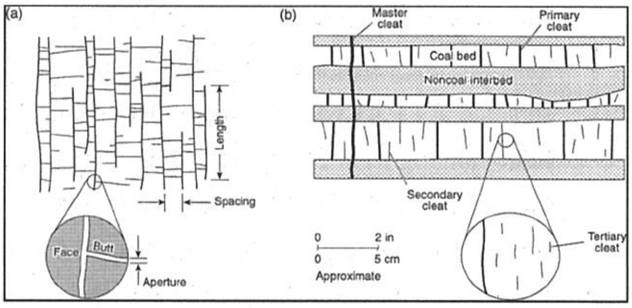

Figure 4. Appearance of a face cleat and butt cleat (Laubach, 1998)

RESULT AND DISCUSSION

In measuring the cleat attributes, there are several parameters, such as cleat length / height, cleat space, and cleat opening. Measurements made on LP 03, 04, 05, 06, and 43 belong to the steeper anticline fold limb while the LP 50 is included in the steeper fold limb (Figure 5).

Figure 5. Measuring cleat attributes

Based on the results of the data recapitulation, the cleat spacing (Table 1) has very diverse values, where the average smallest face cleat spacing is at LP 43 with a value of 2.30 cm and the value ranges from 0.6-5.2 cm, while the largest at LP 50 with an average value of 4.42 cm and the value ranges between 2.7-6.8 cm. At the butt cleat spacing, the smallest average spacing was obtained at LP 43 with a value of 3.11 cm and a value ranging from 2.6-4.2 cm, while the largest was on the LP 50 with an average value of 5.57 cm and a value ranging from between 4-6.7 cm. The value of the butt cleat spacing has an average value that is greater than that of the face cleat.

The value of cleat openings in the field is quite difficult to observe due to the relatively small magnitude, in addition, the relatively large opening values are affected by mining activities carried out at each observation location. This is caused by the dredging and movement of heavy equipment. The average value of the smallest face cleat opening is at LP 04 with a value of 0.89 mm and a value ranging from 0.5-1.6 mm, while the widest is on LP 43 with an average value of 1.09 mm and a value ranges from 0.5-1.2 mm. At the butt cleat openings, the smallest average space was obtained on the LP 43 with a value of 0.72 mm and a value ranging from 0.5 to 1 mm, while the widest was on the LP 05 with an average value of 0.86 mm and a value ranging from 0 , 5-1.3 mm. There was no significant difference between the opening values of the steep folded limb and the sloping fold limb (Table 2).

The average value of the smallest face cleat length is at LP 50 with a value of 7.03 cm and the value ranges from 4.4-12 cm, while the longest is on LP 04 with an average value of 13.86 cm and the value ranges from 7-23 cm. At the length of the butt cleat, the shortest average length was obtained on the LP 43 with a value of 3.04 cm and a value ranging from 1-5.8 cm, while the widest on the LP 04 with an average value of 4.49 cm and a value ranging from 1 , 3-9.5 cm. There was no significant difference between the length value of the steep folded limb and the sloping flap (Table 3).

Table 1. Recapitulation of interval values and mean cleat space

LP	Interval Spasi (cm)		Rata-rata Spasi (cm)	
	Face cleat	*Butt cleat*	*Face cleat*	*Butt cleat*
03	2,0-5,1	4,0-5,1	3,30	4,84
04	1,8-4,9	3,6-5,9	2,94	4,27
05	1,4-6,2	4,4-6,2	3,34	5,27
06	1,0-4,2	3,2-6,0	2,76	4,52
43	0,6-5,2	2,6-4,2	2,30	3,11
50	2,7-6,8	4,0-6,7	4,42	5,57

Table 2. Recapitulation of interval values and mean of cleat openings

LP	Interval Bukaan (mm)		Rata-rata Bukaan (mm)	
	Face cleat	*Butt cleat*	*Face cleat*	*Butt cleat*
03	0,5-2,0	0,5-2,0	0,91	0,82
04	0,5-1,6	0,5-1,3	0,89	0,79
05	0,5-2,0	0,5-1,3	1,02	0,86
06	0,5-1,6	0,5-1,4	1,05	0,85
43	0,5-1,2	0,5-1,0	1,09	0,72
50	0,7-1,5	0,6-1,4	0,94	0,84

Table 3. Recapitulation of interval values and mean length of cleats

LP	Interval Panjang (cm)		Rata-rata Panjang (cm)	
	Face cleat	*Butt cleat*	*Face cleat*	*Butt cleat*
03	4,0-20,0	2,1-5,1	10,37	3,51
04	7,0-23,0	1,3-9,5	13,86	4,49
05	5,3-18,0	1,2-6,0	10,53	3,29
06	2,4-12,2	1,8-5,0	8,21	3,19
43	3,5-13,4	1,0-5,8	8,50	3,04
50	4,4-12,0	2,7-4,4	7,03	3,27

Based on the results of the analysis using GeoRose software, a relatively uniform cleat orientation pattern was obtained at each observation location. Plot of data is carried out on the face cleat which is crossed with the position of the coal seam. This is done to determine the genetic type of cleats, namely endogenic cleats, exogenic cleats, or induced cleats.

In general, the orientation of the cleat in the Keban area represented by LP 03, the orientation of the face cleat is in the range N 164-184oE, while the butt cleat has almost an angle perpendicular to it with the range N60-88oE (Figure 6). The cross position of the seam (N 75oE / 68o) with the orientation of the face cleat shows that the orientation pattern of the face cleat follows the normal pattern, where the direction is relatively perpendicular to the coal seam plane, and the orientation pattern of the butt cleat is relatively parallel to the coal seam plane. This indicates that the cleats measured are endogenic cleats (Table 4).

Table 4. Recapitulation of cleat orientation data LP.03

LP	Strike dip	*Cleat* Orientation	
		Face	*Butt*
03	N 075° E/68°	N 164-184° E	N 060-088° E

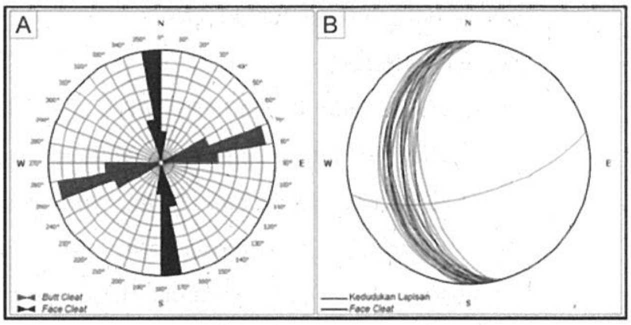

Figure 6. (A) Cross section of the rossette diagram with the orientation of the face cleat and the butt cleat, and (B) the intersection of the orientation of the face cleat with the position of the LP 03 layer

Based on Ammosov & Eremin (1963) in Solano (2007), cleats in the study area are endogenic cleats. Jeremic (1986) in Kuncoro (2012) states that endogenic cleats are fractures in coal formed by internal forces due to drying or shrinkage of organic material. Generally perpendicular to the bedding plane (Figure 6). Moreover, the spacing values measured in all the observed locations indicate that these cleats are classified as macrocleats, namely cleats that have a relatively large spacing value and a tendency to intersect in one coal layer (Figure 6). Endogenic cleats are often associated with the development of CBM rather than exogenic cleats due to their formation associated with the coalification process. Therefore, it can be concluded that there is potential for CBM in the research area and needs to be studied further.

CONCLUSION

Cleats in the research area are endogenic cleats in the form of macrocleats. The spacing cleats are in centimeters where the cleats intersect individually to form coal blocks.

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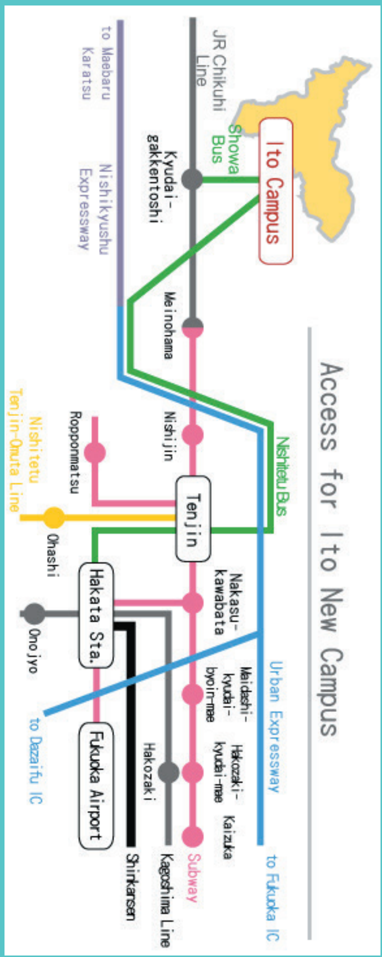

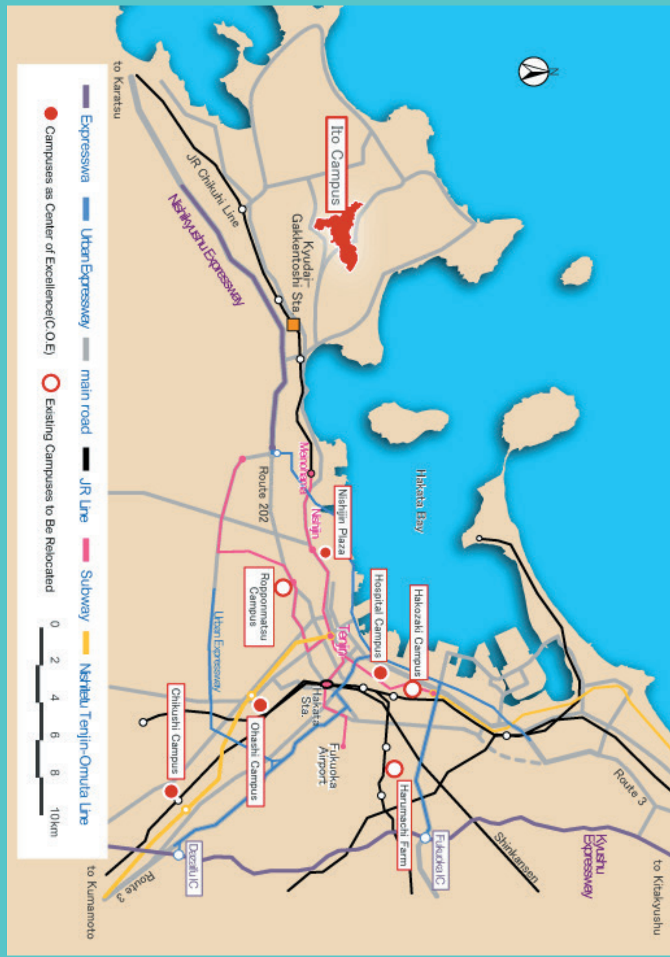

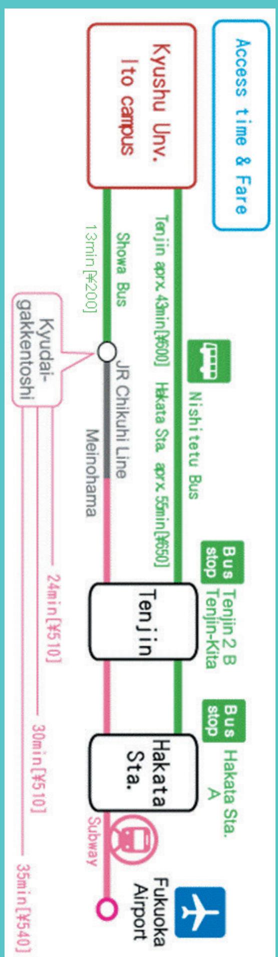

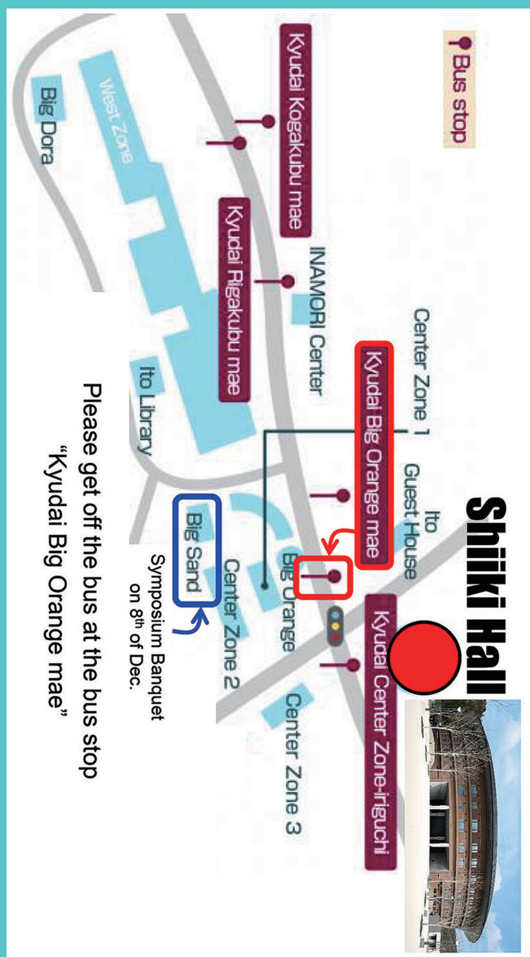

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