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Source rock characterization based on geochemical observations using Well BO-1, Central Sumatra Basin

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Abstract. The Central Sumatra Basin, characterized as a tertiary back-arc basin, stands as one of Indonesia's foremost hydrocarbon-producing basins. Consequently, in the pursuit of hydrocarbon exploration endeavors, a comprehensive analysis of the potential source rocks within this region becomes imperative. The focal point of this study is the BO-1 well, situated within the Pematang Formation. Geochemical analysis methods, specifically leveraging Total Organic Carbon (TOC) and Rock-Eval Pyrolysis data, were employed to assess the quality, quantity, and maturity of the source rock. The research findings reveal a noteworthy organic material content at a fair-to-good level, registering an average TOC value of 0.69% and a Potential Yield of 1,994 mg/g, both falling within the fair-to-good classification. The Hydrogen Index value designates the source rock as type III kerogen, indicating a propensity for gaseous product generation. Maturity evaluation places the source rock within an immature to mature range, with a maximum temperature range of 383-452°C. In summary, the analysis discerns the source rock within the research area as an effective type, characterized by a substantial organic material abundance at a fair-to-good level and a mature maturity level. This conclusion is reinforced by the lithology of the research area, predominantly comprising mudstone, recognized for its richness in organic material.

1. Introduction

The Central Sumatra Basin is a back arc basin formed due to subduction activity of the Indian Ocean plate subducting the Asian plate which resulted in the formation of uplift in the form of row hills, which is divided into four phases: F0 (deformation), F1 (Rifting), F2 (Sagging and Transitional), F3 (Compression) (Thompson et al., 1991 in Longley and Soemantri, 1992). The stratigraphy of the Central Sumatra Basin according to Heidrick and Aulia (1993) consists of several formations from the oldest to the youngest, namely the Bedrock, then unconformity deposited Pematang group which was deposited in fluvial lacustrine, Sihapas group deposited unconformity above, Telisa Formation which form at the time of maximum transgression, Petani Formation which deposited unconformity above the Telisa Formation, and the Minas Formation deposited conformity above it which can be seen in Figure 1.

The Central Sumatra Basin is a basin consisting of tertiary sediments and is one of the largest petroleum producing basins in Indonesia. Petroleum is produced from sedimentary rocks that have the potential to produce hydrocarbons (source rock). Source rock is a low permeability rock that is rich in organic material, generally clay/shale and has matured. Waples (1985) divides source rocks into 3,

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namely:

1. Effective source rock (sedimentary rock that has produced and released hydrocarbons).
2. Possible source rock (sedimentary rock that is not yet mature, but is known to have the capability to produce and emit hydrocarbons).
3. Potential source rock (sedimentary rock that is not yet mature, but has the capability to produce and emit hydrocarbons when its thermal maturity is higher).

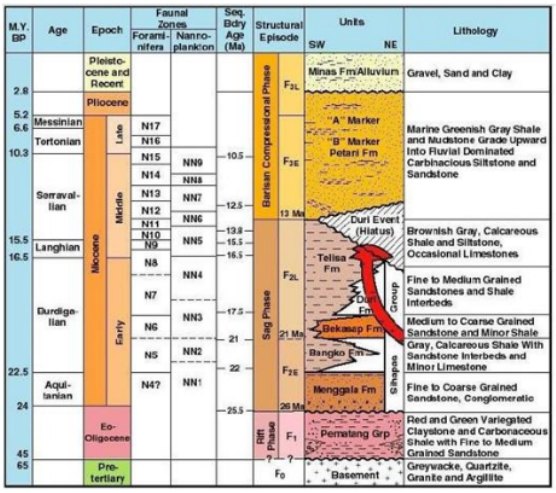

Figure 1. Regional stratigraphy of the Central Sumatra Basin (Heidrick and Aulia, 1993).

In hydrocarbon exploration activities, it is crucial to consider the petroleum system of the Central Sumatra Basin, a hydrocarbon producing basin. Therefore, analyzing the source rock is necessary to determine its quality, quantity, and maturity. And Pematang Formation is one of the primary source rock in the Central Sumatra Basin and research in this area has been carried out for quite a long time, therefore it is felt necessary to re-evaluate this formation. This study aims to evaluate the source rocks in the BO-1 field "B" well of the Central Sumatra Basin, more specifically in the Pematang Formation, using geochemical data. The research area is located in Central Sumatra Basin shown in Figure 2. This basin is in the form of an asymmetrical half-graben trending northwest-southeast and is filled with tertiary sediments in the form of non-marine and lacustrine clastic sediments from the Pematang group in some deep parts of the basin. Meanwhile, further quality analysis can be done through biomarker analysis which has been carried out previously with result that Central Sumatra Basin hydrocarbons are dominate with organic material came from higher plants and lacustrine algae, where deposited in estuarine or bay to open marine and based on the CPI data the oil in this area is mature (Anil et al., 2021).

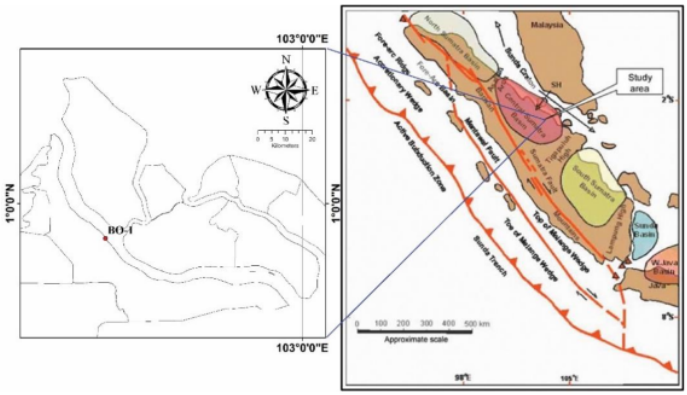

Figure 2. Location of the research area

2. Method

The research was conducted through a geochemical analysis method that used Rock Eval Pyrolysis (REP) data, specifically Total Organic Content (TOC), Potential Yield (PY), and Hydrogen Index (HI). The purpose of this analysis was to evaluate the potential of the source rock in terms of quantity, quality, and maturity. This was achieved by assessing the rock's richness value and type. Through this analysis, we can interpret the relationship between the formation of the source rock and its geochemical properties. The data used in the analysis can be found in Table 1.

Table 1. Geochemical data of well BO-1.

Formation	Depth	TOC (%)	PY (g/mg)	HI (mg/gC)	Tmax (°C)
Pematang Formation	7660	0.64	0.13	19	443
	7710	0.6	1.04	123	453
	7720	0.64	1.59	158	450
	7750	1.03	1.75	131	452
	7800	1.18	3.33	152	446
	7830	0.47			
	7850	0.81	1.71	115	444
	7890	0.54	0.87	93	424
	7940	0.6	1.25	127	441
	7950	0.5	0.64	84	449
	7960	0.71	1.46	124	441
	7980	0.91	2.2	133	446
	8020	0.52	1.12	115	426
	8064	0.16			
	8070	0.26			
	8076	0.64	2.92	123	383
	8088	0.45			
	8094	1.39	5.81	221	394
	8120	0.37			
	8150	0.74	1.46	108	449
	8170	0.89	2.62	163	439
	8190	0.61	1	108	430
	8210	1.26	5.09	248	437

3. Results and Discussion

3.1 Richness of Organic Material

The amount of organic material in a sample can be measured through its Total Organic Carbon (TOC) value. In the BO-1 well, the TOC value of the Pematang Formation ranges between 0.16% to 1.39%, with an average of 0.69%. Based on the classification by Waples (1985), the organic material falls within the fair-good category. Additionally, the formation's capability to generate hydrocarbons, as indicated by its Pyrolysis (PY) value, is also within the same category as the TOC value. The PY value range is 0.13g/mg to 5.81g/mg, with an average of 1,994 g/mg. A comparison of the TOC versus PY values was plotted and can be seen in Figure 3. The graph shows that the formation's source rock contains organic material that falls within the fair-good category, and it has the potential to generate hydrocarbons, which is again in the fair-good category according to Peters and Cassa's (1993) classification.

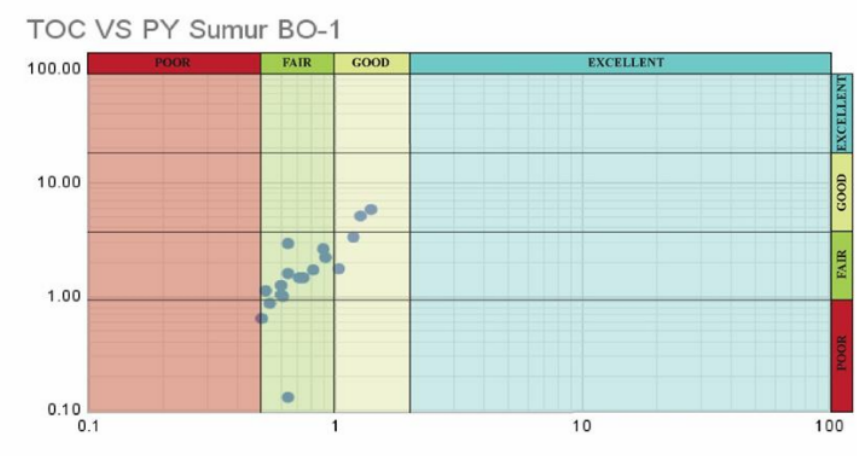

Figure 3. Plotting the ratio of TOC to PY in the BO-1 well.

3.2 Types of Organic Material

This analysis is conducted using the Hydrogen Index parameter to determine which products can potentially be produced by the source rock. Other parameters used in this analysis include the Total Organic Carbon (TOC) value and maximum temperature value. By analyzing the correlation between HI and TOC parameters, we can establish the capacity of the source rock and its capacity to produce specific products. The comparison of TOC to HI reveals that the source rock in this area is a lean-to fair source rock, with the resulting product being gas. Please refer to Figure 4 for the results of the analysis.

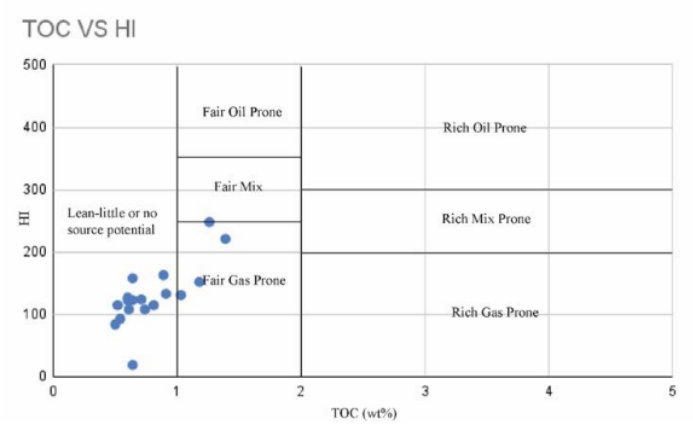

Figure 4. Comparison of TOC to HI in well BO-1.

An analysis was conducted using HI and Tmax parameters to determine the correlation between hydrocarbon maturity and the end product. The Van Krevelen diagram (refer to Figure 5) was used to compare Tmax and HI values. The analysis indicated that the source rock in the study area contains type II-III kerogen, which tends to produce oil/gas that is in the immature-mature stage according to Peters and Cassa's (1994) classification system.

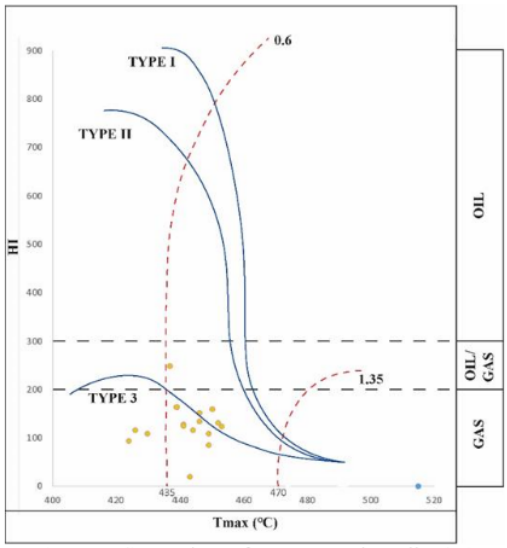

Figure 5. Comparison of Tmax to HI in well BO-1.

After conducting an analysis, it can be inferred that the organic material of the source rock in the Pematang Formation, located in the research area, is of fair quality and has the potential to produce hydrocarbons that are fair to good in quality. The source rock's organic material consists of type III kerogen, which typically produces gas from lean-fair source rock. The source rock rock has matured to a certain degree. Based on these parameters, the source rock in the area can be

classified as an effective source rock, according to the Waples (1985) classification. Hence, it can be concluded that the source rock in the area is a mudstone lithology source rock that is rich in organic material and has the potential to produce hydrocarbons.

3.3 Discussion

The Pematang Formation is a formation that has potential as a source rock seen from the total organic carbon sufficient to produce hydrocarbons, as well as its capacity based on comparative analysis of TOC to PY which is included in the fairly good category (Peters and Cassa, 1993) with the organic material produced in the form of oil and gas. Meanwhile, the maturity itself is at a mature maturity level. The capacity and ability of the source rock to produce hydrocarbons itself is greatly influenced by the organic material, and based on Anill et al (2021) shows that the Central Sumatra basin is dominated by lacustrine algae and higher plants which are good for producing hydrocarbons and it is known that the oil in this area is mature. Apart from that, according to Afifah et al (2023), the Pematang Formation can produce hydrocarbons and is mature, which was caused by the uplift of the Bukit Barisan in the Middle Miocene

4. Conclusion

After carrying out a geochemical evaluation of the source rock, it can be concluded that the source rock of the Pematang Formation in the research area has a wealth of organic material which is included in the fair-good category, potential yield which is included in the fair-good category. The source rock in the research area has a lean-fair capacity as source rock with type III kerogen which tends to produce gas and is at a mature maturity level. So based on these parameters, the source rock in this formation is included in the effective source rock category according to the Waples (1985) classification which the source rock is already mature and has produced and release the hydrocarbon. This is in line with the lithology of this area which consists of mudstone which is rich in organic material.

Table 2. Conclusion of geochemical analysis.

PARAMETER		BO-1 WELL
TOC	Min	0.16
	Max	1.39
	Mean	0.69
HI	Min	19
	Max	248
	Mean	130.28
Tmax	Min	383
	Max	453
	Mean	453.94
Ro	Min	0.91
	Max	1.06
	Mean	0.92
Summary	TOC	Fair
	HI	Gas
	Tmax	Mature
	Kerogen Type	Type III
	Ro	Mature

References

[1] Longley, I M, Soemantri, I S 1992. An Analysis of the Pre-Sihapas Deep Play in the Northern Bengkalis Trough Area if the Central Sumatra Basin. *Unpublished Lasmo Report,* No. R. 1573, Vol **III**.

[2] Heidrick, T L, Aulia K 1996. Regional Structural Geology of The Central Sumatera Basin, Petroleum Geology of Indonesia Basin. *Pertamina BPPTKA Indonesia*, 283-317.
[3] Waples, D W 1985. Geochemistry in Petroleum Exploration. *The International Human Resources Development Corporation*. Boston.
[4] Anil, Giovanny, A. A., Sutadiwiria, Y. 2021. The Relationship of Organic Components to Source rock Types Based on Biomarker Data at Central Sumatra Basin. *Proceeding Indonesian Petroleum Assotiation Forty Fifth Annual Convention and Eexhibition.* Jakarta
[5] Peters, E, Cassa, R 1994. Applied Source Rock Geochemistry. *AAPG Memoir* **60**. 97-102.
[6] Afifah, P. D., dkk. 2023. Source Rock Quality and 1D Maturity Model in Pendalian Sub-basin, Central Sumatra Basin. *Journal of Applied Geology,* Vol **8**,48-55

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