DETERMINING MATURITY RATE OF HYDROCARBON USING SAMPLE CORE FROM GEOCHEMISTRY SURVEY IN PADAMARANG SUB-BASIN, BONE GULF, SOUTH OF SULAWESI

Widyatri Pusparini[1*], Nisa Nurul Ilmi[1],and Edy Sunardi[1]
[1]Universitas Padjadjaran

* Corresponding author : widyatripsprn@gmail.com

ABSTRACT

Sulawesi is one of the area in Eastern Indonesia that still has frontier area. South Sulawesi has several basins which formed as a result of tectonic activity that caused a geological condition complexity. The complexity of the regional geology is one of the interest of this research. The presence of gas seep within research area ensure that there is a potential petroleum system underneath the surface of the research area which is Padamarang sub-Basin, Bone Basin, South of Sulawesi. New insights into Bone Gulf is based on surface geochemical exploration that came up with 26 core sea sediments samples using piston core acquisition that has been analyzed with Gas Chromatography in sediment extract. This study aims to identify the geochemical characteristics of migrated hydrocarbon. These geochemistry characteristics referred to depositional environment and maturity determination that are analyzed using non biomarker parameters including CPI and OEP, and cross plot between CPI and Pr/Phy. According to the CPI value has shown the number from 0.169 to 1.27 with the majority of the values is 0.4. While OEP value has shown the number from 0.312 to 1.5 with the majority of the values is 0.75. Thus, according to the majority value of CPI and OEP, we could determine that it was thermally immatured.

Keywords*: Biomarker, Core, Geochemical, Non Biomarker, Padamarang*

INTRODUCTION

Oil and gas are fossil energy that hold a major part in the industry, transportation and economic sector, especially in Indonesia. Regarding to that, exploration activity is necessary to fulfill the demand that keeps on rising as we speak. Oil and gas are not renewable energy, therefore, new methods are required to enhance the production or finding new reserve from oil & gas fields in Indonesia.

On exploration phase, usually it is only focusing on reservoir evaluation and types of traps. Source rock evaluation information is very few. Whereas source rock is the source of the oil and gas itself. According to that, it is important to understand the characteristics of source rock in exploration phase.

Geochemistry analysis is a method that is used to identify characteristics of hydrocarbon. The output of the analysis can answer questions about maturity rate, migration pathway, when and where do hydrocarbon generates, and so on.

Exploration in Indonesia is dominated in the western area. It is affected by several things such as facility availability, more accessible area, research and data availability are some of the reasons on why western Indonesia is still the main focus. Sulawesi is one of the area in eastern Indonesia that has a lot of frontier area. The complexity of it's regional condition is what makes it interesting to be studied to.

Sulawesi is one of the biggest island in Indonesia with area approximately 174.600 km^2. There are 3 gulf that divides the island of Sulawesi. On the north is Tomini Gulf, on the middle is Tolo Gulf, and on the south is Bone Gulf. These gulfs divide Minahasa peninsula, East peninsula, South East peninsula, and South peninsula. Around Sulawesi, there are big island which are Kalimantan in the west, Phillipine in the north, Maluku in the east and Flores in the South (Soputan, 2012).

Sulawesi island is divided into several tectonic province which are West & Noth Sulawesi Volcano-Plutonic Arc as magmatic path that includes in the eastern edge of Sunda Platform, Central Sulawesi Metamorphic Belt that is consist of mélange stones from Australia block, East Sulawesi Phiolite Belt that is consist of Ophiolite and part of oceanic crust segment which imbricated with sediment rocks with age ranging from Triassic to Miocene, and the last on is Continent Fragment of Banggai-Sula-Tukang Besi which are located at eastern and southeastern of Sulawesi.

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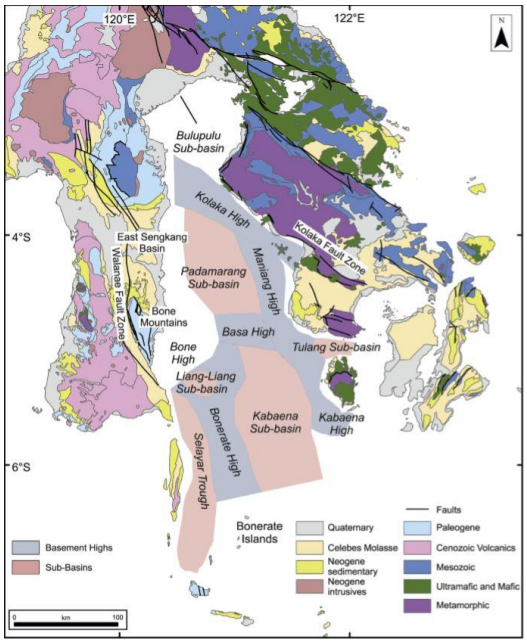

Figure 1 Bone Basin Fisiography (Camplin & Hall, 2014)

The research area itself is located in Bone Basin, South of Sulawesi, precisely in Padamarang Sub-Basin. It is surrounded by Kolaka High in the north, Maniang High in the east, Basa High in the south, and Bone Platform in the west.

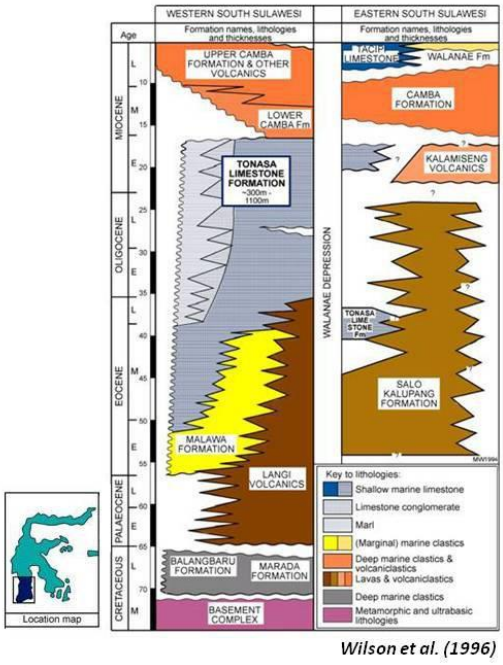

Figure 2 Stratigraphic column of South of Sulawesi (Wilson, Moyra, & Dan WJ, 1996)

There are several formations that was deposited underneath Sulawesi, especially in Bone Basin. According to LEMIGAS (2005) the deposition time is ranging from Cretaceous to Pliocene. Starting from Balangbaru Formation that is consist of flysch sediment (shale strata or marls that intersect with coarser sediments such as conglomerates, sandstones), above that is Kalumpang Formation that consist of sandstone, shale, mudstone and intersect with volcaniclastics. Malawa/Toraja Formation is deposited above it, it is consist of Sequence that is ranging from Middle-Late Eocene and represented by deltaic-marine sediments. After that, Langi Formation which are consist of lava and pyroclastic andesite type is deposited, this formation is associated with subduction in this area. And then there's Tonasa/Makale Formation that is mostly consisted of limestone, Camba Formation that consist of sandstones and volcaniclastics, Taccipi Formation that consist of limestone and calcareous shale, and Walannae Formation that consist of calcareous mudstone and arenaceous. The stratigraphic column can be seen in the Figure 2.

It is predicted that there is a working petroleum system in Bone Basin, and it is proved by the gas seep appearance in Pongko and Malangke Area. This findings is a significant prove that there is a potential hydrocarbon reserve in Bone Basin.

Hydrocarbon consist of 2 carbon elements and 1 hydrogen elements. Some of the examples of hydrocarbon are benzene, paraffin, methane, and so on. Naturally, hydrocarbon occurs in natural gas, crude oil, and coal. Doing oil and gas exploration, there is a method called geochemistry surface survey. This method is based on the premise that hydrocarbon migration that happen from source rock to reservoir could be detected on the sediment that is located near it and this could be used to evaluate potential of the exploration itself.

Geochemistry method consist of many method but the one that this research used to characterized maturity rate is non biomarker method. Parameters that is used is Carbon Preference Index (CPI) and Odd to Even Predominance (OEP). CPI or OEP values significantly above (odd preference) or below (even preference) 1.0 indicate low thermal maturity. Values of 1.0 suggest, but do not prove, that an oil or rock extract is thermally mature. CPI or OEP values below 1.0 are unusual and typify low-maturity oils or bitumens from carbonate or hypersaline environments. (Peters & Moldowan, 1993).

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RESEARCH METHOD

This research use 26 sediment core that is processed to sediment extract and then processed once again using Gas Chromatograph. The output itself is a normal alkanes ranging from nC_{15} – nC_{35} . These normal alkanes are then calculated with CPI and OEP formulas and determined whether they are mature or immature.

$$\text{CPI} = \frac{1}{2} \text{ X } \frac{C_{25}+C_{27}+C_{29}+C_{31}+C_{33}}{C_{24}+C_{26}+C_{28}+C_{30}+C_{32}} + \frac{C_{25}+C_{27}+C_{29}+C_{31}+C_{33}}{C_{26}+C_{28}+C_{30}+C_{32}+C_{34}} \dots (1)$$

$$\text{CPI (1)} = \frac{2(C_{23}+C_{25}+C_{27}+C_{29})}{C_{22}+2(C_{24}+C_{26}+C_{28})+C_{30}} \dots\dots (2)$$

$$\text{OEP (1)} = \frac{C_{21}+6C_{23}+C_{25}}{4C_{22}+4C_{24}} \dots\dots (3)$$

$$\text{OEP (2)} = \frac{C_{25}+6C_{27}+C_{29}}{4C_{26}+4C_{28}} \dots\dots (4)$$

After that, cross plot of CPI and Pristane/Phytane is done to determine in what condition the hydrocarbon is deposited.

RESULT AND DISCUSSION

CPI and OEP analysis is done on core sample WP01-WP27. Where the closer CPI and OEP value to 1, the source rock is more likely to be mature (Peters & Moldowan, 1993). The result of the calculation could be seen on table 1.

The result shows that majority of the value determined as immature because majority of the value is either under 0,9 or above 1,1. Based on the value of CPI and OEP, the writer also make a map to see the distribution of the value within the research area. It is shown as Figure 4.

The cross plot shows that the maturity rate is immature while the hydrocarbon is deposited mostly in the oxic condition.

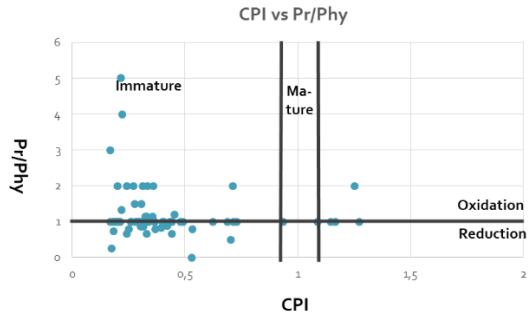

Figure 3 Cross plot between CPI vs Pr/Phy

CONCLUSION

The conclusion of this research is that the maturity rate of hydrocarbon in Padamarang Sub-Basin, Bone Basin, South of Sulawesi is immature with the value of CPI ranging from 0,167-1,27 and OEP 0,312-1,5.

ACKNOWLEDGEMENT

For further research, it is better to retrieve the well data through drilling activity to identify a more valid data. Evaluating geochemistry of the source rock is also advised to make sure the quality of the source rock more comprehensively.

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APPENDIX

Table 1 Result of CPI and OEP Calculation

Core no.	CPI (1)	OEP	Maturity Rate
WP 1	0,728279	1,036199	Mature
	0,713571	0,966856	Mature
WP 2	0,366116	0,751736	Immature
	0,302055	0,602703	Immature
	0,491652	0,880081	Immature
WP 3	0,332314	0,56082	Immature
	0,241765	0,346065	Immature
	0,304942	0,382905	Immature
WP 4	0,479605	0,626042	Immature
	0,357305	0,537382	Immature
WP 5	0,454605	0,732244	Immature
	0,331537	0,531832	Immature
	0,316919	0,506944	Immature
WP 6	0,421953	0,499843	Immature
	0,291005	0,503274	Immature
	0,184386	0,431818	Immature
WP 7	0,53375	0,685826	Immature
	0,394478	0,539502	Immature
	0,329287	0,547619	Immature
WP 8	0,251985	0,402102	Immature
	0,369841	0,515734	Immature
	0,433654	0,650794	Immature
WP 9	0,441046	0,597538	Immature
	0,314337	0,440657	Immature
	0,36646	0,577899	Immature
WP 10	0,359975	0,411905	Immature
	0,276937	0,422715	Immature
	0,182844	0,51127	Immature
WP 11	1,088542	1,1	Mature
	0,934584	0,8125	Mature
WP 12	0,307381	0,720982	Immature
	0,205424	0,342262	Immature
	0,198231	0,375	Immature
WP 13	0,272548	0,533333	Immature
	0,528504	0,688158	Immature
	0,219417	0,6031	Immature
WP 14	0,312358	0,727748	Immature
	0,211168	0,432369	Immature
	0,169234	0,438853	Immature
WP 15	0,325535	0,593889	Immature
	0,280961	0,725062	Immature
	0,182159	0,529861	Immature
WP 16	0,220857	0,883573	Immature
	0,242751	0,700893	Immature
	0,173367	0,528061	Immature
WP 17	0,338459	0,561603	Immature
	0,407827	0,653926	Immature
	0,200309	0,417058	Immature
WP 18	0,311322	0,6375	Immature
	0,216223	0,412338	Immature
	0,624777	0,825962	Immature
WP 19	0,442192	0,942708	Immature
	0,439654	0,702922	Immature
WP 20	0,286556	0,585337	Immature
	0,314927	0,644531	Immature
	0,259736	0,634824	Immature
WP 21	0,190433	0,58629	Immature
	0,263242	0,671196	Immature
	0,313325	0,657475	Immature
WP 23	0,214061	0,545833	Immature
	0,169234	0,570192	Immature
	0,198112	0,452381	Immature
WP 24	0,292176	0,595395	Immature
	1,273504	1,166667	Mature
	0,710373	0,709722	Immature
WP 25	1,25197	0,877616	Mature
	1,14505	0,90625	Mature
	1,167625	1,2625	Mature
WP 26	0,688483	0,630952	Immature
	0,703125	0,6875	Immature
	0,400016	0,683824	Immature

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WP 27	0,325008	0,517949	Immature

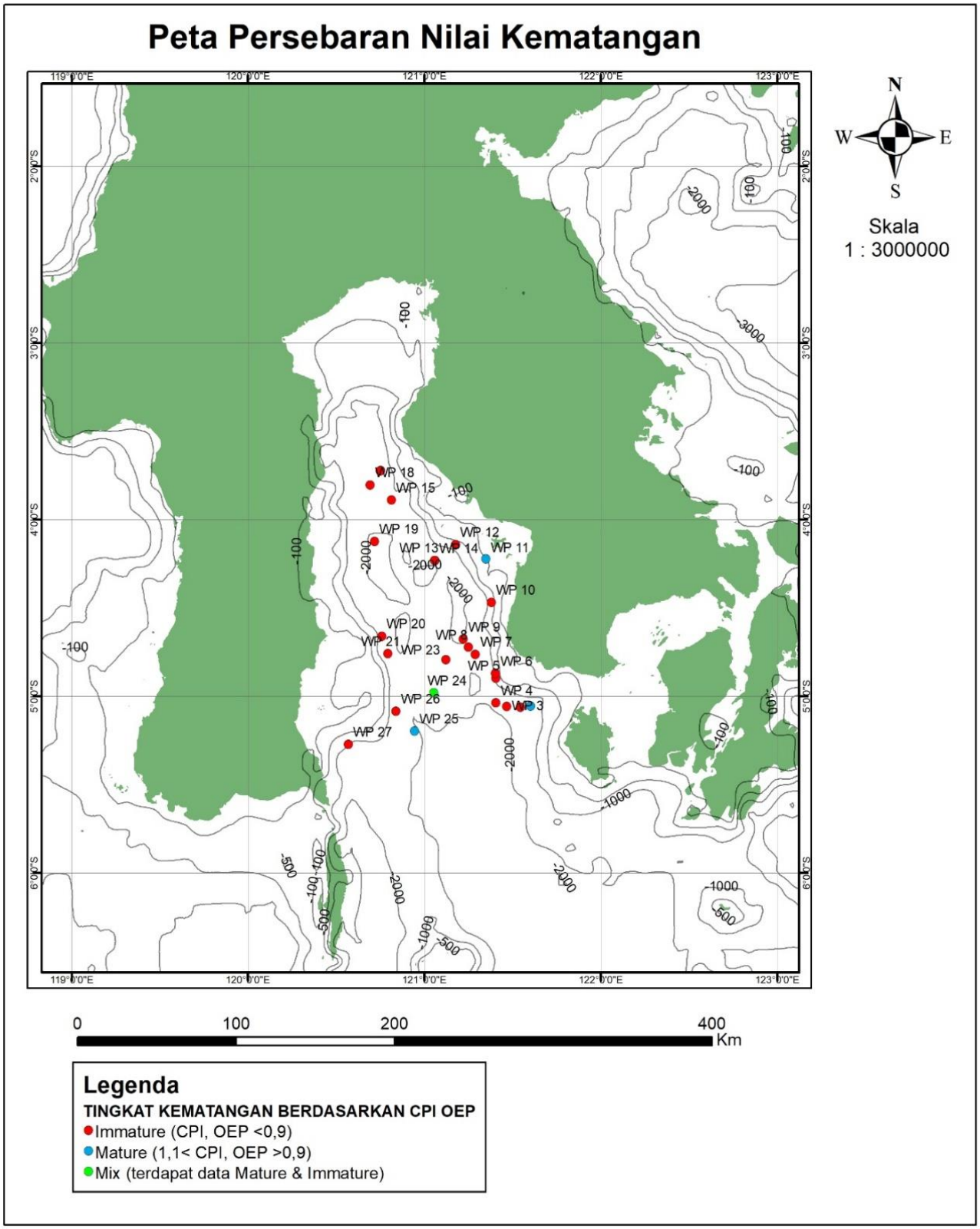

Figure 4 Map of Distribution of Maturity Rate based on CPI Value

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