

Mineral Content of Surficial Sediment of the Rangsang Island and Its Surrounding Area, Meranti Regency, Archipelago Riau Province

Kandungan Mineral Pada Sediment Dasar Laut Di Pulau Rangsang Dan Sekitarnya Kabupaten Kepulauan Meranti Propinsi Riau

Deny Setiady and Ediar Usman

Marine Geological Institute of Indonesia (MGI)

Jl. Dr. Junjuran No. 236, Bandung 40174, Indonesia Email:deny_mgi@yahoo.com

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ABSTRACT: According to the regulation No 4 of 2009 of Mineral and Coal Mining Management stated that the requirement of an inventory for mineral resources data was created to support the establishment of mining area. This study is intended to obtain mineral resources content and surficial sediment data, Geographically the study area belongs to Meranti Archipelago Regency, Riau Province. it is located between 102°00'00" - 103°15'00" E and 00°35'00" - 01°28'00" N.

Grain size analyses result show that surficial sediment in the study area consists of silt, silty sand and sand which is dominated by silt. Based on the mineral identification, some of the minerals such as quartz, cassiterite, magnetite, hematite, dolomite, biotite and zircon have been found.

Silt distribution is very wide started from estuarine southeast part northern part of Rangsang Island toward southeast of Rangsang island. Sandy silt only found at the southeast of Rangsang Island, while sand sediment is found at the south and southeast of Rangsang Island.

The presence of silt and sand grains is influenced by moderate to strong currents and wave patterns, so that the silt and sand grains sediment was transported along coastal to offshore area, while the fine grained (clay - silt) are deposited in the valley at the western part of Rangsang Island.

Key words: mineral, surficial sediment, Rangsang Island

ABSTRAK: Berdasarkan Undang Undang Nomor 4 tahun 2009 tentang Pengelolaan Pertambangan Mineral dan Batubara, disebutkan bahwa inventarisasi data sumber daya mineral diperlukan dalam rangka mendukung penetapan Wilayah Pertambangan (WP). Penelitian ini dimaksudkan untuk memperoleh data kandungan sumber daya mineral dan sedimen dasar laut. Daerah penelitian, secara geografis termasuk dalam Kabupaten Kepulauan Meranti, Provinsi Riau, dan terletak pada koordinat antara 102°00'00" - 103°15'00" BT dan 00°35'00" - 01°28'00" LU.

Hasil analisis besar butir menunjukkan sedimen permukaan dasar laut di daerah penelitian terdiri atas lanau, lanau pasir dan pasir yang didominasi oleh lanau. Berdasarkan identifikasi mineral pada sedimen permukaan dasar lautnya menunjukkan kehadiran mineral kasiterit, magnetit, hematit, dolomit, biotit, zirkon dan kuarsa.

Penyebaran lanau sangat luas dimulai dari daerah estuari barat laut dan bagian utara Pulau Rangsang, hingga ke sebelah tenggara Pulau Rangsang. Lanau pasir hanya terdapat di tenggara Pulau Rangsang, sedangkan pasir hanya terdapat di daerah di bagian selatan - tenggara Pulau Rangsang.

Adanya butiran lanau - pasir dipengaruhi oleh pola arus dan gelombang yang sedang sampai kuat, sehingga butiran berukuran lanau - pasir dapat terangkut ke arah lepas pantai, sedangkan butiran halus (lempung) mengendap di daerah lembah di bagian barat Pulau Rangsang.

Kata kunci: mineral, sedimen permukaan dasar laut, Pulau Rangsang

INTRODUCTION

Study area is located at Meranti Archipelago Regency, Riau Province, and geographically between $102^{\circ}00'00''$ - $103^{\circ}15'00''$ E dan $00^{\circ}35'00''$ - $01^{\circ}28'00''$ N (Figure 1). The study area is one of a strategic area due to of its position as an international shipping lines which is bordered between Indonesia – Malaysia Waters. (Usman, 2011).

The aim of study is to obtain the mineral resources in the surficial sediment. The other proposed of this study is also possibility to find out the main source of the minerals. It is reported that the surficial sediment and mineral resources derived from granite mainland Sumatra Island, or from granite island, Riau Archipelago Kundur Island and Karimun Island.

Wyrski, (1961) state that regional sediment deposition flow patterns of the study area is started from northwest to southeast in Malaka Strait. Regional investigations of the presence of potential important minerals, is derived from the precipitation origin of Sumatra mainland through the Kampar River. (Cameron, N.R., 1983)

Based on Regional Geological Map of Siak Sri Indrapura and Tanjung Pinang (Cameron, et al., 1982),

lithology in the study area are composed by Alluvium deposits. Alluvium deposits at study area can be divided into two namely Old surface deposit and young Surface deposit.

Old surface deposit are widespread distributed at Kundur Island and its surrounding, consist of clay, silt, gravelly clay, plant debris and granite sand. This unit was deposited in the fluvial and Upper Pliocene age.

While young surface deposit, which is deposited unconformity above the old surface deposit, consist of clay, silt, gravel, the remnants of marsh plants, peat and coral reefs. This unit was deposited in the inner sublittoral and Holocene age.

Placer minerals are mineral deposits that have been formed by the mechanical concentration of detrital mineral particles in marine environments. And can occurs in rivers and on the sea floor. They usually originate on breakdown of their source rock. Most placers are of high specific gravity and are resistant to chemical breakdown, otherwise they would not have survived the erosional, transportational and depositional processes that took place prior to their concentration. (Cronan, 1980).

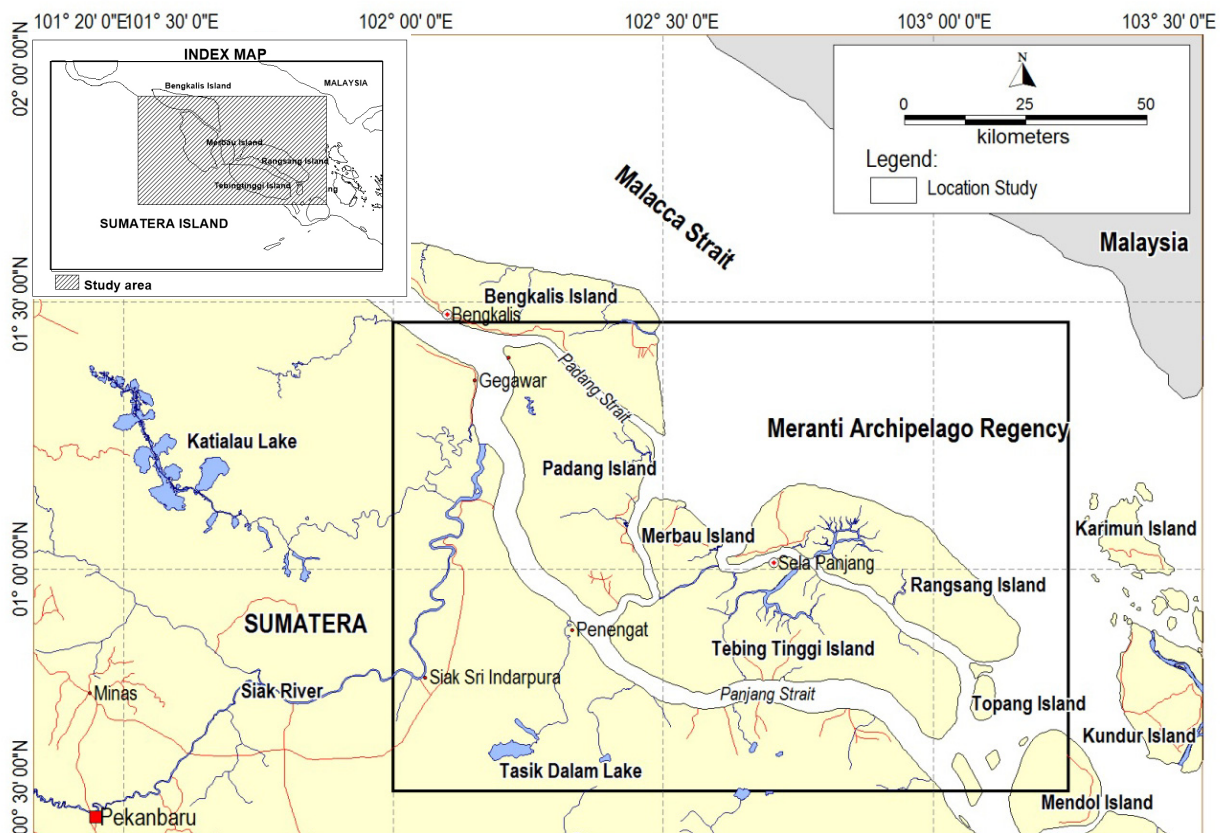


Figure. 1. Map of the study area

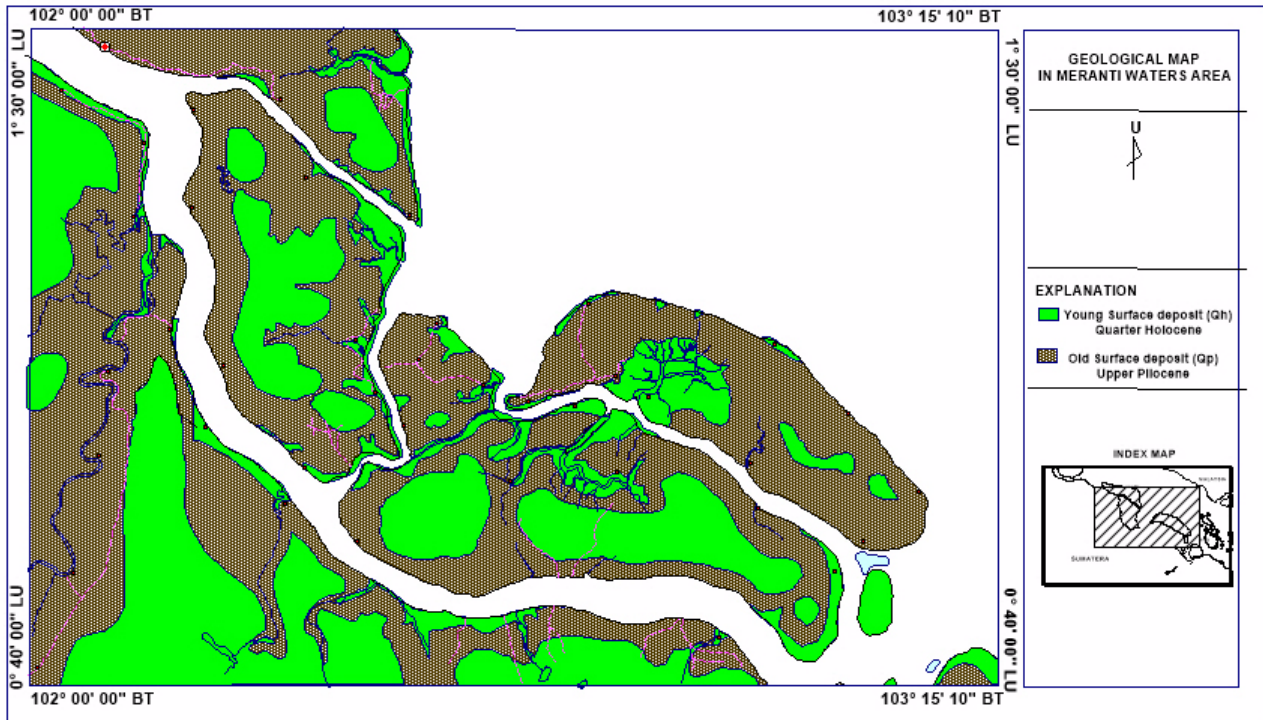


Figure-2. Geological map of Meranti waters and its surrounding (Cameron, et al., 1982)

METHOD

Ten samples from Thirty-five grab samples have been taken for heavy mineral analysis. The samples were analyzed megascopically, and then they prepared for grain size analysis

The grain size analysis is based on the classification of Folk (1980), where the separation of grain size fraction is done by sieving methods. These sieving consists of weight percentage of each fraction for every sample which is plotted versus their quantities in order to give that name of sea floor sediment.

For heavy mineral analysis, all samples were weighed, and sieved to achieve the grain size fraction of 3 phi (0,125 mm) following the method by Luepke, G.1984. The heavy minerals with magnetic character are separated by using hand magnetic equipment, on the other hand, for non-magnetic minerals, the separation is done by using bromoform liquid (sg = 2,889). At last the result is compared to their bulk density and their percentage (Hartono, 1996).

RESULTS

The 35 sediment samples was taken by using grab sampler. Base on grain size analysis, surficial sediment types in study area consists of: silt (Z), sandy silt (sZ) and sand (S) (Table-1).

Sand sediment type are commonly characterized by quartz and black igneous fragments. (table-3). Silt

sediment is very wide distribution in study area. They founded in northwest part of Rangsang Island. Sandy silt sediment founded only in two samples in the county in the south-east Rangsang island and around mouth of the Channel between Rangsang Islands and Tebingtinggi island. (Figure 4).

The maximum water depth of study area is about 50 m, especially in the northern part of the study area. In nearshore average of the depth between 10-20 meters. Ocean currents condition is strong enough at 50 meters depth.

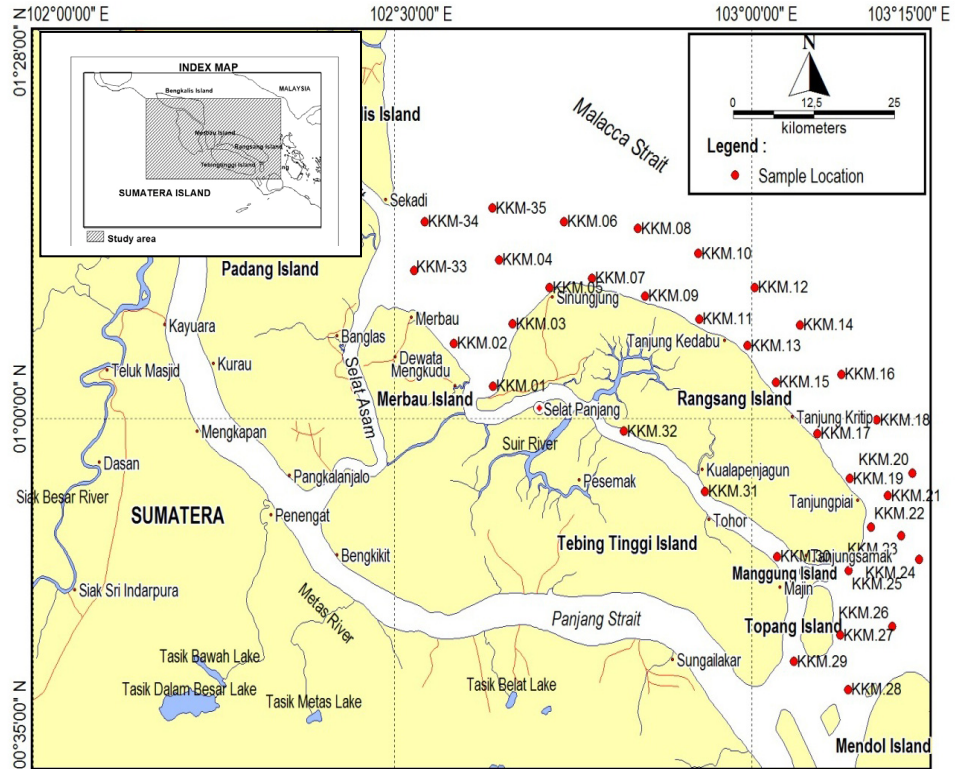


Figure 3. Surficial Sediment sampling locations

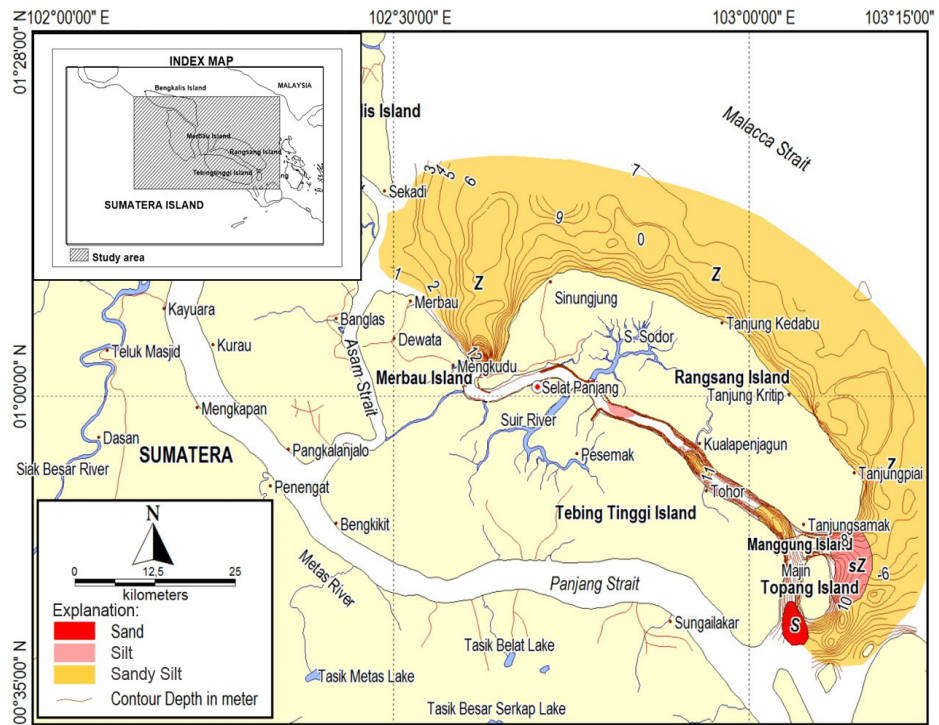


Figure 4. Surficial sediment and Bathymetry Map

Table-1 Grain size analysis result (Folk, 1980)

No.	Sampel Identity	X (Phi)	Sortation	Skewness	Kurtosis	Percentage (%)			Classification
						Sand	Silt	Clay	
1	KKM-01	5.6	1.1	0.7	2.8	0.9	95.7	3.4	Silt
2	KKM-02	5.5	1.1	0.3	2.9	3.4	95.4	1.3	Silt
3	KKM-03	5.7	1.3	0.5	2.9	3.5	89.7	6.8	Silt
4	KKM-04	5.7	1.2	0.3	2.6	2.4	94	3.6	Silt
5	KKM-05	5.7	1.2	0.2	2.7	3.2	94.2	2.7	Silt
6	KKM-06	5.7	1.2	0.7	2.7	0.5	94.3	5.2	Silt
7	KKM-07	5.7	1.2	0.7	2.6	0.6	93.8	5.5	Silt
8	KKM-08	5.7	1.2	0.7	2.6	0.7	94.3	5	Silt
9	KKM-09	5.8	1.3	0.6	2.5	0.5	92.6	6.9	Silt
10	KKM-10	5.7	1.1	0.6	2.5	0.4	96.9	2.7	Silt
11	KKM-11	5.7	1.2	0.4	2.6	2.5	93.8	3.7	Silt
12	KKM-12	5.6	1.2	0.2	2.9	2.6	95	2.4	Silt
13	KKM-13	5.9	1.2	0.5	2.3	0.2	94.6	5.3	Silt
14	KKM-14	5.7	1.2	0.5	2.2	0.2	97	2.8	Silt
15	KKM-15	5.4	1.5	0.4	3	9.4	83.3	7.3	Silt
16	KKM-16	5.6	1.3	0.8	2.8	1.2	92.1	6.8	Silt
17	KKM-17	5.7	1.2	0.7	2.7	0.6	94.8	4.6	Silt
18	KKM-18	5.6	1.1	0.6	2.5	0.2	98.7	1.1	Silt
19	KKM-19	5.9	1.3	0.5	2.3	0.3	91.9	7.7	Silt
20	KKM-20	5.6	1.1	0.6	2.7	0.5	97	2.5	Silt
21	KKM-21	5.7	1.2	0.7	2.6	0.4	94.5	5.1	Silt
22	KKM-22	5.7	1.2	0.6	2.6	0.9	95.4	3.7	Silt
23	KKM-23	5.5	1.2	0.1	3.9	3.2	94.4	2.4	Silt
24	KKM-24	5.5	1.5	-0.4	3.7	7.5	87.3	5.2	Silt
25	KKM-25	5.3	1.4	-0.1	3.2	11.7	84.8	3.5	Sandysilt
26	KKM-26	5.6	1.2	0.4	3.2	1.9	94.7	3.4	Silt
27	KKM-27	5.4	1.5	0.1	3.1	11.8	82.6	5.6	Sandysilt
28	KKM-28	5.6	1.2	0.1	2.7	5.9	92.1	1.9	Silt
29	KKM-29	2.8	0.5	0.7	1.6	100.00%	0	0	Sand
30	KKM-30	5.6	1.2	0.6	3	2.2	92.5	5.2	Silt
31	KKM-31	5.7	1.3	0.5	2.8	1.6	92	6.4	Silt
32	KKM-32	5.4	1.6	0.1	2.5	15.7	78.2	6.1	Sandysilt
33	KKM-33	5.5	1.1	0.3	2.9	3.4	95.4	1.3	Silt
34	KKM-34	5.7	1.2	0.3	2.6	2.4	94	3.6	Silt
35	KKM-35	5.7	1.2	0.3	2.6	2.4	94	3.6	Silt

Base on mineral analysis, mineral content found in the study area are quartz, zircon, cassiterite, magnetite, hematite, biotite and dolomite (Table 2).

DISCUSSIONS.

The distribution of cassiterite contents could be seen in all samples which has been analyzed. Cassiterite is common minerals in the study area. As a tin mineral, cassiterite in this study area has been deposited as a

placer deposit from hydrothermal alteration mineral in the summit of granitic intrusions. This mineral represents the existence of S type granitic rocks which occurs in Kundur until Bangka Island (Surachman, 2006). There are some alternatives of the origin of this cassiterite mineral. Cassiterite occurs in granite pegmatite, for example, S – type granitic rocks or greissens, or high temperature hydrothermal veins or even it can accumulate in marine placers. The mineral is

Table 2. Mineral analysis result

Sample Identity	Mineral Percentage (% apperance)								Total (100%)
	Fragment	Quartz	Zircon	Cassiterite	Hematite	Magnetite	Biotite	Dolomite	
KKM02	20	70	1	2	1	1	3	2	100
KKM05	15	80	-	1	1	1	1	1	100
KKM12	20	70	-	2	2	2	2	2	100
KKM15	35	50	-	3	2	3	5	2	100
KKM22	22	65	-	2	3	2	4	2	100
KKM25	20	75	-	1	1	1	2	-	100
KKM28	30	65	1	1	1	1	1	-	100
KKM29	30	50	-	4	4	3	6	3	100
KKM30	40	50	-	1	1	1	3	4	100
KKM31	40	50	-	2	1	1	4	2	100

mined from all deposits as a tin ore. Placer deposits are mechanically concentrated by alluvial and by marine processes. The cassiterite mineral is one of the heavy minerals which is occurred in the placer deposit and it is derived from the weathering of granitic rocks. Cassiterite mineral represents the existence of granitic rocks. It is interpreted that the source of the cassiterite minerals are derived from western part of the study area (Karimun-Kundur mainland).

Magnetite is marine placer deposits. Which were originated from mineral alteration in the primary the high grade metamorphism sedimentary rock. The existence of magnetite which is associated with ilmenite minerals is not common in the study area. The minerals are predicted as marine placer deposits which are originated from mineral transformation in the primary volcanic and the sedimentary rocks during high grade metamorphism. These minerals might be come from Sumatera Island. We found only magnetite minerals are not related to the existence of granitic rocks in the study area. The magnetite minerals are quantitatively richer than other heavy minerals, but their origin in relation to granitic rock are difficult to explain.

Zircon ($ZrSiO_4$), as carriers of zirconium rare earth element, including silicate group, white/translucent, prismatic, flat surface, hardness 7-8, specific gravity 4.68 to 4.7, is radioactive element. Occurs at a small area in the magmatic intrusive rocks, nephelin, syenit, granite, diorite. (Aryanto, 2010). Zircon ($ZrSiO_4$) is a silicate mineral group associated with intrusion rock (granites, nepheline, syenite and

diorite). The content of zircon is KKM-02 of 10 meters water depth near Merbau Island and KKM-28 south of Rangsang island near Sumatera island. While zircon mineral only found in 2 location, this thing happened due to zircon have specific gravity 4.68 to 4.7. Occurs at a small area in the magmatic intrusive rocks, granite, (F. J. Pettijohn, 1975). Based on thing, so source rock from zircon mineral is Kundur granite rock that the location is far from study area, though zircon is metastable mineral but because the density is high and far from the source, they will settle to the botton of sediment in nearshore, not so far from source rock so mineral zircon found only in 2 location.

The seafloor sediment commonly is quartz sandstone which is dominant and it is originated from the granitic rock. All minerals including heavy minerals deposited in this quartz sandstone when granitic rocks weathered, eroded, and brought by river to the beach and to the sea. These minerals may accumulate near the granitic rock outcrop. They may be washed and by process of agitation the heavy minerals will settle to the bottom and they will remove the lighter minerals to their top of the seafloor sediment.

Generally mineral grains shows sub-angular. Sub angular suggests that the sediment condition is not far from source rock. These conditions also reinforce the notion that the quartz grains are not derived directly from granite rocks. (Rubey, W.W., 1933). Base on the microscope analysis, the largest grains are quartz and other minerals. The presence of quartz grains derived from sandstone unit debris on Tertiary sediments and

Table 3. The mineral content in sediment samples

Sample Identity	Mineral Percentage (% apperance)									Sediment
	Fragment (lithic)	Quartz	Fragment (Shell)	Zircon	Cassiterite	Hematite	Magnetite	Biotite	Dolomite	
KKM02	10	70	10	1	2	1	1	3	2	Silt
KKM05	10	80	5	-	1	1	1	1	1	Silt
KKM12	10	70	10	-	2	2	2	2	2	Silt
KKM15	25	50	10	-	3	2	3	5	2	Silt
KKM22	10	65	12	-	2	3	2	4	2	Silt
KKM25	10	75	10	-	1	1	1	2	-	Sandysilt
KKM28	20	65	10	1	1	1	1	1	-	Silt
KKM29	10	50	20	-	4	4	3	6	3	Sand
KKM30	30	50	10	-	1	1	1	3	4	Silt
KKM31	25	50	15	-	2	1	1	4	2	Silt

bedrock (basement rock) is estimated as the granite rocks from Sumatera island.

From the method of sampling which was done on the top of surficial sediment, we calculate that all minerals belong to the placer deposits. Even, some of them only occur as hydrothermal processes, such as, cassiterite, but according to their deposition in surficial sediment, they are not insitu. Most of heavy minerals have sub angular to sub rounded in shape. They can be interpreted that all minerals are predicted of having origin from the weathering of granitic rocks and at last they are deposited as placer deposit (Table 4).

As a placer deposit, it can be interpreted that the source is come from the southern part of the study area.

It can be proven by sub angular to sub rounded in their texture that is their sources were not too far from the study area (The Sumatera Island is in the southern part and Kundur island in the western of the study area). The origin of all minerals in the study area is formed by the hydrothermal process which is then deposited on the seafloor sediment.

Almost all minerals are originated from hydrothermal processes but they are deposited as a placer deposits. The hydrothermal processes can be happened somewhere outside the study area but they are not related only to the granitic rocks, they could exist from sedimentary rocks.

Table 4. A few heavy mineral type and the source rock (F.J. Pettijohn, 1975)

Heavy Mineral type	SOURCE ROCK				
	Igneous Rock		Metamorphic Rock		
	Alkali	Acid	Hydrothermal	High level	Low level
Augite	x				
Hiperstene	x				
Ilmenite	x	x			
Magnetite	x	x		x	
Rutile	x				
Biotite		x	x	x	
Zircon		x			

CONCLUSION

The results of the analysis of particle size distribution can be arranged a map of surficial sediments. Surficial sediment types obtained are: silt (Z), sandy silt (sZ) and sand (S). Generally in all samples analyzed, which are common minerals are quartz, zircon, tin, magnetite, biotite and lithic. Mineral hematite, cassiterite, biotite and dolomite and magnetite are economical mineral, found equally in all samples in the sediment surrounding the island and the Rangsang Island.

The presence of quartz grains derived from sandstone unit debris on Tertiary sediments and bedrock (basement rock) is estimated as the granite rocks that make up the basis of the islands in Rangsang Islands. Source rock from zircon mineral is Kundur granite rock that the location is far from study area, though zircon is metastable mineral but the density is high and far from the source, so mineral zircon found only in 2 location

From these entire heavy minerals only oxide and hydroxide and carbonate group which are not related to the existence of the granitic rocks in the study area, except cassiterite. Almost all heavy minerals are originated from hydrothermal processes but they are deposited as a placer deposits. The hydrothermal processes can be happened somewhere outside the study area but they are not related only to the granitic rocks, they could exist from sedimentary rocks.

As a placer deposit, it can be interpreted that the source is come from the southern part of the study area. It can be proven by sub angular to sub rounded in their texture that is their sources were not too far from the study area (The Bangka Island is in the southern part of the study area)

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ACUAN

- [1] Aryanto, D.A. and Setiady D. 2010. Heavy Minerals in Placer Deposits in Singkawang Waters, West Kalimantan, related to Felsic source rock of its coastal area Bulletin of the marine Geology, Vol.25. No.1, June 2010.
- [2] Cameron, N.R, Kastawa. W. and Thompson, S.J., 1982. *Peta Geologi Lembar Dumai, Sumatera, skala 1:250.000*. Puslitbang Geologi, Bandung.
- [3] Cameron, N.R., 1983, The Stratigraphy of the Sihapas Formation in The North West Of The Central Sumatera Basin, Proceedings Indonesia Petroleum Association, 12th Annual Convention, p. 43-61
- [4] Cronan, D.S. 1980, Underwater Minerals, applied Geochemistry Research Group, Department of Geology, Imperial College of Science and Technology, London, England
- [5] Folk, R.L., 1980. Petrology of Sedimentary Rocks, Hamphill Publishing Company Austin, Texas: 170pp.
- [6] Hartono, 1996, Heavy Minerals and smear slides analysis, (*Marine Geological Institute, Unpublished*)
- [7] Luepke, G.1984, Stability of heavy minerals in sediments, Benchmark papers in *Geology*, Vol. 81.
- [8] Pettijohn F.J. 1975, Sedimentary Rocks, 3 rd ed: Newyork, Harper & Row, Publisher, p.487,
- [9] Rubey, W.W., 1933. *The Size Distribution of Heavy Minerals Within A Water-laid Sandstone*; Journal Sediment Petrology.
- [10] Surachman M. and Setiady, D. 2006. Heavy Minerals in the Placer deposits in North Bangka Waters Bulletin of The Marine Geology, Vol. 21, No.1, November 2006
- [11] Usman, E., Setiady, D., Rohendi, E., 2011. *Inventarisasi Potensi Pertambangan dan Sumber Daya Mineral di Perairan Kabupaten Kepulauan Meranti*. Kerjasama Pemerintah Kabupaten Kepulauan Meranti dan Pusat Penelitian Geologi Kelautan (Lap. intern), Bandung: 81 hal.
- [12] Wyrтки, K., 1961. *Physical Oceanography of Southeast Asian Waters*, Naga Report 2, SIO La Jolla, CA: 195pp.