Characteristic of Rare Earth Element in Sediment at Coastal and Offshore Area of Kundur Island, Riau Province

Karakteristik unsur tanah jarang dalam Sedimen di Kawasan Pantai dan Lepas Pantai Pulau Kundur dan Sekitarnya, Propinsi Riau

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ABSTRACT: The study area is located at coastal and offshore Kundur and Adjacent Area, geographically located at coordinates of 0º 39'00 "0º 50'00" N and 103º 10'00 "103º 25 '00" S. Rare earth elements are found in seven seafloor surfacial sediment and 3 core samples are Cerium (15.41 to 16.88 ppm), Lanthanum (5.40 to 6.80 ppm), Ytrium (5.18 to 5, 58 ppm), Zirconium (5.05 to 5.95 ppm) and Neodymium 20.25 to 20.95 ppm). The minerals that containing of rare earth elements at the study area are apatite, zircon, monazite, and pyrochlore and xenotime. Seafloor surfacial sediment at Kundur are composed by silt (Z), sandy silt (sZ), sandy gravel, mud and sand. Silt unit covering nearly 55% of the study area and followed by sandy gravel, sand, silt and sandy silt. Seafloor morphology varies those are flat morphology with gradually depth changes and a regularly shaped identation curves and holes likely a result of sand mining. Coastal characteristics consists of: sandy and muddy beach. Sandy beach has medium relief (5° - 8°), composed by medium to coarse sand, brownish yellow. The muddy beach has low relief (1° - 5°) where the edges of the beach is mangroves planted by the local peoples.

Keywords : rare earth elements, seabed sediments, sea floor morphology, and Kundur Island

ABSTRAK: *Daerah penelitian terletak di kawasan pantai dan lepas pantai perairan Pulau Kundur dan Sekitarnya. Secara geografis terletak pada koordinat 0º 39'00" - 0º 50'00" LU dan 103º 10'00"- 103º 35' 00"BT. Mineral di daerah penelitian yang mengandung unsur tanah jarang adalah mineral apatit, zirkon, monazit, dan mineral pyrochlore. Unsur tanah jarang yang dijumpai pada tujuh contoh sedimen permukaan dasar laut dan 3 contoh bor inti adalah Cerium (15,41 – 16,88 ppm), Lanthanum (5,40 – 6,80 ppm), Ytrium (5,18-5,58 ppm), Zirkonium (5,05-5,95 ppm) dan Neodimium 20,25 – 20,95 ppm). Sedimen permukaan dasar laut di perairan Kundur tersusun oleh lanau (Z), lanau pasiran (sZ), kerikil pasiran, lumpur dan pasir. Satuan lanau menutupi hampir 55% dari seluruh daerah penelitian diikuti oleh krikil pasiran , pasir, lumpur dan lanau pasiran. Morfologi permukaan dasar laut sangat bervariasi ada yang landai dengan perubahan kedalaman yang teratur ada juga yang berbentuk lekukan lekukan dan lubang lubang besar kemungkinan akibat dari penambangan pasir. Karakteristik pantainya terdiri dari : pantai berpasir dan pantai berlumpur. Pantai berpasir, berelief sedang (5° - 8°), tersusun oleh pasir ukuran butir sedang sampai kasar, berwarna kuning kecoklatan. Pantai berlumpur berelief rendah berkisar antara (1° - 5°) dimana pada bagian tepinya ditanami bakau oleh penduduk setempat.*

Kata kunci : *unsur tanah jarang, sedimen permukaan dasar laut, morfologi permukaan dasar laut, dan Pulau Kundur*

INTRODUCTION

The study area (Figure 1) is located at the coastal area and offshore of Mendol and Kundur Island, geographically at coordinates 0º 39'00 "0 º 50'00" N and 103 º 10'00 "103 º 25 '00" E, (Setiady, 2000).

Kundur and Mendol islands as well as other islands at Natuna Waters are included in the granite belt as a primary rock bearing minerals such as tin, apatite, zircon, monazite, and xenotime (Bachelor, 1983). Rare earth elements or also called lanthanida series consists of 15 elements that have similar chemical properties, with atomic numbers between 57 up to 71. These elements are lanthanum *(La),* cerium *(Ce),* praseodymium *(Pr),* neodymium *(Nd),* promethium *(Pm),* Samarium *(Sm),* Europium *(Eu),* gadolinium *(Gd),* Terbium *(Tb),* dysprosium *(dy),* holmium *(Ho),* erbium *(Er),* thullium *(Tm),* yterbium *(Yb)* and luthetium *(Lu).* Promethium *(Pm),* is the result of division (fission) of uranium, in nature there is no found as a stable isotope.

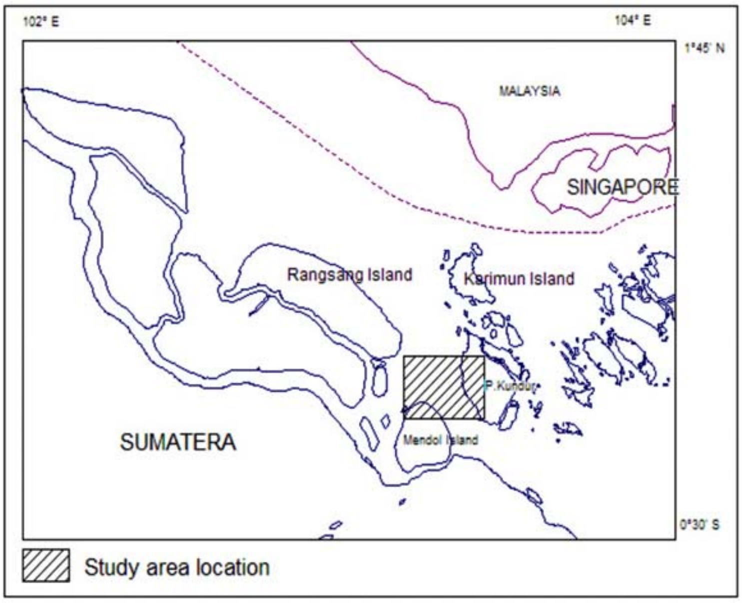

Figure 1. Map of study area

The rare earth elements are classified into two sub-group elements namely:

- Sub group cerium or also called light rare earth elements, consisting of lanthanum, cerium, praseodymium, neodymium, promethium, samarium and europium
- Sub group ytrium or heavy rare earth elements consisting of gadolinium, terbium, dysprosium, holmium, erbium, thullium, yterbium, luthetium, and also ytrium

The most important use of rare earth elements are as catalyst activator. The mixture chloride of lanthanium, neodymium and praseodymium is used for oil refining catalyst with a concentration between 1% to 5%. Mixed chloride of rare earth element is added to the zeolite catalyst to increase the conversion efficiency of crude oil (crude oil) into the ingredients of the oil proceeds. In the future, is estimated utilization of rare earth metal catalysts in the petroleum industry will more increase. Alloymetal, resulting from electrolis mixed of rare earth chlorides, were used in iron and steel industries to improve the physical properties of iron and steel produced. Rare earth element such as cerium, praseodymium, neodymium, samarium, dysprosium and alloymetal also used in permanent magnet industry such as conductor pipe tubes, line printer, electric motors and generators. Trend market and utilization of rare earth element in future as shown in table 1.

Otherwise, the rare earth mineral types are found at study area are apatite, zircon, monazite, pyrochlore , and xenotime.

Monazite *(Ce La Nd Th)* PO_4, including the phosphate group, carriers of the rare earth elements such as cerium, lanthanum, neodymium and thorium. Generally occurs as individual crystals, yellowish white, the edges hexagon shape, black, flat surface, hardness from 5 to 5.5, specific gravity of 4.9 to 5.5, is an element radioactive, occurs in granite pegmatites.

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.

YPO_4 xenotime, rare earth element bearing mineral of ytrium, including the phosphate group, red-brown, elongated forms, hardness 4-5, specific gravity 4.45 to 4.59. Occurs in granite and pegmatite, and often associated with zircon.

Pyrochlore $(Na\ Ca)_2\ (Nb\ Ta\ Ti)_2O_6$, as rare earth element carrier of neobium and tantalum. These rare earth element including oxide group, brownish red, hardness 5 to 5.5, specific gravity of 4.03 to 4.36, is radioactive element. Occurs in pegmatite, often associated with feldspar

Apatite $CA_5\ (PO_4)_3\ (FClOH)$, carrier of cerium rare earth elements, including the phosphate group, clear, rounded, hardness 5, specific gravity 3.18 to 3.21. Occur in pegmatite, often associated with nephelin, zircon, sphene. Apatite and phosfor used for fertilizer.

Regional Geology

Based on the Geological Map of Siak Sri Indrapura and Tanjung Pinang (Figure 2) (Cameron, et al., 1982), lithologically the study area are compossed by Alluvium deposits, Intrusive rocks, Malarco Formation, Papan Formation and Bintang Formation.

Table 1. Utilization and market trends of rare earth element (A. P. Jones, 1984)

MATERIALS	PARTICLES	USES
Glass	Nd, Sm	Laser
Glass	Nd_2O_3 and oxides	colored glass for TV filter
	Er and Pr	Mikrowave Crystal
$Y2Fe5O_{12}$	La	Camera Lens
Zr-B-O	La	Permanent Magnet
Fe	Nd, Sm	polymerization catalysts
Al	La, Nd	

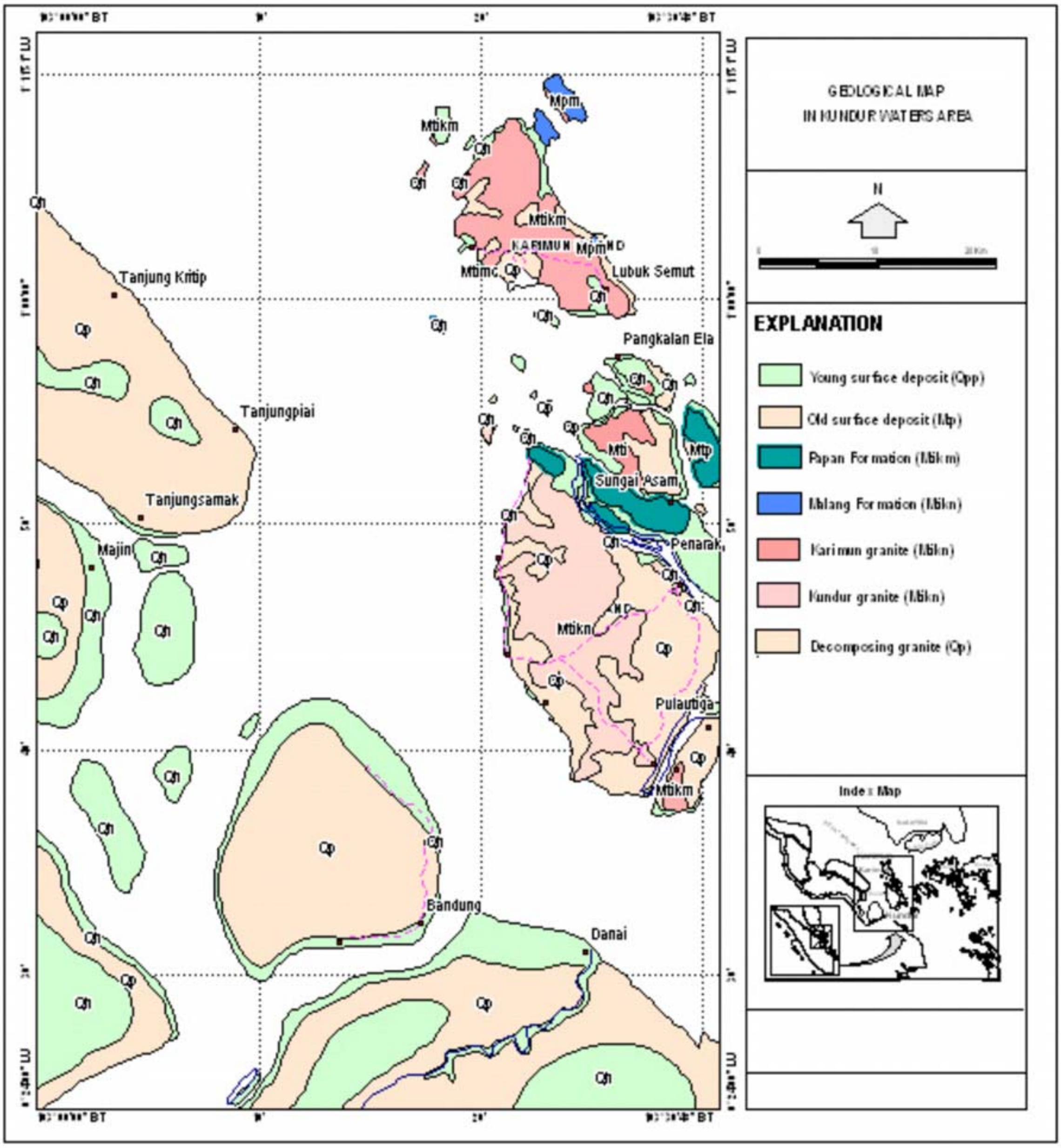

Figure 2. Geological Map ofSiak Sri Indrapura and Tanjung Pinang (Cameron et al, 1982)

Alluvium at study area can be divided into two namely Old and young Surface deposit.

Old surface deposit *(Mtp),* are widespread at Kundur Island and its surrounding, consist of clay, silt, gravelly clay, plant debris and granite sand. This unit is fluviatil sediment and Upper Pliocene age.

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

Papan Formation *(Mtikm)* which is contained at Kundur Island, consist of shale, sandstone and quartz conglomerate that became hornfels at the contact with the granite and the old Middle Triassic-Late Triassic. This formation is similar to the Bangka Formation.

Intrusive rocks are often found at Kundur Island consists of granite and gabbro. Granite can be divided into Karimun Granite, Kundur Granite and inseparable Granite, whereas gabbro complex is only found at Merak complex.

Kundur granite *(Mtikn),* with gray colour, generally coarse sized with orthoclas megacrystal / microcline. The granite is found at the center of Kundur Island.

METHODS

Data position is obtained using GPS directly that can be monitored from the computer while the seabed sediment sampling conducted by using gravity corer grab sampler and shallow drilling. Laboratory analysis such as grain size analysis, chemical analysis (rare earth element Sn content) and heavy mineral analysis performed on selected sediment samples.

The aims of grain size analysis is to determine the statistical parameters aand to know of sediment texture horizontally and vertically. Grain size fraction separation is done by dry sieving method with sieve holes diameter between -4 phi to 4 phi, sieve diameter and interval between fractions is 0.5 phi (Folk, 1980). Data processing is done by a computer using a special software for grain size analysis. To separate the magnetic minerals used hand magnet 300 gauss, while for other heavy minerals were separated by bromoform liquid. Heavy mineral bearing rare earth mineral analysis was taken from the top of the core samples (0-20 cm) for the 3 phi fraction (0.125 mm). The considerations is based on commonly of heavy minerals found in openings sieve of 3 phi. Heavy mineral separation method is done by using bromoform liquid (BJ 2,88). So heavy minerals obtained has the same density or greater than 2.88 (Gretchen, 1984).

Minerals identification using Nikon polarization microscope, 100 times magnification (enlargement). Percentages of each heavy mineral obtained from appearance frequency of each minerals to the total mineral grains of microscope observations times 100%.

Analysis of rare earth elements (REE) is performed to some selected samples using Iductively Couple Plasma (ICP) method. REE extraction with tributilfosfat (TBP) in kerosene. The biggest challenge is to find the best way in the chemical separation or purification of REE.

This is due to the chemical properties of each REE is similar and also contained in one mineral species.

In experiments, extraction of ytrium which is conducted from monazite and senotim converted into sulfate salt, then precipitated as the REE oxalate.

REE oxalate is changed again to RE $(OH)_3$. REE were separated from other elements such as Sn, Fe, Al and others to extract REE with tributilfosfat (TBP) in kerosene. Parameters used are pH ranging from 1.0 to 5.0 and extraction time from 30 to 150 minutes with an 30 minutes time interval. While the sedimentary process based on statistical approach (cumulative frequency curve, frequency curve (histogram), the mode and moment (Friedman, 1987). Sediments are classified according to the nomenclature of "triangle diagram Folk" (1980), based on the grain size .analysis. Seafloor depth measurements performed by using the echosounder Furuno/FE6200. Coastal characteristics mapping, is done descriptively and qualitatively based on lithology changes, relief, shoreline characteristics and predominant of coastal processes (Doland, et al., 1972). Base map is used 1: 50,000 scale map.

RESULTS

Seven teen selected samples mineral analysis results of seafloor surfacial sediment are found a rare earth element bearing minerals such as apatite, monazite, xenotime, zircon and pirochlor (Table 2). Meanwhile, based on the analysis of core sample (from sahllow drilling) is found only 4 rare earth element bearing minerals those are apatite, monazite, xenotime, zircon (Table 3).

Monazite present in 14 seafloor surfacial sediment samples, with the largest content in KDR-29 (0.02367%) and the smallest content in KDR 60 (0.00008%). While the monazite at sub surface (below the sea floor) based on drilling core data, namely the BM1 (2 – 3 m, 9 – 10 m, 17 – 18 m depth), has content between 0.00037% - 0.000434%, BM3 (7 – 8 m depth) (0.0008%) and at BM4 (2 to 2.5 m, 11 – 12 m, 18 – 19 m depth), has 0.00032% -to 0.0021% content.

The beautiful shape of zircon mostly used for stone jewelry. Zircon found in 11 seafloor surfacial sediment samples with the largest content at KDR-24 (0.00234%) and the smallest content at KDR 3 (0.00012%).

While, at the sub surface (based on core drilling samples) at BM1 (9 – 10 m, 17 – 18 m depth) is 0.00016% -0.0021%, at BM2 (7 – 8 m depth), is 0.0018% and at BM3 (7 – 8 m

Xenotime as source of rare earth element of Ytrium, is found in 16 seafloor surfacial sediment samples. The largest content found in KDR-1 (0.0233%) and the smallest content in KDR 3 (0.00006%).

While, at sub surface, based on core drilling data of BM1 (2 - 3m, 9 - 10m, 17 – 18 m depth), has content ranging from 0.00021% to 0.00169%, at BM2 (7 – 8 m depth) is 0.0001% and at BM4 (2 to 2.5 m , 18 – 19 m depth) the content ranging from 0.00013% to 0.0014%.

Pyrochlore at study area is a pyrochlore mikrolite series, are likely contain of rare earth elements such as cerium and lanthanum. Sometimes found as well as the source of the niobium, uranium and tantalun

Pyrochlore found in 5 seafloor surfacial sediment samples with the largest content in KDR-23 (0.0032%) while at sub surface is not found.

The smallest content of apatite at KDR-03 (0.00014%) and the largest in KDR -12 (0.0048%). At sub surface, apatite mineral abundant in BM I, II, III and IV with the content ranging from 0.00001 to 0.0825%.

Table 2. The rare earth element bearing mineral which is analyzed from seafloor surfacial sediment samples

NO	MINERAL SAMPEL NO	Apatite (%)	Monazite (%)	Xenotime (%)	Zircon (%)	Pirochlor (%)
1.	KDR 03	0.00014	0.00041	0.00006	-	-
2.	KDR 11	0.02796	0.00776	0.0233	-	0.0031
3.	KDR 12	0.0048	0.00256	0.00608	-	0.00064
4.	KDR 14	-	0.0002	0.0002	-	-
5	KDR 20	0.0003	-	-	-	-
6	KDR 22	-	0.0006	0.0009	-	-
7	KDR 23	0.00596	0.00921	0.0065	-	0.00325
8	KDR 24	0.00468	0.00515	0.00703	-	-
9	KDR 25	0.00946	0.02367	0.00591	-	-
10	KDR 26	0.00098	0.00041	0.00024	-	-
11	KDR 28	0.00349	0.00436	0.00291	0.00058	-
12	KDR 29	0.00267	0.00067	0.00134	0.00019	-
13	KDR 43	0.00917	0.00554	0.00426	0.00085	0.00106
14	KDR 44	0.00073	-	-	-	-
15	KDR 50	0.00042	0.00017	-	-	-
16	KDR 51	0.00191	0.00574	0.0051	-	0.00064
17.	KDR 60	-	0.0002	-	0.00014	-

Five minerals as rare earth element bearing mineral found in KDR 43. Other minerals such as apatite, monazite, xenotime found in 15 samples, followed by pyrochlore were found in 5 samples, whereas zircons in 3 sediment samples.

Apatite with the highest content found in KDR-11 (0.02796 %), while the lowest content (0.0014 %) in KGR 03. Monazite highest content in samples KDR 25 (0.02367 %), and the lowest content is 0.00017 % in KDR 50.

The highest content of Xenotime (0.0233 %) in KDR-11 and the lowest 0.00006 % in KDR-03. Zircon is only found in three sediment samples those are KDR 28 (0.00058 %), KDR 29 (0.00019 %) and KDR 43 (0.00085 %). Pyrochlore encountered had the highest content is 0.00325 % (KDR 23) and lowest is 0.00064 % (KDR 12 and 43). The distribution patterns of rare earth elements bearing minerals presented on the Figure 4.

Division segments / depth in analyzing the samples that was taken by shallow drilling (core samples) to obtain vertically detailed analysis results. Core sample of BM I is toke 4 segments namely 2-3 meters, 9-10 and 17-18 meters depth. BM II only taken one segment (7-8 meters depth), while the BM III taken 3 segments. For BM IV, those are four segments analyzed namely 2 to 2.5 meters, 11-12, 14-15 and 18-19 meters depth.

Four core samples analysis results, found four rare earth element bearing minerals are apatite, monazite, xenotime and zircon. Apatite with the highest content (0.000825%) found in BM IV (2 to 2.5 meter depth) and the lowest (0.00001%) in BM III at 7-8 meters depth.

The highest monazite content (0.00434%) found at BM I (9-10 meters depth) and lowest content (0.00001%) at BM II (7-8 meters depth). Highest xenotime content (0.00169%) found at BM I (9-10 meters depth) and the lowest content (0.00001%) at BM III (7-8 meters depth).

While, highest zircon content (0.0021%) found at BM I (9-10 meters depth) and lowest content (0.00001%) at BM II (7-8 meters depth). Distribution

Table 3. The rare earth element bearing minerals which is analyzed from core samples (bore hole -BM)

Borehole	BM I	BM I	BM I	BM II	BM III	BM III	BM IV	BM IV	BM IV	BM IV
Depth	(2 - 3m)	(9-10m)	(17 - 18m)	(7-8m)	(7 - 8m)	(11-12m)	(2 - 2,5m)	(11-12m)	(14-15m)	(18-19M)
Apatite			0.00148	0.0004		0.0003	0.00825	0.00044	0.001669	0.00363
Monazite	0.00155	0.00434	0.00037		0.0029	0.00008	0.00032	0.00077		0.0021
Xenotime	0.00103	0.00169	0.00021	0.0001			0.00013			0.0014
Zircon		0.0021	0.00016		0.0018					

patterns of rare earth elements bearing mineral, that were analyzed from core samples as shown on Figure 5.

Rare earth elements found in 7 seafloor surfacial sediment samples and one core sample (BM I). Those are Cerium (the carrier mineral apatite and pyrochlore), Zirconium, Thorium, Ytrium, Cerium (zircon), Cerium, Lanthanum, Neodymium, (monazite), and Ytrium (xenotime) as shown in table 4.

Cerium including light rare earth element sub-group. used as glass for radiation protection at the front of the cathode ray tube. as addition paint materials (lead replacement). as fuel corrosion prevention. The highest cerium content (16.91 %) found on the seafloor surfacial sediment samples KDR 57 and the lowest at 51 KDR (16.01 %).

Table 4. Rare earth element at Kundur Waters and Kundur Island

Sample Number	Ce (%)	La(%)	Y (%)	Zr (%)	Nd (%)
KDR3	16.88	6.10	5.18	5.95	20.88
KDR24	16.08	6.05	5.18	5.13	20.25
KDR30	16.88	6.80	5.30	5.35	20.50
KDR31	16.28	6.75	5.38	5.80	20.25
KDR42	16.23	5.40	5.40	5.05	20.75
KDR51	16.01	5.95	5.50	5.25	20.27
KDR57	16.91	5.93	5.53	5.55	21.33
BM1(4-5m)	15.41	5.60	5.58	5.70	20.41
BM1(15-16 m)	15.80	5.55	5.45	5.30	20.95
BM1(18.5-19m)	15.78	5.88	5.48	5.95	20.55

Lanthanum content ranging between 5.40 % to 6.80 %. including the light rare earth element sub-group. used as microwave processing. the camera lens and catalyst. The highest lanthanum content (6.80 %) at KDR 30 and the lowest content (5.40 %) at KDR 42.

Ytrium with 90 atomic number are grouped in rare earth element. because often occur together with lanthanum. and including the heavy rare earth elements. Mostly used as a colored ceramics. oxygen sensors. a protective layer of rust and hit. The highest Ytrium content (5.40 %). at KDR 42. and the lowest content at KDR 3 and 24 (5.18 %).

Highest zirconium content (5.95 %) at KDR 3 and the lowest (5.05 %) at 43 KDR. The highest Neodymium content (21.33 %) at KDR 57 and lowest (20.25 %) at KDR 24 & 31. including the light rare earths. used in laser and decomposition catalyst

While the highest cerium content (15.80 %) of core sample. found at of 15-16 meters depth and the lowest at 4-5 meters depth. Highest Lanthanum content (5.88 %) is found at of 18.5 to 19.00 m depth and the lowest content (5.45 %) at of 15-16 m depth. The highest Ytrium content (5.58 %) at of 4-5 m depth and the lowest (5.45 %) at 15-16 m depth.

Highest zirconium content (5.95 %) is found at 18.5 to 19 m depth and the lowest (5.30 %) at 15-16 m depth. Highest Neodymium is 20.95 % (15-16 m depth) and the lowest is 20.41 % (4-5 m depth).

Seafloor surfacial sediment distribution

Seafloor surficial sediments types of study area can be differentiated become 5 types. namely three units of main sediment and two groups of combined fad sediment. (Figure 3)

Unit of main sediment are : silt (Z). silty sand (sZ). gravelly sand (sG)

Silt (Z)

Megascophically this unit as mud. young-old gray pallor. containing remains of plants (peat) and biogenic shell. Its surface is mostly covered by a thin layer of brown sludge containing quartz and a thin sheet (plate) muskovit

Silt has spread most widely compared with other units that nearly 55% of total study area and located at 4-17 m water depths. The distribution pattern were surrounds of Mendol island waters till to southern coast of Kundur Island and a little at west off Ketapang waters. Kundur Island. Granulometry analysis results showed that the percentage of silt is 89.1 to 98.2%. sand 0.8 to 9%. and clay. 0.5 to 2.7%.

Sandy silt.

The physical properties of sandy silt unit similar to the silt. but the difference is a part of sample contained of very fine grains quartz sand. Separation of shells and organic. showing the maximum each percentage are 0.5349% and 7.389%. Sandy silt covering approximately 10% of the study area. spread over two locations and located at from 4 to 12 m and 8 to 12 m water depths. Granulometry analysis results showed that the percentage of sand is 10.3 to 49.9%. silt 48.5 to 89.5% and clay. 0.2 to 1.6%.

Mud (M)

Texturally mud unit consist of sandy mud gravelly. mud slightly gravel. and mud sandy slightly gravel. This group covers 10% of the study area. located from 10 to 14 m water depths. The distribution pattern of this

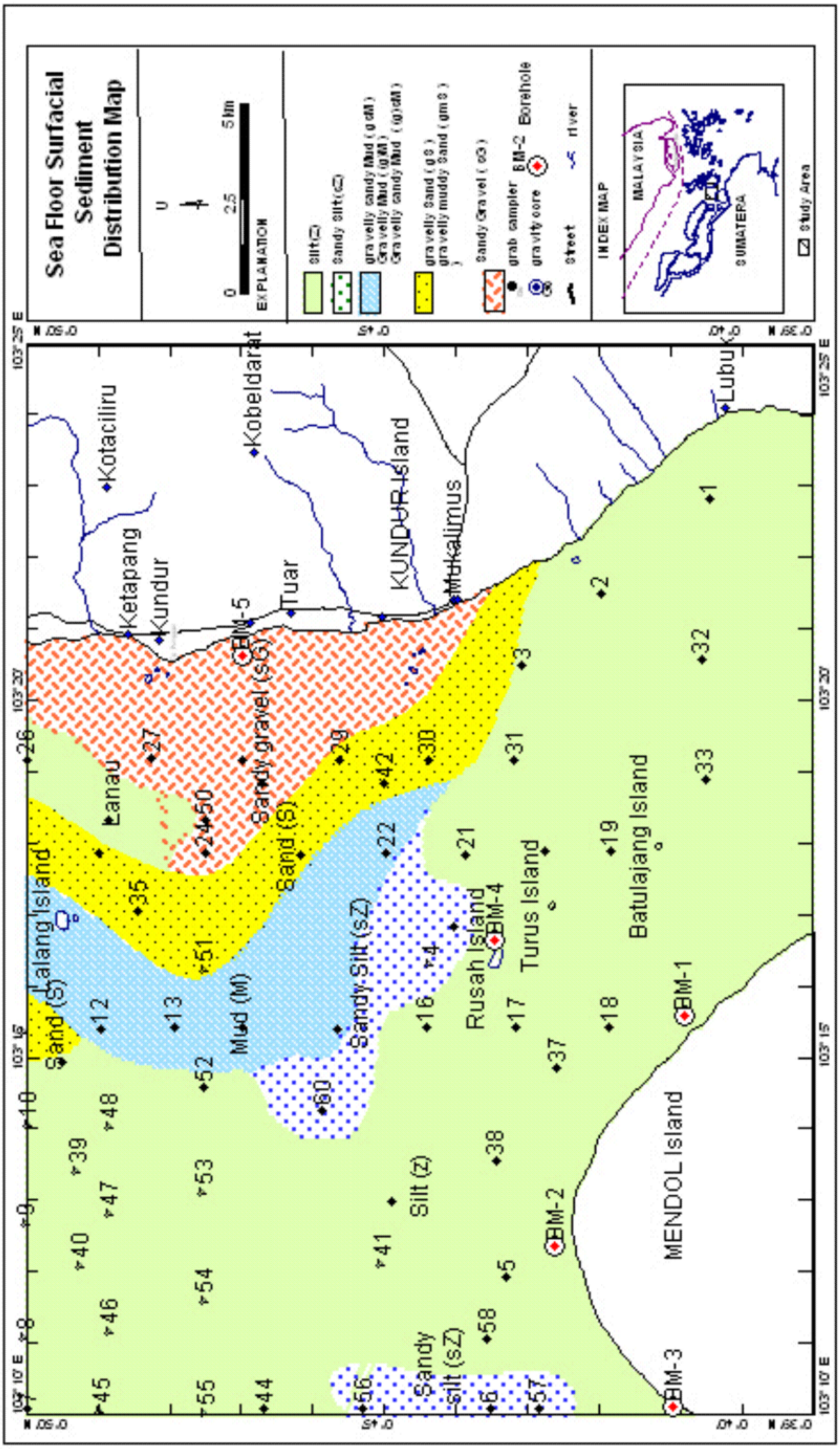

Figure 3. Sea Floor Surfacial Sediment Distribution Map

unit are northeast turn and narrows to the southeast like a sickle. Percentage of mud (silt + clay) was 72.8 to 93.4%; gravel from 0.1 to 3%. and sand from 6.5 to 26.1%. The physical characteristics of mud is similar with silt. but the difference can be seen from most sample contain of fine- very coarse grains quartz sand. Separation of the shell shows the percentage between 0 to 0.0303%.

Sand (S)

Megascopically this unit is quartz sand. whitish brown. fine to very coarse grained. partially gravelly. rounded to sub angular. poor to very poor sorting. containing a thin slab muskovit. pyrite. rock fragments. plant remain sand biogenic shells fragment. Sediment texture of the sand unit is comprised of several units namely sandy garvel. sand sand muddy gravelly. sand muddy slightly gravel. This unit covers 10% of the study area. occupies 10 to18 m water depths with a distribution pattern similar to mud unit. To the south direction. sand unit occupies seafloor basin shaped like bowls. suspected effect of mined tin sand. Percentage of gravel is 0.2 to 28.3%. sand 42.9 to 96.2%. silt from 0 to 45.2% and clay from 0 to 0.8%. Separation of the shell indicates the maximum percentage is 1.0718%

Sandy gravel (sG)

Sandy gravel unit has physical properties and mineral content is relatively same with sand. In a part of sample found rock fragments diameter 30 mm. dark to brown oxidize.
Sandy gravel covering 15% of the study. occupy a maximum sea depth about 23 m. spreading approached the shore with relatively similar with mud pattern. Percentage of gravel is 31.8 to 71.2% and sand from 28.8 to 68.2%. Separation of the shell fragment shows the maximum percentage of 1.4222%.

Seafloor morphology

The total length of sounding survey is approximately. 252 450 km. Sounding results after correction of transducer position and tides influence is made bathymetry map with 1 meter interval depth. Seafloor morphology of study area show varies morphology. At the northern of Mendol island seafloor morphology relatively gradual changes and ramps (Figure 3).

But at some places the surface of the seafloor showed as grooves and steep hollows. Along the west off Kundur waters. showed an irregular morphology. especially starting from Lalang Island to Ketapang Waters. Morphological form is large steep pits with 12 to 24 meters depth. This condition continuous to the south with holes (pits) depth varying between 13 meters to 18 meters

Beside that at along west off coast Kundur Island there is a granite rock outcrop comes up from seafloor until to the surface waters so it disrupt the navigation channel (shipping channel). At several places granite outcrop to form a small island. which is surrounded by the deep sea.

DISCUSSION

The graphs of rare earth elements bearing mineral on the seafloor surfacial sediments (Figure 5), shows that the mineral apatite in samples KDR-11. 25 and KDR 45 has a high content. KDR-25 containing of high monazite while zircon. xenotime and pirokhlor are low content. This. indicates that the rare earth elements contained in the sediment which is derived from apatite mineral is cerium (16.01 to 16.99 %). Whereas. monazite is neodymium (Nd) with a content between 20.25 – 21.33 %.

Based on core sample analysis results (Figure 6), vertically the apatite mineral have great content in BM-4 (2-19 meters depth). Monazite and zircon minerals abundant in BM-1 and BM-3. While there is a slight xenotime mineral in the BM-1 and BM-4. It mean. dominant rare earth element bearing mineral are apatite and monazite. so abundant rare earth elements are cerium and neodymium.

Types of minerals that found in seafloor surfacial sediment samples as rare earth element bearing mineral at Kundur Waters and its surroundings. closely related to the complex granitic bedrock. Based on this fact. the rare earth elements of minerals that mentioned above are abundant the granitic rocks (granite belt from Malaysia. Kudur. to Bangka)

Based on coastal characteristic map. the geological resources at Kundur Beach composed of granitic rocks. and quartz sands are located around Ketapang until Kundur. Sawang. Layang and Lubuk. While at Kundur Water is contained of tin and quartz sand. Mostly quartz sand has quartz content more than 90% (Surachman. et al.. 1998). Widespread distribution of quartz sand along the coast of West Kundur. to the open sea of study area. The chemical analysis results it can be seen that the Sn elements at study were 10 % and 50 %. (Setiady. 2000).

Generally the stratigraphy of Kundur Karimun area can be divided into two groups namely Pre-Tertiary and Quaternary rocks. Pre-Tertiary are found in the study area are sedimentary rock / metasediment and intrusive rocks. Most of the sedimentary rocks that was found. has been transformed into metasediment. such as shale hornfels and hornfels sandstone.

Based on geological map of Kundur and Adjacent Area, that rare earth beraing minerals such as *apatite, monazite, xenotime and zircon its source from Kundur Garanite Rock.*

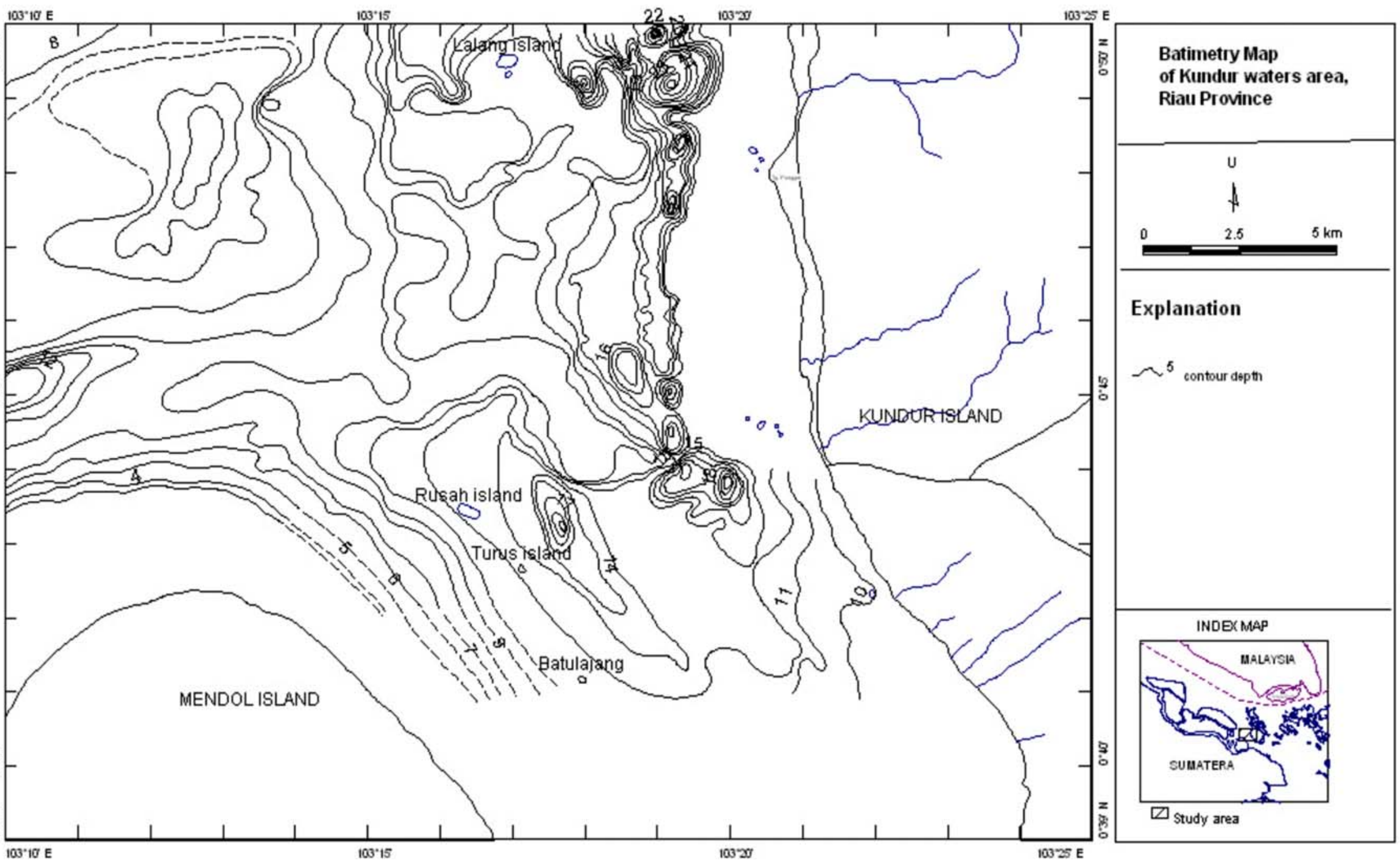

Figure 4. Batimeri Map of Kundur Water Area, Riau Province

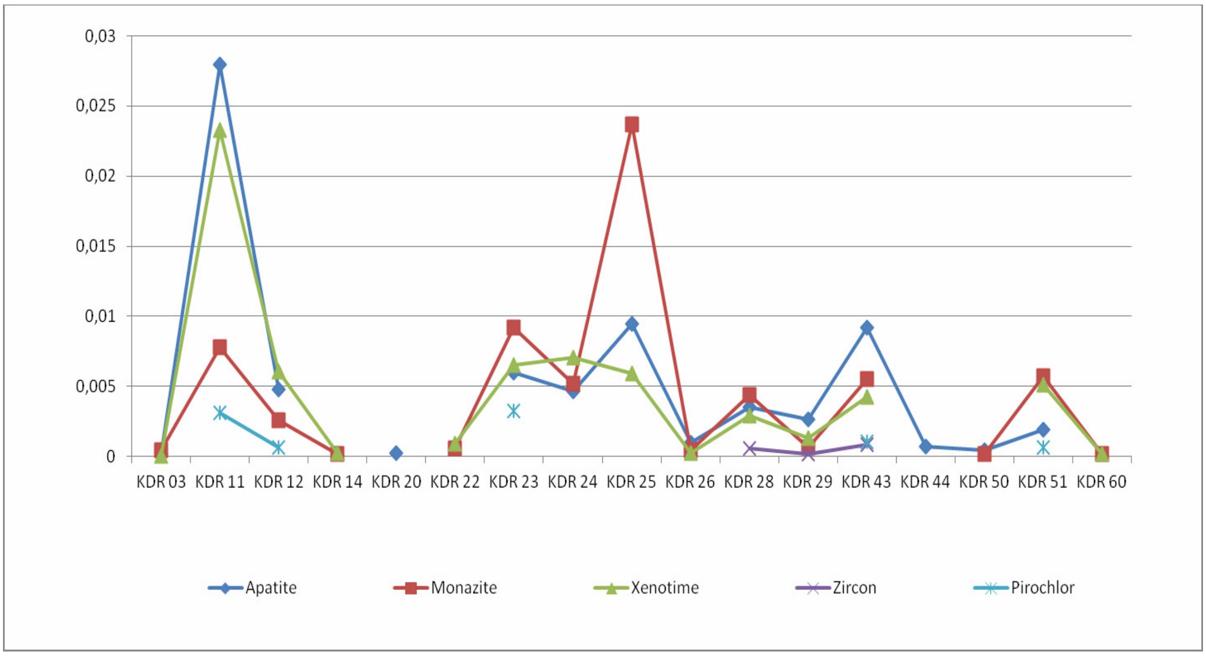

Figure 5. Distribution pattern of Rare Eart Element bearing mineral at sea (which is analysed from seafloor surfacial sediment)

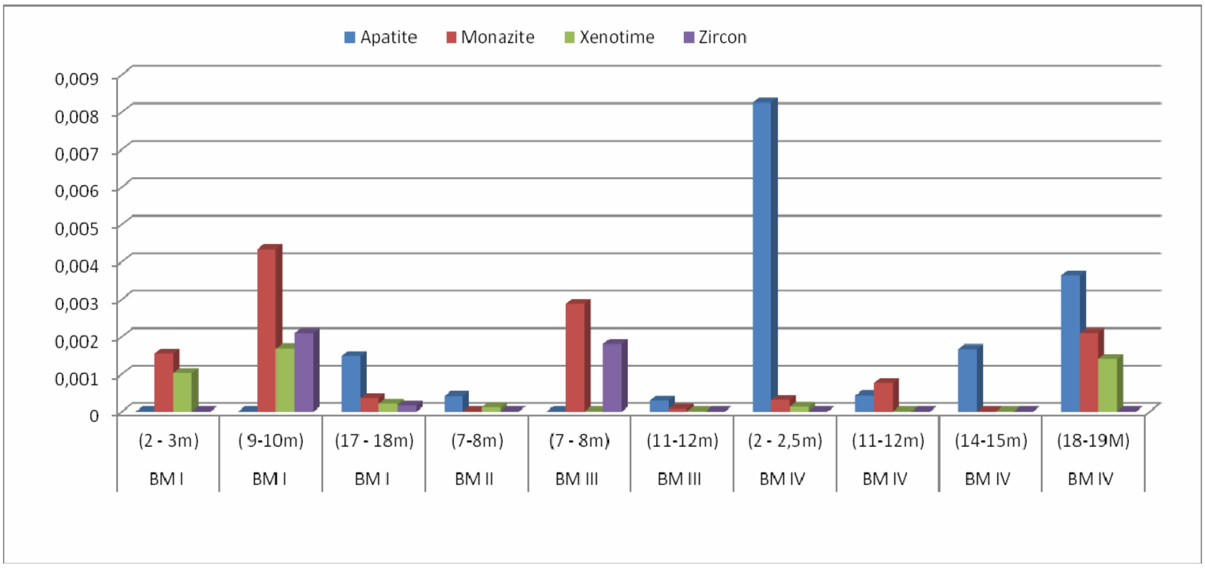

Figure 6. Distribution pattern of rare earth element bearing mineral from core sample analysis

CONCLUSIONS

Based on coastal Characteristics Map. the geological resources which is contained at Kundur Waters. consists of granite rocks. and sand quartz contained on sandy beach and rocky beach. where sandy and rocky Beaches can be found around Ketapang-Kundur. Sawang - Layang as well as at the southern part namely at Lubuk.

Seafloor surfacial sediments distribution. the offshore geological resources such as gravelly sand. sandy gravel. sand mud gravelly can be found from west coast of Kundur Island to the offshore. While. to ward central of Kundur Waters be found sand muddy gravelly. mud slightly gravel. mud sand slightly gravel.

The minerals that has a high content of rare earth elements in seafloor surfacial sediment are apatite and monazite. Rare earth element which is derived from apatit is cerium with content ranging from 16.01 to 16.99%. While. that was derived from monazite is neodymium (Nd) between 20.25 to 21.33 %.

The rare earth mineral elements bearing minerals. that contained in seafloor surfacial sediment samples at Kundur Waters and its surrounding are closely related to granitic bedrock complexes. Because. generally economic minerals formed in the primary rocks. Geologically. the study area is part of a granite belt. extending from Malaysia Peninsular. Kundur and Bangka Island is rich with economical mineral.

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