High Percentage of Rare Earth Element Connection with the Accumulation Sediment as Response Longshore Currents in the Belitung Waters

Prosentase Unsur Tanah Jarang yang Tinggi Hubungannya dengan Akumulasi Sedimen Sebagai Respon Arus Sejajar Pantai di Perairan Belitung

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ABSTRACT: The study area is geographically located in the West coast of Belitung island at coordinates 105°48'00" - 106°06' 00" E and 06°46'00" – 06°50' 00" S. The beach and coastal area is influenced by wave energy from the West and North directions

The purpose of this study is to analyze the relationship between the zone of sediment accumulation of empirical approaches on oceanography parameter containing rare earth elements. The approach used is to predict the shore wave energy using wave prediction curve deep waters to obtain the energy flux of the wave at each point of reference. Sediments containing rare earth elements tend to lead to the south as a result of the movement of longshore currents. Regional coastal area of the western part of the island of Belitung, especially in the southern part of the estuary of the river Tanjung Pandan is estimated to be a zone of sediment accumulation. The movement of sediment caused by wave energy from the north led to sedimentation evolved significantly in the south which is thought to contain rare earths minerals derived from land. This sedimentation process takes place on a seasonal basis, which allegedly took place in the west.

The movement of sediment to the south of the mouth of the Cerucuk River it is predicted that rare earth elements were supplied from these rivers tend to settle in the southern part of the estuary Cerucuk throughout the year.

Key words : accumulation of sediment, longshore currents, rare earth elements offshore Belitung

ABSTRAK: *Lokasi daerah penelitian secara geografis terletak di pesisir pantai barat Pulau Belitung pada koordinat 105°48'00"– 106°06'00" BT dan 06°46'00" – 06°50'00"LS. Pesisir pantai termasuk pantai terbuka terhadap pengaruh energi gelombang dari arah barat dan utara. Tujuan dari penelitian ini untuk melakukan analisis hubungan antara zona akumulasi sedimen dari pendekatan empirik parameter osenografi dan kandungan unsur tanah jarang. Pendekatan yang digunakan yaitu dengan memprediksi energi gelombang pantai menggunakan kurva prediksi gelombang perairan dalam untuk memperoleh energi fluks gelombang pada setiap titik referensi. Pengendapan sedimen bermuatan unsur tanah jarang cenderung mengarah ke selatan sebagai akibat dari pergerakan arus sejajar pantai. Daerah kawasan pesisir bagian barat Pulau Belitung terutama di bagian selatan muara sungai Tanjung Pandan diperkirakan menjadi zona akumulasi sedimen. Pergerakan sedimen akibat dari energi gelombang dari arah utara menyebabkan adanya sedimentasi berkembang cukup signifikan di bagian selatan yang diduga bermuatan mineral unsur tanah jarang asal dari darat. Proses sedimentasi ini berlangsung secara musiman, yang kemungkinan berlangsung pada musim barat.*

Adanya pergerakan sedimen ke arah selatan dari muara Sungai Cerucuk maka diperkirakan unsur tanah jarang yang dipasok dari sungai tersebut cenderung mengendap di bagian selatan dari muara Sungai Cerucuk sepanjang tahun.

Kata kunci : *akumulasi sedimen, arus sejajar pantai, unsur tanah jarang lepas pantai Belitung*

INTRODUCTION

The study area is geographically located in the west coast of Belitung island at coordinates 105 48'00"-106 06' 00" E and 06 46'00" – 06 50' 00" S (Figure 1). This area has the potential to precipitate minerals tin and rare earth elements (Widhiyatna et al, 2006). Rare earth elements (REE) is a very rare element or the discovery of very, in nature in the form of complex compounds, are generally complex compounds phosphate and carbonate (Suprapto, 2009). Several rare earth elements include zirconium, yttrium, niobium and tantalum contained in the surface of the seabed sediments of sand, silty sand, sandy silt, silt and sandy silt (Setiady et al, 2008). Along with the development of materials processing technology, rare earth elements are increasingly required, and generally in high-tech industries (Ahmad, 1996).

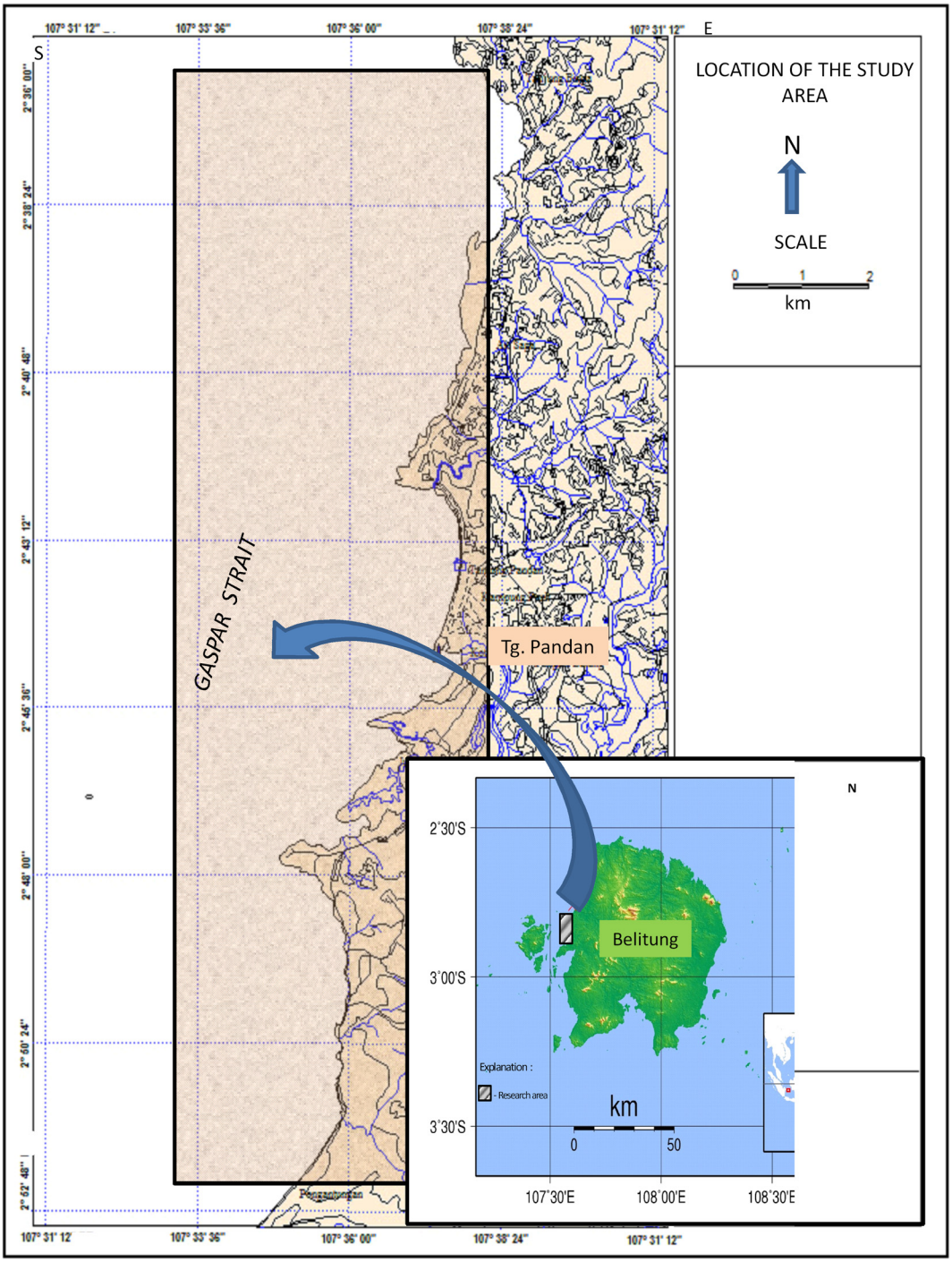

Figure 1. Location of the study area in Belitung Island

This paper is more emphasis on the analysis of the direction of the accumulation of sediments contains of REE. Accumulated sediments in the West coast of Belitung island occurs periodically and it is estimated to have lasted long time.

In the estuary of Tanjung Pandan River, sediment deposition tends to be relatively thick to cover the river mouth as a shipping channel in this area.

The process of sedimentation along the west coast of Tanjung Pandan, shows that the effect of waves during the west season resulted sediment movement and accumulated surrounding the river mouth. The accumulated sediments in the western part of Tanjung Pandan is quite significant and evidently ,these sediments contains of REE

Sediments in the estuary of Cerucuk river (southern/middle part of the area) show a negative impact on shipping lines. Therefore, the study of aspects of hydro-oceanography related tothe accumulated sediments contain REE is needed by analysising longshore currentsalong the Belitung coastal area.

In order to assess the movement of sediments, it is needed data collection and data frequency oceanographic parameters of surface winds > 10 knots within five years (2007-2011). They were recorded at the Meteorological Station BMKG Bulu Tumbang, Tanjung Pandan, Belitung. These data are then analyzed using predictive curve deep water wave (deep-water-wave forecasting).

In terms of influence of oceanographic parameters, the geographical study area is grouped as the type of open sea of the ocean wave activity in the west season. the very dominant natural factors in the coastal areas of Tanjung Pandan is a wave that causes longshore currents and the dynamics of the local climate. The beach lithology consists of alluvial sand and gravel with a relatively gentle slopes. Generally, beach slope is varies between 5 and 20 degrees to the west. In the Belitung region, there are several rivers flowing into the Gaspar Strait (between Belitung and Bangka) of including Cerucuk River as one of the largest rivers in the study area.

The study area is a dynamic environment and in a weak position to environmental changes due to human activities, particularly mining industries in the mainland or offshore areas. Mining activity is the main factor that influence the occurrence of rapid sedimentation around the river mouth and affecting the siltation in the estuary area.

Besides, the estuary of Cerucuk River affected by the dynamic interaction between the inputs of water from the sea and fresh water. Furthermore, the balance of fresh and sea water in estuaries is influenced by the rate of precipitation and evapotranspiration. Various materials of human activities are transported and accumulated in the Tanjung Pandan that causes environmental changes in the coastal areas.

External influences are naturally seasonal wave energy, thatonly occurs in the coastal areas in the northern part of the Belitung island. While the input materials, generally as sediments are transported through the river flow. Actually, these materials do not regularly providea negative impact on the development of the coastal areat as stable or unstable coasts. Silting process in coastal areas and surrounding Tanjung Pandan is due to the natural processes that periodically affect coastal areas such as fluctuation of oceanographic parameters and dynamics of the local climate.

Similarly, sediments move towards the sea is strongly influenced by the dynamics of currents and waves on the coast both from the northern and southern parts of Tanjung Pandan. For the aspects of oceanography, this study will assess the dynamics of the interaction of oceanographic parameters on the supply of sediments contains REE in the coast of Tanjung Pandan.

METHODS

The sediments the coastal area were carried out by a grab sampler and a hand drilling in a few sites that are considered to be representativ of the study area. Then the sediment samples were used for grain size based on Folk (1980) and geochemical analyses. Wind direction frequency obtained for five years was used to analyze the movement of sediment along the coast (longshore drift) using a formulation of CERC (1984). While the prediction results of oceanographic parameters include wave height (H) and period (T) areused to analyze the flow of longshore using wave prediction curve deep water (deep water wave forecasting curve) by CERC, (1973).

By using empirical approach oceanographic parameters, it is expected to be known the movement of sediments contains REEs along the coast. Formulation of wave energy along the coast according to Triatmodjo (2012) are:

$$Pb = \frac{\rho g^2 T H^2}{16\pi} \quad \text{.....1}$$

$$K' = \frac{K \rho g}{32} \quad \text{.....2}$$

Retrieved K` value = 0.014 (coefficient of CERC, 1975), then:

$$Qs = 0.014\ Hb^2.Cb\ .K^2\ Sin\ \acute{a}\ Cos\ \acute{a} \quad \text{.....3}$$

$$K' = \frac{K\ \rho g}{32} \quad \text{.....4}$$

Where :

QS = Transport of sediment along the coast (m / day)
ρ = Density of water
Pb = Components wave energy flux along the coast (Newton- m/d /m)
g = Acceleration due to gravity (9,81m / d)
Hb = Wave height (m)
Cb = Fast wave propagation (m / d) = (gdb) ½
α = Angle comes waves
K = Coefficient of refraction on the outer side of the breaker zone

Substituting water density (ρ) of 1025 kg / m , angle of attack (α), as well as the wave height (Hb), the acceleration due to gravity (g) and rapid propagation (Cb) into linear equations empirically formulated in equation 1, 2 and 3 then the value of the wave energy flux (Pb) in units (Newton-meters/sec) can be known. Pb values are presented on the map the movement of sediment along the coast that can determine the movement of sediment containing rare earth elements. The direction of movement of sediments derived from the curve of the movement of sediment along the coast by substituting the results of predictive analytics average wave height in deep water are presented in maps the movement of sediment.

RESULTS

Based on climatological data analysis, there are five components that affect the wind direction surrounding the Belitung coast. The wind component is the north, northwest, west, southwest and south. Percentage wind direction and speed are illustrated in windrose diagram (Figure 2).

Frequency of the wind direction is used to analyze the movement of sediment along the coast (longshore drift). While the value of oceanographic parameters include wave height (H) and period (T) is used to analyze the flow of longshore using wave prediction curve deep water (deep water wave forecasting curve) (CERC, 1973). To obtain the amount of wave energy, the frequency of wind data collected over five years to analyze the energy flux of the waves along the coast. Oceanographic parameter values, among others, the wave height (H) and period (T) is obtained from the prediction curve deep water (Figure 3).

Substituting wind frequency (n) for 5 years and the results predicted wave height (H) and wave period (T)

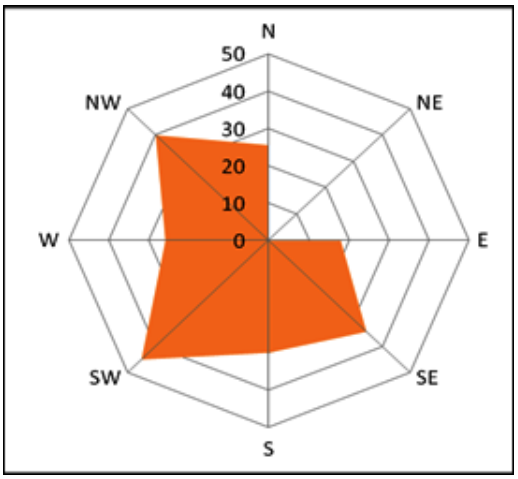

Figure 2. Diagram of the percentage frequency of the wind windrose surface area Tanjung Pandan, Belitung (Modification of BMKG 2007-2011).

on any component of the formulation into the dominant wind direction Ijima and Tang (1967) it will obtain the value of the wave energy flux below.

$$Pb = 0.09952\ n\ \rho\ H^2\ T\ Sin\ Ø \quad \text{.....} \quad (5)$$

Wave energy flux value calculation results for each component are presented in Table 1 and the results of these calculations then made chart analysis wave energy flux (Figure 4).

Table 1. Analysis of energy flux at reference points

Reference Point	Energy Flux
1	-20323
2	-15893
3	-3914
4	25654
5	-7683
6	-6239
7	3020
8	768
9	-37361
10	-7744

A reference point (Tabel 1) is projections of shoreline of the study areas ranging from point 1 to 10 (the horizontal axis). Energy value of the flux is the amount of energy flux of the waves along the coast (vertical axis). A negative value indicates that the left

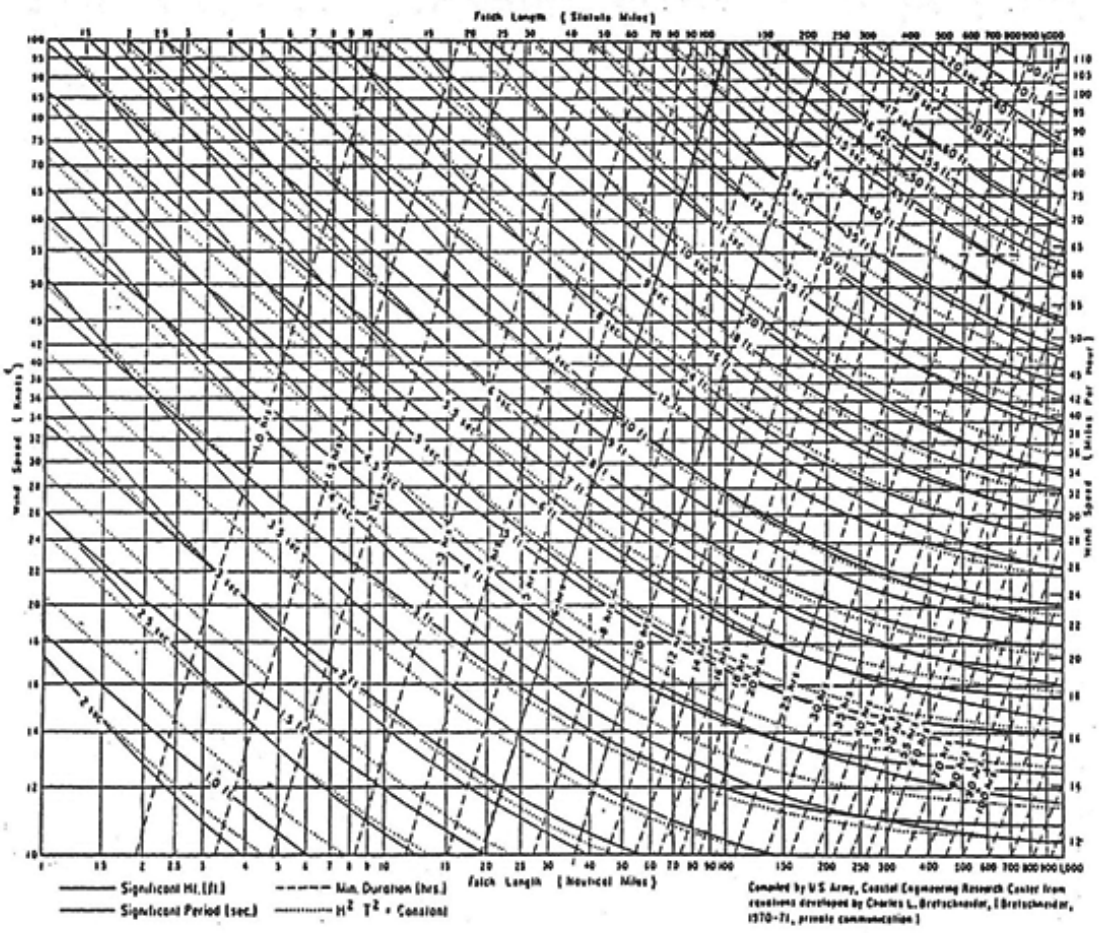

Figure 3. Waves prediction curve in deep water (CHERC, 1973).

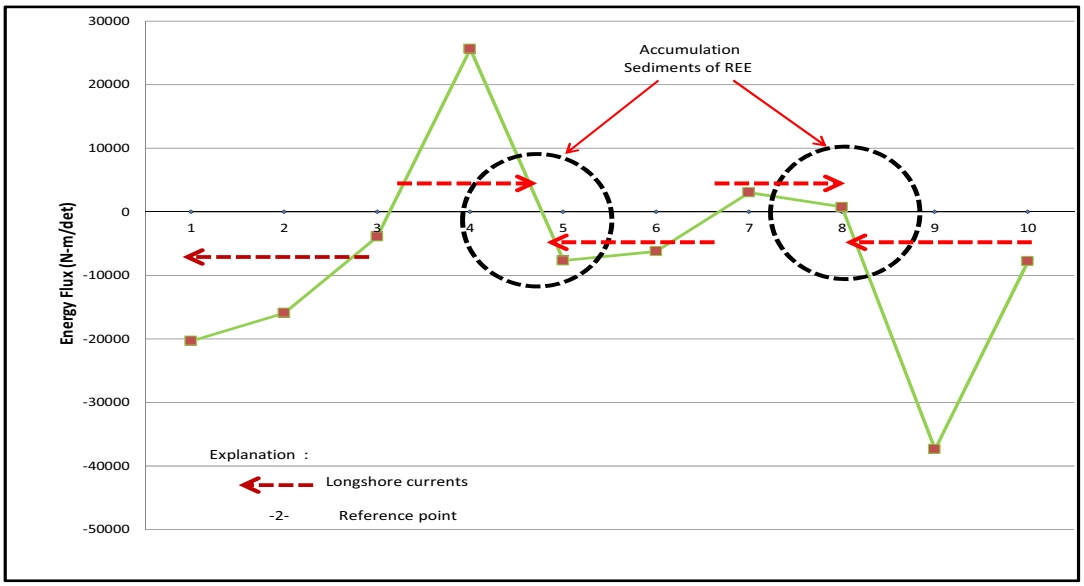

Figure 4. The results of the analysis of the movement of sediment from the analysis of the wave energy flux along Tanjung Pandan and adjacent areas.

direction of longshore current while a positive value indicates the direction of right longshore current right. Longshore currents encounter an area of sediment accumulation that developed into a sedimentation area. From the curve of the wave energy flux is then projected back to the shoreline of the study area (Figure 5).

From the analysis of sediment movement curve (Figure 4) shows that the direction of movement of sediment in the northern part of the estuary of the Cerucuk River move to the south, then the opposite direction to the movement of sediment from the south at the mouth of Cerucuk. The movement of sediment due

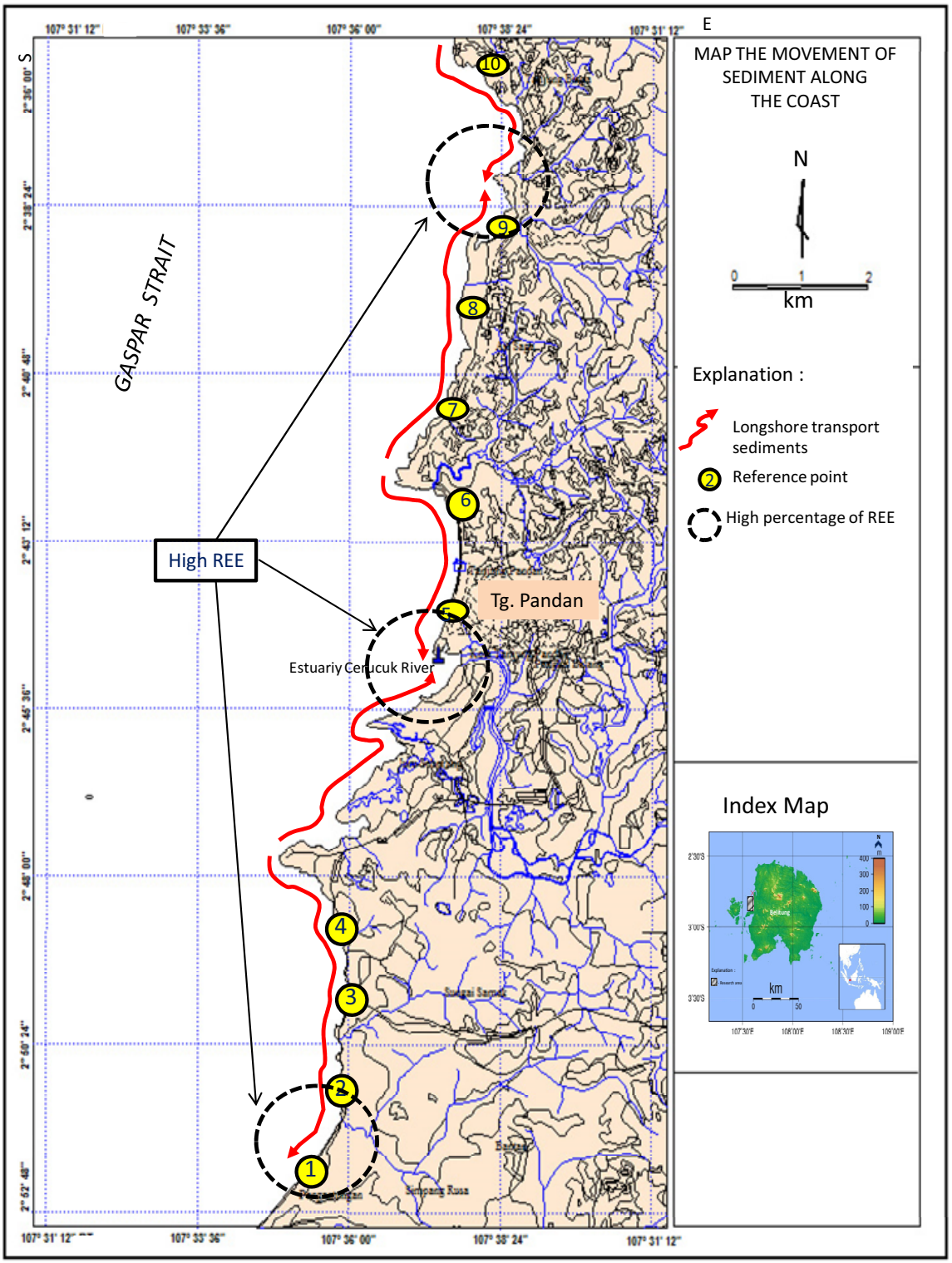

Figure 5. The movement of surface sediments containing REE.

to longshore currents in the north and south of the mouth of the Cerucuk, River. It is a natural process that occur dominantly throughout the season.
The sediment movement in the estuary is likely from the southern part up to the west of the estuary of Cerucuk. It is characterized by the deposition of sand which is quite extensive in the coast of Tanjung Pandan. Apparently sediments (sandbar) is derived supply sediment from the Cerucuk River. It is indicated by the movement of longshore currents in the northernpart of the estuary of the Cerucuk River (Figure 5).

The sediment movement from the northern into the estuary will increase rapidly the sedimentation in the estuary of the Cerucuk River. This condition is shown by occurence of sandbank (sand bar) extends parallel to the coast during the low tide, in Tanjung Pandan. found.

The movement of sediment from the northern entrance to the estuary will accelerate the sedimentation in the estuary area Cerucuk River. This condition is shown where at low tide, the estuary of the river cerucuk in Tg. Pandan found sand bar extends parallel to the coast.

The result of these longshore currents analysis could be related to the accumulated sediments along coastal area, particularly in the three locations: north, middle and south of the study area. These locations have high percentages of REE as seen in Figure 6. Several rare earth elements contained in the sediment on the Belitung coast shown in Table 2.

Therefore, if the frequency of sediment supply from t the Cerucuk River increased throughout the year, tREE within these sediments will accumulate in the south-west and north of the river mouth.

While the study area is covered by six types of sediment: sand gravelly, slightly gravelly sand, gravelly muddy sand, sandy silt and silt (Figure 7). Gravelly sand deposits are distributed quite widely in the northwest and southwest areas while the silt sediments are concentrated in the estuary of the Cerucuk River .

The sedimentary material supplied from surrounding the estuaries is t assumed to be derived from tin mining on land. In association with the high percentages of REE values around the river mouth, sand sediments in the estuary is suspected as a result of supply material fromtin mining, which contains REE on the ground (Djunaidi, 1997).

DISCUSSION

As mentioned above, there are some points that are interesting to study the results of the analysis. It is due to the movement of sediment longshore wave energy into the input to determine the accumulated sediments contains high percentages of REE in the coastal area of Belitung island. The quite high value of REE present in the area of longshore currents sites. Longshore currents movement is determined by the frequency of winds into a wave energy that directly trigger longshore currents in these waters.

With reference of the data distribution of the surface sediment and sediment data containing REE, the process of sedimentation in the coastal area of the Belitung Islands as a product of the supply sediments by currents parallel to the coast. It is also suspected the influence of rock mining activities containing REE on the mainland. The influence the supply of material is visible from the deposition of silt along the estuary of the Cerucuk River.

Tabel 2. Result Of Chemical Analysis Rare Earth Elements Contents In Sediment Samples

NO	CODE Sample	Ce ppm	Gd ppm	La ppm	Nb ppm	Nd ppm	Pr ppm	Sm ppm	Ta ppm	Y ppm	Zr ppm
1	BT-01(130-150cm)	30	5	19	87	14	0	1	119	10	12
2	BT-03(40-115cm)	6	2	5	16	5	8	0	31	3	8
3	BT-04(30-100cm)	14	3	9	17	7	5	0	46	8	4
4	BT-05(60-100)	7	2	6	65	5	4	0	30	3	13
5	BT-07(20-110)	7	2	8	20	6	2	0	48	3	1
6	BT-08(bottom)	32	2	14	27	8	13	1	13	3	4
7	BT-09(40-115cm)	25	3	22	56	11	2	1	45	5	18

Description :
1 % = 10.000 ppm
1 ppm (gr/ton) = 1000 ppb

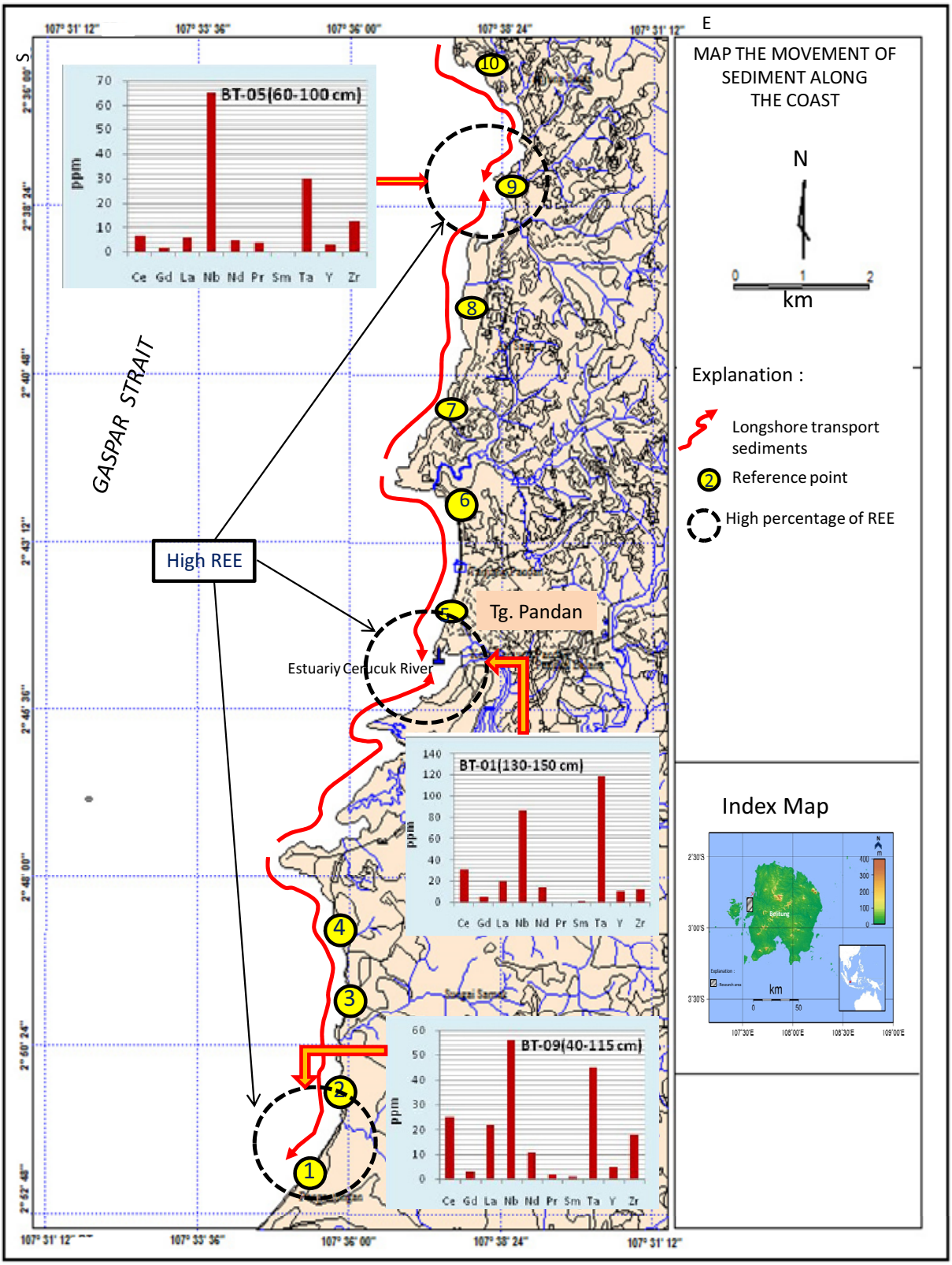

Figure 6. The high accumulation of REE in the West coast of Belitung Islands

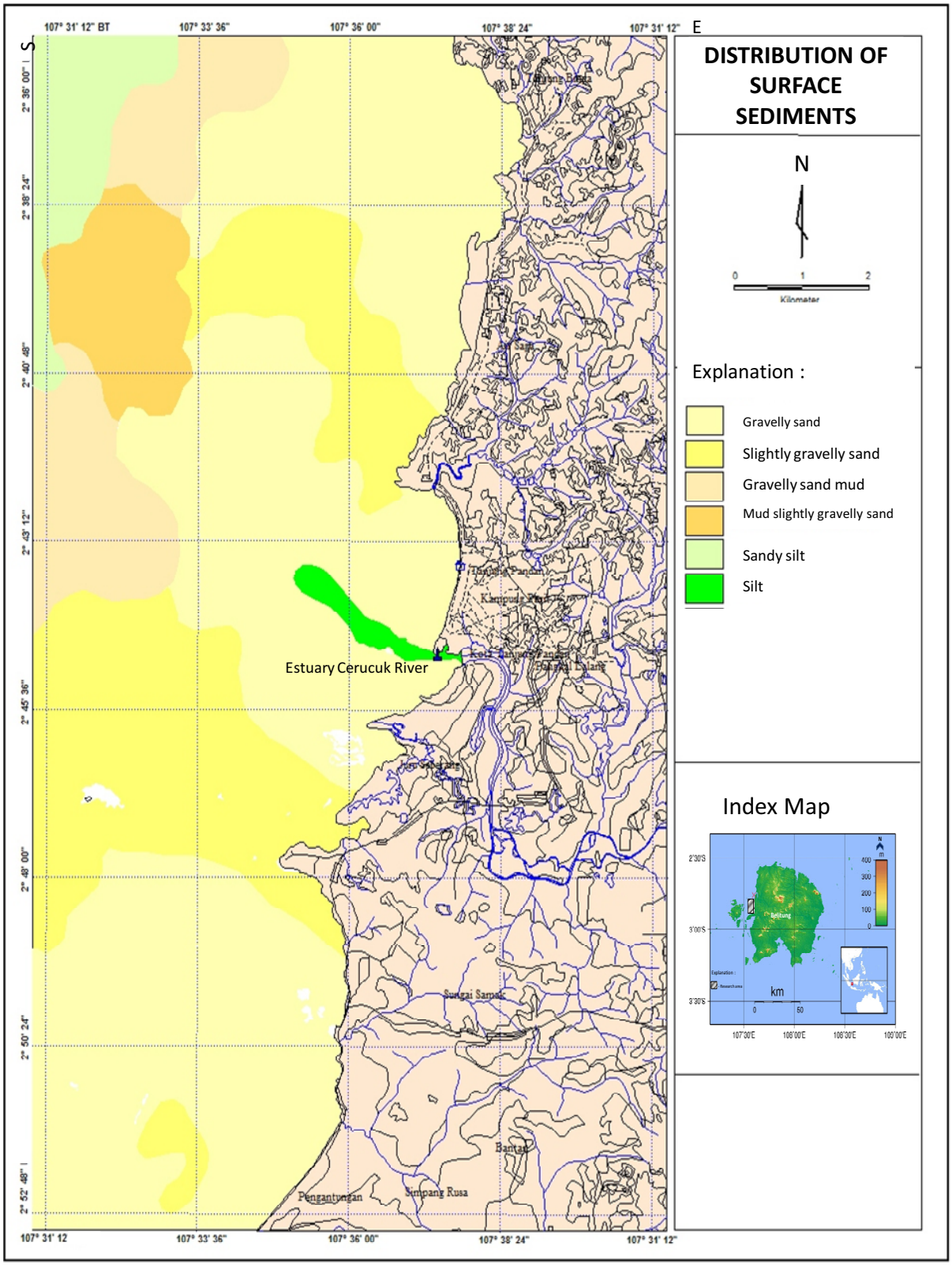

Figure 7. The surface sediment of the seabed in Belitung waters. (Surachman et al, 2013)

CONCLUSION

Sediment movement caused by wave energy from the north led to sedimentation evolved significantly in the south who allegedly charged rare earth element minerals derived from land. This sedimentation process is seasonal, which allegedly took place in the west season.

The movement of sediment into the mouth of the river south of cerucuk estimated that rare earth elements are supplied from the mouth of the river tend to accumulate in the southern part of cerucuk estuary throughout the year.

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