HEAVY MINERAL DISTRIBUTION PATTERNS AND CHARACTERISTICS OF SEA FLOOR SURFICIAL SEDIMENT AT EAST BALI WATERS, BALI PROVINCE

By :

I Wayan Lugra [1]

(Manuscript received 24-June-2010)

ABSTRACT

Analyses result of the heavy minerals that was took from beach sediments and sea floor surficial sediments was founded ten heavy minerals namely hematite, magnetite, limonite and rutile from oxide and hydroxide group, pyroxene, amphibol and zircon from silicate group, biotit from mica group, barite from sulfide group and dolomite from carbonate group. From 10 minerals identified, only magnetit distributes in the whole area, with the highest percentage of 34,15% in the sea and 35,14 % on beaches. Other heavy minerals distribute locally with the percentage of less than 0,01 %.

Grain size analyses result of sea floor surficial sediment had identified six units sediment such as sand, sand with few gravel, sandy gravel, gravely sand, gravel and reef. Distribution area of the six units sediment as follows sand and sandy gravel are occupied 25 % respectively of the study area, reef 20%, sand 15 %, gravel 10 % and gravely sand occupied 5%.

The best sediment for making art goods is sand sizes which is rich of heavy minerals such as magnetite, hematitre, limonite, zircon, pyroxene and amphibol. If will be exploited of the sand sediment on beach or sea floor surficial sediment, should be considering of the environment sustainable..

Keyword: grain size analyses, heavy mineral, seafloor surficial sediment, besach sediment, Karang Asem

SARI

Hasil analisis mineral berat dari sedimen pantai dan permukaan dasar laut dijumpai sepuluh jenis mineral berat yaitu magnetit, hematit, limonit, rutil dari kelompok oksida & hidroksida, piroksen, ampibol, sirkon dari kelompok silikat, biotit dari kelompok mika, barit dari kelompok sulfida dan dolomit dari kelompok karbonat.

Dari sepuluh jenis mineral berat yang teridentifikasi hanya magnetit yang sebarannya merata di seluruh daerah penyelidikan baik di laut maupun di pantai dengan persentase tertinggi 34,15 % di laut dan 35,14% di pantai, sedangkan sembilan mineral lainnya sebarannya tidak merata atau setempat-setempat dengan persentase umumnya di bawah 0,01 %.

Hasil analisis besar butir sedimen permukaan dasar laut dapat di bedakan menjadi 6 satuan yaitu pasir, pasir sedikit krikilan, pasir krikilan, krikil pasiran, krikil dan terumbu

1. Marine Geological Institute of Indonesia, Jl. Dr. Junjunan No.236 Bandung 40174

karang. Luas sebaran ke enam jenis sedimen tersebut terhadap luas daerah penelitian adalah pasir sedikit krikilan menempati 25%, pasir krikilan 25%, terumbu karang 20%, pasir 15%, krikil 10% dan menempati pasir krikilan 5%.

Jenis sedimen yang baik untuk pembuatan benda seni adalah sedimen berukuran pasir dengan kandungan mineral berat yang tinggi seperti magnetit, hematit, limonit, sirkon, piroksen, dan ampibol. Bila akan dilakukan eksploitasi terhadap sedimen jenis pasir baik di laut maupun di pantai, harus memperhatikan kelestarian lingkungan.

Kata kunci: analisis besar butir, mineral berat, sedimen permukaan dasar laut, sedimen pantai, Karang Asem

INTRODUCTIONS

As we know that Karangasem regency located at the eastern tip of Bali Island is one tourist destination in Bali, both cultural tours, shopping and coastal tourism object. For that is always required to improve it self in order to improve services and support facilities for the tourists feel comfortable during the trips.

As a consequence is a particular innovation should continue to be done to make new creations of art items that can become acommodity for local communities to improve living standards, and improvement of tourism facilities and supporting infrastructure such as roads, hotels.

To support as mensioned above, that necessary basic data of mineral resources and aggregate for basic building materials of physical facilities and infrastructure are urgently needed. As an example of material with fine grain size to coarse sand which contains magnetite, hematite, limonite, muscovite, biotite and rutile is very good for making buildings Balinese architecture or art form of sculptures, souvenirs. Art goods will provide authoritative and solid colors to reflect light under the bright lights lamp.

Administratively the study area whithin the subdistrict of Kubu, Karangasem and the District of Seraya, Karangasem regency located at the geographic coordinates of 33'-115O 115O 44 'East Longitude and 8O 15' – 8O 30 'LS. The study area covers an area of ??approximately 660 km2 with a coastline about 60 km length.

Generaly, the aimed of study, to obtain marine geological and geophysical data, where one of the objective is to find indications of mineral resources is included in the category of heavy minerals that may exist in the study area. During the field study has taken 86 sediment samples consist of 54 of seafloor surficial sediments samples and 32 of coastal sediment samples (Figure 1). 86 sediment samples analysis results showed that only 43 samples containing of heavy minerals namely 20 sea floor surficial sediments and 23 sediments taken at the beach.

REGIONAL GEOLOGY

Based on Geological Map Sheet Bali (Hadiwidjojo, 1971), a regional stratigraphic sequence of the study area can be divided into six units from youngest to oldest as follows:

- Alluvium deposits that limited spreading in the DAS area and is found in ??Amed and Bunutan areas
- Quaternary volcanic rocks composed of Pawon Volcano deposite that deposited at the Middle Quaternary Period with limited spreading in the Tanjung Pilah area.
- Gunung Agung Volcano rocks deposited on the Middle Quaternary Period covered nearly 50% of the study area on the ground, spreading from Ujung Karangasem in the southern part, until Sukadana area in the northern part of the study area

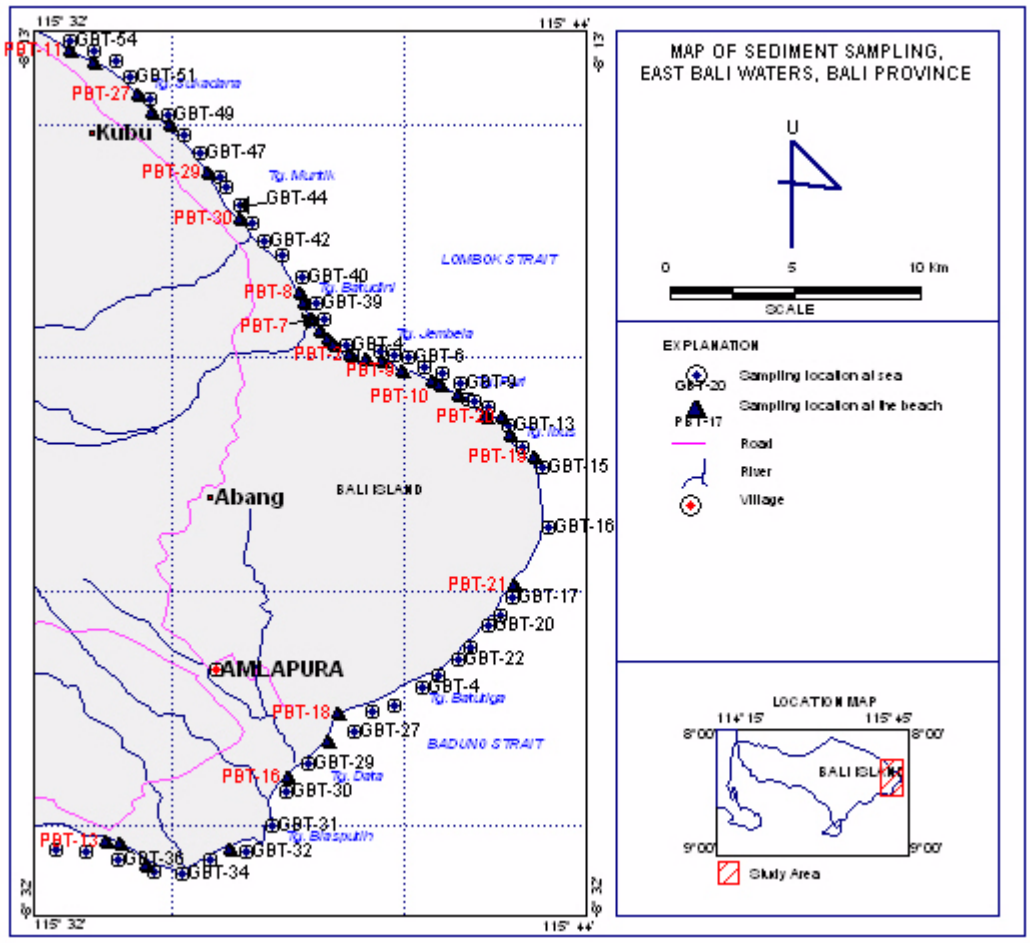

Figure 1. Map of sediment sampling

- Tuffs and lahar deposits of Buyan, Beratan and Batur, occupies the south coast of ?? study area and estimated deposited on the Middle Quaternary.
- Seraya Volcano rocks deposited on the Lower Quaternary, occupies the eastern part of study area and quite widespread, from Tanjung Bias to Teluk Amed in the northern part of study area.
- Ulakan Formations composed by volcanic breccia, lava and tuff and inserted by limestone, and its believed deposited on the Upper Miocene. This formation is widely exposed in Desa Bugbug and dominating the southern part of study area.

Referring to some previous researchers, Bali Island tectonics is closely related to Java. The northern and largest part of the Bali island consists of Quaternary volcanic deposits and some active volcanoes that allegedly is a continuation of the Solo Zone in Java (Van Bemmelen, 1949). While in the southern island of Bali and Nusa Penida island composed by limestone, known as Selatan Formation, its believed deposited on Miocene and as continuation of Sub-Zone Blitar in Java Island. Structural patterns that developed in Java is still expected to grow on Bali Island and ends on the Lombok Island.

METHODS.

The method applied in this study as follows:

Beach sediment samples was taken along the coast of study area, carried out by taking sediment that can be distinguished by megaskophic, such as grain size, color, and sorting.

Seafloor surficial sediments carried by grab sampler in accordance lattice which has been determined in order to obtain data that could represent for the whole of study area. Distance sampling seafloor surficial sediments from the coast line, ranging from 100 meters to 2000 meters depend on the water depth of study area.

Positioning for taking samples onshore and at sea determined the Garmin GPS Map 250.

Laboratory analysis conducted for determination of heavy minerals, ranging from very fine sand fraction (<3 phi) of each sediment samples. Magnetic minerals are separated by "handmagnet" 600 gauss, while for non-magnetic minerals are separated by using liquid bromoform. Identification for non-magnetic minerals is done by using microscope.

Grain size analysis conducted to determine the type of sea floor surficial sediments based on the nomenclature refers to the Folk, 1982. From the results of this analysis will be mapped distribution patterns of seafloor surficial sediments that would be associated with heavy mineral distribution patterns.

Some experts define a heavy minerals is minerals that have a specific gravity (BJ) is greater than the density of quartz (2.65) or feldsfar (2.54 to 2.76). While the opinion generally follows the opinion of Brenininkmeyer, 1978 and Folk, 1980 which states that the heavy mineral is a mineral that has a specific gravity of 2.8. In this paper the author follows the opinion of both experts.

RESULTS

The results of of 86 sediment samples analysis showed that only 43 samples containing of heavy minerals, namely 20 seafloor surficial sediments and 23 sediment samples that was taken at the beach (Figure 1).

Identification of heavy minerals at sea

From 54 sediment samples that was taken from the seabed, only 20 samples of sediment containing heavy minerals, consists of five groups: silicates, oxides and hydroxides, mica, sulfides, carbonates, as shown in table 1.

Oxides and hydroxides Group

Oxide and hydroxide minerals group which is found were hematite, rutile, limonite and ilmenite

Magnetite

This mineral is found at whole of study area, from north to south with the lowest percentage was 0.68% on the GBT-54 located at near Tanjung Sukadana, while the highest percentage was 34.15% on the GBT-25 located at Batutiga . In the southern part of study, the heavy mineral is not very evenly distributed due to coral reefs. While in the north, a relatively equitable distribution of the mineral magnetite from Batudawa to Tanjung Sukadana

The distribution of the mineral magnetite that is almost evenly this may be caused by the weight of its kind to be relatively smaller than the other heavy minerals thus transported further from the source. The presence of magnetite in the entire area, ??inquiry allegedly came from volcanic rock are scattered in almost every area of ??the study area.

Hematite

Hematite is only found in 11 sediment samples with the lowest percentage (0.0011%) located at GBT-33 in the south of the Tanjung Bias Putih and the highest percentage (0.0091%) on the GBT-07 located at Bunutan. Distribution of this mineral is found localy viz around the Tanjung Bias Putih (GBT-33-35), Batu Tiga(GBT-25), Tukad Tiis (GBT-17) around the Salang (GBT-12-14) and the Teluk Amed (GBT-4-7).

Rutile

Rutile is only found in two of seafloor surficial sediments samples in the GBT-04 is located in Teluk Amed waters with content of 0.00021% and on GBT-14 is 0.00029 %.located at Salang waters

Limonite

Limonite found in 3 locations namely the seafloor suficial sediment samples GBT - 07 with 0.0056% is located in the Bunutan waters, GBT-12 with 0.00161 % content in the Tanjung Ibus waters, and GBT-14 is 0.00012% found in Salang waters

Silica Group

Fraction of this mineral that is found consists of pyroxene, Amfibol and zircon.

Pyroxene

Distribution of pyroxene minerals found in a location that is almost same as the distribution of the mineral hematite, localy found at 11 samples with the lowest percentage of .0012 in GBT-14 located at Salang, and the highest percentage is 0.00917% in GBT-07, located at Bunutan.

Zircon

The presence of the mineral zircon found in only 9 samples with the highest percentage is 0.0055% on GBT-07 located at Bunutan and the lowest percentage is 0.001% on GBT-1 at Tukad Tiis. The pattern of distribution is slightly different with hematite and minerals found around Tanjung Bias Putih (GBT-33-35), Tukad Tiis (GBT-17), Salang (GBT-12-14), Bunutan-Amed (GBT-4-7) and Sukadana (GBT-50)

Amfibol minerals found only in 7 samples namely GBT-04-07-12 and 14Located at Amed to Salang, GBT-22 at Batutiga, GBT-33 at area Nyuh Tebel and GBT-45 around TAnjung Muntuig. The highest percentage that can be identified is 0.009%(GBT-20) and the lowest percentage of 0.00032% (GBT-22). The distribution of heavy minerals in the sea water can be seen in Figure 3

Mica Group

Minerals mica group that were found in the study area is biotite scattered in five

NO	Sample Number	Magnetite	Pyroxen	Amphibol	Biotite	Zirkon	Rutile	Baryt e	Hematite	Limonite	Dolomite
1	GBT-04	11,8946	0,001347	0,00074	0,00031	-	0,00021	-	0,00021	-	-
2	GBT-07	7,7101	0,00971	0,00733	-	0,0055	-	0,03851	0,00971	0,0056	-
3	GBT-12	6,9475	0,0131	0,0901	0,00257	0,00096	-	0,00161	0,00193	0,00161	0,00128
4	GBT-14	15,3118	0,00102	0,00063	0,00012	0,00034	0,00029	0,00047	0,00021	0,00012	0,00017
5	GBT-17	14,3348	0,00094	-	0,00017	0,00011	-	0,00053	-	-	-
6	GBT-22	30,6791	0,00058	0,00033	0,00016	0,00016	-	0,00232	0,00041	-	-
7	GBT-27	21,6313	-	-	-	-	-	-	-	-	-
8	GBT- 33	13,8471	0,01136	0,00138	-	0,00138	-	-	0,00011	-	0,00221
9	GBT-35	4,6828	0,00631	-	-	0,00046	-	0,0021	0,00046	-	0,00117
10	GBT-39	19,8890	0,00009	-	-	0,00001	-	0,00004	0,00001	-	0,00002
11	GBT-45	7,4600	0,00056	0,0004	-	0,00005	-	0,00017	0,00023	-	0,00023
12	GBT-40	9,7276	-	-	-	-	-	-	-	-	-
13	GBT-46	4,0039	-	-	-	-	-	-	-	-	-
14	GBT-47	5,7568	-	-	-	-	-	-	-	-	-
15	GBT-49	7,0842	-	-	-	-	-	-	-	-	-
16	GBT-50	10,3984	-	-	-	0,00072	-	0,00615	-	-	0,00181
17	GBT-51	3,8361	-	-	-	-	-	-	-	-	-
18	GBT-52	17,6971	-	-	-	-	-	-	-	-	-
19	GBT-53	11,2780	-	-	-	-	-	-	-	-	-
20	GBT-54	0,6870	-	-	-	-	-	-	-	-	-

Table 1. Heavy mineral analysis result of sea floor surficial sediment

locations: GBT-04, GBT-12, GBT GBT-17-14-22 and GBT-22. The highest content found in GBT-12 is 0.00257% followed by the GBT-04, 0.00031%, then GBT-17, 0.00017% and GBT-22, 0.0001% and the lowest content found in the GBT-14 is 0.00012%.

Sulfide Group

Sulfate group was found in the study area is barite, spread over nine locations at various depths seabed. The highest content are found in the GBT 07 is 0.03851% which is located at Bunutan waters, while the lowest was found in the GBT-39 is 0.00004% at the Salang waters.

Carbonate Group

This group only represented by dolomite are found at seven sediment samples namely GBT-12, GBT-14, GBT-33, GBT-35, GBT-39, and GBT GBT-45-50. The highest content of dolomite found in the GBT-33, is 0.00221%, which is located at Nyuh Tebel waters, while the lowest content found in the GBT-39 is located at Paselatan waters.

Identification of heavy minerals on the beach.

The analysis results of the 32 sediment samples that was taken at beach area, showed that 23 samples contain a heavy mineral that is oxides and hydroxides mineral group such as magnetite and hematite, rutile and limonite, silica group consisting of pyroxene, amfibol, zircon, carbonate groups are dolomite, whereas the sulfide group is barite, as shown in Table 2. Of all the heavy minerals were identified only magnetite being the most prominent.

Oxides and hydroxides group

Magnetite

Mineral magnetite found in 23 sediment samples that were analyzed, with the spreading pattern almost evenly throughout the study area from south to north. The lowest percentage was 0.97% on PBT-17 at Tanjung Data, while the highest percentage was 35.14 in PBT-06A at Paselatan.

Hematite

This mineral is found only in three coastal sediments samples around the Salang and Bunutan. The lowest percentage was 0.0002% can be identified in PBT-20 located at Salang and the highest percentage was 0.0023% in PBT-23A at Bunutan.

Rutile

Rutile is only found in three locations namely PBT-13 with 0.02671% content at Nyuh Tebel, PBT-24C with 0.00049% content and PBT-25 with the lowest content is 0.0005%

Limonite

Limonite found in 3 locations namely PBT-23A, PBT-20 and PBT-24C. The highest content found in PBT-23A is 0.00376% located at Bunutan, while the lowest content in PBT-20 is 0.00077% located at Salang.

Silica Group.

Amphibol

This mineral is found in 5 sediment samples viz PBT-13-20-23A-24C and PBT-25 with the highest percentage is 0.032% (PBT-13) and the lowest percentage is 0.00052% (PBT-20). The spread is very limited such as around Salang, Bunutan and Nyuh tebel beaches.

Pyroxene

This mineral is found in 5 of 23 sediment samples containing heavy minerals with the locally distribution such as at Bunutan-Salang on PBT-23A, 24 and 25 , and on PBT-20 at Tukad Tiis. The lowest percentage that can be identified is 0.009% (PBT-20) around the

NO	Sample Number	Magnetite	Pyroxen	Amphibol	Biotite	Zirkon	Rutile	Barite	Hematite	Limonite	Dolomite
1	PBT-04	29,7740	-	-	-	-	-	-	-	-	-
2	PBT-06A	39,4136	-	-	-	-	-	-	-	-	-
3	PBT-07	16,8870	-	-	-	-	-	-	-	-	-
4	PBT-10B	18,2611	-	-	-	-	-	-	-	-	-
5	PBT-12	0,9821	-	-	-	-	-	-	-	-	-
6	PBT-15A	7,4050	-	-	-	-	-	-	-	-	-
7	PBT-18A	1,0730	-	-	-	-	-	-	-	-	-
8	PBT- 21B	0,8065	-	-	-	-	-	-	-	-	-
9	PBT-23B	5,2390	-	-	-	-	-	-	-	-	-
10	PBT-13	33,3957	0,23774	0,03205	-	0,00534	0,02671	0,07212	-	-	0,03739
11	PBT-23A	3,1725	0,01727	0,00069	-	-	-	0,00306	0,00432	0,00376	-
12	PBT- 25	1,9442	0,00009	0,00012	-	-	0,00005	0,00043	0,00004	-	0,00067
13	PBT-05B	0,4721	-	-	-	-	-	-	-	-	-
14	PBT-06B	3,5450	-	-	-	-	-	-	-	-	-
15	PBT-08	14,7753	-	-	-	-	-	-	-	-	-
16	PBT-11C	4,0626	-	-	-	-	-	-	-	-	-
17	PBT-14B	0,6110	-	-	-	-	-	-	-	-	-
18	PBT-17	0,9782	-	-	-	-	-	-	-	-	-
19	PBT-18B	6,3704	-	-	-	-	-	-	-	-	-
20	PBT-22B	7,6618	-	-	-	-	-	-	-	-	-
21	PBT-26	12,4430	-	-	-	-	-	-	-	-	-
22	PBT-20	16,5810	0,00337	0,00052	-	-	-	0,000337	0,00026	0,00077	0,00013
23	PBT-24C	8,0133	0,00728	0,00077	-	0,0028	0,00049	0,00595	0,00203	0,00112	0,00147

Tabel 2. Heavy mineral analysis result of beach sediment

Salang and the highest percentage is 0.0172% (PBT-23A) at Bunutan.

Zircon

The presence of the mineral zircon found in two locations just namely at Nyuh tebel on PBT-24C with the percentage of 0.00028,qand in the area between Salang and Bunutan.

Sulfide Group

The sulfide group represented by barite found in five locations: PBT-13 with a 0.07212% content and the highest content of five other sediment samples followed by PBT-24C, 0.00595%, and PBT-23A, 0.00306%, further PBT-25, 0.00043% and the lowest content in PBT-20, is 0.00037%.

Carbonate Group

Dolomite, is presented carbonate groups found in four locations: PBT-13 with a high content is 0.03739%, followed by PBT-24 C, 0.00147%, and PBT-25, 0.00067% and the lowest content is 0.00013%.in PBT-20.

The spreading of seafloor surficial sediment

The grain size analysis results of 54 seafloor surficial sediment samples showed that the type of sediment covering the sea floor surficial sediment of the study area can be divided into 6 types (Figure 2):

Sand

Sand occupies approximately l0% the entire of study area namely in offshore areas around Tanjung Ibus, south of Tanjung Batutiga, and Nyuh Tebel. Based on statistical parameters, the calculation of moments, obtained the value of , sorting 0.6 to 0.7; skewness (skewness) -1.2 to -0.2 and kurtosis 2.4 to 8.4; containing 100% sand fraction. Generally, this black sand deposits, identifying the presence of iron sand, occasionally found bentonic fossil foraminifera, such as cibicides and ostracoda. Scattered of this sediment localy in areas with relatively gentle topography.

Sand with a few of gravel

Sand with a few of gravel deposits are found in several places around Paselatan. Tanjung Jempela, Tegal Alas, Tukad Tihis, north of Tanjung Batutiga, and Bugbug, occupies nearly 25% of study area. Based on the statistical parameters moment calculation, obtained the average value (X) between 1.0 to 2.3 phi, sorting is 0.8 to 1.3, skewness -1.3 to 0.6, and kurtosis 1, 5 to 7.3. Sand fraction contains 99.1% to 99.8%; gravel fraction 0.2% - 0.9%. Sometimes, in sand gravelly, founded a cibicides fossil.

Gravelly Sand

Gravelly sand deposits are found in several places, namely the off shore of the northern tip of Tanjung Sukadana, until Paselatan, Tanjung Data, and a few at Candi Dasa tourist complex, covering about 20% of the study area..

Based on the grain size analysis, are obtained the average value (X) between 0.2 to 1.6 phi. sortation 1.1 to 2.1; skewness -0.9 to 0.0, and, kurtosis from 1.9 to 3.8, it means the sediment contains of sand fraction is 73.3% to 86.2%, pebble fraction 13 , 8% to 26.7%, fragments of red pumice, sometimes found rocks and fossils fragments.

Sandy gravel

Sandy gravel sediment is found scattered in the area around Pangkuh, and covered only 5% of the study area. While the results of statistical calculations, obtained average value (X) -0.8 to -1.0 phi; sortation 0.5 to 1.7; scewness -0.3% to 1.0 and kurtosis 1.5 to 2.9, containing 44.7% fraction of gravel up to 61%; sand fraction 38.77% to 55.3% . Sand fraction containing of mollusks shells fragment , and a few of red pumice.

Gravel

The spreading of gravel sediments covered nearly l0% of the study area, namely

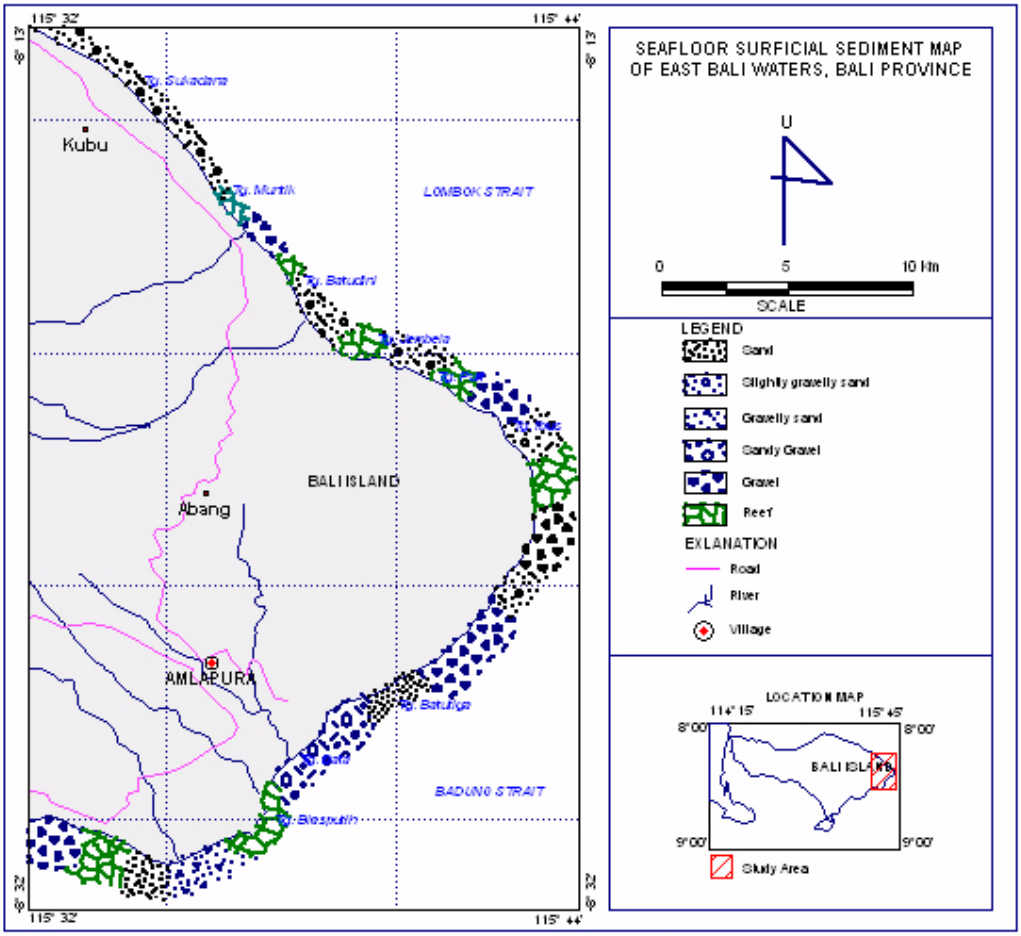

Figure 2. Map of seafloor surficial sediment

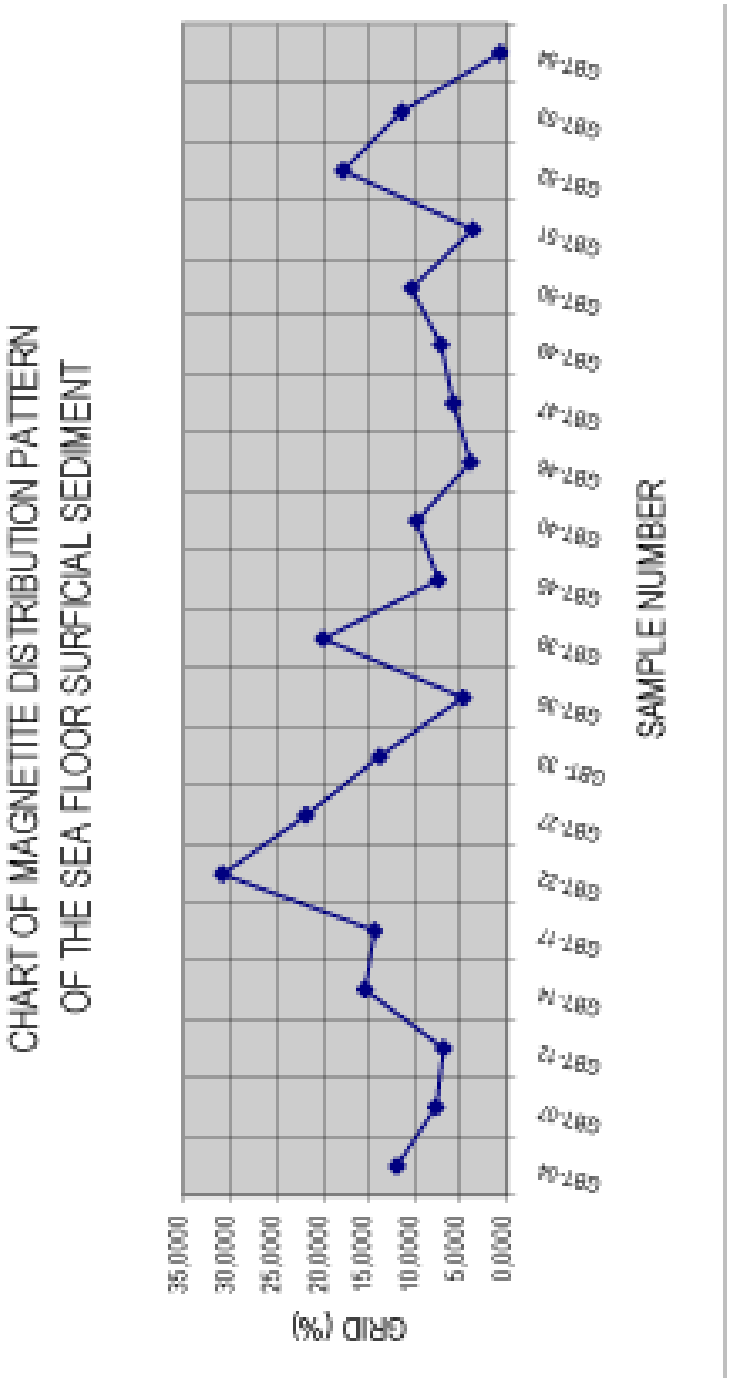

Figure 3. Magnetic Distribution pattern of seafloor sediment (from south to the north)

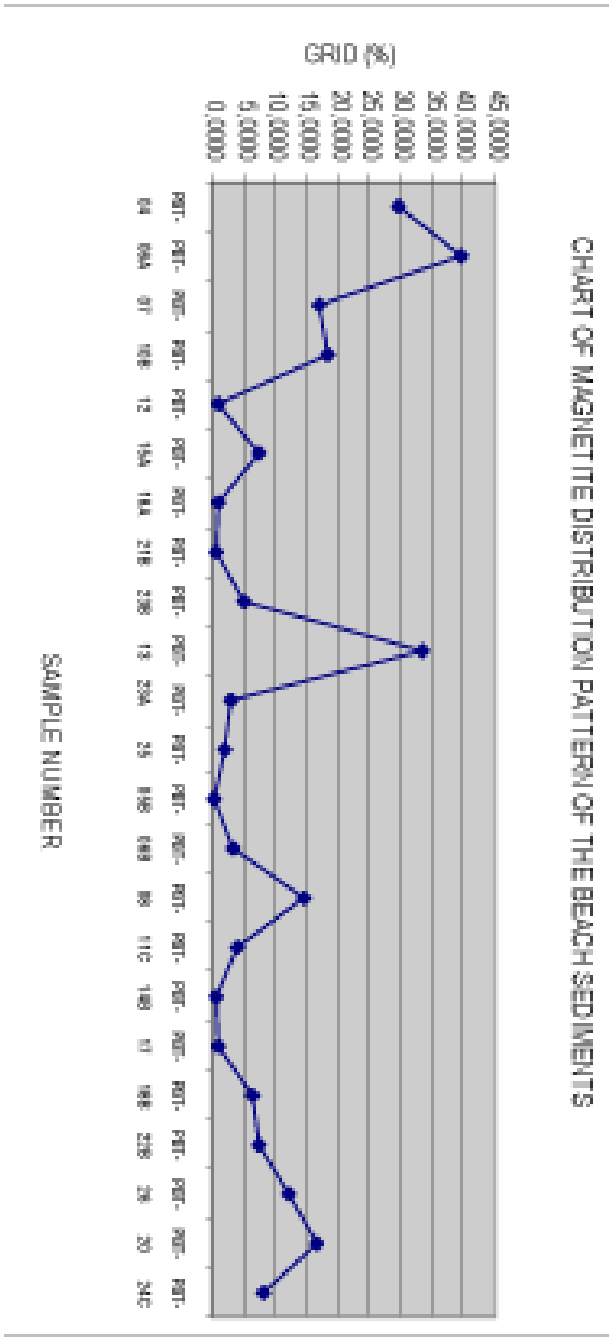
CHART OF MAGNETITE DISTRIBUTION PATTERN OF THE BEACH SEDIMENTS
GRID (%)
SAMPLE NUMBER

in the Tanjung Batunidi. and Giliselang Island. Based on the moment calculation results, obtained the average value (X) -2 phi, sorting 1,.2, scewness 1.2 and kurtosis 10.2. These sediments contain gravel fraction 88.30%, while the sand fraction is 11.7%, also found black and red rock fragments.

Reef

These reefs are scattered nearly 30% of the entire study area, appeared at offshore of Tanjung Muntig, Tanjung Barunidi, Teluk Jemeluk, Tanjung Puri, Tegal Alas, Tanjung Bias Putih, and at the tourist complex area of ??Candi Dasa. The area around the spreading of coral is characterized by white sand beaches, and used by local residents as a tourist area destination.

Heavy mineral content of 20 seafloor surficial sediment samples showed that only magnetite is found in all samples with content ranging from lowest (quality) is 0.68698% in GBT-54 located at Tanjung Sukadana waters, whereas the highest content is 30.6791% in GBT-22 located at Batu Tiga waters.

Similarly, the distribution patterns of these minerals from the north, central and southern of study area, highly varied as shown in figure 3. Subsequently pyroxene and sirkon found at ten locations, barite and hematite at nine locations, amphibol and dolomite in seven locations biotite in five locations, limonite and at three location and rutile in two locations. Heavy minerals are commonly found scattered in the northern part of the study area, except sirkon, barite and dolomite found in the south.

Magnetite has a specific gravity less than the other heavy minerals so it will spread relatively further away from its source and found almost all over study area, both at sea as well as on shore. Except in the southern part of study area, generally consists of coral reefs. Magnetite sources is estimated originate from the Quaternary volcanic rocks consist of Mount Pawon deposits with limited spread in the Tanjung Pilah, Gunung Agung Volacano deposit rocks, and lava Tuff Buyan, Beratan Seraya, Batur Volcano.

Meanwhile, other heavy minerals such as hematite, rutile, limonite, pyroxene, ampibol, sirkon, dolomite, biotit which has a greater specific gravity of magnetite is only scattered in northern study area and relatively close to the same source with the source of magnetite.

The analysis results of 23 samples of beach sediment which is containing heavy mineral, only hematite is found to have nearly uniform distribution patterns along the coast of the study area as shown in Figure 4. Other minerals such as pyroxene, ampibol zircon, rutile, hematite limonite dolomite respective, premises on four samples of sediment with content less than 0.01%.

Types of seafloor surficial sediments that can be utilized for the manufacture of art goods, situated at Nyuh Tebel waters, Batutiga, Tanjung Ibus, Cape Jembela, Paselatan.

Type of these sand, rich heavy mineral content namely magnetite, limonite, rutile and biotite. But when will be exploited for the fulfillment of the requirements, its must consider the surrounding environment, so as not to disturb the coral reef ecosystem of tourist destination in the study area.

Utilization of beach sand is recommended for the manufacture of art goods are scattered in the coastal of Prasi, Nyuh tebel, Krobokan, Tegal Alas, Salang, Bunutan, Amed and Village Paselatan, because to handling the environmental issues is much easier

Sand which is richest heavy mineral content located at Amed. The sand that will be used to create a art goods, must be located behind the sand dunes, so it does not lead to coastal erosion

CONCLUSIONS

The results of heavy mineral analysis of seabed sediments indicate that the minerals

found in the study area namely oxides & hydroxides mineral group, silicates, sulfides, carbonates, and the mica group, whereas the coastal sediments encountered oxides & hydroxides mineral, silicates, sulfides, and the carbonate group.

Commonly type of heavy mineral found were magnetite, hematite, limonite, rutile (oxide & hydroxide group), pyroxene, ampibol, sirkon (group of silicate), barite biotite (mica group), (sulfide group) and dolomite (carbonate group).

Ten types of heavy minerals were determined at study area, only magnetite is distributed uniformly throughout on the study area, both at sea and ashore with a high percentage of 34.15% at sea and 35.14% on the beach, while nine other minerals are not evenly distributed or locally, generally less than 0.01% content

Sea floor surficial sediments consist of 6 units namely sand, sand with afew of gravel, gravelly sand, sandy gravel, gravel and coral reefs.

The spreading of sediment respectively were sand with covered about 25% of the entire study area, sand with few gravel 25%, coralreefs, 20%, sand 15%, 10% and sandy gravel 5%.

Types of sediments that are suitable for making a art goods are sand-sized sediment with a high content of heavy minerals such as magnetite, hematite, limonite, zircon, pyroxene, and ampibol

If will be exploited of sand-sized sediment type for the manufacture of art goods, at sea and beach, should pay attention to environmental sustainability.

ACKNOWLEDGEMENTS

Apreciation and thanks to the honorable Head of Marine Geological Institute for the trusting to the author for leading the research team.Team members and the resource persons for all their help and discussions so that this paper can be resolved. Editorial board of Bulletin of the Marine Geology who have the pleasure to provide input and discussion that this paper is feasible published in the bulletin.

REFERENCES

Bemmelen, R.W., van, 1949. The Geology of Indonesia, vol. 1A, Martinus Nijhhoff, The Hague, the Netherland.

Brenininkmeyer, C.L., 1978, Heavy Minerals. The Encyclopedia of Sedimentology, Encyclopedia of Earthsciences, Volume VI, Ed. By Rhodes W Fairbridge & Joanne Bourgeois, Dowden, Hutchisoon & Rose Inc.

Folk RR., 1974, Petroloogy of Sedimentary Rock, Hemphill, Pub Co, Austin, Texas.

I Wayan Lugra, drr, 1998, Penyelidikan Geologi Wilayah Pantai Perairan Bali Timur, Propinsi Bali. Pusat Pengembangan Geologi Kelautan Bandung, tidak dipublikasi

Purbo Hadiwidjojo, M.M., 1971, Peta Geologi Lembar Bali, sekala 1 : 250.000, Direktorat Geologi