Genes and physical properties of iron sand from Kinali Pasaman

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Abstract. West Coast of Sumatra island has a large amount of iron sand. Research in the Pariaman area and Agam Regency has been carried out, but for the Pasaman area it is not yet available. This research will reveal the iron sand genes found in Kinali Pasaman and find out physical properties such as: Grain size, Magnetization, Specific Gravity and magnetic susceptibility of the samples obtained. The purpose of this study is to provide information and data for the West Pasaman district government to bring in Regional Revenue / PAD (Royalty) as well as one of the solutions for PT Semen Padang in meeting its iron sand needs. The methodology used is to take 5 (five) iron sand samples systematically and represented at several points. The sampling point at the coordinates: 1. S004'46,49 "E99046'6,33", 2. S005'8,93 "E99046'2,34", 3. S007'39,40 "E99045'25,60", 4. S008'20,60 "E99044'55,55", 5. S008'39,00 "E99044'55,43". The sample was analyzed for its physical properties at the UNP FT Mining Laboratory. The results of research on the physical properties of iron sand at Kinali Pasaman beach: sample size 0.425mm-0.15mm, % magnetization fraction from size of 0.425mm-0.075mm 20%-40%, specific gravity 2.9-3.5, and susceptibility 497.8-2644, 3 x10^-8m^3kg^-1 which shows iron sand is superparamagnetic.

1. Introduction
The coast of the west coast of West Sumatra has iron sand content which has been widely studied, including the Study of Magnetic Properties at Sunur Pariaman Beach [1], Iron Sand at Masang Tiku Beach, Agam Regency [2], iron sand at Kata Pariaman Beach [3]. Katiagan Beach and Muaro Lasak Beach in the Kinali Pasaman region are also located on the west coast of the Sumatra coast adjacent to Pariaman (fig.1). Iron sand investigations have not been carried out in the Kinali area of West Pasaman, so this study revealed how the influence of the iron sand genesis on physical properties.

Some important terms that need to be known in this study: 1. Iron Sand is sand deposition containing particles of iron ore (magnetite), which is located along the coast, formed due to the process of destruction by weather, surface water and waves of origin rocks containing iron minerals such as magnetite, ilmenite, iron oxide, then accumulated and washed by waves of sea water, 2. Iron Sand Concentrate is Crude sand that has been benefited through a magnetic separation process that has a magnetic percentage (MD) [4].

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It has been known before (Mufit et al., 2013) that iron sand deposits can have magnetic minerals such as magnetite (Fe3O4), hematite (α-Fe2O3), and maghemite (β-Fe2O3) which have potential for industrial materials, for example as dyes and a mixture (filler) for paint, as well as a permanent magnet base. Iron is the second most abundant metal on earth. The character of these iron deposits can be metal deposits that stand alone but are often found in association with other metal minerals. Iron is sometimes present as a soil metal content (residual), but rarely has a high economic value. Economical iron deposits are generally in the form of Magnetite, Hematite, Limonite, and Siderite. Sometimes it can be in the form of minerals: Pyrite, Pyrhotite, Marcasite, and Chamosite.

Figure 1. Map of West Pasaman Regency Administration

An iron sand deposit in addition to containing the main iron ore minerals is possible to associate with other Fe-containing minerals including: pyrite (FeS2), headquarters (FeS), pyrethite (Fel, S), chamocytes [Fe2Al2 SiOs (OH) 4 ], ilmenite (FeTiO3), wolframite [(Fe, Mn) W04], chromite (FeCr2O4); or also non-Fe minerals that can provide added value such as: rutile (TiOz), cassiterite (SnO2), monasite [Ce, La, Nd, Th (P04, SiOd)], diamond, gold (Au), platinum (Pt), xenotime (YP04), zircon (ZrSiO4) and others. This iron sand is usually dark gray or blackish. In general, iron sand consists of opaque minerals mixed with mineral grains such as quartz, calcite, feldspar, amphibian, pyroxene, biotite, and tourmaline. Iron sand consists of magnetite, titaniferous magnetite, ilmenite, limonite, and hematite. Iron sand is mainly derived from basaltic and andesitic volcanic rocks [4].

2. Research Methods
The research began by reading journals relating to iron sand, analyzing geological and topographic maps and taking samples. Samples were taken at 5 different locations around the Kinali coast. Sampling
locations are in the coordinates: 1. S004'46.49 "E99046'6.33" 2. S005'8.93 "E99046'2.34", 3. S007'39.40 "E99045'25.60", 4. S008'20.60 "E99044'55.55", 5. S008'39.00 "E99044'55.43".

The samples obtained were placed in a rectangular container then dried with an oven in the Soil Mechanics Laboratory, FT UNP Mining Engineering. Then the increment method is carried out with a 4x4 matrix. 4/16 of each sample was measured for susceptibility with a Bartington MS2 Magnetic Susceptibility Meter, 4/16 for other measurements and 6/16 parts put in a sieve to measure grain size, and 2/16 parts for measuring specific gravity.

3. Results and Analysis

3.1. Iron Sand Genesa
Iron sand is a mineral genesis of the magmatic environment. This magmatic environment is characterized by volcanoes. In the area around the study there is the Talamau volcano. Based on the coordinates of the sampling location, the location is in the Mount Talamau deposit. Sediment in the form of lava deposits with andesite, dacite, basalt and porphyry lithology. The irreducible flow (QTau) in the form of lava and other coluvium deposits, Tuff Batuapung and Andesite (Basal). Andesites from Mt. Talamau (Qat) in the form of lava flows, lava and other coluvium deposits that are not known with certainty their sources are Quaternary or Tertiary age. Andesite and Basal Porfirik (Qvsk). The weathering results of these rocks undergo transportation to become alluvium deposits which are the source of iron sand.
Figure 4. Map of Regional Geology of West Pasaman [5]

Based on the map and observations at the location of the sampling location of the study including the terrain (0 - 3%). Sand deposits along the coast are controlled by Batang Masang River which carries sand material towards the estuary (downstream). Because the wave and wind activity influences the formation of coastal morphology, the sand deposits spread in the direction of the shape of the beach.

Based on the process of forming the coast of Kinali sub-district, including the type of Spit beach. Because this type of beach is very closely related to the sedimentation process. The processes and forms of sedimentation that occur also vary with characteristics that differ from each other. However, the main characteristic of the spit beach is that one end of the beach is connected directly to the mainland. This can be interpreted that the concentration of sedimentation is very large at the tip that is united with the land. In this case the sedimentation is usually in the form of beach sand or some type of material carried by the flow of water.

3.2. Grain size

Measurement of grain size from the sample using a sieve shaker with a sieve size from 4.75 mm to 0.075 mm.

Table 1. Sieve analysis with Shieve Shaker

| Sample | % Slip (Shieve Shaker) |
|--------|------------------------|
| 4.75mm | 2.36 | 1.18 | 0.425 | 0.355 | 0.3 | 0.15mm | 0.125 | 0.075 |
| 1      | 0   | 0.39 | 1.65 | 34.36 | 9.36 | 15.28 | 36.47 | 1.23 | 1.02 |
| 2      | 0   | 0   | 0.07 | 40.50 | 15.79 | 18.04 | 24.66 | 0.63 | 0.29 |
| 3      | 0.35 | 0.52 | 3.03 | 62.92 | 5.99 | 7.45 | 17.33 | 1.25 | 0.93 |
| 4      | 0.27 | 0.28 | 0.75 | 10.97 | 7.09 | 13.00 | 59.74 | 3.77 | 3.58 |
| 5      | 0.16 | 3.32 | 20.61 | 62.36 | 3.34 | 2.57 | 2.62 | 1.43 | 1.74 |

From the table it can be seen that sample 1 of grain size passes at 0.3 mm sieve by 36.47%, sample 2 of grain size passes 1.18 mm by 40.50%, sample 3 grain size passes 1.18 mm by 62.92%, sample 4 of grain size passes by 0.3 mm sieve by 59.74 % and samples of 5 grain sizes that passed 1.18 mm sieve were 62.36%. the samples obtained had a variety of grain sizes, samples 2.3 and 5 had a grain size of 1.18 mm while samples 1 and 4 had a grain size of 0.3 mm.
After getting the iron sand concentrate from iron sand using a magnet, then the magnetic percentage of each sample left in the filter is calculated. The concentrate obtained from magnetic separation is weighed in grams. By comparing the weight of the concentrate and the weight of the sample results of the reduction, the magnetic percentage value is obtained by the formula [4]:

\[ MD = \frac{\text{concrete Weight}}{\text{Weight of Sample reduction results}} \times 100\% \] (1)

The results can be seen in Figure 7.

**Figure 5. Iron sand grain size**

**Figure 6. Grain size vs magnetism**

In this study, the smallest size that can still be passed by iron sand is 0.075 mm (200 mesh) can be seen in sample 4 with a value of 35%. Previous studies [6] in 120 mesh were 81% and Norman in 100 mesh obtained 90.7-93.5% [7].
The grain size of the five samples varies. When viewed from the sampling location, the 5th (five) sample is closer to the Batang Masang river so that it has bigger grains. The process of reducing the size due to transportation and sedimentation is still not running thoroughly. Based on the iron sand genesis, the Batang Masang river originates from Mount Talamau which is a source of andesite and basalt. Space considerations

3.3. Specific Gravity
The specific gravity of iron sand is measured using the pycnometer method.

| No. | Sample | Specific Gravity (SG) |
|-----|--------|-----------------------|
| 1   | 1      | 3.502                 |
| 2   | 2      | 3.390                 |
| 3   | 3      | 2.975                 |
| 4   | 4      | 3.226                 |
| 5   | 5      | 2.891                 |

The specific gravity obtained is in accordance with the criteria of the Geological Agency where iron sand has Specific Gravity 2.99-4.23 [4].

3.4. Magnet susceptibility
The measuring instrument used is the Bartington MS2 Magnetic Susceptibility meter. Measurements were taken at the Physics Laboratory, FMIPA UNP.

| Sampel | Massa (gr) | $\chi_{LF}$ ($x10^{-6}m^3kg^{-1}$) | $\chi_{HF}$ ($x10^{-6}m^3kg^{-1}$) |
|--------|------------|-----------------------------------|-----------------------------------|
|        |            | X1 | X2 | X3 | $\bar{X}$ | X1 | X2 | X3 | $\bar{X}$ |
| 1      | 8,44313    | 499,6 | 496,9 | 496,9 | 497,8 | 403,5 | 495,9 | 494,7 | 494,7 |
| 2      | 9,96894    | 770,0 | 770,0 | 771,1 | 763,2 | 763,2 | 765,1 | 765,2 | 764,5 |
| 3      | 6,63021    | 1041,5 | 1063,3 | 1063,3 | 1025,9 | 1025,9 | 1025,9 | 1025,9 | 1025,9 |
| 4      | 7,50621    | 2647,7 | 2647,7 | 2647,7 | 2644,3 | 2644,3 | 2635,3 | 2640,8 | 2640,1 |
| 5      | 6,45125    | 1501,3 | 1502,9 | 1502,9 | 1494,3 | 1494,3 | 1495 | 1494,6 | 1494,6 |

Based on the results of $\chi_{LF}$ the data above shows the obtained iron sand has a value of $4.947 \times 10^{-6}m^3kg^{-1}$ is a topsoils and ultrabasic rock which is magnetic (superparamagnetic) [8] according to the graph provided by Dearing. The susceptibility of the iron sand obtained is smaller than the research in Sunur Beach, and Masang Pariaman Beach, and Arta Beach [10]. Magnetic susceptibility is the ratio of the induced magnetic field strength in a sample to the given external magnetic field [8]. The susceptibility of the sample 4 (four) is higher because it has a lot of magnetic minerals as evidenced by the greater fraction of the magnetization magnetization on fine grain size.
4. Conclusion

1. Based on the analysis of the geological and topographic maps of the Kinali Pasaman region, the iron sand on the Kinali Pasaman beach originated genetically from Mount Talamau which became alluvium deposits and was transported among them by the Batang Masang river. Kinali Beach is a type of Spit beach and has a slope of 0-3%.
2. The results of measurements of iron sand grains using shieve shakers obtained iron grains of all samples in the range of 0.425mm-0.075mm.
3. The results of the separation of iron sand using magnets obtained the percentage of iron sand that can be drawn by a magnet (iron sand concentrate) on grain sizes 0.425mm-0.075mm about 20% -40%.
4. Specific Gravity measurement results using the Pycnometer method obtained values 2.9-3.5
5. Measurement results using Bartington MS2 Magnetic Susceptibility meters, susceptibility of all samples in the range of 497.8-2644.3 x10^-8m3kg^-1 which shows iron sand is superparamagnetic.
6. Of all the existing samples, sample 4 located at location S008°20.60 'T99044 °55.55" has high susceptibility and has finer granules which has a high magnetization fraction.

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