Eksakta: Berkala Ilmiah Bidang MIPA
VOLUME 22 NO 04 2021, pp 302-310
ISSN : Print 1411-3724 — Online 2549-7464
DOI : https://doi.org/10.24036/eksakta/vol22-iss4/274

Eksakta
Berkala Ilmiah Bidang MIPA
http://www.eksakta.ppj.unp.ac.id/index.php/eksakta

Article

Distribution Pattern of Magnetic Susceptibility Value of Iron Sand on the Surface of Pasia Jambak Beach Pasia Nan Tigo Padang

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Article Info

Article history :

Received May 27, 2021
Revised September 10, 2021
Accepted September 14, 2021
Published December 30, 2021

Keywords :

Magnetic Susceptibility, Iron Sand, Pasia Jambak, Surfer 17

Abstract. Iron sand is a natural resource in Indonesia that can be utilized based on magnetic mineral content (Fe_20_3, Fe_3O_4, $FeTiO_3$), to be processed into materials of high economic value. Iron sand magnetic mineral distribution was analyzed to see potential in Pasia Jambak Beach, Pasia Nan Tigo, Padang, where the iron sand in this area has not been fully utilized by the community and government. The potential of iron sand can be seen usiing Magnetic Method with a magnetic chaaracteristic test in the form of the susceptibility value of iron sand. Magnetic susceptibility value iron sand on the surface of Pasia Pantai Jambak varies betwen 485,2 × 10^{-8} m^3/kg up to 13077 × 10^{-8} with an average 3.306, 37 × 10^{-8} m^3/kg.. The results of the contour map show that high-value magnetic susceptibility values are scattered near the estuary, namely Muaro Anai and Muaro Baru, this is because magnetic minerals (Fe_20_3, Fe_3O_4, $FeTiO_3$) which have high density are more likely to settle near the estuary, then the rest spreads to the coast.

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1. Introduction

Indonesia is a country rich in natural resources which attracts the mining sector. The mining sector has a very important role in people's lives. Almost every community life is influenced by the mining sector, not a few areas whose economies are growing and supported by the mining sector. The mining sector produces mining materials that can be used as raw materials for industry, jewelry, and others. Some of the mining minerals found in Indonesia are gold, coal, limestone, nickel, diamonds, and iron sand [1].

Iron sand is formed due to the activity of volcanic eruptions that cross the coast [2], where volcanic activity affects the distribution of iron through its liquid hydrothermal phase [3]. On the beach there is an estuary which is the meeting point between the river and the sea, causing material in the form of gravel, sand and volcanic ash to be carried away by the water currents. The carried material then undergoes a sedimentation process containing iron sand. Sediment containing iron sand is carried to the surface of the beach and has increased from time to time to produce a large amount of iron sand.

Iron sand is widely scattered along the coast, one of which is on the coast of West Sumatra, namely Pasia Jambak Beach, Pasia Nan Tigo Village, Padang. Pasia Jambak Beach is included in the form of a sloping beach, which consists of dark brown-black sand [4] with the main mineral composition being iron oxide with varying levels of iron in each region [5]. The coastal sediments that make up the Pasia Jambak Beach area mostly consist of beach sand, especially around the estuaries of large rivers which show an active sedimentation process [6]. According to the people around the iron sand at Pasia Jambak Beach, it has not been utilized, this is evidenced by insufficient information or references regarding the potential of iron sand in this area. Even though the beach is scattered so much iron sand can be used by both the community and the government.

The utilization of iron sand is made based on the content of magnetic minerals and iron oxides such as *hematite, magnetite, maghemite* (α–Fe_2O_3, Fe_3O_4, γ-Fe_2O_3). Magnetic minerals contained in iron sand have the potential to be processed into industrial materials [7], one of which is an industry based on magnetic properties as a basic material for making magnets [8][9]. magnetite can also be used in cement-making materials [10], as a toner in photocopier machines and laser printers [11] and maghemite is used as a material for making recording tapes on audio cassettes [7]. Magnetite, hematite, and maghemite are also used as dyes and mixtures filler for paints [12]**.** Even magnetite nanoparticles are used in the biomedical world as a material for cancer therapy [13]. So, a magnetic mineral is a mineral that has high economic value to be utilized.

Of find out that iron sand on Pasia Jambak Beach has the potential to be utilized, then performed the magnetic characteristic test of iron sand, where the characteristic magnetic can be see using magnetisme method [14][15] by using the magnetic susceptibility value measuremeent on the material [16][17]–[19]. Magnetic susceptibility will provide information about the minerals contained in a material [19][20]. The magnetic susceptibility value is then analyzed using a contour map plotted with Surfer 17.

The advantage of Surfer 17 compared to the previous version is that the display feature is equipped with new features in the form of axes, titles, tick marks, which are clearer and easier to understand in making 3D maps and surface modeling. This research includes measuring the magnetic susceptibility value to determine the magnetic characteristics of iron sand in the form of magnetic mineral concentrations using Bartington Magnetic Susceptibility Meter type MS2B. The magnetic susceptibility value is measured using the Bartington Magnetic Susceptibility Meter MS2 model connected to the MS2B sensor. The analysis of the susceptibility value used a contour map plotted with Surfer 17, in order to obtain a distribution pattern of the magnetic susceptibility value of iron sands on the surface of the Pasia Jambak Beach, Pasia Nan Tigo, Padang.

2. Experimental Section

The sampling location in this study is Pasia Jambak Beach, Pasia Nan Tigo Village, which is located north of the center of Padang City, West Sumatra Province. Pasia Nan Tigo is divided into 3 regions, namely Pasia Jambak, Pasia Kandang, and Pasia Sabalah where each is Pasia Jambak located between two estuaries, namely between Muara Anai and Muara Baru. Muara Anai is initiated by the Batang Anai River which crosses four administrative regions in West Sumatra Province, namely Padang City, Padang Pariaman Regency, Tanah Datar Regency, and Padang Panjang City, where the upstream of this river originates from the western part of the Marapi Mountains [21]. Meanwhile, Muara Baru is an artificial estuary made for flood control in the Batang Kandis river [22] and also this new estuary that connects with the Batang Anai river. At Pasia Jambak Beach, there are many tourist attractions, while there are not so many residential areas in this coastal area. The coastal sediments that make up the Pasia Jambak area in Padang City mostly consist of sand, especially those in the area around large river estuaries, which shows an active sedimentation process [6]. Research at Pasia Jambak Beach, Padang City began in January 2020 with sampling carried out in June 2020. The following is a map of the research location of Pasia Jambak Beach, Pasia Nan Tigo, Padang can be Figure 1).

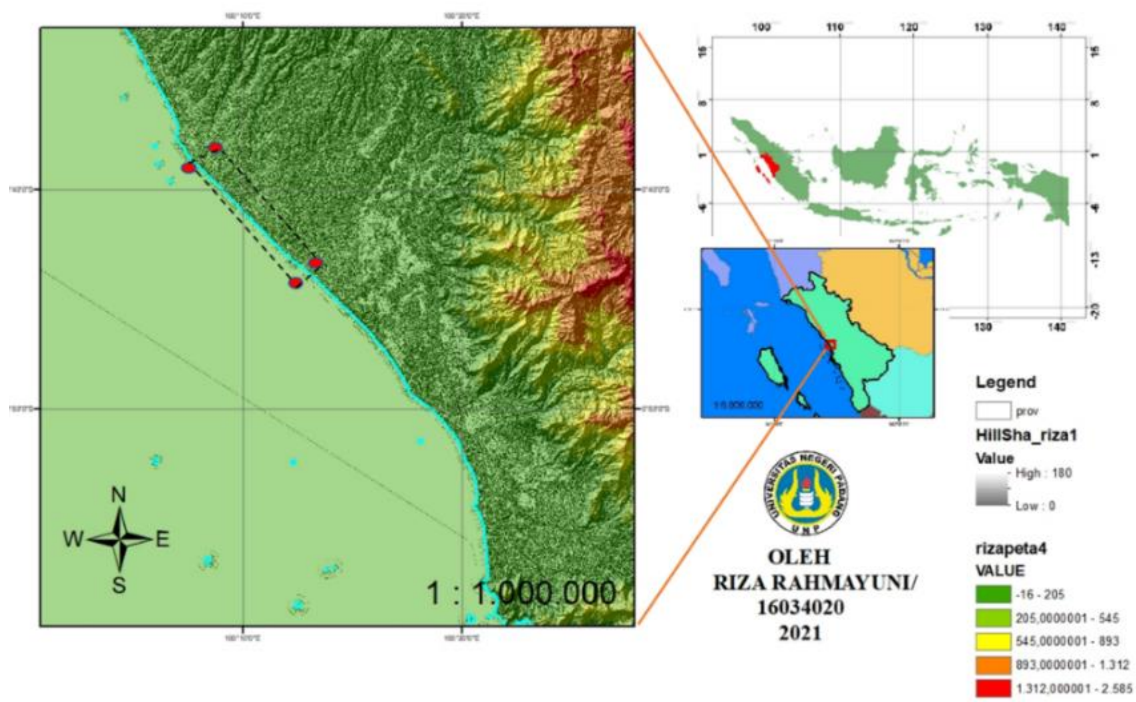

Figure 1. Map of Sampling Location

2.1. Sampling and Sample Preparation

Sampling was carried out on a surface along ±3,5 km which is located between 00º 17.974' LS to 00º 64.961' LS and 100º 19.791 BT to 100º31.850 BT. Sampling consists of two routes where the path that leads to the coast is called path A, while the point that leads to land is called path B. The distance between points A1 to A2, A2 to A3 between paths ±50 m so on, and for the distance A to B ±20 m. After determining the sampling point, then the sample is taken horizontally ±5 cm from the surface of the Pasia Jambak beach. The number of sampling points for line A is 70 points and line B is also 70 points so that the total sampling points as a whole are 140 points.

Samples that have been taken are then taken to the Geophysics Laboratory of the Department of Physics, Padang State University to be continued at the sample preparation stage. Each sample that has been obtained is inserted into four holders with a holder diameter of 2.4 cm and a holder height of 2.3 cm. Previously, the mass of the empty holder has been measured first, to be followed by measuring the mass of the sample that has been inserted into the holder using a *Neraca Ohauss* SN EO271119030112 which has been calibrated first.

2.2. Measurement of Magnetic Susceptibility Value and Contour Map Making

The magnetic susceptibility value of iron sand was measured using the Bartington Magnetic Susceptibility Meter MS2B where the susceptibility value used was low field susceptibility (χ_{lf}). Measurement of the susceptibility value for every three repetitions is useful to see the average value of the magnetic susceptibility of the iron sand. Magnetic susceptibility measurements can provide information on the number of minerals contained in iron sand samples. The results of the measurement of the susceptibility value that has been obtained are entered into the worksheet Microsoft Excel.

Analysis of the distribution of magnetic susceptibility of iron sand using a contour map plotted with Surfer 17. Contours are made based on the value of low field susceptibility (χ_{lf}) and use longitude data and data latitude. In making a contour map, the magnetic susceptibility value used is the average of the susceptibility values from three adjacent points ($X_1=(A1+A2+A3)/3$) and so on. This is done so that the distribution pattern of the resulting magnetic susceptibility value of iron sand is representative of the 140 sampling points. The process of making a contour map is carried out with the stages of plotting data, gridding data, and editing stages. From the contour map, it can be seen the shape of the distribution pattern of magnetic susceptibility values on the surface of Pasia Jambak Beach, Pasia Nan Tigo, Padang (Figure 2).

3. Results and Discussion

Data from the measurement of magnetic susceptibility values were analyzed using contour maps to see the distribution pattern of the magnetic susceptibility value of iron sand at Pasia Jambak Beach, Pasia Nan Tigo Village, Padang. The value of magnetic susceptibility of iron sand Pasia Beach Jambak varied between 485,2 × 10^{-8} m^3/kg to 13.077 × 10^{-8} m^3/kg with an average value of 3.306,37 × 10^{-8} m^3/kg (Table 1).

Table 1. Summary of Measurement Results of the Magnetic Susceptibility Value of Iron Sand at Pasia Jambak Beach, Padang.

No	POINT	N	POSITION	LOW FIELD SUSCEPTIBILITY (χ_{lf}) (x 10^{-8} m^3/Kg)				FDS (%)	
				MAX	MIN	Average	Overal Average	MAX	MIN
1	A	7	-0,817974.100,291979	10706,86	485.2	3485.84	3306.37	5.40	0.007
2	B	7	-0,817655.100,292132	13.077	745.9	3126.91		2.76	0.106

Where the value of magnetic susceptibility (χ_{lf}) in lintasan A varied between 485.2 × 10^{-8} m^3/Kg to 10706.86 × 10^{-8} m^3/Kg, while in lintasan B between 745.9 × 10^{-8} m^3/Kg up to 13.077 x$10^{-8}$$m^3$/Kg. Where the magnetic susceptibility value (χ_{lf}) is on lintasan B namely at point B55 with sample code Pnt20-S-0617-B55, while the lowest magnetic susceptibility value is found on lintasan A point A65 with sample code Pnt20-S-0617-A65. Based on the average magnetic susceptibility value (χ_{lf}) it can be seen that lintasan A lintasan B, meaning that on lintasan A there are more magnetic susceptibility values above the average compared to lintasan B. According to Erwin (2020), the increase in the value of magnetic susceptibility towards seawater occurs due to the movement of sand due to the flow or movement of seawater around the shore.

The results of measuring the magnetic susceptibility value of low field susceptibility (χlf) were analyzed using a contour map to further clarify the distribution pattern of the magnetic susceptibility value on the surface of Pasia Jambak Beach, Pasia Nan Tigo Village, Padang City. The distribution pattern of magnetic susceptibility values is shown in the form of color variations, ranging from green to red (Figure 2). Color variations show the highest susceptibility value marked in red and the lowest susceptibility value marked in blue. The blue color represents the value range 500 × 10^{-8} m^3/kg to 3,500 x 10^{-8} m^3/kg, yellow color 3,500 × 10^{-8} m^3/kg to 6,000 × 10^{-8} m^3/kg and, red color 6,000 × 10^{-8} m^3/kg hingga 9,500 × 10^{-8} m^3/kg. The following is a countour map of the magnetic susceptibility value of Pasia Jambak Beach, Padang (Figure 2).

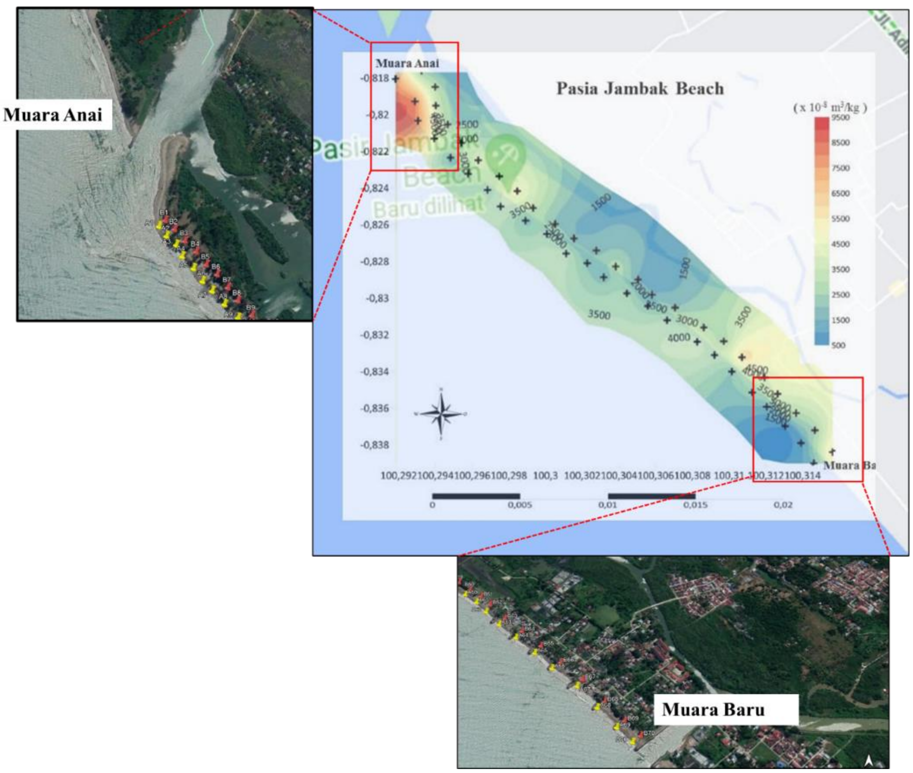

Figure 2. Distribution Pattern of Low Field Magnetic Susceptibility Value at Pasia Jambak Beach Padang.

The highest value of magnetic susceptibility (13077 x 10^{-8} m^3/kg) at a point B55 (Pnt20-S-0617-B55) distance $\pm$750 to the Muaro Baru. The distribution of magnetic susceptibility values that have high value at a point A1 to A2 (Figure 3) which is marked in red on the map contour with a range of 6.000 x 10^{-8} m^3/kg – 10.000 x 10^{-8} m^3/kg. Susceptibility value at the point A1 (Pnt20-S-0617-A1) 9837.26 x 10^{-8} m^3/kg, where point A1 is the first point of sampling near Muaro Anai, point A3 (kode sampel Pnt20-S-0617-A3) with a value of 10073.2 x 10^{-8} m^3/kg, the point A4 (sample code Pnt20-S-0617-A4) with a value of magnetic susceptibility 10706.86 x 10^{-8} m^3/kg and the point A7 (sample code Pnt20-S-0617-A7) with the value of magnetic susceptibility 10186.9 x 10^{-8} m^3/kg, where this point is also close to Muaro Anai Pasia Nan Tigo Beach, Padang.

In the middle of Pasia Jambak Beach, the magnetic susceptibility value obtained has a magnetic susceptibility value of 500 x 10^{-8} m^3/kg to 5,000 x 10^{-8} m^3/kg which is in the green and yellow color range on the contour map. As for the part which is close to the estuary has a range of high value 6.000 x 10^{-8} m^3/kg – 9.000 x 10^{-8} m^3/kg. This shows that the magnetic mineral iron sand from the estuary spreads to the left and right, then the magnetic minerals which have a large mass mostly settle in the areas that are close to the estuary and then spread to the middle of the beach. For more details, the following graph of the relationship between the density (ρ) of iron sand and susceptibility value low field can be seen in Figure 3.

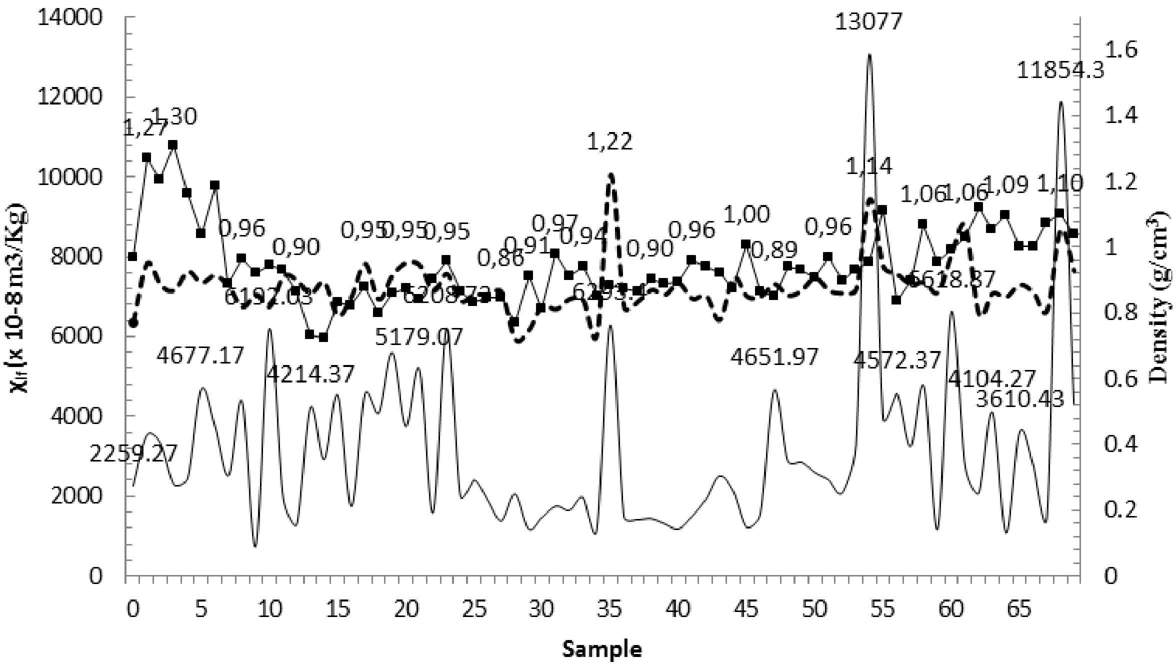

Figure 3. The graph of Low Field Susceptibility (χ_{lf}) vs Density (ρ) of Iron sand Pasia Jambak Beach, Padang.

Based on Figure 3, the Graph of Low Field Susceptibility (*χlf*) and Density (*ρ*) has a comparable curve where it can be seen that the Low Field Susceptibility value is high at points close to the estuary, where the density of iron sand is dominant, it is also close to the estuary, namely Muaro Anai and Muaro Baru, it has increased, while in the coastal area or the area in the middle there is a downward curve, this is due to the low value of magnetic susceptibility in the coastal area. According to Purnawan (2018), where the weak currents in the area near the estuary allow deposition of magnetic mineral grains such as (Fe_20_3, Fe_3O_4, $FeTiO_3$) which have a high density [16].

According to Purnawan (2018), the estuary is a fairly good depositional environment for magnetic minerals that have high density [20]. His is the same as the density condition in the iron sand of Pasia Jambak Beach, Padang City, where the high density is more dominant at the points located in the estuary. This has something to do with the process of forming iron sand, where the material released by volcanoes that flows through rivers and undergoes a sedimentation process at the mouth causes the iron sand material to settle more in the area near the estuary and then spread to other coastal surfaces.

The magnetic mineral iron sand that has accumulated a lot in the estuary and beaches can also come from the weathering process of the rocks that are in the upstream or oxygenic areas [16]. The process of deposition of oxygenic material from land generally occurs horizontally and vertically, which plays a role in this process is river currents that carry the material from the upstream dry and spread along the coast through the dynamic of the coast based on the process dynamic forcing [16]. In several areas in Indonesia, iron sand is found in line with regional conditions related to the existence of volcanoes [17], and also because many rivers in Indonesia are in volcanic areas [18].

The amount of sediment on the coast is caused by the material carried by the river to the estuary, causing some areas which are river estuaries to have a large sediment transport value, while in coastal areas, the density of iron sand is found which is dominantly low. According to Purnawan (2018) this occurs because the interaction between the aquaria and the sea allows magnetic mineral grains to be transported to the coastal area, namely through the river runoff process or during the movement of tidal currents [18-20].

Based on the value of magnetic susceptibility of iron sand Padang Beach Jambak Pasia, it can be said that the sample contained within the mineral Ilmenite ($FeTiO_3$) that is 46×10^{-8} m^3/kg up to $80{,}000 \times 10^{-8}$ m^3/kg and Hematite (α–Fe_2O_3) is 0 to 760×10^{-8} m^3/kg (based on Table Hunt, 1991) [19]. Dari profil nilai suseptibilitas magnetik (Tabel 1). From the profile of the magnetic susceptibility value (Table 1). When compared with the value of magnetic susceptibility of iron sand Sunur Beach Padang Pariaman) which has a range of values of magnetic susceptibility of iron sand 333.65×10^{-8} m^3/kg up 2883×10^{-8} m^3/kg [20], Pasia Jambak Beach has a fairly high range of susceptibility values.

4. Conclusion

Based on the results of magnetic susceptibility values of iron sands on the surface Pasia Beach Jambak varied between 485.2×10^{-8} m^3/kg to $13{,}077 \times 10^{-8}$ with an average of 3306.37×10^{-8} m^3/kg. The results of the contour map showed that high-value magnetic susceptibility values were scattered near Muara Anai and near Muara Baru, this was because magnetic minerals (Fe_20_3, Fe_3O_4, $FeTiO_3$) which had a high density were more likely to settle in the part near the estuary than the remaining low-density magnetic minerals spread out to the shore.

5. Acknowledgement

The author gives as much appreciation to UNP Research and Service Institute for funding the SKIM for Applied Research through Contract Number 1617/ UN35.13/ LT/ 2020.

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