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Evaluation of Pumice Source from Lubuk Basung Based on Magnetic Susceptibility Values

Mutiara Kusuma Febriwanti, Hamdi*, Ahmad Fauzi, Syafriani, Rahmi Hidayatul Lisma
Department of Physics, Universitas Negeri Padang, Padang 25131, Indonesia

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Corresponding Author
*Author Name: Hamdi
Email: rifai.hamdi@fmipa.unp.ac.id

Abstract: Lubuk Basung is one of the distribution areas of pyroclastic material from the Maninjau Caldera eruption that occurred 50,000 years ago and produced two different types of white pumice. The research purpose is to reveal whether the pumice samples taken from Lubuk Basung come from the same eruption or not based on the magnetic susceptibility of pumice. Magnetic susceptibility values can be measured using the Rock Magnetic Method with a Bartington Magnetic Susceptibility Meter Type B. The obtained susceptibility values were analyzed using IBM SPSS Statistics software version 27.0.1 to perform normality tests, homogeneity tests, and mean similarity tests for two different samples. In the LBS 23-02 sample, a susceptibility of magnetic range of 41.9 x 10^{-8} m^3/kg to 582.2 x 10^{-8} m^3/kg was obtained, and the LBS 23-03 DB sample obtained a magnetic susceptibility value of 42.9 x 10^{-8} m^3/kg to 535.5 x 10^{-8} m^3/kg. From the normality, homogeneity, and mean similarity test, it is known that the LBS 23-02 and LBS 23-03 DB samples come from a population that is not distributed normally and not homogeneous, but an average comparison is obtained with a score of significance at 0.0426, which can be concluded that the two pumice samples found in Lubuk Basung come from the same eruption source, although each sample has different types and characteristics.

Keywords: Magnetic Susceptibility; Mean Similarity Test; Pumice; Rock Magnetic Method

1. Introduction

West Sumatra is one of the regions in Indonesia with a strong volcanic history. West Sumatra is located in the Bukit Barisan mountain range that stretches across the centre of the island of Sumatra. This area is on the border of the continental plate and the oceanic plate whose movement causes magma to rise to the surface of the earth which produces several volcanoes that are still active and some of them are inactive. In the Padang Pariaman Regency area there is one active volcano, Mount Tandikek, the volcano is adjacent to Mount Singgalang which is dormant, besides that there are also old tertiary volcanic mountains such as Mount Maninjau Purba which is one of

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the mountains of Bukit Barisan range. About 50,000 years ago, there was a major eruption that resulted in the formation of the Maninjau Caldera. At least 220-250 km^3 of volcanic material were produced during the eruption, and they were dispersed up to 75 km away from the site of eruption.

The Mount Maninjau eruption was preceded by the unloading of the plugs, the eruption is thought to have had a modest eruption column. Then, the collapse of the eruption column slid through the upper slopes of the volcano and formed turbulent currents, this process produced base surge deposits which were then followed by the deposition of ignimbrites. Ignimbrites are rocks or deposits composed of pyroclastic flows that are dominantly pumice [1]. All the rocks of the Maninjau Volcano (Maninjau Andesite) are entirely covered by pumice tuff, these tuff deposits are probably the result of the last eruption of the Maninjau Caldera. Pyroclastic material from the Maninjau Caldera eruption is scattered in the Ngarai Sianok area, Lubuk Basung, Tiku area, around Palembayan, and around Sicincin.

To characterise the Maninjau ignimbrites both vertically and horizontally. In the well exposed proximal zone deposits along the Bukittinggi - Maninjau road, charcoal remains and traces of gas/vapour flow from post-deposition hot cloud deposits were seen. With the charcoal remains found in several layers, absolute dating can be done using the Radiocarbon method. The results of Radiocarbon analysis gave a number greater than 40,000 years. The results of the dating are considered the age of the Maninjau ignimbrite deposits and are reinforced by the results of the correlation of statigraphic sequences in the field, which cover the youngest Toba tuff unit which is 74,000 years old [2].

The Maninjau Caldera eruption maked two different types of pumice or white pumice, Translucent Pumice (TWP) and Non-Translucent Pumice (NTWP). TWP is usually fragile, amorphous in form, and the vesicle walls have transparent glass properties due to large vesicles that are easily visible, while NTWP is blocky in shape, rather robust, and the walls of the vesicles exhibit non-transparent glass qualities because of the tiny, invisible vesicles [3]. Generally speaking, pumice or volcanic eruption material contains a number of vital minerals, such as Silicon (Si), Aluminium (Al), Iron (Fe), Calcium (Ca), Magnesium (Mg), Sodium (Na), and Potassium (K). Pumice also includes minerals that are magnetic, consists of ilmenite ($FeTiO_3$) and magnetite (Fe_3O_4) [4]. Based on the results of XRF characterisation, the composition of pumice stone is SiO_2 by 58.3%, Al_2O_3 by 12%, K_2O by 7.73%, CaO by 6.75%, TiO_2 by 1.45%, MnO by 0.42%, and Fe_2O_3 by 12.4% [5].

To find out the abundance of magnetic minerals in volcanic materials can use the rock magnetism method. The rock magnetism method is a geophysical technique that relies on measuring variations in the magnetic field. This method is characterized by its ease of use, relatively high measurement accuracy, cost-effectiveness, and rapid result acquisition. This method has measurable rock magnetic parameters such as magnetic susceptibility. The magnetic susceptibility parameter is a parameter that the Bartington Magnetic Susceptibility Meter sensor type B (MS2B) equipment uses to determine the quantity of magnetic minerals present in the sample to be examined. The susceptibility of magnetic scores magnitude is dependent on the quantity of magnetic minerals present the more magnetic minerals there are in a material, the higher the susceptibility score [6]. Rock magnetism methods have been widely used to study the identification, like determining the types of rocks from iron sand at Pasia Jambak Beach, Padang, West Sumatra [7], Identification of Elemental Content and Rock Types in West Lampung Regency [8], and many other studies.

Many studies on volcanic materials have been done on the island of Sumatra, such as research on the distribution pattern of volcanic materials in Lake Maninjau [9], susceptibility of magnetic from pre- and post- caldera lavas through Maninjau, west sumatera [10], susceptibility of magnetic from pumice at Mount Singgalang, West Sumatra [11], analysis of the relationship between rare earth elements and magnetic mineral concentrations in pumice around Sigura-gura [12] and the development of white pumice that is both transparent and opaque: An analysis of the Indonesian 52 Ka Maninjau caldera [3]. With the discovery of two types of white pumice in the eruption of the Maninjau caldera, namely Translucent Pumice (TWP) and Non-Translucent Pumice (NTWP) in previous studies, research can be carried out to examine the susceptibility value of pumice samples from Lubuk Basung which is one of the distribution areas of volcanic material from the eruption of Maninjau caldera, then analysed using the mean similarity test to see whether the two samples have a significant average value or not, which means that the two samples are likely to come from the same eruption source or not. Before conducting the mean similarity test, normality and homogeneity tests were done on the samples. A normality test is done to reveals if two samples originate from a population with a normal distribution. Verifying the assumption of normality is essential for deciding whether to apply a parametric or non-parametric test. The literature offers various methods for assessing normality [13]. Then the variance homogeneity test is carried out to reveal whether the data from the two samples come from a population that has a homogeneous variance or not. If two or more data groups share the similar variance, there is no need to conduct a homogeneity test, as the data is already deemed homogeneous. Homogeneity tests are applicable when the data groups follow a normal distribution. These tests are used to confirm that the differences observed in parametric statistical tests are not statistically significant [14].

2. Materials and Method

Lubuk Basung is located in Agam Regency, West Sumatra, and has interesting geological features due to its location on the Pacific Ring of Fire. Lubuk Basung has a hilly and mountainous topography with some higher and steeper areas. The area is dominated by volcanic and sedimentary rocks, with various geological formations that reflect past volcanic activity. These rock formations include andesite, basalt and sedimentary rocks. Based on the Geological Map of Padang Sheet, Sumatra [15], this area is included in the pyroclastic material distribution area from the Maninjau Caldera eruption, which is characterised by the discovery of pumice tuff deposits that overlay all Maninjau rocks. Therefore, sampling was conducted in the Lubuk Basung area, which is part of the pyroclastic material distribution area. Figure 1 shows the sampling location.

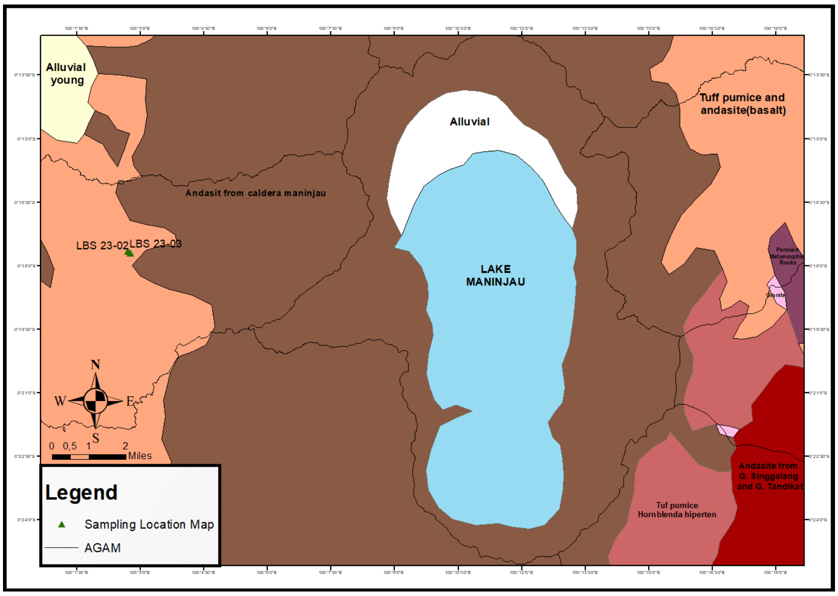

Figure 1. Sampling location map

Determining the coordinates of the location of sampling is the first process in the procedure for sampling. Samples were got at coordinates S0˚17.700' E100˚2.760' and S0˚17.670' E100˚2.700' in September 2023. This sample was taken from a cliff with a height of 7 and 13 meters from the ground. The samples were taken using a hammer and put into labeled plastic samples. The sample name is ascertained using the date and sample number. The individual preparing the sample will be cleaning it using distilled water. After that, it is dried and mashed using a mortar and then put into the holder. Next, using a digital balance, determine the empty holder mass, add the sample, mark it with the sample name, and then determine the holder's mass while the sample is inside (Ohauss Balance SN E0271119030112). After all samples were weighed, using the Bartington Magnetic Susceptibility Meter Type B (MS2B), There were two distinct frequencies used for the magnetic susceptibility measurements: low frequency and high frequency. The measurement ratio at both frequencies refers to the magnetic susceptibility level obtained from the Equation (1) [16]:

$$\%\ \chi_{fd} = \frac{\chi lf - \chi hf}{\chi lf} \times 100\% \qquad (1)$$

Where, χ_{lf} is the susceptibility value at lack frequency and χ_{hf} is the susceptibility value at big frequency. The magnetic susceptibility value obtained can be used to determine the magnetism of the sample. Then, the frequency-dependent susceptibility value (χ_{fd}) (%) of magnetic mineral grains can be determined [17].

From the magnetic susceptibility values obtained, an average similarity test was done using IBM SPSS Statistics software version 27.0.1. Before conducting the mean similarity test, a normality test is first carried out, this looks to reveal if the sample is representative of a population that is regularly distributed. The ability to examine data graphing is necessary for normality testing. The findings reached are probably incorrect if there is sufficient data and the distribution is not 100% normal, or absolutely normal. Experts have created a variety of methods these days to check for normality. Among these are the Lilliefors Test and the Test of Kolmogorov-Smirnov. Normality test with Lilliefors test is a non-parametric normality. The test of Lilliefors is also a refinement of the Kolmogrov-Smirnov formula so that its nature is simplified. The hypothesis formulation for this normality test is H_0: $f(x)$ is normal and H_1: $f(x) \neq$ normal [18].

To test the hypothesis, steps are taken by determining the mean and data standard deviation. The z-value is revealed through the Equation (2):

$$z\ skor = \frac{x - \bar{x}}{\sigma} \tag{2}$$

Where $\bar{x}$ is mean and σ is standard deviation. Where the standard deviation is obtained from Equation (3):

$$\sigma = \sqrt{\frac{\sum(x1 - \bar{x})^2}{n - 1}} \tag{3}$$

After that, the test of homogeneity purposes to see whether the two samples have variants in homogeneous or not. The homogeneity test of variance is very simple because it is enough to compare the largest variance with the smallest variance with the hypothesis of H_0: $f(x)$ is homogeneous and H_1: $f(x) \neq$ homogeneous [18].

The statistics used to test the H_0 hypothesis are Equation (4):

$$f = \frac{largest\ variance}{smallest\ variamce} \tag{4}$$

Test statistics can adhere to an extensive range of theoretical distributions, the form of which can change depending on the sample size and degrees of freedom. One way to conceptualize the degrees of freedom is as the bare minimum of data needed to regenerate the sample distribution.

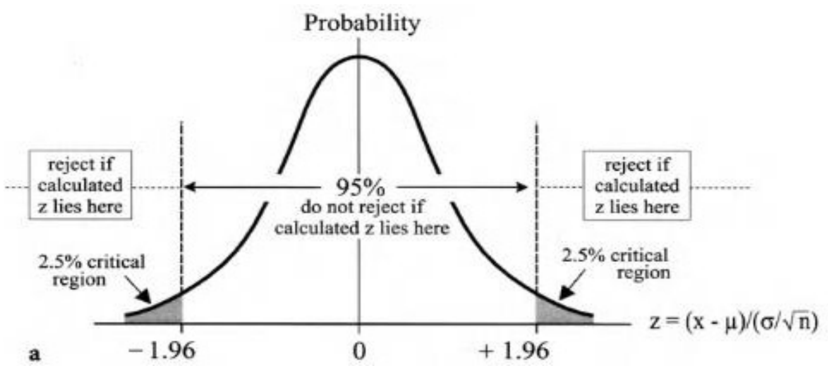

Figure 3. The standard normal distribution shows the two-sided rejection region with 95% confidence (a=0.05); the shaded area is rejected because the values lie further from 1.96σ and from the mean [19]

The 95% confidence level rejects the hypothesis that z = 0 if the z-value derived from the data falls inside the critical and darkened zone (Figure 3). If the data's computed z-value is in the unshaded area, then the hypothesis is not rejected that z = 0 with 95% confidence [19]. After doing the normality test and homogeneity test, there are several possibilities, such as:

If it is obtained that both samples are normally distributed and have homogeneous variances, so the test statistic used in the test of hypothesis is the t test can be seen in Equation (5):

$$t = \frac{\overline{x_1} - \overline{x_2}}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \tag{5}$$

And Equation (6):

$$S = \sqrt{\frac{(n_1 - 1)S_1{}^2 + (n_2 - 1)S_2{}^2}{n_1 + n_2 - 2}} \tag{6}$$

Where $\overline{x_1}$ is mean score of sample A, $\overline{x_2}$ is mean score of sample B, S_1 is standard deviation of sample A, S_2 is standard deviation of sample B, S is combined standard deviation, n_1 is number of samples A and n_2= number of samples B.

If it is found that both samples are normally distributed and have inhomogeneous variances, the test statistic used in test of hypothesis is the t' test can be seen in Equation (7):

$$t' = \frac{\overline{x_1} - \bar{x}}{\sqrt{(S_1{}^2/n_1) + (S_2{}^2/n_2)}} \tag{7}$$

If the sample is not distributed in normally and has an inhomogeneous variance, the test statistic used in the hypothesis test is the U test can be seen in Equation (8) [20]:

$$U_1 = n_1 + n_2 + \frac{n_1(n_1 + 1)}{2} - \sum R_1 \tag{8}$$

And Equation (9):

$$U_2 = n_1 + n_2 + \frac{n_2(n_2 + 1)}{2} - \sum R_2 \tag{9}$$

The hypothesis formulation for the mean similarity test is as follows H_0 is the two samples come from the same eruption source and H_1 is the two samples are from different eruption sources [21]. With the test criteria using a significance level of 5% namely, when the score of significance (Sig.) ≥ 0.05 then H_0 is accepted and when score of significance (Sig.) < 0.05 the results known as H_0 is not accepted.

3. Results and Discussion

At the sampling location (Figure 1), pumice samples were found that have different characteristics. Differences in pumice characteristics can be caused by cooling processes, erosion, and transport processes that can change shape and size and affect physical characteristics. The pumice samples obtained at the locations for sampling are shown in Figure 2.

Figure 2. Sampling pumice (a) Densed banded pumice (b) Mixed transparent pumice

The pumice samples from Lubuk Basung show diverse characteristics. Figure 2(a) shows densed banded pumice with higher density, heavier mass, and clear banding patterns. Figure 2(b) shows transparent mixed pumice, which is smoother, lighter, and less porous. The samples are labeled by location, year, month of collection, and type of pumice. The first sample was named LBS 23-02 ("LBS" for Lubuk Basung, "23" for year 2023, and "02" for February). The second sample was named LBS 23-03 DB ("LBS" for Lubuk Basung, "23" for 2023, "03" for March, and "DB" for Densed Banded). The susceptibility of magnetic scores of the samples were then measured, and the findings can be shown in Table 1 and Table 2.

Table 1. Magnetic susceptibility value of the samples LBS 23-02

Name sample	Magnetic Susceptibility ($10^{-8}m^3/kg$)								
	Low Field (χ_{lf})			High Field (χ_{hf})			χ_{fd} (%)		
	1-15	16-30	31-43	1-15	16-30	31-43	1-15	16-30	31-43
LBS 23-02	536.2	443.5	370.6	530.5	437.4	366.6	1.1	1.4	1.1
	131.2	539.9	45.6	130.3	535.3	45.6	0.7	0.9	0.0
	476.2	125.7	41.9	473.8	124.3	41.5	0.5	1.1	1.0
	462.1	582.2	266.0	458.6	571.7	263.5	0.8	1.8	0.9
	127.5	576.8	60.2	88.5	569.8	59.3	0.6	1.2	1.5
	62.5	145.7	67.8	60.0	145.4	67.6	4.0	0.2	0.3
	144.2	47.0	57.6	142.9	46.4	56.5	0.9	1.3	1.9
	549.2	65.9	71.6	547.4	64.3	71.2	0.3	1.8	0.6
	536.8	486.2	42.1	534.1	482.2	42.0	0.5	0.8	0.2
	483.4	337.1	53.8	480.0	335.0	53.4	0.7	0.6	0.7
	536.8	57.7	43.9	532.0	56.3	43.7	0.9	2.4	0.5
	514.2	311.2	66.0	510.4	306.9	65.3	0.7	1.4	1.1
	538.7	87.1	82.8	536.8	85.5	82.4	0.4	1.8	0.5
	510.3	71.9		507.6	70.7		0.5	1.7	
	541.0	85.3		537.3	83.6		0.7	2.0	
χ_{Min}	41.9			41.5			0		
χ_{Max}	582.2			571.7			2.4		
$\chi_{Average}$	264.7			261.5			1.0		

Table 1 presents measurements of samples LBS 23-02. Pumice with the χ_{lf} largest scores is found in sample LBS 23-02-19 (582.2 x 10^{-8} m^3/kg), while pumice with the χ_{lf} smallest value is found in sample LBS 23-02-33 (41.9 x 10^{-8} m^3/kg) with a score of mean at (264.7 x 10^{-8} m^3/kg). The largest χ_{fd} (%) scores is found in sample LBS 23-02-26 (2.4 %) and the smallest percentage χ_{fd} (%) value is found in sample LBS 23-02-32 (0 %) with an average value of 1.0 %.

Table 2. Magnetic susceptibility value of the samples LBS 23-03 DB

Name sample	Magnetic Susceptibility ($10^{-8}m^3$/kg)								
	Low Field (χ_{lf})			High Field (χ_{hf})			χ_{fd} (%)		
	1-15	16-30	31-41	1-15	16-30	31-41	1-15	16-30	31-41
LBS 23-03 DB	96.7	260.1	379.8	96.4	258.1	375.4	0.3	0.8	1.2
	137.6	42.9	128.1	136.9	42.3	126.9	0.5	1.4	0.9
	96.8	72.1	64.3	96.4	71.1	62.9	0.4	1.3	2.2
	118.5	283.0	72.4	115.3	280.2	70.2	2.7	1.0	3.0
	122.5	264.9	533.8	122.2	263.2	530.9	0.2	0.6	0.5
	150.6	264.2	61.4	149.1	261.7	60.5	1.0	1.0	1.5
	228.3	520.8	360.5	227.2	516.6	355.6	0.5	0.8	1.4
	74.9	276.8	73.4	74.3	274.4	69.6	0.8	0.9	5.2
	54.0	267.1	63.3	53.0	263.6	63.3	1.9	1.3	0.0
	269.2	508.0	379.0	266.1	503.3	375.0	1.2	0.9	1.8
	63.6	43.7	535.5	60.9	43.7	533.0	4.3	0.0	0.5
	43.9	167.5		43.7	166.8		0.5	0.4	
	278.5	71.0		275.8	70.4		1.2	0.9	
	260.2	68.1		256.6	67.5		1.4	0.9	
	267.2	353.3		265.0	348.9		0.8	1.3	
χ_{Min}		42.9			42.3			0	
χ_{Max}		535.5			533.0			5.2	
$\chi_{Average}$		204.3			202.3			1.2	

Base on Table 2, samples LBS 23-03 DB pumice, the sample which has the greatest susceptibility value LBS 23-03-41 DB with a value of χ_{lf} (535.5 x 10^{-8} m^3/kg) and the sample that has the lowest susceptibility value is sample LBS 23-03-17 DB with the score of χ_{lf} (42.9 x 10^{-8} m^3/kg) and value χ_{lf} average (204.3 x 10^{-8} m^3/kg). With the score of χ_{fd} (%) the highest is 5.2 % which is found at LBS 23-03-38 DB sample, while the lower value is 0 % which is found in the LBS 23-03-39 DB sample, with an average value of 1.2 %.

The results of the measurements on the 2 samples show that changes in the magnetic susceptibility value in each sample indicate that the sample contains a variety of magnetic minerals with a range that is far enough. The susceptibility value obtained is almost the same as Susceptibility of Magnetic from Volcanic Soil on the Mount Singgalang Surface, Sumatra Barat through the score range of 93.3 x 10^{-8} m^3/kg – 352.5 x 10^{-8} m^3/kg according n the score, the magnetic mineral properties are thought to be antiferromagnetic. The χ_{fd} (%) ranges from 0.831 – 2.090 %. The content and type of these minerals can vary depending on the volcanic process and the environment in which the material formed [22]. The existence of a range of high or low susceptibility of magnetic scores can be caused by differences in the total distribution of magnetic minerals found in the sample as well as environmental conditions in the sampling area and the addition of anthropogenic materials, such as non-magnetic elements [23]. The difference in magnetic susceptibility values obtained is then plotted and shown in Figure 4.

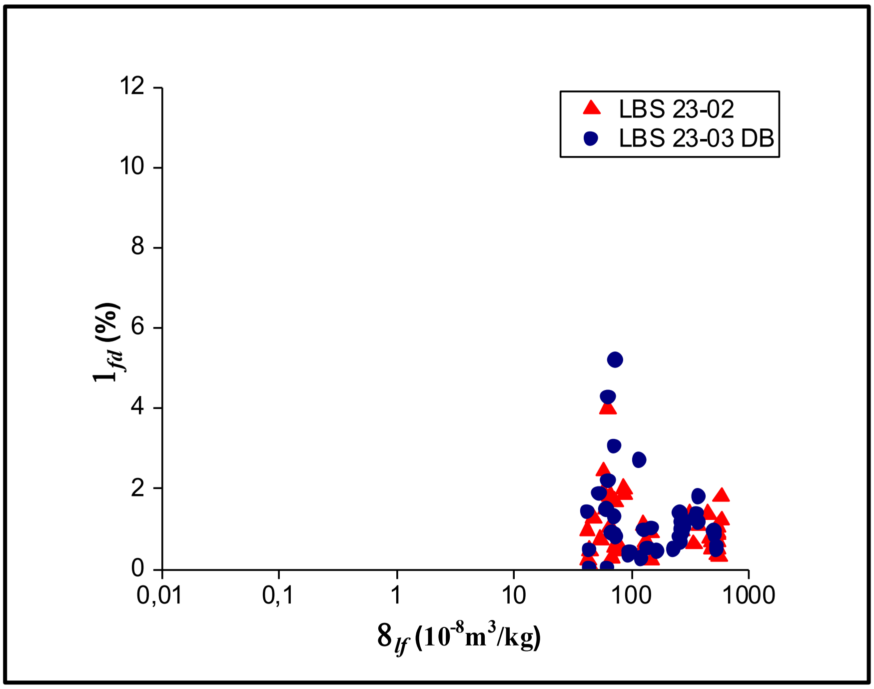

Figure 4. Plot of relationship from susceptibility of Low field (χ_{lf}) and Susceptibility of Frequency Dependent (χ_{fd})

The difference from the χ_{lf} value and the χ_{fd} (%) value in all samples is not too far away (Figure 4). On sample LBS 23-02 the red color can be obtained range of magnetic susceptibility varying from (41.9×10^{-8} m^3/kg to $582.2 \times 10^{-8}$$m^3$/kg) and sample LBS 23-03 DB blue color, results for magnetic susceptibility varying from (42.9×10^{-8} m^3/kg to 535.5×10^{-8} m^3/kg). From different susceptibility scores, the type of superparamagnetic grains obtained. The grain size of volcanic material is inversely proportional to the magnetic susceptibility value, the smaller the grain size, the greater the susceptibility value, this is caused by the reduction of the impector in volcanic material [9]. The difference in magnetic mineral content in each sample is due to differences in properties of magnetic and various kinds from minerals of magnetic contained in each sample [24].

From the susceptibility of magnetic values obtained, the test of normality, homogeneity and test of two mean similarity were then conducted, which shown in Table 3, Table 4 and Table 5.

Table 3. Normality test result of samples LBS 23-02 and LBS 23-03 DB

Tests of Normality						
Nama Sample	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
LBS 23-02	.246	43	.000	.796	43	.000
LBS 23-03 DB	.159	41	.011	.869	41	.000

Normality can be tested by several methods, including the tests of Kolmogorov-Smirnov and Shapiro-Wilk. The test of Kolmogorov-Smirnov is utilized while the sample size is large while the test of Shapiro-Wilk is utilized while the sample size is small [25]. From the test of normality results using the Shapiro-Wilk way Table 3. the significance scores of the LBS 23-02 sample is 0.000 and the LBS 23-03 DB sample is 0.000. These values are smaller than 0.05 so it can be said that the LBS 23-02 and LBD 23-03 DB samples come through a population that is distributed in not normally. The normality curve shown in Figure 5.

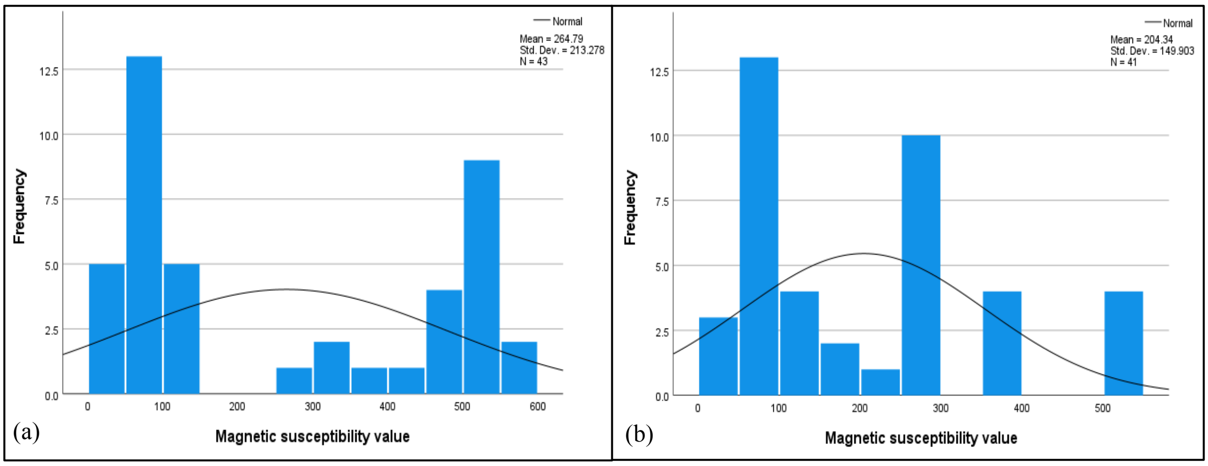

Figure 5. Normality histogram of samples (a) LBS 23-02 (b) LBS 23-03 DB

The shape of the histogram can also be used to see if it looks normal or not, decisions made using the histogram will be subjective [25]. The histogram is away from the probability region (0.05) with standard deviation values of 213.3 (Figure 5a) and 149.9 (Figure 5b). So it can be concluded that the normality value is in the rejection region of the distribution. Based on the criteria chosen to check normality, it was decided to use a non-parametric test.

Table 4. Homogenity test results of samples LBS 23-02 with LBS 23-03 DB

Tests of Homogenity of Variances				
	Levene Statistic	df1	df2	Sig.
Based on Mean	21.563	1	82	.000
Based on Median	5.882	1	82	.017
Based on Median and with adjusted df	5.882	1	70.569	.018
Based on trimmed mean	20.886	1	82	.000

From the homogeneity of variance test results Table 4. a scores of significant of 0.000 was obtained. This scores is under 0.05, so the conclusion that the sample data of LBS 23-02 and LBS 23-03 DB have inhomogeneous variances. Because the data is distributed in not normally and inhomogeneous, the U test or test of Mann-Whitney is performed. The test of Mann-Whitney is one of the nonparametric tests used to determine the difference between two data but not normally distributed [26].

Table 5. The means of similarity test results

Test Statistics[a]	
Mann-Whitney U	792.500
Wilcoxon W	1653.500
Z	-.797
Asymp. Sig. (2-tailed)	.426

After obtaining the Mann-Whitney way test final results Table 5. the initial hypothesis H_0 = no difference. The reference used for decision making is if the Asymp. Sig (2-tailed) or significance scores is smaller than the probability of 0.05, then the initial hypothesis (H_0) is not accepted. However, if Asymp. Sig (2-tailed) or the scores in significance is greater than the probability of 0.05, then the initial hypothesis (H_0) is accepted [27]. The results of testing the similarity of the means using the Mann-Whitney method obtained an Asymp. Sig (2-tailed) 0.426 which is greater than the probability of 0.05, so H_0 is accepted. Thus, the conclusion that the samples of LBS 23-02 and LBS 23-03 DB came from the same eruption source.

4. Conclusion

Prior to the evaluation, the pumice from Lubuk Basung was identified as volcanic material with the source of origin still requiring further research. Measurements using a Bartington Magnetic Susceptibility Meter type B (MS2B) showed that the magnetic susceptibility values of these pumice have significant variations with a considerable range of values. Based on the measurement results, it is known that both samples get from populations that are distributed in not normal and have different variations (not homogeneous). However, the results of the mean similarity test using the Mann-Whitney method show that the differences between the two samples are not significant or have fairly similar averages. After the evaluation, it can be concluded that both pumice samples from Lubuk Basung originated from the same source, namely the eruption of the Mount Maninjau Purba. Despite this, the two samples still show differences in their type, characteristics, and magnetic mineral content, which are influenced by various geological and volcanic factors.

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References

[1] A. Pribadi, E. Mulyadi, And I. Pratomo, "Mekanisme Erupsi Ignimbrit Kaldera Maninjau, Sumatera Barat," Vol. 2, No. 1, Pp. 31–41, 2007.

[2] P. Shane, J. A. Westgate, M. Williams, and R. Korisettar, R, "New Geochemical evidence for the youngest Toba tuff in India." *Quarternary Research*, 44, p. 200-204,1995.

[3] I. Suhendro, A. Toramaru, A. Harijoko, And H. Edi, "The Origins Of Transparent And Non-Transparent White Pumice : A Case Study Of The 52 Ka Maninjau Caldera-Forming Eruption , Indonesia," *J. Volcanol. Geotherm. Res.*, Vol. 431, No. September 2021, P. 107643,

2022, Doi: 10.1016/J.Jvolgeores.2022.107643.
[4] Lomboan Felisa O, Kumaat Ellen, And Windah Reky, "Pengujian Kuat Tekan Mortar Dan Beton Ringan Dengan Menggunakan Agregat Ringan Batu Apung Dan Abu Sekam Padi Sebagai Substitusi Parsial Semen," *J. Sipil Statik*, Vol. 4, No. 4, Pp. 271–278, 2016.
[5] D. W. Kurniawidi, S. Alaa, S. Mulyani, and S. Rahayu, "Sintesis Zeolit Dari Batu Apung (Pumice) Daerah Ijobalit Lombok Timur Sebagai Adsorben Logam Fe," *ORBITA: Jurnal Pendidikan dan Ilmu Fisika*, *7*(2), 313-317, 2021.
[6] R. Putra, H. Rifai, And C. M. Wurster, "Relationship Between Magnetic Susceptibility And Elemental Composition Of Guano From Solek Cave, West Sumatera," *J. Phys. Conf. Ser.*, Vol. 1185, No. 1, 2019, Doi: 10.1088/1742-6596/1185/1/012011.
[7] D. A. Visgun, H. Rifai, R. Rahmayuni, A. N. Yuwanda, A. Rahmi, and L. Dwiridal, "Identification of Rock Types from Iron Sand at Pasia Jambak Beach, Padang, West Sumatra," In *Journal of Physics: Conference Series*, Vol. 2309, No. 1, p. 012023, 2022.
[8] N. F. Kurnia, H. Rifai, S. Syafriani, L. Dwiridal, and F. Mufit, "Identification of Elemental Content and Rock Types in West Lampung Regency," *EKSAKTA: Journal of Sciences and Data Analysis*, 2022.
[9] S. Putra, H. Rifai, R. Fadila, E. D. Ningsih, And R. Putra, "Distribution Of Pyroclastic Deposits Around Lake Maninjau Agam District, West Sumatera, Indonesia Based On Magnetic Susceptibility," *Trends Sci.*, Vol. 19, No. 7, 2022, Doi: 10.48048/Tis.2022.3218.
[10] M. R. Fadila *Et Al.*, "Magnetic Susceptibility Of Pre- And Post Caldera Lavas From Maninjau, West Sumatra," *J. Phys. Conf. Ser.*, Vol. 1481, No. 1, 2020, Doi: 10.1088/1742-6596/1481/1/012017.
[11] M. Arrazi, R. Hamdi, M. Fatni, And A. Harman, "Magnetic Susceptibility Of Pumice At Mount Singgalang, West Sumatera," *Manazhim*, Vol. 5, Pp. 945–956, 2023, [Online]. Available: Https://Doi.Org/10.36088/Manazhim.V5i2.3623
[12] D. Laila Fitri, A. Fauzi, And L. Dwiridal, "Analysis On The Relationship Of Rare Earth Elements With Magnetic Mineral Concentration In Pumice Around Sigura-Gura," *J. Exp. Appl. Phys.*, Vol. 1, No. 3, P. 40, 2023.
[13] F. Orcan, "Parametric or non-parametric: Skewness to test normality for mean comparison," *International Journal of Assessment Tools in Education*, *7*(2), 255-265, 2020.
[14] R. Sianturi, "Uji homogenitas sebagai syarat pengujian analisis". *Jurnal Pendidikan, Sains Sosial, Dan Agama*, *8*(1), 386-397, 2022.
[15] R. . Kastowo And G. . Leo, "Peta Geologi Lembar Padang," *Puslitbang*. Direk. Geologi., 1973.
[16] J. A. Dearing *Et Al.*, "Frequency-Dependent Susceptibility Measurements Of Environmental Materials," *Geophys. J. Int.*, Vol. 124, No. 1, Pp. 228–240, 1996, Doi: 10.1111/J.1365-246x.1996.Tb06366.X.
[17] J. A. Dearing, "Ms2/Ms3 Magnetic Susceptibility System Manual," 1999.
[18] Usmadi, Usmadi. "Pengujian Persyaratan Analisis (Uji Homogenitas Dan Uji Normalitas)." *Inovasi Pendidikan* 7.1, 2020.
[19] Borradaile, G. J., & Borradaile, G. Statistics of Earth Science Data: Their Distribution in Time, Space, And Orientation (Vol. 351, P. 329). Berlin: Springer, Hal 89-91, 2003
[20] E. Hendrik, "Uji Mann -Whitney (U-Test)," 2011.
[21] A. Septian, "Penerapan Geogebra Untuk Meningkatkan Kemampuan Pemecahan Masalah

Matematis Mahasiswa Program Studi Pendidikan Matematika Universitas Suryakancana [The Application Of Geogebra To Improve Mathematical Problem Solving Skills Of Students Of The Mathematics] E," *J. Prism.*, Vol. 6, No. 2, Pp. 180–191, 2017.

[22] ARR. Alrahmadana, H. Rifai, S. Syafriani, F. Mufit, And N.Y. Sudiar, "Kerentanan Magnetik Tanah Vulkanik di Permukaan Gunung Singgalang Sumatera Barat". *Jurnal Fisika dan Aplikasinya*, *18* (2), 31-35, 2022.

[23] N. Y. Daryanti, S. Zulaikah, N. Mufti, And D. S. Haryati, "Suseptibilitas Magnetik Dan Kelimpahan Mineral Magnetik Pada Tanah Sawah Di Lawang Dan Soekarno-Hatta, Malang," *Jpse (Journal Phys. Sci. Eng.*, Vol. 3, No. 1, Pp. 48–54, 2018, Doi: 10.17977/Um024v3i22018p048.

[24] Jahidin, "Analisis Suseptibilitas Magnetik Pasir Besi Desa Laea Kabupaten Buton Utara Sulawesi Tenggara Jahidin," *J. Apl. Fis.*, Vol. 8, No. Gambar 1, Pp. 20–24, 2012.

[25] F. Orcan, F, "Parametric or Non-Parametric: Skewness to Test Normality for Mean Comparison". *International Journal of Assessment Tools in Education*, *7*(2), 255-265, 2020.

[26] M. Irfan And M. Effendy, "Analisis Data Uji Beda Parameter Yang Mempengaruhi Kebutuhan Konsumsi Energi Bangunan Menggunakan Statistika Non Parametrik," *Semin. Keinsinyuran Progr. Stud. Progr. Profesi Ins.*, Vol. 1, No. 2, Pp. 63–68, 2021, Doi: 10.22219/Skpsppi.V2i1.4415.

[27] M. Haries, "Perbandingan Kinerja Teknologi Near Field Communication Pada Perangkat Android Menggunakan Metode Mann Whitney". *Journal of Information System Management (JOISM)*, *4*(2), 113-118, 2023.