Original Research Article

ASSESSMENT OF MAGNETIC SUSCEPTIBILITY OF SOME ROCKS SAMPLE IN NYANYA AND KARU QUARRIES

ABSTRACT

Magnetic susceptibility is a very sensitive indicator of magnetic minerals present in rock because any slight variation in magnetic mineralogy is usually reflected by a profound change of susceptibility. The study of rocks composition and its properties is a major concern globally. However, the knowledge of its mineral composition does not provide adequate information about the rock and mineral composition of rock and properties such as magnetic susceptibility determines the property of rock. The assessment of magnetic susceptibility of some sample in some sites at Nyanya and Karu quarries in Karu Local Government Area Council, Nassarawa State were measured with an instrument called magnetic susceptibility meter EM2S+. The results obtained shows that limestone has low magnetic susceptibility compared to other rock samples in Nyanya and pegmatite has the low magnetic susceptibility compared to other rock samples in Karu. The average magnetic susceptibility of the rock samples from Nyanya and Karu are 4.11 x 10^{-4} (SI) and 4.99 x 10^{-4}(SI) respectively. In conclusion, the rock sample from Karu quarry are more susceptible to magnetism than those in Nyanya quarry, which shown high number of iron and magnesium in the rock sample.

Keywords: assessment, karu, magnetic susceptibility, nyanya, rock

1. INTRODUCTION

Geological maps of an area give general information about the type of formation or rock units that exist in the area. The comprehensive nature of this depends on the scale of the maps. However, there is a limit to the type of information that can be extracted from geological maps because of the complex mechanism of geomorphology [1,2,3]. Hence, for detail study of an area especially with the view to producing scientifically based for provision of social infrastructures, additional method like drilling and geophysical technique are necessary and complimentary because they pick up other details which are usually not available in geophysical maps [4,5,6,7]. Rocks are the hard materials that makeup the earth crust. These include igneous rocks, metamorphic rocks and sedimentary rock. Rock generally consists of magnetic properties which are measure by an instrument called magnetometer. Due to these magnetic properties, rocks are mostly susceptible to be magnetized. Susceptibility is the degree to which a rock sample is magnetized. Magnetic anomalies are caused by magnetic minerals mainly Magnetiite and pyrrhotite contained in rocks. Studies of the magnetic history of the earth crust shows that the earth`s field has varied in magnitude and has reversed its polarity a couple of times [8,9,10]. Magnetic susceptibility is the measure of the ease with which a rock sample is magnetized when subjected to magnetic field. The ease of magnetization is related to the concentration and composition (size, shape and mineralogy) of the magnetisable mineral content of the rock sample [11,12,13]. Magnetite for example, account for most of the susceptibility observed in rocks. Thus, the measurement of susceptibility can be done before magnetic survey take place to determine which rock will be detectable magnetically and to what extent. The measurement can be performed in the field on outcrop or on samples in laboratory. Magnetism is a vector quantity whose magnetic anomaly is produced by the contrast between the intensity and direction of magnetization of the disturbing mass and that of the surrounding rock material. Magnetization is composed of induced and remnant vector. The former depends on the susceptibility of the magnetic material present and the strength of the ambient geomagnetic field. The latter is of permanent nature and depends on the type and amount of magnetic material present in the rock and on its magnetic history [14,15,16]. Mineral composition of rock and properties such as magnetic susceptibility determine the property of rock, about these demands, the aim of this investigation is to look at the assessment of magnetic susceptibility of some rock at Karu Local Government Area Council, Nassarawa State, Nigeria.

UNDER PEER REVIEW

2. MATERIALS AND METHOD

2.1. Study Area

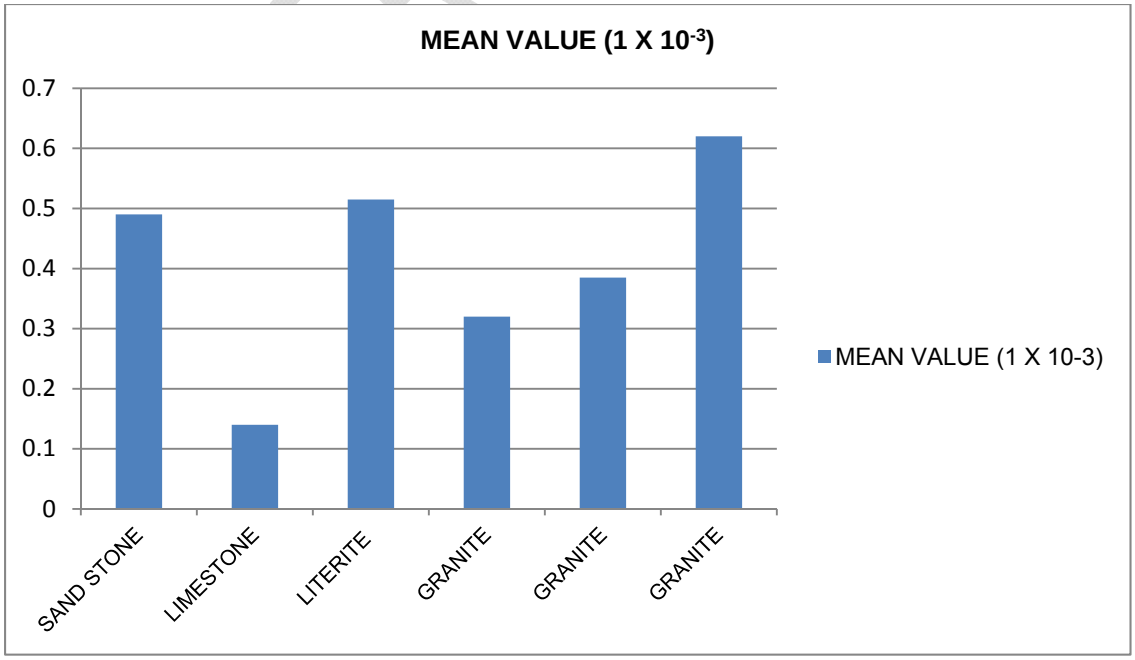
The study area is Nyanya and Karu in karu local government area council of Nassarawa state is bounded by latitude $8^{o}30^{1}0^{11}$N and $8^{o}15^{1}0^{11}$E. The major soil units of Nassarawa state belong to the category of oxisols or tropical ferrugi nous soils. The soils are derived mainly from the basement complex and old sedimentary rocks. Lateritic crust occurs in extensive areas on the plains. While hydromorphic soils (humic inceptisols) occur along the flood plains of major rivers. The rocks sample were obtained from Reynolds and Nkefred quarries located at Nyanya and Karu site respectively, fresh outcrop of the sample was obtained after blasting the rock into various sizes. Six rocks samples were obtained from both Reynolds and Nkefred quarries respectively.

2.2. Experiments Design

These samples were taken to National Geosciences Research Laboratory Centre in Kaduna for identification and analysis using an instrument called magnetic susceptibility meter EM2S+. The identification was carried out in the Geographical Laboratory after label sample were taken to Geophysics Laboratory for the susceptibility analysis of measurement. Magnetic susceptibility meter was first raising up in the air about one meter (1m) away from the sample to take the air reading after which it was placed on the sample for magnetic susceptibility measurement were taken on each sample and susceptibility on each sample determined. After the last magnetic susceptibility measurement on each sample, air reading was taken again. The mean of the first and second air reading were then calculated and subtracted from the mean magnetic susceptibility of the sample. This is to ensure that the interference errors were reduced as much as possible. This procedure was repeated for the entire samples both from Reynolds and Nkefred respectively, as shown in fig 1 and fig 3.

3. RESULT AND DISCUSSION

From the analysis, figure 1&2 shows that the limestone has the lowest magnetic susceptibility value of 0.140 x 10^{-3} which is 6% while one of the granite has the highest magnetic susceptibility value of 0.620 x 10^{-3} which is 25%, compare to other two (2) granite with magnetic susceptibility value of 0.320 x 10^{-3} which is 13% and 0.385 x 10^{-3} which is 15% respectively, follow by sandstone with magnetic susceptibility value of 0.490 x 10^{-3} which is 20%, and literite with magnetic susceptibility value of 0.515 x 10^{-3} which is 21%. This result agrees with those of earlier studies such as George and Priscillia [2], Abon and Osazuwa [5], Aydin [12], and Holger *et al*, [17].



PEER REVIEW

Figure 1: Bar chart shows the assessment of Magnetic Susceptibility of Rocks in Reynold Quarry (Nyanya)

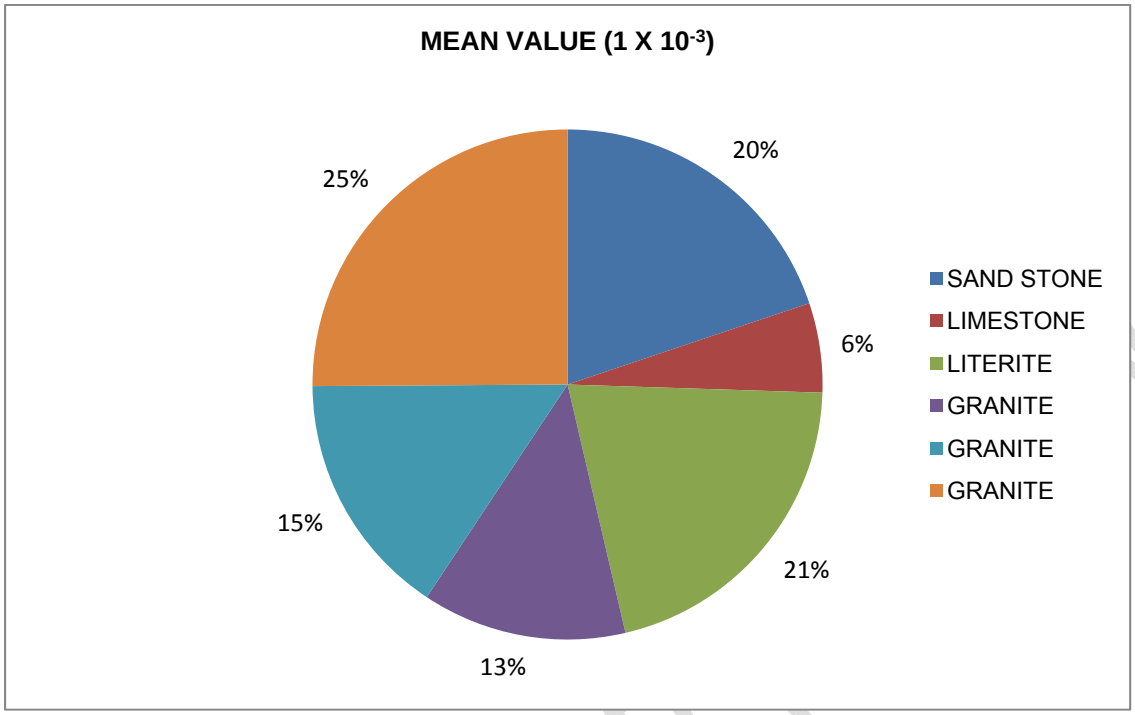


Figure 2: Pie chart shows the assessment of Magnetic Susceptibility of Rocks in Reynold Quarry (Nyanya)

From the figure 3&4 the pegmatite has the lowest magnetic susceptibility value of 0.170 x 10^{-3} which is 6% while one of the granite gneiss has the highest magnetic susceptibility value of 1.110 x 10^{-3} which is 37%, compare to other two (2) granite gneiss with magnetic susceptibility values of 0.350 x 10^{-3} which is 12% and 0.910 x 10^{-3} which is 30% respectively, quartzite follow the lowest with magnetic susceptibility value of 0.205 x 10^{-3} which is 7%, and gneiss with magnetic susceptibility value of 0.250 x 10^{-3} which is 8%.

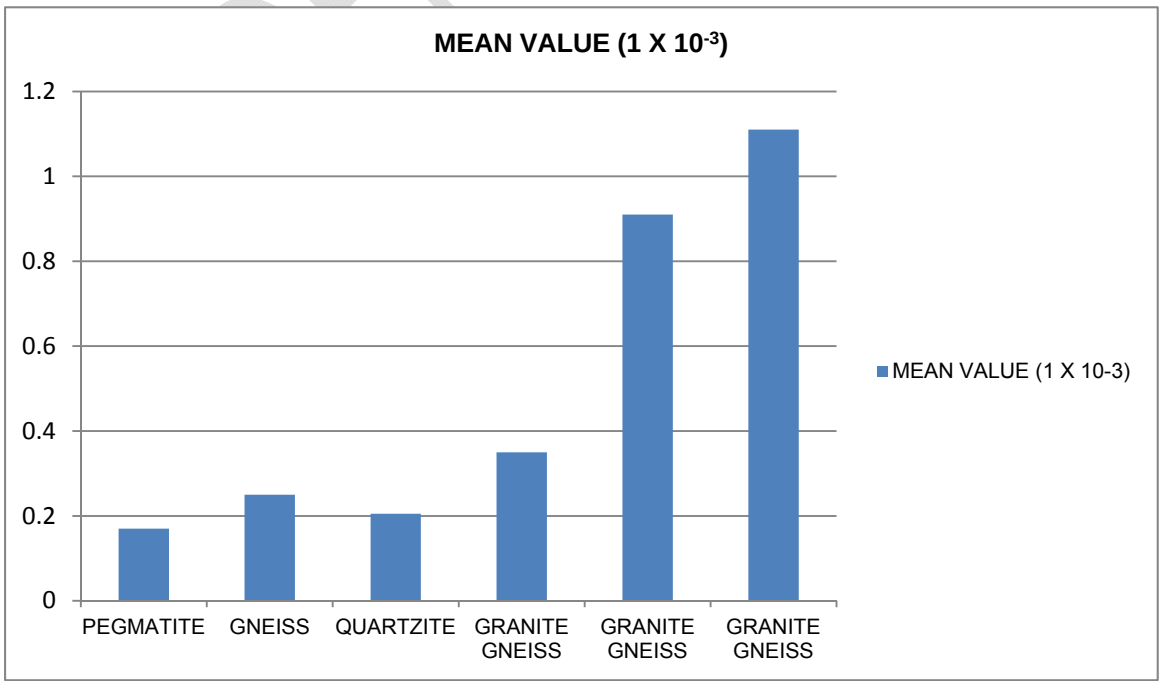


Figure 3: Bar chart shows the assessment of Magnetic Susceptibility of Rocks in Nkefred Quarry (Karu)

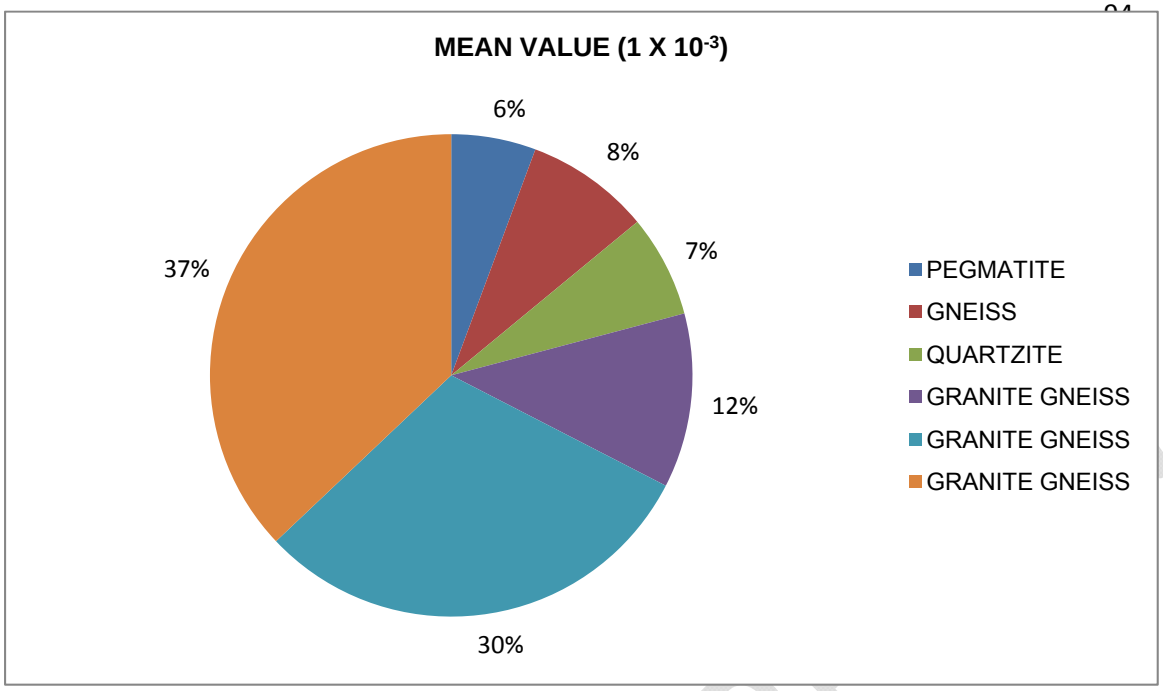


Figure 4: Pie chart shows the assessment of Magnetic Susceptibility of Rocks in Nkefred Quarry (Karu)

In summary, it was found that the Limestone has lowest susceptibility compared to others rock sample while granite has highest in Nyanya and pegmatite has the lowest susceptibility compared to others rock sample while one of the granite gneisses has highest in Karu. It was found that the Granite which are light coloured has low susceptibility. The graphical representation shown in figure 1 to 4 in both locations Reynolds and Nkefred quarries, shows that limestone has the lowest magnetic susceptibility, this is as a result of the presence of Felsic materials found in the rocks while granite gneiss has a very high magnetic susceptibility, this is as a result of the presence of large amount of iron and magnesium present in the sample.

CONCLUSION

In this paper, we found that the average magnetic susceptibility for the sample of rocks from Nyanya is 0.412×10^{-3} and those from Karu is 0.499×10^{-3}. The result shows that rocks samples from Karu site are more susceptible to magnetism than those from Nyanya, which demonstrate or indicate large amount of iron and magnesium in the rock sample.

REFERENCES

1. Okweze EE, Seiemo A, Ezeanyim VE. Preliminary lithologic deduction from a regional electrical resistivity survey of Ogojo, Nigeria. Journal of Physics. 1995; 7: 43-52.

2. Nyam GG, Egbelehulu OP. Measurement of magnetic susceptibility of some rock's samples in Dede and Kubwa in Bwari Area Council of the Federal Capital Territory Abuja. International Journal of Basic and Applied Science. 2012; 1(2): 166-167.

3. Kjetil S. Magnetic susceptibility of sedimentary rocks from Bjørnøya MSc Thesis Unpublished submitted to Norwegian University of Science and Technology 2012.

4. Dobrin MB. Introduction to geophysical prospecting, 3rd edition McGraw Hills Books Co. New York 1976.

5. Aboh HO, Osazuwa IB. Lithological deductions from a regional geoelectric investigation in Kaduna, Kaduna state, Nigeria. Nigeria Journal of Physics. 2000; 12: 1-7.

UNDER PEER REVIEW

6. Oniku SA, Osazuwa IB, Meludu OC. Preliminary report on magnetic susceptibility measurements on rocks within the Zaria granite batholith, Nigeria. GEOFIZIKA, 2008; 25(2): 203–213.
7. Martin C. Application of magnetic susceptibility as a function of temperature, field and frequency;Latinmag Letters, Proceeding Tandil, Argentina. 2011; 1(E03): 1.
8. Lowrie W. Fundamental of Geophysics Cambridge University Press, low price paperback edition 72-75 and 229-306; 1990.
9. Kuma JS, Al-hassan S, Stainforth B, Thompson FA. Magnetic susceptibility of rock units in the Bogosu Gold Limited Concession Western Region Journal 1999; 5: 11-17.
10. Johannes V. Magnetic susceptibility of crystalline basement and soil, Loviisa area, southern Finland; master thesis unpublished University of Tartu 2014.
11. Da Silva AC, Dekkers MJ, Mabille C, Boulvain F. Magnetic susceptibility and its relationship with paleoenvironments, diagenesis and remagnetization: examples from the Devonian carbonates of Belgium. Stud. Geophys. Geod., 2012; 56: 677−704, DOI: 10.1007/s11200-011-9005-9 677.
12. Aydin A. The magnetic susceptibility of granitic rocks as a proxy for geochemical composition, tectonophysics 2007; 441: 85-95.
13. Tosiboah T, Arko JA. Magnetic Susceptibility index measurement and it's implication for Gold Explorational at Ashanti Mine, Obuasi; Ghana Mining Journal 1999.
14. Eccles DR, Sutton R. Magnetic Susceptibility Measurements on Kimberlite and Sedimentary Rocks in Alberta; Alberta Geological Survey 2004.
15. Gerardo A, Arrigo B. Magnetic susceptibilities of some standard samples of silicate rocks and minerals. Rendiconti Societa Itallana DJ M1neralogla E Petrolog1a, 1986; 41(2): 257·259.
16. Pal PC, Varaprsada RSM. Exploration Geophysics by Indian National Science Academy and Centre Osmania 1976; 29-35.
17. Holger P, Sven A, Volker H, Jan I. Classification of soil magnetic susceptibility and prediction of metal detector performance - case study of Angola; Proc. of Spie. 2009;7303, 730313-1

UNDER PEER REVIEW