X-Ray Diffractometer Characterization of South Western Nigeria's Dolomite.

A.O. Adesakin, PGD[1*]; O.K. Ukoba, B.Eng[1]; and O.O. Ajayi, Ph.D.[2]

[1]Engineering Materials Development Institute, Akure, Nigeria.
[2]Industrial Chemistry Department, Federal University of Technology, Akure, Nigeria.

E-mail: adesakin@emdi.gov.ng*

ABSTRACT

Limestone is the general name use for most of the sedimentary carbonated rocks found in Nigeria. The sedimentary carbonated rocks are composed of different types of minerals. These minerals are difficult to identify by simple chemical analysis due to their similar physical and chemical properties. This research characterizes a given sedimentary carbonated rock sample from south western Nigeria using Mini X-ray Diffractometer. The sample was made into a very fine powder, which was run in Radicon MD 10 Mini-Diffractometer. The diffractogram of the result was then analyzed. The outcome of the characterization indicates the sample to be $CaMg(CO_3)_2$ which is Dolomite with reference card number 36-0426 of international center for diffraction data. The crystal structure of the sample was found out to be rhombohedra.

(Keywords: dolomite, sedimentary carbonated rock, mini X-ray diffractometer, XRD)

INTRODUCTION

Sedimentary carbonate rock has being found to be composed of different minerals which are difficult to differentiate by simple chemical analysis due to the presence of carbonate which gives them similar chemical and physical properties. Dolomite is a type of sedimentary rock composed of Calcium Magnesium Carbonate ($CaMg(CO_3)_2$ found in crystals [1,2]. Dolomite has being found to be a solid mineral of great importance, which has found its uses in various aspect of life. Most, if not all dolomite is a replacement of pre-existing limestone and this process is known as dolomitization [2].

Dolomite and other sedimentary carbonated rock have being found to be predominating in south western Nigeria [3].This non-metallic mineral is relatively cheap and affordable. Identification of dolomite among other sedimentary rock has being a major task when using simple chemical analysis procedure.

X-ray Diffraction analysis has been reported to be of help in proffering solution to the identification problem for crystal samples [4, 5]. X-ray powder diffraction (XRD) is a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions. The analyzed material is finely ground, homogenized, and average bulk composition is determined. The technique applied in X-ray diffraction analysis was reported to provide more reliable and accurate additional information about the chemical and physical properties of the suspected material [5, 6].

The aim of this research is to carry out an easier, faster and accurate characterization procedure on the dolomite sample found in south western Nigeria using X-ray Diffraction analysis.

EXPERIMENTAL PROCEDURE

X-Ray Diffraction Analysis

The X-ray diffraction analysis was carried out at Engineering Material Development Institute. The sample was made into a fine powder and small portion of the fine powder sample was filled into the XRD curvette. The curvette with the sample was then loaded into the sample holder of XRD machine.

The machine has an automated interface with the computer. The sample was automatically run for 1200sec, after which the diffractogram with the corresponding data of intensity versus 2θ was display on the computer monitor. The diffractogram was analyzed using International Center for Diffraction Data (ICDD) database for

the search-match of the sample with the database compounds, to obtain the accurate result.

RESULTS AND DISCUSSION

The results of the XRD analysis were given in Figures 1 and 2. Figure 1 contains the diffractogram of the dolomite sample as it was observed from the computer. The plot of the diffractogram is that of 2θ versus intensity (count/sec).

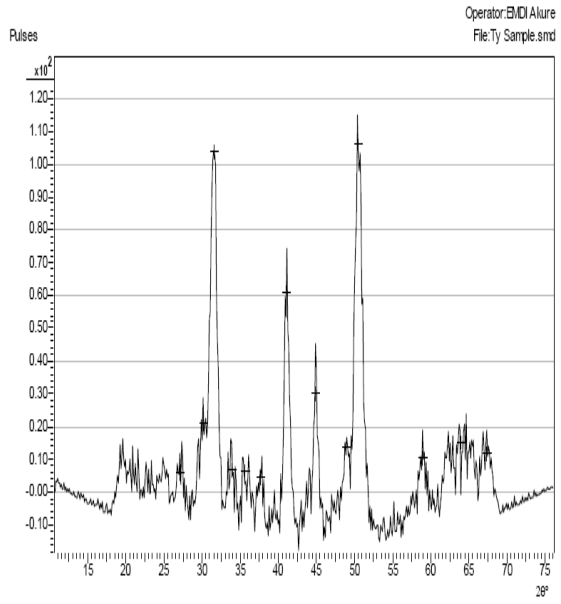

Figure1: XRD Diffractogram of the Dolomite.

Figure 2 is the result of the search-match of the sample phase analysis with that of compound in International Center for Diffraction Data (ICDD) database reference card number 36-0426.

Table1 is the result of the analysis of the diffractogram of the sample with reference to the ICDD standard Dolomite. The 2Θ of the sample diffractogram was evaluated with that of the standard. There are four prominent peaks from the sample diffractogram, these peaks are at 2Θ: 31.29, 41.07, 44.82 and 50.49 which correspond to the 30.9389, 41.1281, 44.9503 and 50.5271 respectively for the standard. The difference in the value of the 2Θ for the sample and the standard was found to be ≤ 0.3 which can still be considered to be within the range. The difference in the value may be as a result of different factors such as background noise, sample impurities and others.

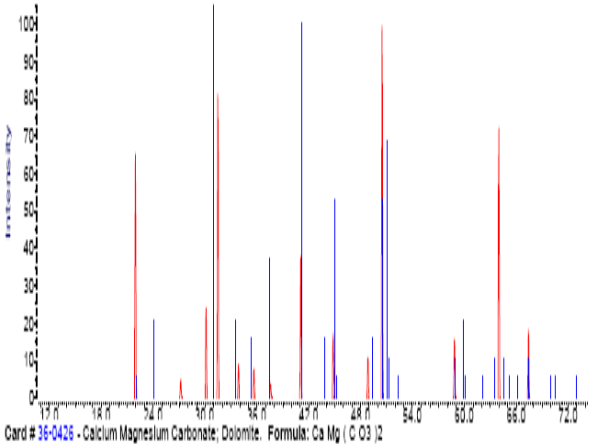

Figure 2: Search-Matched Peaks of the Sample with the ICDD Database.

Table1: Sample Diffractogram data analyzed with reference to ICDD Standard; Card number 36-0426.

2Θ ICDD standard	2Θ Analyzed sample	D spacing Analyzed sample	hkl
22.022	21.95	4.04999	101
30.9387	31.29*	2.84093	104
33.5366	33.86	2.64697	006
35.3223	35.66	2.51791	015
37.3772	37.59	2.39291	110
41.1282	41.07*	2.19771	113
44.9503	44.82*	2.02221	202
50.5271	50.49*	1.807563	018
58.9009	58.84	1.56926	211
63.4348	63.98	1.45508	214
67.3899	67.40	1.38932	300

With the 2Θ values of diffractogram of the standard and the sample closely compared with each other especially for the prominent peaks, this result shows that the sample is a Dolomite having matched with that of the database.

The crystal structure of the dolomite was found out to be Rhombohedra from the phase analysis.

CONCLUSION

The result of this work has revealed the importance of X-ray Diffraction for the identification of Dolomite. The uniqueness of this analysis is the diffraction peaks which appear at different points of the 2Θ angles.

The process of analysis is easier, faster and more accurate in identifying dolomite from other sedimentary carbonated rock minerals compare with the wet-chemical method of analysis. The process also helps to determine the phase and crystal structure of the dolomite sample.

In Nigeria now especially in south western part that is predominated with the dolomite, identification problem which has being a major problem, will be a thing of the past base on the result of this research. The result of this analysis will also encourage proper application of dolomite for industry without the fear of taking it for another mineral with similar chemical and physical properties.

REFERENCES

1. Gence, N. 2006. "Wetting Behavior of Magnesite and Dolomite Surface". *Applied Surface Science*. 252:3744-3750.

2. Hessin, K., Shamsul, B. Jamaludin, C.M.R. Ghazali, M.S. Idris, M.N. Salley, and K.N. Ismail. 2006. "The Development of Artificial Marble from Dolomite (Batu Reput) in Perlis, Kukum". Engineering Research Seminar: Northern Malaysia University College of Engineering (Kukum).

3. Bell, J.P. 1963. "A Summary of the Principal Limestone and Marble Deposits of Nigeria". *Geol. Surv. Nigeris, Pep.* 1192.

4. Wenk, H.R., H. Meisheng, and S. Frisia.1993. "Partially Disordered Dolomite: Mirostructural Characterization of Abu Dhabi Sabkha Carbonates". *American Mineralogist*. 78:769-774.

5. Chung, F.H. 1974. "Quantitative Interpretation of X-Ray Diffraction Patterns of Mixtures, I. Matrix-Flushing Method for Quantitative Multi-Component Analysis". *Journal of Applied Crystallograpy*. 7:519.

6. Kugler, W. 2003. "X-Ray Diffraction Analysis in the Forensic Science: The Last Resort in Many Criminal Cases". *International Centre for Diffraction Data, Advances in X-ray Analysis*. 46.

ABOUT THE AUTHORS

A.O. Adesakin is an officer in the research and development department of Engineering Materials Development Institute, Akure Nigeria. He holds a Higher National Diploma (HND) in Applied Chemistry and Post Graduate Diploma (PGD) in Industrial Chemistry. He is presently doing his Master's in Industrial Chemistry (M-Tech) at Federal University of Technology, Akure Nigeria. He is a member of Material Society of Nigeria. His research interests are in Materials synthesis and Characterization, Micro analysis, Polymer composite and Nanotechnology.

K.O. Ukoba is a Design and Simulation Engineer in the Manufacturing Department, Engineering Materials Development Institute, Akure Nigeria. He holds a B.Eng. degree in Mechanical Engineering and currently doing his M.Eng. in Mechanical Engineering. His research interests are in the areas of design/simulation, materials (testing and synthesis), corrosion, and ergonomics.

O.O. Ajayi is a Professor of Chemistry in the Department of Chemistry at Federal University of Technology, Akure Nigeria. He was the immediate past Head of the Department of Chemistry at the same University. He is an author of many chemistry research publications in both local and International journals.

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