ISSN 2229-5518

Geochemical Analysis On Major And Trace Elements Of Limestone Deposit, At Kalambaina Formation, Sokoto Basin North Western Nigeria

By

Ahmed Bello Bakori[1]

1948209341@qq.com,

Dr Jie Yan[2]

(Corresponding Author)

Yanjie02016@163.com,

and

Prof. Pan Jiayong[1, 2]

184799613@qq.com

1 School of Earth Science, East China University of Technology.

2 State Key Laboratory of Nuclear Resources and Environment, East China University of Technology, Nanchang, 330013, Jiangxi, China

Abstract

The study covers the geochemical aspect of limestone and the surrounding rocks such as shale and marl, as they are the main wall rock in contact with the limestone bed of the study area. The limestone bed consist of greyish limestone which is been covered by shale at the top and trapped by marl at the bottom. The geochemical studies were carried out in both the limestone, shale and marl using an XRF Panalytical Minipal 4 instruments, and XRF oxford instruments, Xsuperem 8000uk. Were the major oxides and trace/rare earth elements were carefully assessed. The result shows that the limestone is divided into to two layers the high grade and low grade as it was rightfully observed during the field work and sample collection, with the high grade containing about 92.412% of Cao, using Xsupreme and 54.06% using Panalytical Minipal 4, the low grade containing about 43.09% using Panalytical Minipal 4 and 72.430% usig Xsupreme. The Sio_2 is 0.02 in the high grade $CaCo_3$ and 0.84 in the low grade $CaCo_3$. Oxide such as; Fe_2O_3, Na_2O, and Mgo were also captured which account for 2.98% in high grade $CaCo_3$ and 4.21% low grade $CaCo_3$.

Keywords

Kalambaina Formation, limestone, Shale, Marl, Sokoto Basin.

Introduction

The sokoto basin in north western also known as lullemmeden Basin, is a cratonic sedimentary, young Mesozoic-Cenozoic basin in part of west Africa. Formed by marine transgression which was overlain by the sokoto group of sediments. Using major and trace elements analysis will help in bringing out a more understanding of the origin and the depositional environment of the limestone bed in the basin and also give a clue in future study to find out more potentials of the basin. Major and trace elements have been used to determine the origin and deposition environment of some basins in Nigeri such as: Bida Basin and Benue Trough. The objective of this study is to accertain the quantity, quality and history of the limestone to see its economical value for industrial purposes. The kalambaina formation of the sokoto basin consist of limestone, shale, clay, marl and laterite as major content of the top soil signifying marine history. The kalambaina formation is calcareous and very rich in Invertebrate Fossils.

Study Area

The chosen study area falls around hamma ali and kalambaina town with latitude: 13˚3’25.3”N and longtitude: 5 ˚9’31.6”E, the kalambaina formation covers the lagest area of the sokoto basin. The basin extends towards the northwestern edge of Nigeria which boders with Niger republic. The basin is part of the west African sub-sahara sudan belt the basin has an average elevation of 250-450m above sea level. Sediment in the basin were deposited during the Palaeocene which has a marine origin predominantly containing limestone, other sediments that constitute the sokoto basin are dukamaje, wurno and taloka formation which are also known as the Rima Group.

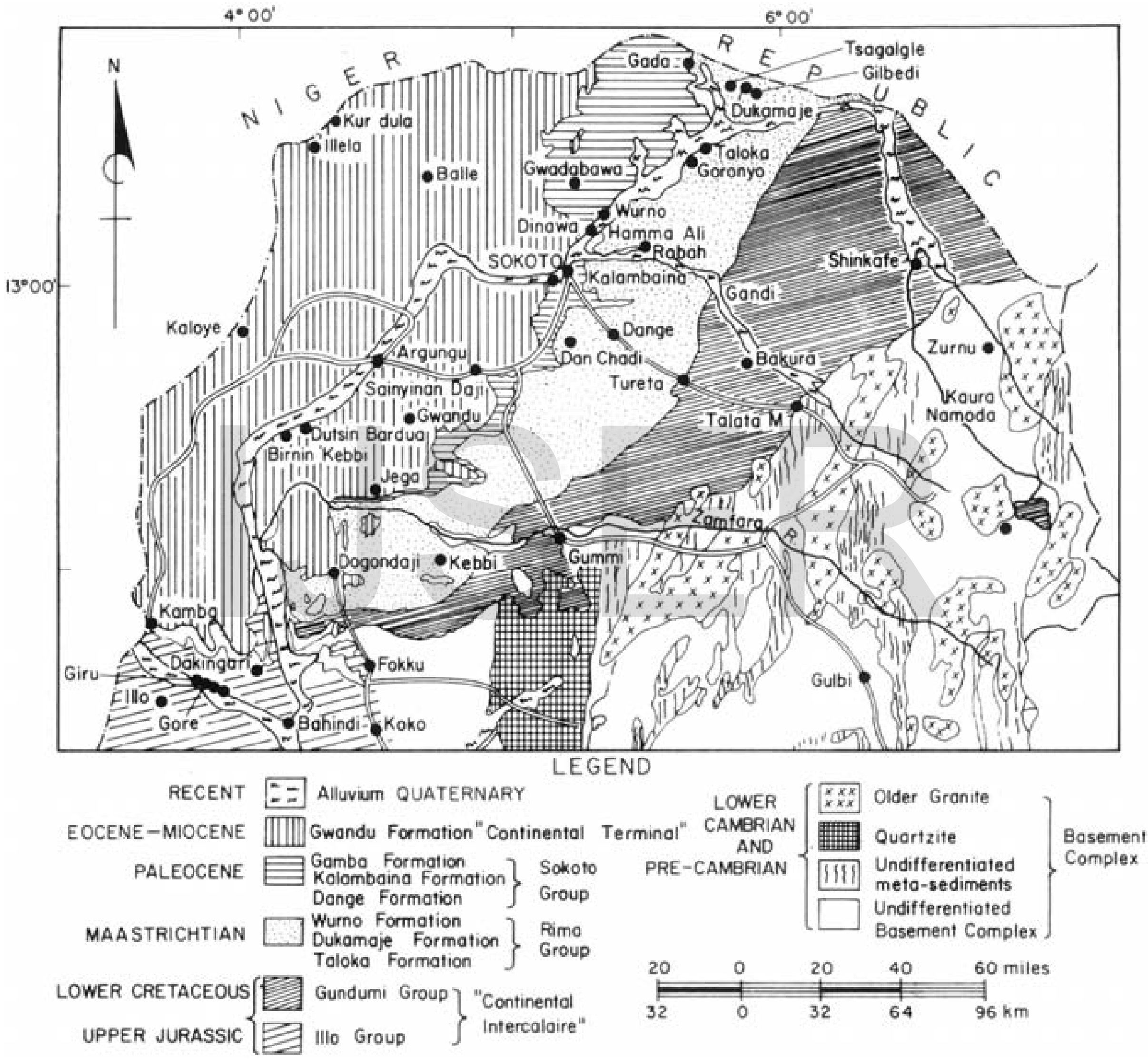


Fig 1.0 Geological sketch map of the southeastern sector of the lullemmeden Basin (SokotoBasin) (After Kogbe,1981b)

Geological Setting

The Iullemeden basin is a cretonic sedimentary basin created during the Palaeozoic as a result of epirogenic tectonic movement this result to the younger ones moving toward southwest away from the northern part were it is referred to as Sokoto Basin. In the northwest part of the country the sokoto basin sediments were deposited in three phases, which are the continental Mesozoic and Cenozoic then Maastrichtian to Palaeocene phase intervention. The sedimentary rocks of the basin are grouped into four classes namely; The pre-maastrichtian which are sediments of lacustrine origin, the are part of the Gundumi formation. The second sediment depositional phase started during the Maastrichian then the Rima group unconformable deposition occurred. The Taloka, wurno and dukamaje formations also referred to lower sandstone and mudstone with some fine grain sand and a carbonaceous shale. Dukamaje Formation is mostly dominated by shale and some limestone which is rich in vertebrate fossils. The Rima Group in sokoto basin is overlain sokoto basin is overlain by the Upper Palaeocene age. The sokoto Group of sediments consist of interbedded bluish grey Shale and a slim layer of greyish limestone. The contact between the Kalambaina, Dange and Wurno Formation is well expose in some areas of the basin due to erosion, the contact shows the boundary of cretaceous Palaeogene.

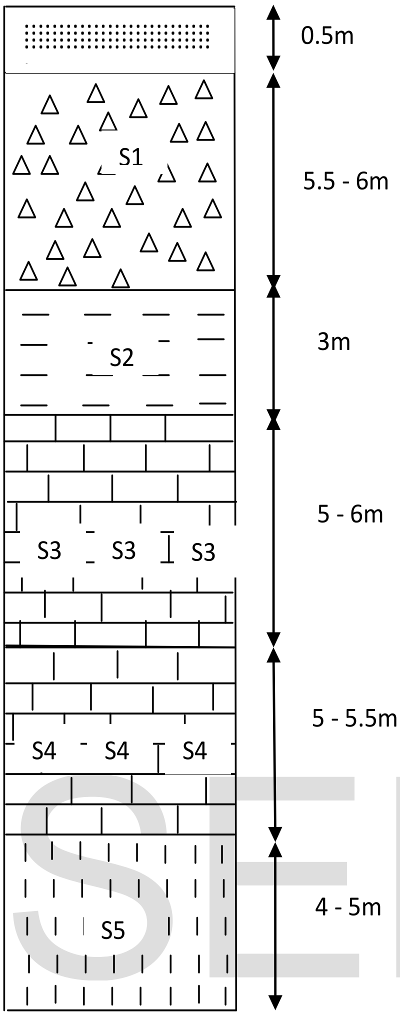
ISSN 2229-5518

Date: 17th August, 2018

Weather: Rainy Season

G.P.S Coordinate: 13˚2’45.5”N

5˚10’24.1”E



Top soil: Somehow lateritic and ferruginous

Laterite: Reddish in color, highly indurated and rich in bioturbation

Shale: Grayish in color, flaky, friable and rich in invertebrate fossils

Limestone: Low grade limestone, dark grey, less dense and higly porous. The water table is found here. It is somehow clay. Contains >75% $CaCO_3$

Limestone: High grade limestone, grayish but lighter and harder than the low grade. Its porosity and clay content is less than that of low grade.

Marl: Looks like the shale in texture and color.

KEY

S1, S2, S3, S4, S5: Sample Location 1,2,3,4 and 5 respectively

FIG 2.0 : SOIL PROFILE OF A TYPE SECTION OF KALAMBAINA FORMATION AND SAMPLE LOCATIONS

Methodology

The processes or method of study used in this research was carried out in two phases, which are the Field Work that also involves sample collection and the second phase which is the Laboratory Analysis.

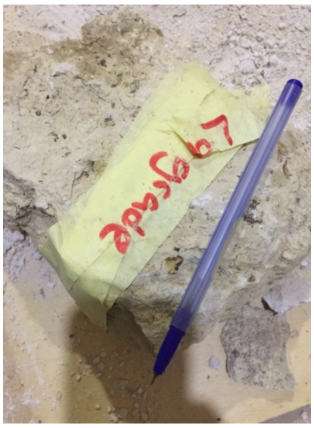
Field work And Sample Collection

The field work was carefully conducted and outcrops were well observed and studied in the kalambaina formation, A bedding format of sample collection method was adopted. Which about 45 samples were collected, which includes Shale, Limestone, and Marl.

The above field picture shows the bedding format and deposition of limestone as shown in figure 2.0.

ISSN 2229-5518






Shale High grade limestone Low grade limestone Marl sample

Laboratory Analysis

SAMPLE PREPARATION

Pulverization:

The samples were pulverized (grind to fine powder) using arget pulverizing machine (planetary micro mill pulverisette 7). The ground samples were ensured to pass 150 micro mesh sieves. This was to ensure homogeneity of the samples.

Pelletization:

5g of the pulverized sample was weighed into a beaker, 1g of binding aid (Starch soluble). The mixture was thoroughly mixed to ensure homogeneity, which was pressed under high pressure (6 “tone”) to produced pellets; labeled and package ready for the analysis.

Procedure of the analysis:

Energy Dispersive x-ray fluorescence (EDXRF) spectrometer of model “Minipal 4” was used for the analysis.

The pellets were carefully placed in the respective measuring positions on a sample changer of the machine. The following condition sets were made as the machine was switched on.

Elemental composition determination

Nature of the samples to analyzed as press powder (pellet)

The current used as 14kv for major oxides, 20kv for the trace elements/rare earth metals.

Selected filters were “kapton” for major oxides, Ag/Al-thin for the trace elements/rare earth metals.

The selection of filters was guided by a given periodic table used for elemental analysis. Time of measurement for each sample was 100 seconds and the medium used was air throughout.

The machine was then celebrated by the machines gain control, after which the respective samples were measured by clicking the respective positions of the sample changer.

LOI was determined gravimetrically by heating 1g of the powdered sample in a cleaned weighed crucible at 1000^{o}c. After which the crucible and the content was weighed to get the difference in weight before and after heating.

$$LOI = (a-b/1) \times 100\% = H_2O^+$$

Where a = weight of crucible + 1g of the sample before heating

b = weight of crucible + 1g of the sample after heating.

Result And Interpretation

The result of the analysis is giving in a tabular form. It include major and trace/rare earth elements which can be used in understanding the environment of deposition, interpretation, and source of the sediments.

Table: 1.0, LAB. Result No: 2018/0202B, MAJOR OXIDES ANALYSIS

Oxides Composition %	SS Marl	L1 High Grade	L1, S3	L1, HGL	La, L1	L1, S2 SHALE
SiO_2	17.40	0.02	0.84	1.04	16.70	52.50
CaO	40.60	54.06	53.03	54.10	43.09	7.30
MgO	6.26	0.03	0.02	0.03	1.06	0.63
Se_2O_3	0.73	1.30	1.40	1.00	0.93	ND
K_2O	ND	ND	ND	ND	ND	0.38
Na_2O	ND	ND	ND	ND	ND	0.45
TiO_2	0.41	ND	0.19	ND	0.28	1.61
MnO	0.11	ND	ND	ND	0.04	0.11
Fe_2O_3	2.81	0.20	1.05	0.25	1.91	8.94

Al_2O_3	1.06	ND	ND	0.80	1.20	18.04
LoI	30.20	43.24	42.74	42.02	34.34	10.40

Table.2.0 TRACE/RARE EARTH ELEMENTS

Elements (ppm)	SS Marl	L1, High Grade	L1, S3	L1 HGL	La, L1	L1, S2 Shale
V	320.20	68.82	51.31	8.00	410.00	54.00
Cr	230.40	27.00	4.06	0.34	190.21	41.38
Cu	33.38	35.30	36.40	350.00	400.00	540.00
Sr	<0.001	850.30	1200.80	1200.34	1300.00	900.00
Zr	720.00	<0.001	<0.001	<0.001	<0.001	1300.00
Zn	19.39	0.12	0.64	<0.001	180.33	560.30
Ce	<0.001	<0.001	<0.001	6.00	<0.001	<0.001
Hg	20.20	<0.001	<0.001	<0.001	<0.001	<0.001
Hf	43.00	<0.001	<0.001	<0.001	<0.001	34.81
Ge	1.784	<0.001	<0.001	<0.001	<0.001	<0.001

ND=NOT DETECTED

The table 1.0 and 2.0 shows the geochemical analysis result that was obtained from samples of the kalambaina formation. Where CaO, SiO_2, Fe_2O_3, Al_2O_3

account for about 75% to 95% 0f the sample concentration. The trace elements analysis of the kalambaina formation shows a possible stratigraphic relationship across the basin due to some similar trace elements like Zn and Cr were found in Gamba formation which borders with kalambaina formation (Fig.1.0) this can be as a result of low energy during the deposition of sediments, Also some factors such as weathering may responsible.

Discussion And Conclusion

The major contents or unit of the sokoto basin which is a sedimentary basin are mudstone, clay, shale, limestone, and silt, and laterite as top soil which are divided into Palaeogene, Quaternary and upper cretaceous series. Some of this unit are rich in Invertebrates and Vertebrate Fossils. Therefore based on the geochemical analysis homogeneity and heterogeneity quality of the limestone, and also the grade content of the CaO and the amount of silica, magnesium, content that were carefully studied it suggest that the limestone in a very good raw material for industrial use such as cement manufacturing.

Acknowledgement

We acknowledge the support from National Natural Science Funds (U1403292, 41772066) of China and the Open Fund (NRE1807) from the State Key Laboratory of Nuclear Resources and Environment of the East China University of Technology, China. And also I will like to appreciate the support of the Nigeria Geological Survey Agency (NGSA) and Ahmadu Bello University Multi User laboratory for providing laboratory assistance, which have been very helpful throughout this research, we sincerely appreciate.

Reference

Akande SO, Ojo OJ (2000): petrology, Organic and Rock-Eval studies on rock Nigeria. NAPE Bull 16:22–38

Akande, & Adeleye, O. A S. O. (2004). Mineralogical and geochemical studies of phosphate nodules in the Dange Formation Sokoto basin, north western Nigeria. Jour. Mining & Geol., 40(2), 101-106.

Braide, S. P. (1993): Clay sedimentation facies; A Niger Delta example.

NAPG Bull, 8, 10, 61-73.

Etu-Efeotor, J. O. (1998): A review of the mineral resources potential of

Sokoto Basin. Journal of Mining and Geology, 34, 2, 171-180.

Geological Survey of Nigeria (GSN). (1986). Phosphate Exploration in Sokoto basin. Unpublished work.

Johnson, A. K., Pierre, R., & Lang, J. (2000). Le basin sedimentairea phosphates du Togo (Maastrichtian–Eocene): Stratigraphae, environnements et evolution. Jour. Afri. Earth Sci., 30(1), 183-200.

http://dx.doi.org/10.1016/S0899-5362(00)00015-4

Faure, H. (1996): Report de fin d champagne 1956. Less formation

sedimentaires du SE et de I'est de I'air (Niger). Arch. Dir. Fr. Mine et Geol-

ogy, Dakar.

Jones, B. (1948): Sedimentary rocks of Sokoto Province. Bull. GSN, 18, 1-79.

Kogbe, C. A. (1970): Preliminary Notes on the Geology of the Nigeria sector of the Iullemmeden Basin. Proceeding on 1st conference on African Geology, Ibadan, 219-229.

Kogbe, C. A. (1970): Preliminary Notes on the Geology of the Nigeria sector of the Iullemmeden Basin. Proceeding on 1st conference on African Geology, Ibadan, 219-229.

Kogbe, C. A. (1972): Geology of the Upper Cretaceous and Lower Tertiary sediments of the Nigeria sector of the Iullemmeden Basin. Geologische Rundschau. 62, 1, 197-211.

Roser, B. P. and Korsh, R. J., (1988): Provenance signatures of sand-stone-mudstone suites as determined using discriminant function analysis of Major element data. Chemical Geology, 67, 119-139

Sheldon, R. P. (1980). Episodicity of phosphate deposition and deep ocean circulation: a hypothesis. Spec. Publ. Soc.eon. Paleont. Tulsa, 29, 239-247.

Bertrand-Safarti, J. Moussine-Pouchkine, A. and Fabre, J. (1977): Geodynamique desaires sedimentaires cratoniques: quelques examples sahariens, Bull. Centres Reh. Expir, Elf Aquitaine, 1, 1, 217-231. .