



## **PALYNOLOGICAL STUDY AND AGE DATING OF THE EARLY MIOCENE DUKKU CLAYSTONE TYPE SECTION OF GWANDU FORMATION, SOKOTO BASIN, NORTHWESTERN NIGERIA**

**Ola-Buraimo A.O.<sup>1</sup>, Oladimeji R.G.<sup>2</sup> and Adamu K.W.<sup>2</sup>**

<sup>1,2</sup>Department of Geology Federal University Birnin Kebbi, Birnin Kebbi, Nigeria

<sup>2</sup>Department of Geological Sciences, Osun State University, Osogbo, Osun State, Nigeria

Corresponding author: [rolaburaimo@yahoo.com](mailto:rolaburaimo@yahoo.com), [olatunji.ola-buraimo@fubk.edu.ng](mailto:olatunji.ola-buraimo@fubk.edu.ng)

Tel: +2348033714079

### **Cite this article:**

Ola-Buraimo A.O., Oladimeji R.G., Adamu K.W. (2023), Palynological Study and Age Dating of the Early Miocene Dukku Claystone Type Section of Gwandu Formation, Sokoto Basin, Northwestern Nigeria. African Journal of Environment and Natural Science Research 6(1), 9-18. DOI: 10.52589/AJENSR-F7T6YNYK

### **Manuscript History**

Received: 28 July 2022

Accepted: 24 Aug 2022

Published: 3 Feb 2023

### **Copyright** © 2022 The Author(s).

This is an Open Access article distributed under the terms of Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0), which permits anyone to share, use, reproduce and redistribute in any medium, provided the original author and source are credited.

**ABSTRACT:** *Outcrop samples were collected from Dukku area for the purpose of subjecting them to palynological analysis in order to determine the relative age of Gwandu Formation and palaeoenvironment of deposition of the deposit. Field and laboratory methods were carried out in order to obtain lithological sequence description of the outcrop. The samples obtained went through processes of acid digestion with hydrochloric acid, hydrofluoric acid and separation of macerals by floatation with the use of zinc bromide. The prepared slides were observed under microscope for palynomorph contents. Diagnostic palynomorphs that are stratigraphically important for palynozonation were retrieved such as *Belskipollis eligans*, *Verrutricolporites laevigatus*, *Striamonocolpites* sp., *Retibrevitricolporites* sp., *Retibrevitricolporites obodoensis*, *Retistephanocolpites* sp., *Cingulatisporites ornatus*, *Longapertites marginatus* and *Proteacidites* sp. The marker fossils belong to Magnatariatites horwardii zone; Zone P600 and Subzone P630 and C1 Zone of Nigerian Niger Delta sedimentary basin zonal schemes, dated Early Miocene age. Dinoflagellate forms recovered include *Batiacasphaera* sp., *Senegalinium* sp., *Andalusiella polymorpha*, *Selenophemphix nephroides*, *Andalusiella* sp., *Andalusiella laevigata*, *Histrichosphaera turocona* and undifferentiated dinoflagellate cysts of peridinacean forms that belong to marginal marine setting.*

**KEYWORDS:** Early Miocene, Marginal marine, Palynozonation, Palynomorphs, Peridinacean, Type Section

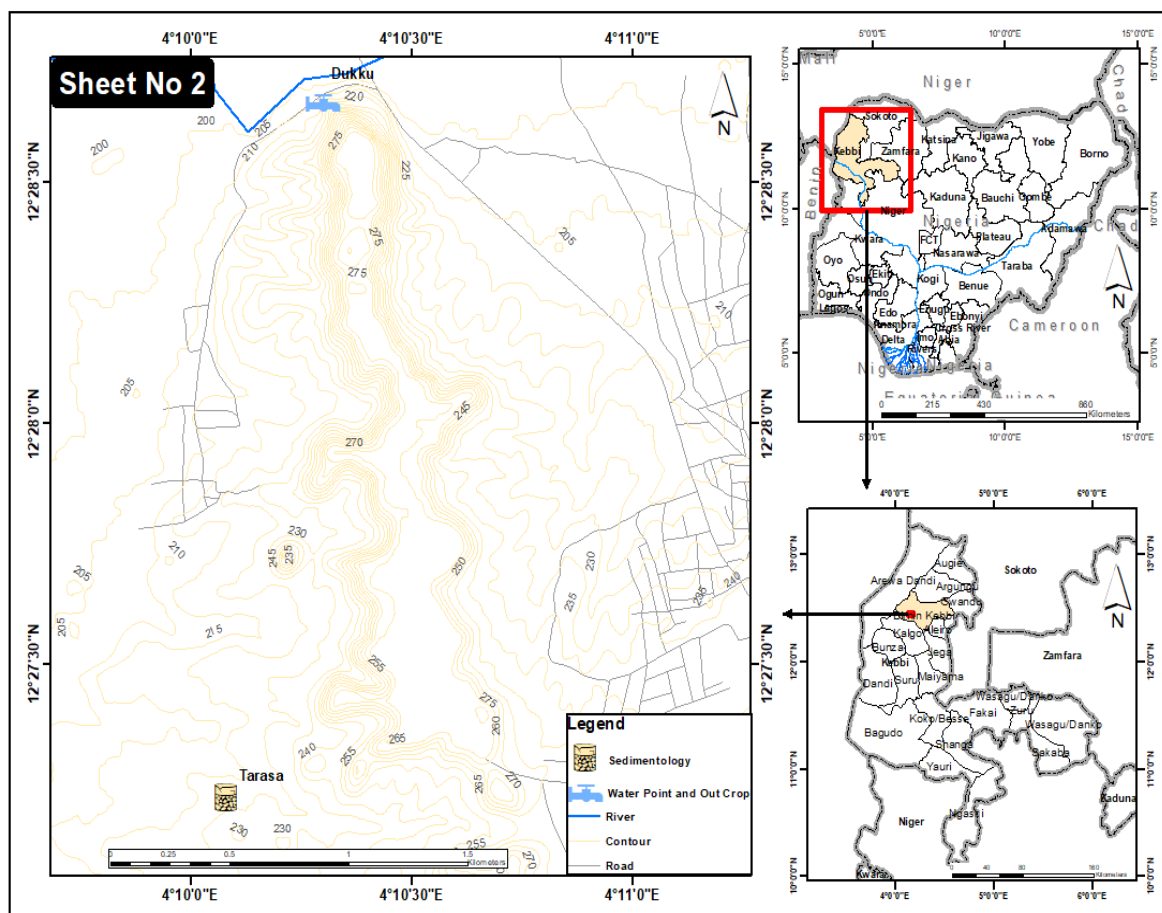


## INTRODUCTION

Palynology has become an increasingly important tool in basin analysis worldwide. However, in Sokoto Basin, information on sedimentary palynological studies are still limited with no detail and reliable reports on the palynological zones and geologic ages of formations present in the basin. The study area is located in the outskirts of Birnin Kebbi town between Longitude N12° 28' 50" to 12° 35' 0"N and Latitude E4° 10' 16" to 4° 15' 20"E (Fig. 1).

The Sokoto Basin is situated in northwestern Nigeria, underlain by sequence of semi consolidated sedimentary rocks which at the surface form undulating plains broken by hills which are capped by resistant crusts of laterite or ironstone. (Kogbe 1972, 1974 and 1979; Ola-Buraimo *et al.*, 2018; Ola-Buraimo and Ologe, 2020). The evolution of the Sokoto Basin went through four geological phases. Overlying the Pre-Cambrian Crystalline Basement unconformably are the Illo and Gundumi Formations, made up of grits and claystones; constitute the Pre-Maastrichtian "Continental Interclaire" of West Africa. They are overlain unconformably successively by mudstone and unconsolidated sandstones of Taloka and Wurno Formations constituting the Maastrichtian Rima Group. They are separated by the fossiliferous, shaley Dukamaje Formation. The Dange and Gamba Formations are composed mainly of shales separated by calcareous Kalambaina Formation of Paleocene age belonging to Sokoto Group. These subsurface sequences dip gently and thicken slightly towards the northwest with a maximum thickness of over 1,200 m on Nigerian side of the boundary with Niger Republic (Okosun, 1989, 1995, and Adeleye, 1975).

The geology of the area of study was described to contain different lithofacies varying from one location to another. Generally, the lithosequence was described to vary from high energy fluvial deposits of poorly sorted sandstone sitting unconformably on conglomeratic bed (Ola-Buraimo *et al.* 2018). The conglomerate is underlain by sandstone, siltstone and carbonaceous shale at the bottom; suggesting downward decrease in grain size, energy of transportation and deposition of the sediments (Ola-Buraimo *et al.*, 2018). The downward sequence was described to indicate varying paleoenvironment of deposition, suggested to vary from fluvial environment at the top, but prograded into deltaic setting at the bottom (Ola-Buraimo *et al.*, 2018).



**Figure 1. Location map of the study area**

## METHODOLOGY

### Palynological slide preparation

The samples collected from the field were selected at varying interval, sequentially. Samples were treated with hydrochloric and hydrofluoric acids to digest calcareous and siliceous materials present respectively. Finally, acetolysis to dissolve cellulose for easy identification of palynomorphs was carried out on the samples using zinc bromide. After the treatment, samples were mounted on slides and studied under Olympus CH30 microscope with attached camera for photography of preserved palynomorphs.

## RESULT AND INTERPRETATION

### Field and Lithological Description

The lithostratigraphic exposure was observed at Dukku hill near Dukku River very close to the bridge. The total thickness of exposure is about 21.83 m (Fig. 2) consisting of 2.6 m thick of variegated and laminated silty clay (Plate 3), characterized by loadcast structure (Fig. 2, Plate

4). This is overlain by 1.03 m thick, bulky red patched silty claystone. The red claystone is overlain by 1.43 m thick fossiliferous silty claystone (Plate 5), overlain by another 6.0 m thick claystone associated with loadcast structure; alternating with bioturbated silty claystone; capped at the top by 1.5 m thick ferruginized ironstone (Fig. 2).

The Gwandu Formation is characterized by different sedimentary structures which were observed on the outcrops. These include bioturbation, fracture, lamination, loadcast, preserved fossil imprint and herringbone structures as shown in Plates 1-6



**Plate 1. Bioturbation**



**Plate 2. Fracture**



**Plate 3. Lamina**



**Plate 4 Loadcast structure**



**Plate 5. Fossil**



**Plate 6. Herringbone structure**

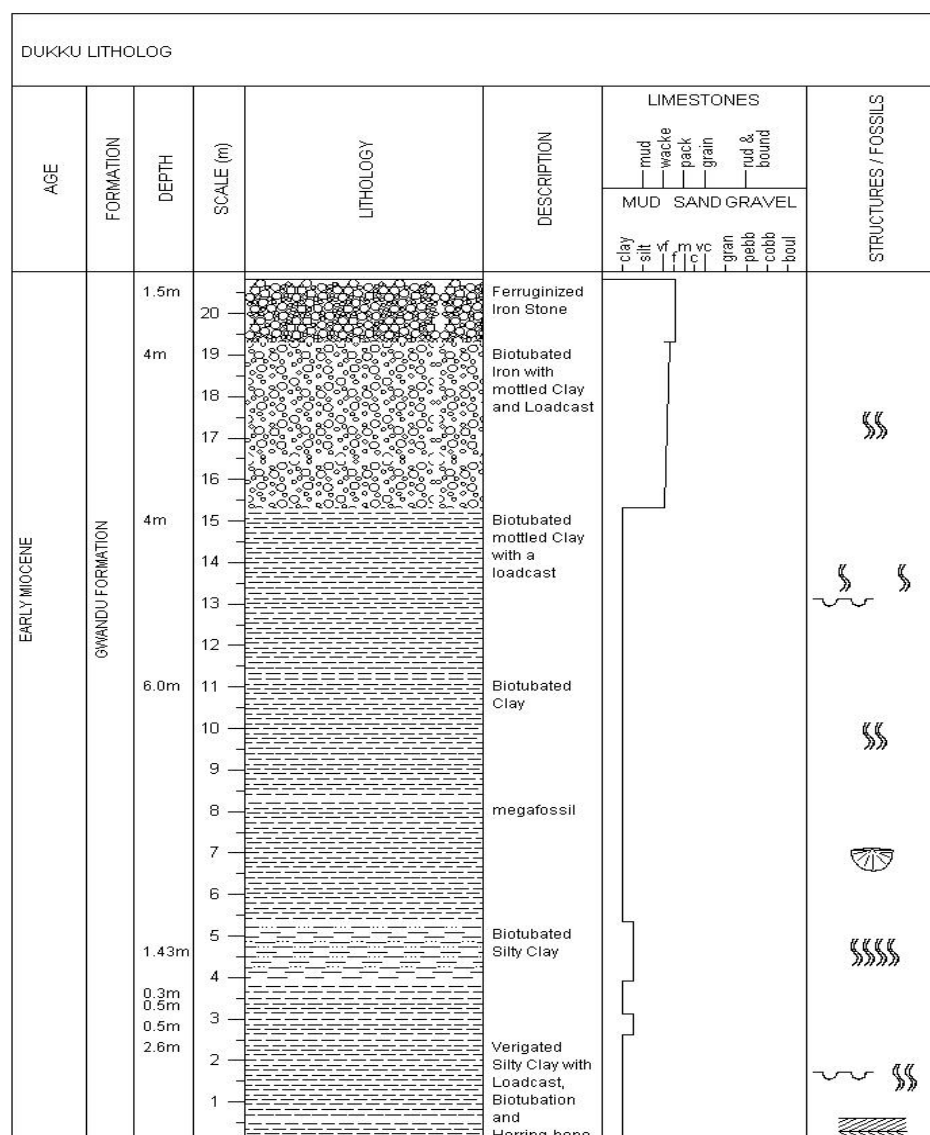


Figure 2. lithostratigraphic section of Gwandu Formation at Dukku hill

### Palynozone

The palynological zone erected for this study is after the works of Germeraad *et al.*, (1968), Evamy *et al.* (1978) and Legoux (1978). The interpretation of the analyzed samples was carried out on each sample. Details of the palynological zones and the basis of the establishments are given below.



## Sample W1

**Zone:** *Magnastriatites howardii* Zone (Germeraad *et al.*, 1968)

**Zone/Subzone:** P600 Zone/ P630 Subzone (Evamy *et al.*, 1978)

**Zone:** C1 Zone (Legoux, 1978)

**Age:** Early Miocene

**Characteristics:** The samples W1 is characterized by relatively moderate frequency of palynomorphs and moderate diversity of pollen and dinoflagellates in the ratio percentage of 65:35 % respectively. The sample has occurrence of diagnostic pollen such as *Belskipollis elegans*, *Longapertites microfoveolatus*, and other environmentally important dinoflagellates such as *Senegalinium* sp., *Andalusiella laevigata*, *P. polymorpha* and *Batiascasphaera* sp. (Fig. 2). Key fossils that characterize the interval include *Cingulatusporites ornatus*, *Proteacidites* sp. and *Longapertites marginatus* (Plate 7). The presence of *Belskipollis elegans* in the sample suggested Early Miocene age. This assemblage is similar to those reported in the works of Germeraad *et al.* (1968) for Tropical area sediments; similar to the palynozones established by Evamy *et al.* (1978) for Niger Delta sediments, Nigeria and also has resemblance to the work of Legoux, 1978 for the Neogene sediment of Niger Delta, Nigeria. The paleoenvironment of deposition is marked by dominance of peridinacean forms of dinoflagellates constituting 35 % of the palynomorph suite; depictive of marginal marine environment (Ola-Buraimo, 2020; Ola-Buraimo and Ehinola, 2021).

## Location W2

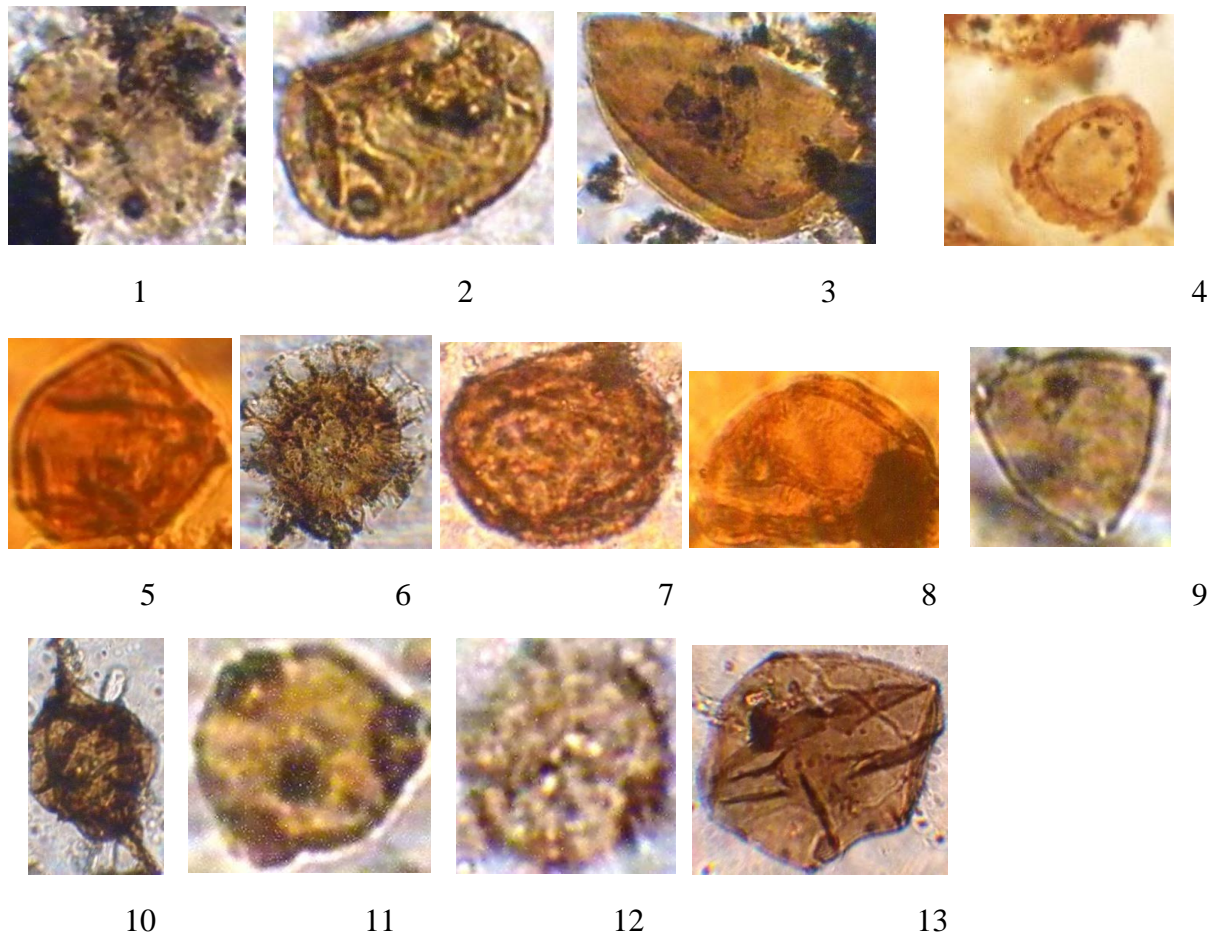
**Zone:** *Magnastriatites howardii* Zone (Germeraad *et al.*, 1968)

**Zone/Subzone:** P600 Zone/P630 Subzone : (Evamy *et al.*, 1978)

**Zone:** C1 Zone (Legoux 1978)

**Characteristics:** The sample W2 is characterized by relatively moderate frequency of palynomorphs and moderate diversity of pollen and dinoflagellates, with a percentage ratio of 59:41 % respectively. The palynomorphs recovered include *Retibrevitricolporites* sp and *Verrutricolporites laevigata* in relatively high frequency; other stratigraphically important marker fossils that co-occurred in the interval are *Striamonocolpites* sp., *Proteacidites* sp., *Retibrevitricolporites obodoensis*, *Laevigatosporites* sp. and *Longapertites* sp. (Fig. 2). The co-occurrence of *Retibrevitricolporites obodoensis*, *Retibrevitricolporites* sp. and *Striamonocolpites* sp. are indicative of Early Miocene age deposit (Germeraad *et al.*, 1968; Evamy *et al.*, 1978 and Legoux, 1978). Therefore, the Gwandu Formation is hereby dated Early Miocene age in contrary to Eocene age ascribed to it by earlier workers. The paleoenvironment of deposition is marked by appearance of dinoflagellate cysts such as *Senegalinium* sp., *Histrichosphaeridium turocona* and *Andalusiella* sp. (Plate 7). The quantitative occurrence of dinoflagellate cysts constituting 41 % of the total sum of palynomorphs recovered is indicative of marginal marine environment (Ola-Buraimo, 2020). The marginal marine paleoenvironment deduced here corroborate the marginal marine environment suggested by Ola-Buraimo *et al.*, (2018) based on abundant fossils occurrence embedded in one of the claystone beds in the outcrop at Dukku river, outskirts of Birnin Kebbi.





**Plate 7. Assemblage of some recovered Palynomorphs in Gwandu Formation at Dukku Hill**

- 1 *Cyathidites* sp.
- 2 *Laevigatosporites* sp.
- 3 *Longapertites microfoveolatus*
- 4 *Cingulatisporites ornatus*
- 5 *Phelodinium* sp
- 6 *Histrichosphaeridium turocona*
- 7 *Selenopemphix nephroides*
- 8 *Longapertites marginatus*
- 9 *Proteacidites* sp.
- 10 *Andalusiella polymorpha*
- 11 *Retibrevitricolporites obodoensis*





- 12 *Batiacasphaera* sp.  
13 *Andalusiella laevigata*

## CONCLUSION

Lithofacies present in the study outcrop are mainly claystone, silty claystone, siltstone and ferruginised iron stone. The variation in the facies might have been as a result of adjustment of sea level and other geological factors such as lithological composition of the depositing medium and possibly structural style of the Sokoto Basin. Repetitive sequence, joints, fractures, intense bioturbation and fossilization of marginal marine mega fossils are present in the claystone facies.

Presence of marker fossils such as *Belskipollis eligans*, *Verrutricolporites* sp., *Belskipollis elegans*, *Retibrevitricolpites* sp., *Striamonocolpites* sp. and *Retibrevitricolpites obodoensis* depicted Early Miocene age for the Gwandu Formation. The paleoenvironment is marginal marine based on the abundance of peridinacean dinoflagellate forms.

## Acknowledgement

The authors are grateful to Department of Geology, Federal University Birnin Kebbi for permitting us to use the laboratory for palynological sample preparation and slide analysis through use of microscope. We thank the management of Palystat Limited for provision of literature materials used for analysis and interpretation.

## REFERENCES

- Adeleye, D.R. (1975). Nigerian Late Cretaceous stratigraphy and paleogeography. *Bull. Am. Assoc. Petrol. Geol.* 59: 2302-2313.
- Evamy D.D., Heremboe, J., Kemeling P., Knaap W.A., Morlly F.A., and Rowlands P.H. 1978. Hydrocarbon habit of Tertiary Niger Delta. *American Association of Petroleum Geologists Bulletin*, 62:1-39.
- Germeraad, J.H., Hoppings, C.A. and Muller, J. (1968). Palynology of Tertiary Sediments from tropical areas. *Review of Palynology*, 189-348.
- Kogbe, C.A. (1972). Geology of the Upper Cretaceous and Lower Tertiary sediments of the Nigeria sector of the Lullemeden Basin. *Geologische Rundschau*. 62(1): 197-211.
- Kogbe, C.A. (1976). Outline of the geology of the Illumedden Basin in Northwestern Nigeria. In: C.A., Kogbe (ed.), *Geology of Nigeria. Elizabethan Publ. Co., Surulere (Lagos), Nigeria*, 331- 343.
- Kogbe, C.A. (1979). Geology of the South-Eastern (Sokoto) Sector of the Lullemeden Basin. *Department of Geology, Ahmadu Bello. University Zaria Bulletin*, 32-142.
- Legoux, O. (1978). Quelques Espèces De Pollen Caractéristiques Du Neogene Du Nigeria. *Centres de recherches exploration-production ELF-Aquitaine*. 2(2): 265-317.
- Okosun, E.A. (1989). A review of the stratigraphy of Dange Formation, Paleocene NW Nigeria. *Newl. Straigr.*, 21(1): 39-42.



- 
- Ola-Buraimo, A.O. (2020). Palynozonation Chronostratigraphy of deposition of the Albian to Pliocene Sediments of the Nzam-1, Umuna-1, and Akukwa-2 wells Anambra Basin, Southwestern Nigeria. *University of Ibadan PhD thesis*, 182p.
- Ola-Buraimo A.O. and Ehinola O.A. 2022. Sequence stratigraphy and sea level changes in relation to Evolution of Anambra Basin, Southeastern Nigeria. *Savanna Journal of Basic and Applied Sciences*, 3(2): 124-138.
- Ola-Buraimo, O.A., and Ologe, O. (2020). Geochemical Investigation of Groundwater in Some Parts of Birnin kebbi, Northwestern Nigeria. *Global Journal of Science Frontier Research: H Environment and Earth Science*, 20(6): 40-52.
- Ola-Buraimo, A.O., Ologe O. and Benemaikwu, D.O. (2018). Field geology and microbiological investigation of Borehole, Public Tap Water and Hand-dug wells in some parts of the Birnin Kebbi, Kebbi state, Northwestern Nigeria. *Nigerian Journal of Scientific Research*.17(3): 322-333.