

ORGANIC GEOCHEMICAL CHARACTERIZATION AND SOURCE ROCK EVALUATION OF SHALES AROUND GBOKO, MIDDLE BENUE TROUGH, NIGERIA.

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Abstract - The Lower Cretaceous Shales in Gboko were sampled in 20 locations and analyzed for their organic content and, evaluated for source rock potential. The results showed that the Total Organic Carbon test (TOC) ranged from 0.5 to 1.2 %, the Soluble Organic Matter (SOM) ranged from 53 to 11,656 ppm, Saturated Hydrocarbon Content (SHC) ranged from 2 to 3043ppm while Carbon Preferences Index (CPI) ranged from 0.9 to 1.2%. The highest TOC, SOM and SHC were recorded in Ulla village with TOC as high as 7.4%, indicating overcooking. Generally, the values of these parameters indicate mature source rocks for these Shales which belong to the Nkalagu Formation and, could be further investigated.

Keywords: Albian Shales, Gboko, Source rock, Hydrocarbon content, Nkalagu Formation.

1. INTRODUCTION

The discovery of commercial quantities of petroleum in the nearby Republic of Chad has recently attracted geophysical and other investigations on the Nigeria side of the Chad Basin and the adjoining Benue Trough. The Benue Trough is an elongate structure that stretches from the Niger Delta with a broad base and tapers Northwards (Fig. 1). It is a sediment-filled basin to a thickness of about 6,000m, made up of sequences of sandstone, thick shale and thin limestone strata. These were deposited during the marine transgression in the Early Cretaceous.

The utilization of geochemical inputs into basinal studies and evaluation for petroleum potential, was put to use in Gboko by investigating the concentration and maturation of organic matter from 20 shale samples. Geochemical parameters used include the distribution of chemical and molecular markers, and maturity indices which include Carbon Preference Index (CPI), the ratios of Soluble Organic Matter (SOM) to Total Organic Content (TOC) and that of Saturated Hydrocarbon Content to Total Organic Content. Fresh samples of shale of this (Mid-Albian) Nkalagu Formation (Petters and Ekweozor), 1981) in Gboko exhibited identical n-paraffin distribution and Carbon Preference Index (CPI) ranging from 1 to 1.5. The ratios of SOM/TOC and SHC/TOC were generally high indicating maturity.

2. LOCATION AND GEOLOGY

Gboko, located about 62km Southeast of Makurdi, Benue State, Nigeria, lies approximately between Latitude 7° 37'N and Longitude 9.05°E and, Latitude 7.35°N and Longitude 8.84°E. (Fig.1). It belongs to the Nkalagu Formation and part of the Benue Trough Sedimentary Basin (Petters and

Ekweozor,

1981).

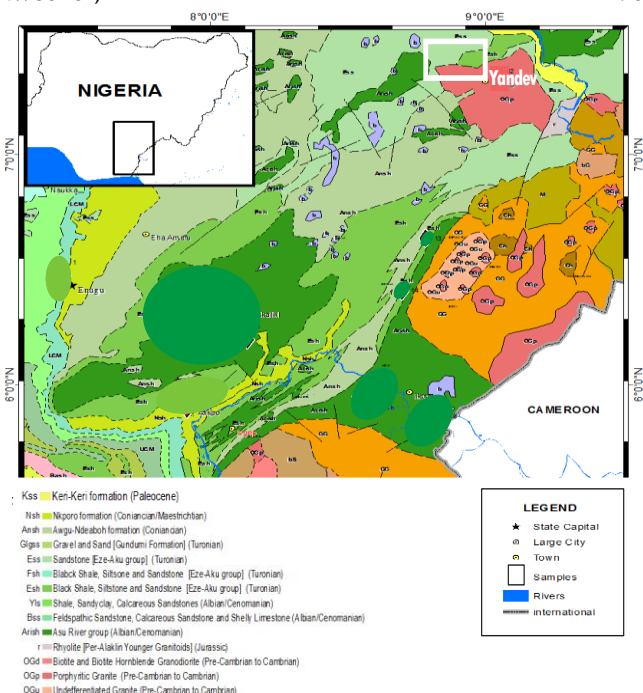


Fig. 1: Geologic Map of Nigeria showing the study area

The Nkalagu Formation in this locality is composed of a sequence of Limestone about 18m thick (evidence from road cuts) which is overlain by Sandstone of the Markurdi Sandstone. This Limestone unit is underlain by dark splintery shale of Early Cretaceous age (Petters, 1979). It is this shale that was studied in this work. *Inoceramus* impressions are common in this shale unit.

Foraminifera and Calcareous nanoplanktons confirm this Early to Mid- Cretaceous age for the type section (Petters and Ekweozor 1982). 20 samples were collected for this study. Some were collected from road cuts and others from auger-drilled holes to depths of approximately 2.5m.

3.0 MATERIALS AND METHOD

The Total Organic Carbon Content (TOC, % C_{org}) of the shales in this study was determined following the procedures described by Philippi (1965). The Soluble Organic Matter (SOM) was extracted with toluene: methanol (3:1) solvent mixture by ultra-sonic agitation (MSE ultrasonic Disintegrator) and quantified relative to the dry weight of the corresponding shale. Saturated Hydrocarbon Fraction (SHF) was also quantified relative to the dry weight of the sample. The SHC was separated into straight chains and branched or cyclic alkane fractions by urea reduction and then analyzed by gas chromatography as described by Leplat 1966. Recognition of specific biomarkers, such as Pristane, Phytane and n-alkane was by co-injection with authentic standards. (Harry et al 2017; 2018)

4.0 RESULTS AND DISCUSSIONS

Table 1 shows the results of the analysis. They indicate very high percentage of Organic Carbon (% C_{org}). This feature together with the presence of abundant planktonic foraminifera and sparse or total absence of benthic fossils, suggest anaerobic bottom conditions. These shales were deposited in the oxygen-deficient marine environment during the Mid Cretaceous. This environmental condition favoured the preservation of large quantities of organic carbon and therefore, making the shales rich hydrocarbon source beds (Offodile 1976). The Nkalagu Carbonaceous Shales at Gboko also have very high SOM values compared to the adjoining Imo and Nkporo Formations of Petters and Ekweozor (1982). The concentration of C_{15} saturated hydrocarbons (SHC) were generally below (100ppm) except for samples 6, 7, 8 and 15. Sample 8 has exceptionally high values of both SOM and SHC. All samples showed a smooth distribution of the n-alkanes, re-miniscent of crude oil. Another significant feature is the high acyclic alkanes, particularly in the C_{21} to C_{27} n-paraffin region.

5.0 CONCLUSION

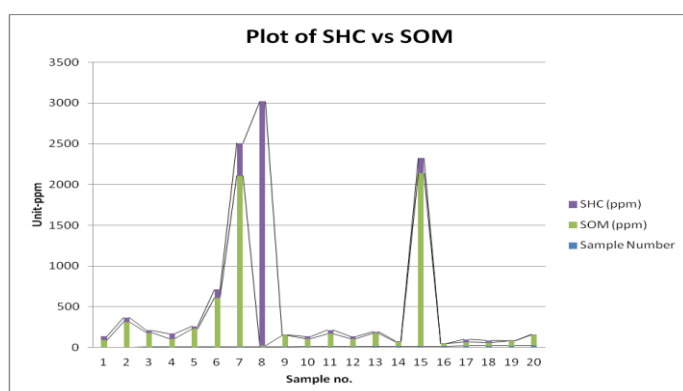
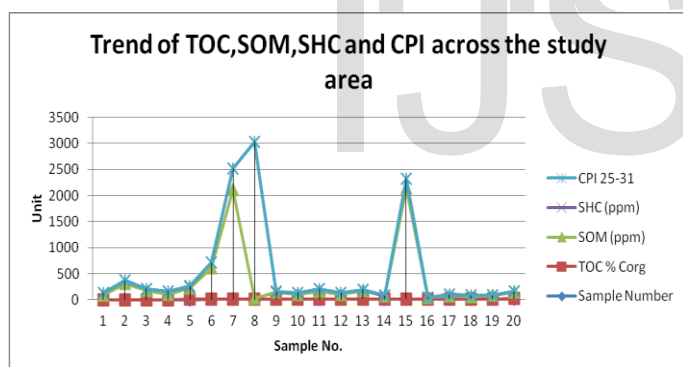
Studies of several sedimentary basins have shown that there is a correlation between the thermal evolution of sedimentary organic matter and geochemical parameters like Carbon Preference Index (CPI $_{25-31}$), Soluble Organic Matter (SOM), Total Organic Matter and Soluble Hydrocarbon Content (SHC), Philippi (1965), Leplat (1966) and Levinson (1974). That the Bituminous Shales at Gboko are mature is suggested by their low CPI (about 1.1) and high SOM and SHC. Based on the results of the geochemical analysis of the shales, it is evident that the Nkalagu Formation within the Middle Benue Trough is the major petroleum source bed in the middle Benue Trough.

Table 1: Organic Geochemical Data for shale samples from Gboko, Middle Benue Trough.

Sample Number	TOC	SOM	SHC	CPI
	% C_{org}	(ppm)	(ppm)	25-31
1	1	88	45	1.2
2	0.9	310	54	1.3
3	0.5	175	31	1.1
4	0.6	102	62	1.1
5	1.2	222	32	1.1
6	4.9	602	102	1.2

7	3.7	2100	402	1.1
8	7.2	11.66	3001	1.1
9	0.9	140	5	1.1
10	0.4	95	30	1.1
11	1.1	156	45	1.1
12	1.4	93	31	1.1
13	1.2	162	16	0.9
14	0.8	54	11	1.1
15	0.8	2121	190	1.1
16	0.8	27	5	1
17	1.5	47	33	1.1
18	0.6	40	27	1.2
19	0.5	63	1	1.1
20	0.6	131	8	1.1

TOC % Corg – Total Organic Carbon percent
SOM – Soluble Organic Matter
SHC – Saturated hydrocarbon fraction
CPI – Carbon Preference Index



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