Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 6, Issue, 03, pp.5600-5604, March, 2014

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

INVESTIGATION OF LATERAL CONTINUITY OF BITUMINOUS SANDS IN PARTS OF THE EASTERN DAHOMY BASIN, NIGERIA

[1]Ayodeji K. Ogundana, [2]Jamiu A. Aladejana, [3]Oluwakemi O. Oladapo-Adeoye and [4*]Abel O. Talabi

[1]Department of Geology, Afe Babalola University, Ado-Ekiti
[2]Department of Geology, University of Ibadan
[3]Department of Physics, Adeyemi College of Education, Ondo
[4]Department of Geology, Ekiti State University, Ado-Ekiti

ARTICLE INFO

Article History:
Received 18th December, 2013
Received in revised form
14th January, 2014
Accepted 19th February, 2014
Published online 25th March, 2014

Key words:

Lateral Continuity,
Bituminous sand,
Coring and Thinning-out.

ABSTRACT

Investigation of the bituminous sand in parts of the eastern Dahomy basin was conducted to establish its lateral continuity across the area. The study area cuts across Irele and Odigbo Local Government Areas of Ondo State and Ovia-West Local Government Area of Edo State, Nigeria. Five core holes (BTW–1, BTW–2, BTW-3, BTW-4, and BTW-5) each of diameter 75mm were bored using mechanical rig. BTW-1 and BTW-2 are located at Ayadi village and Ajana-Ejidokun in irele and Odigbo Local Government Area of Ondo State respectively while BTW-3, BTW-4 and BTW-5 are located within Ibru Farm in Ovia-West Local Government Area of Edo State. Seven different lithologic units (Lateritic Topsoil, Sand, Shaly-sand, Shale, Limestone, Bituminous sand and Basement) were identified. The average overburden thickness in the study area is 14.8m while the average depth to the basement is 34m. Wells BTW-3, BTW-4 and BTW-5 encountered basement at shallow depths of 30m, 42m and 30m respectively indicates reduction in depth to basement towards north-eastern sector of the study area. The average Correlation of the holes revealed two bituminous horizons encountered by wells BTW-2, BTW-3 and BTW-4 while wells BTW-1 and BTW-5 encountered one bituminous horizon. The average thickness of the first bituminous horizon is 1.7m while that of the second bituminous horizon is 3m. Results of the study have established lateral continuity of the bituminous sand across the area but with reduced thickness towards Ovia-West Local Government Area of Edo State, Nigeria.

INTRODUCTION

Bitumen is a tar-like mixture of hydrocarbons derived from petroleum. The tar is the thick, dark, inflammable liquid distilled from wood, coal and other organic matter. It is used for preservation of wood and iron, road construction and as an antiseptic. The two common source of bitumen are; primary and secondary. Primary bitumen are the type found in seepages/outcrops which are formed from degraded hydrocarbon as in the tarsand belt of Nigeria while the secondary one is the product of refineries as one of the end member of functional distillation. Primary bitumen may occur both as surface and subsurface deposits. Surface occurrences are the bituminous and sediments impregnated with tarry oil as observed in some parts of Ogun and Ondo States extending along the tributaries of Siluko River at Ofosu Village in Edo State. They are seen as seapages on some farmlands, river banks and slope breaks. Sub-surface occurrences of bitumen have been encountered by shallow hand dug wells, boreholes and core wells.

Corresponding author: Abel O. Talabi,
Department of Geology, Ekiti State University, Ado-Ekiti

Bitumen exploration in Nigeria began in 1905 when Mineral Survey of Southern Nigeria drilled sixteen (16) shallow boreholes in the southern-most part of a line of oil seepage now known as the tarsand belt (MMSD, 2010). The well drilled near Mafooku and Eregu Valley encountered bituminous section over the depth range of 4m to 9m with overburden thicken generally less than 7m. The Nigerian Bitumen Corporation (NBC) also carried out some investigation between 1907 and 1914. Fifteen boreholes were drilled around the towns of Oso, Sumoge, Mofere, Oke-Oyibo and Oniparata. The borehole penetrated variable thicknesses of bitumen-impregnated sands and grits and eleven of those wells encountered basement. Other groups of companies including both public and private have also carried out some works leading to the drilling of over one hundred and fifteen (115) boreholes and coreholes across the basin. Most of the coreholes confirmed the presence of bitumen (MMSD, 2010). One of the most extensive investigations was carried out by the Geological Consultancy Unit of the University of Ife (GCU) now Obafemi Awolowo University between 1974 and 1980. In 1976, GCU after drilling a number of boreholes concluded that bitumen – impregnated sands were probably continuous in the subsurface

and could be utilized in the road construction and petrochemical industries.

Based on previous work, bitumen resource estimate has been put at thirty one (31) billion metric tons. Recoverable bitumen from the oil and exploitable by open cast mining technique is in the order of 1.079 billion barrel while the hydrocarbon potential resource for the Okitipupa structure (over which the oil and heavy oil are known to occur) is put at 1.5 billion barrel bitumen (MMSD, 2010). Geological Consultancy Unit of the University of Ife (GCU) suggested the probability of subsurface continuity of impregnated tar sands across the study area and the escalated global energy demand in the 21st century has also called for alternative source of hydrocarbon to complement the conventional crude oil. Hence, there is need for further investigation to confirm the lateral continuity of bituminous sand across the basin. However, this study was conducted to investigate the lateral continuity of bituminous sand across the southeastern part of Dahomey basin in order to better evaluate tarsand continuity that area of the basin.

Study locations

The study area lies within the eastern Dahomy basin and cuts across two local government areas in the southwestern part of Nigeria, which include; Irele and Odigbo Local Government Areas of Ondo State and Ovia-West Local Government Area of Edo State, southern Nigeria. BTW-1 is located in Ayadi in Irele Local Government Area of Ondo State on latitude 004° 53.66' E and longitude 06° 38.362' N while BTW-2 is located in Ajana-Ejidokun in Odigbo Local Government Area of Ondo State on latitude 004° 53.566' E and longitude 06° 38.362' N. BTW-3, BTW-4 and BTW-5 are located within Ibru Farm in Ovia-West Local Government Area of Edo State on latitude 004° 53.566' E and longitude 06° 38.362' N, latitude 005° 09.095' E, and longitude 06° 42.745' N and latitude E005° 09.110', and longitude N06° 42.558' respectively (Figure. 1).

Geology of the study area

The study area lies within the Dahomy basin (Figure 1). The stratigraphy of the basin was studied by Billman (1976) and reviewed by Omatsola and Adegoke (1981) on the basis of new subsurface data. The basin is one of the sedimentary basins of the continental margin of the Gulf of Guinea. The basin extends from the Volta Delta complex in South Western Ghana in the west through Republic of Togo, Benin and to the west of the Niger Delta. The basin, bounded by latitude 6°30′N and 6°45′N and longitude 4°45′E and 5°15′E is separated from the Niger Delta by a major regional fault structure, the Benin Hinge line (Jones and Hockey, 1964; Murat, 1970; Omatsola and Adegoke, 1981; Whiteman, 1982). To the west of the Benin Hinge line is the Okitipupa Ridge (Adegoke *et al*., 1980; Omotsola and Adegoke, 1981). The Dahomy basin encloses Cretaceous to Recent coastal/continental shelf sediments, which thicken markedly into offshore. The stratigraphy of Dahomy basin includes; Abeokuta formations, Ewekoro formations, Imo-Shale and Oshosun (Figure 2) formations respectively though previous studies carried out in the tar sand belt have shown that not all the stratigraphic units identified in the Dahomy basin occur in the study area. The Okitipupa structure of the eastern part of the basin is made up of Upper Cretateous sediments which on lap the crystalline basement complex rocks of Precambrian age. The occurrence of tar sands seem to be restricted to this portion of the basin and a band of bitumen seepage occurs along the north eastern fringe of the Okitipupa structure. The Upper Cretaceous sediments are largely made up of terrigenous clastic materials of clay, shale intercalated with sand, limestone and calcareous shale, micaceous shale and clays containing grains of glauconite and pyrite. The lower cretaceous sediments comprise of feldspathic sandstone, ferruginised conglomeratic sequence of very coarse, pebbly to fine gritty clastic with partly weathered feldspar crystals. The sandstones are massive and poorly sorted while the claystones are silty,

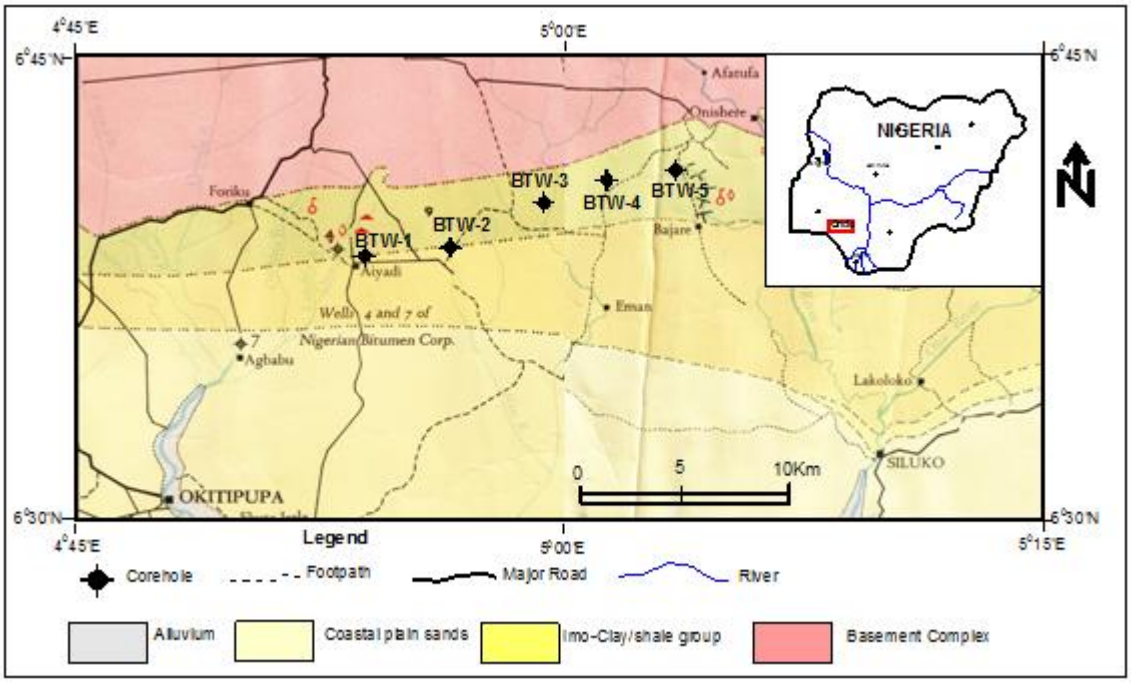

Figure 1. Geological map of the study area with Wells locations

micaceous and sometimes with thinning bands of white kaolinitic clays. Three formational units, the Ise Formation (Neocomian – Albian), Afowo Formation (Cenomanian – Coniacian) and Araromi Formation (Maasstrichtian – Danian) were grouped out of the combination of both Upper and Lower cretaceous succession.

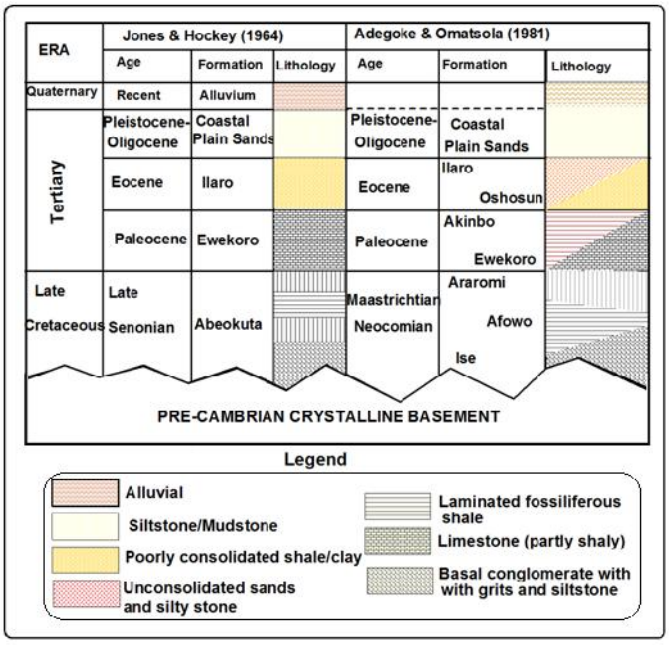

Figure 2. Stratigraphic profile of eastern part of Dahomey Basin including the study area. (Adapted from ADEGOKE and OMATSOLA 1981)

MATERIALS AND METHODS

Intensive literature review was carried-out from which all previous work done on the Bitumen exploration in the Dahomy basins were studied to examine the locations of existing exploration holes within the marked blocks. Reconnaissance survey which includes geologic/geophysical study was carried out after which five suitable sites were selected for coring at different localities. A mechanical core rig with all necessary accessories (60 pieces of 3m long steel drilling rods, 2 water swivels, 2 hoisting plugs, 3 core barrels, 3 core-diamond bits, 3 core-alloy bits, 2 dragon bits, 2 tricone rock-roller bits, 5 pipe wrenches, 30 pieces of 2m long p.v.c treaded casings 3 1000l of water storage thanks, 25 conventional core boxes, 2 standby light generating sets, etc.) were deployed to the various sites. The rig was positioned and mud pit was dug and properly lined to avoid soil and groundwater pollution at each location. Full-hole coring was adopted with the aid of a rotary drilling method. Cores were mechanically retrieved from the barrel while ditch cutting samples were collected where there was no core recovery (Fig. 1a and b). Necessary safety precautions were taken to protect the personnel involved and the environment. At the end of the well, the mud pit was evacuated, cleaned up and properly covered with earth material. The land was restored back to the initial status before drilling commenced at each location. Recovered cores and ditch cutting samples from each core wells were studied; the different lithologic units/horizons encountered by each core wells were recorded and correlated across the entire study area to determine their lateral continuity.

RESULTS

Lithologic/Geologic Description of the Wells

BTW-1 revealed lateritic topsoil with depth ranging from 0-3m. Underlying this topsoil is a shale unit (3-20m) of 17meters thickness. Below this shale unit is a thin bed of Bitumen or Tar sand layer of 1meter thickness. Underlying the sedimentary layer which is the oldest of the stratigraphic unit is the Shale unit with depth ranging from 21 to 26m indicating thickness of 5meters. This shale unit lies conformably on the limestone of the Ewekoro formation where the well terminated

Figure 3. Drilling rig and Core box containing core samples

(Table1, Figure 4). BTW-2 comprised of 6meters lateritic topsoil overlying a relatively thin bed of Bitumen (Tarsand) of 1.5m thickness. Underlying bitumen layer is a Shale unit of depth ranges from 7.5-15m with layer thickness of 7.5meters. Under this is a second layer of relatively thick bed of Bitumen (3m) that is depth range of between 15 and 18m. The oldest of the stratigraphic units is the intercalation of shale, sandy-shale, shaley-sand and sand units from 18 to 38m with thickness of 20meters which overlies the limestone of the Ewekoro formation where the well terminated (Table1, Figure 4). BTW-3 revealed first layer of lateritic sand unit with depth ranging

Table 1. Well log correlation

Lithological Description	BTW-1	BTW-2	BTW-3	BTW-4	BTW-5
Overburden Thickness	20	6	12	11	25
First Tar Sand Thickness	1	1.5	3	1	2
Second Tar sand Thickness	-	3	3	3	-

Table 2. Summary of the Lithology Thickness across the study area

Well name	Co-ordinate			Lithology					
	Easting	Northing	Depth (m)	Top soil	Sand	limestone	Shally sand	Shale	Bitumen
BTW-1	E004.8927	N06.6393	Top	0	-	-	-	3	20
			Base	3	-	-	-	20	21
			Thickness	3	-	-	-	17	1
BTW-2	E005.2099	N7.24700	Top	0	-	-	-		6
			Base	6	-	-	-		7.5
			Thickness	6	-	-	-		1.5
BTW-3	E005.2099	N7.24710	Top	0	3	-	6	9	12
			Base	3	6	-	9	12	15
			Thickness	3	3	-	3	3	3
BTW-4	E005.1515	N06.7124	Top	0	3	9	-	10	11
			Base	3	9	10	-	11	12
			Thickness	3	6	1	-	1	1
	E005.1518	N06.7093	Top	0	6	15	-	21	25
BTW-5			Base	6	15	21	-	25	27
			Thickness	6	9	6	-	4	2

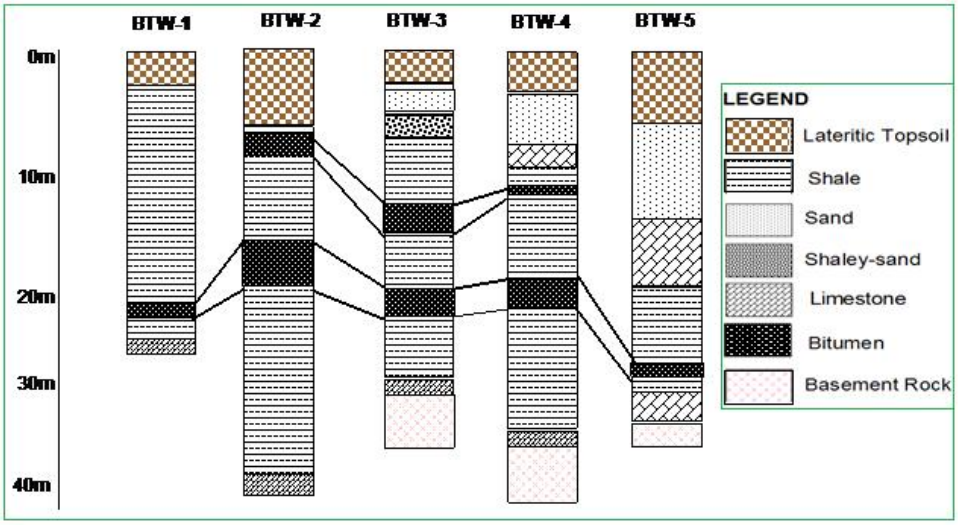

Figure 4. Well Stratigraphic Cross-sections across the Study area

from 0-3m and thickness of 3meters (Table 1). Underlying this lateritic sand unit is a stratigraphic sand unit of 3meters thickness and depth ranges from 3-6m. Below this sand unit is a thin bed of clayey-sand unit commencing from 6m and terminating at 9m. Underlying the sedimentary layer which is the oldest of the stratigraphic unit is the Shale unit with depth ranging from 21 to 27m with thickness of 6meters which is unconformably overlying the Precambrian basement rock underlying the whole basin in which the well terminated (Figure 4.). BTW-4 encountered first layer which consists of lateritic sand unit of 3meters thickness and depth ranging from 0-3m. Underlying this first layer is a stratigraphic sand unit with layer thickness of 6meters and depth range from 3-9m. Below this sand unit, is a thin bed of limestone unit from 9 to] 10m below the surface with layer thickness of 1m. Underlying the limestone layer is the stratigraphic unit comprising of shale with thickness of 6meters and depth ranging from 21 to 27m. This shale unit is underlay by the first thin bitumen bed of 1m thick. The second bitumen bed was encountered after a shale layer (3m thick) ranging from 15 to 18m below the surface. A thick shale bed of between 18 and 39m with underlying layer of limestone of 3m thick unconformably overlies the Precambrian basement rock in the study area. (Table 1, Figure 4). In BTW-5, the stratigraphic units consist of lateritic sand, sand, limestone and shale units with depth ranges from 0 - 6, 6-15, 15-21 and 21-25m, thicknesses of 6, 9, 6, and 4meters respectively(Table 1). These stratigraphic units are underlain by Bitumen with depth ranges from 25 - 27m and limestone of 2m thickness which unconformably overlies the Precambrian basement rock (Figure 4).

Conclusion

Seven different lithologic units were established namely; lateritic topsoil, sand, shaly-sand, shale, limestone, bituminous sand and basement. The various lithologic units were correlated and the lateral continuity especially for the bituminous sands was established (Table 1, Figure 4). Two bituminous horizons were encountered by three of the wells

namely; BTW-2, BTW-3 and BTW-4 while BTW-1 and BTW-5 encountered one bituminous horizon each. Average thickness of the first bituminous horizon is 1.7m while the average thickness of the second bituminous horizon is 3m. Three of the wells namely; BTW-3, BTW-4 and BTW-5 encountered basement at shallow depths of 30m, 42m and 30m respectively.This study has investigated the lateral continuity of bituminous sand using core logging; a method believed to be the most reliable for subsurface delineations. Bituminous bed was observed to be thinning-out towards the north-eastern part of the study area and basement was also encountered at shallower depth which indicates the contact zone. Subsurface lateral continuity has been established in some parts of the south-eastern end of the Dahomy basin in this study. However, more detail work may be required in other parts of the basin to further establish subsurface continuity of bituminous sand in the area

REFERENCES

Adegoke, O. S., Ako, B. D. and Enu E. I. 1980. Geotechnical investigation of the Ondo State bituminous sands. Vol.1. Geology and Reserves Estimate. Unpub. Rept., Geological Consultancy Unit, Department of Geology, University of Ile-Ife, 257p.

Adegoke, O. S., Omatsola, M. E. and Coker, J. L. 1991. The geology of the Nigerian tar sands. In: Heavy crude and tarsands hydrocarbons for the 21st century. Proc. 5th UNITAR Intern. Conf. on Heavy Crude and Tarsands 1991: 369 – 385.

Billman, H.G. 1976. Offshore stratigraphy and paleontology of the Dahomey embayment. Proceedings of the 7th African Micropaleontological Colloquium, March 16-28, 1976, Ile-Ife, Nigeria, pp: 27-42.

Federal Ministry Of Mines And Steel Development, 2010. Tarsand and Bitumen Exploration in Nigeria. 14pp.

Jones, H. A. and Hockey, R.D. 1964. The Geology of part of Southwestern Nigeria, GSN Bulletin No. 31- 101

Murat, R.C. 1970. Stratigraphy and paleography of the Cretaceous and Lower Tertiary in southern Nigeria. In: T.F.G. Dessauvagie and A.J. Whiteman .Ed. African Geology. Ibadan University Press 251-266.

Murat, R.C. 1972. “Stratigraphy and Palaeogeography of the Cretaceous and Lower Tertiary in Southern Nigeria”. In: *African Geology*. Dessauvagie, F.J. and Whiteman, A.J. (eds). University of Ibadan Press: Ibadan, Nigeria. 251 – 266.

Omatsola, M.E. and Adegoke, O. S. 1981. Tectonic evolution and Cretaceous stratigraphy of Dahomey Basin. Jour. Min. Geol., 1. Pp 130-137.

Whiteman, A. 1982. *Nigeria: Its Petroleum Geology, Resources and Potentials*. Vol. 1 and 2. Graham and Trotman Ltd.: London. UK.

****