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Palynofacies Analysis, Organic Thermal Maturation and Source Rock Evaluation of Sedimentary Succession from Oligocene to Early Miocene Age in X2 Well, Greater Ughelli DepoBelt, Niger Delta Basin, Nigeria

Lucas F.A, Omodolor Hope E*

Department of Geology, University of Benin, P.M.B. 1154 Benin City, Edo State, Nigeria
*Corresponding author: hopeomodoor@gmail.com

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Abstract One hundred and ninety (190) ditch cutting samples of depth range within 20ft- 11820ft (6.09m-3603.7m) from X2 Well Greater Ughelli DepoBelt, Niger Delta Basin were subjected to palynological and palynofacies analysis combined with sedimentological studies, with a view to define its organic thermal maturation and source rock potential. The analysis of the ditch cutting samples were carried out using reflected light microscope for lithologic description while the palynofacies analysis was carried out using transmitted light microscope. The sedimentological analysis reveals forty-nine (49) lithozones and seven (7) lithofacies units, which were deduced based on their mineralogical composition, textural properties, fossil content, homogeneity and heterogeneity of the lithofacies units. The major lithofacies units penetrated in the well are sandstone, shaly sand, sandy shale, clay, sandy clay, clayey sand and shale. Its associated minerals include quartz, feldspar, calcium carbonate and glauconite. Identification of the petroleum play elements and hydrocarbon potential of the X2 Well were equally established. The result from the palynofacies analysis reveals miospores (pollen and spores), woody plant materials (black wood and phytoclast), amorphous organic matter which were used to characterize the well of its kerogen type and maturity. Fifty (50) lithofacies units were subjected to palynofacies analysis, this indicates a potential for hydrocarbon generation. Presence of the dark brown to black wood plant material (black wood and phytoclast) suggest gas-prone for this well. However, the high abundance of light brown to brown colour index of spore/pollen shows that the organic matter of X2 Well falls within the zone of mature main phase liquid hydrocarbon generation (Spore Color Index of 4-6). Palynofacies analysis of X2 Well shows that the well can yield about 70% of oil and 30% of gas (kerogen type II).

Keywords: *palynofacies, thermal maturation, kerogen, source rock, sedimentology*

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1. Introduction

The term palynofacies is "the total complement of acid resistant particulate organic matter recovered from sediments by palynological processing techniques". [1]. However, [9], provided the most recent and widely used definition of the palynofacies term as "the total particulate organic matter assemblage contained in a body of sediment thought to reflect a specific set of environmental conditions or to be associated with a characteristic range of hydrocarbon generating potential". The latter definition can be used in paleoenvironment interpretation as well as in source rock evaluation and will be used here because it links palynofacies types to sedimentary sequences. Several palynological investigations have dealt with the paleoenvironmental interpretations of the Niger Delta Basin. However, there is still a lacking in use of detailed palynofacies analyses in interpreting paleoenvironmental settings. The present work aims to study the palynological facies of X2 well with more detailed analyses of the percentage distribution of the palynological organic matter (POM) assemblages to infer the Thermal Maturation, Source Rock potential, and Sedimentology

1.1. Background of Study

The X2 well, is located in the Greater Ughelli Depo Belt, Niger Delta Basin. The Greater Ughelli is one of the Depo Belt in the Niger delta Basin [5]. The Niger Delta is in the Gulf of Guinea on the west coast of Central Africa. The Cenozoic Niger Delta is located at the intersection of the Benue Trough and the South Atlantic Ocean where a triple junction developed during the separation of South America and Africa in the Late Jurassic [10].

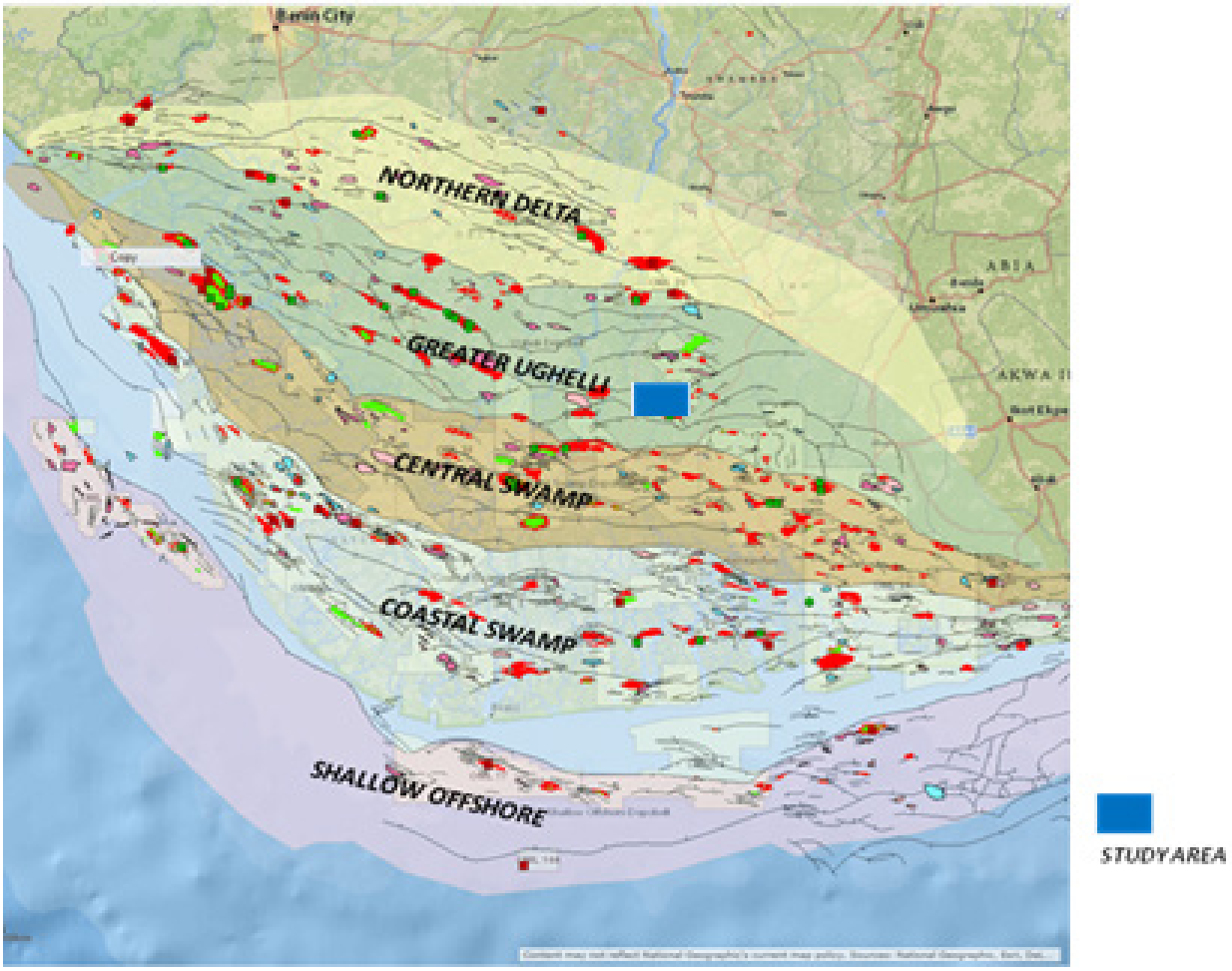


Figure 1. Map showing the distribution of Depo Belts within the Niger Delta and the location of the study area within the Greater Ughelli Depo belt [3]

2. Geology of the Study Area

The Niger Delta Basin occupies the Gulf of Guinea continental margin in equatorial West Africa between Latitude 3^0 N and 6^0 N and Longitude 5^0 E and 8^0 E. The clastic wedge of the Niger Delta formed along a failed arm of a triple junction system (aulacogen) that originally developed during the break-up of the South American and African plates in the late Jurassic [5].

3. Materials and Method

The data and interpretations presented in this study were based on detailed examination of 190 ditch cuttings samples from X2 Well which represent the sedimentary succession of depth range within 20ft-11820ft (6.09m-3603.7m). Standard methods for processing and concentration of organic matter were employed. These involved the use of Hydrochloric (HCl) (35-38 %) and hydrofluoric (HF) acids (40 %) to digest the carbonates and silicate content of the sediments respectively and the release the organic matter from the rock martrix. The residues were sieved through a 10-µ mesh and washed using ultrasonic cleaning for preparing slides. Polyvinyl Alcohol (PVA) was used as a mounting medium. For discriminating among the different palynofacies characteristics, particulate organic matter and palynomorph particles were counted and used to calculate relative abundances.

4. Results and Discussion

The result of the sedimentological analysis is as shown in [Figure 2 to Figure10] below.

4.1. Lithofacies Description and Interpretation

The sedimentological analysis revealed forty nine (49) lithozones and seven (7) lithofacies units, deduced based on their mineralogical composition, textural properties, fossil content, homogeneity and heterogeneity of the lithofacies units (Figure 2 to Figure 10). The major lithofacies units penetrated in the well are sandstone, shaly sand, sandy shale, sandy clay, clayey sand and shale. Its associated minerals include: quartz, feldspar and glauconite.

4.2. Maturity

The maturity of sediment encountered in X2 well were determined based on their textural (sorting and rounding) and compositional maturity (minerals present).

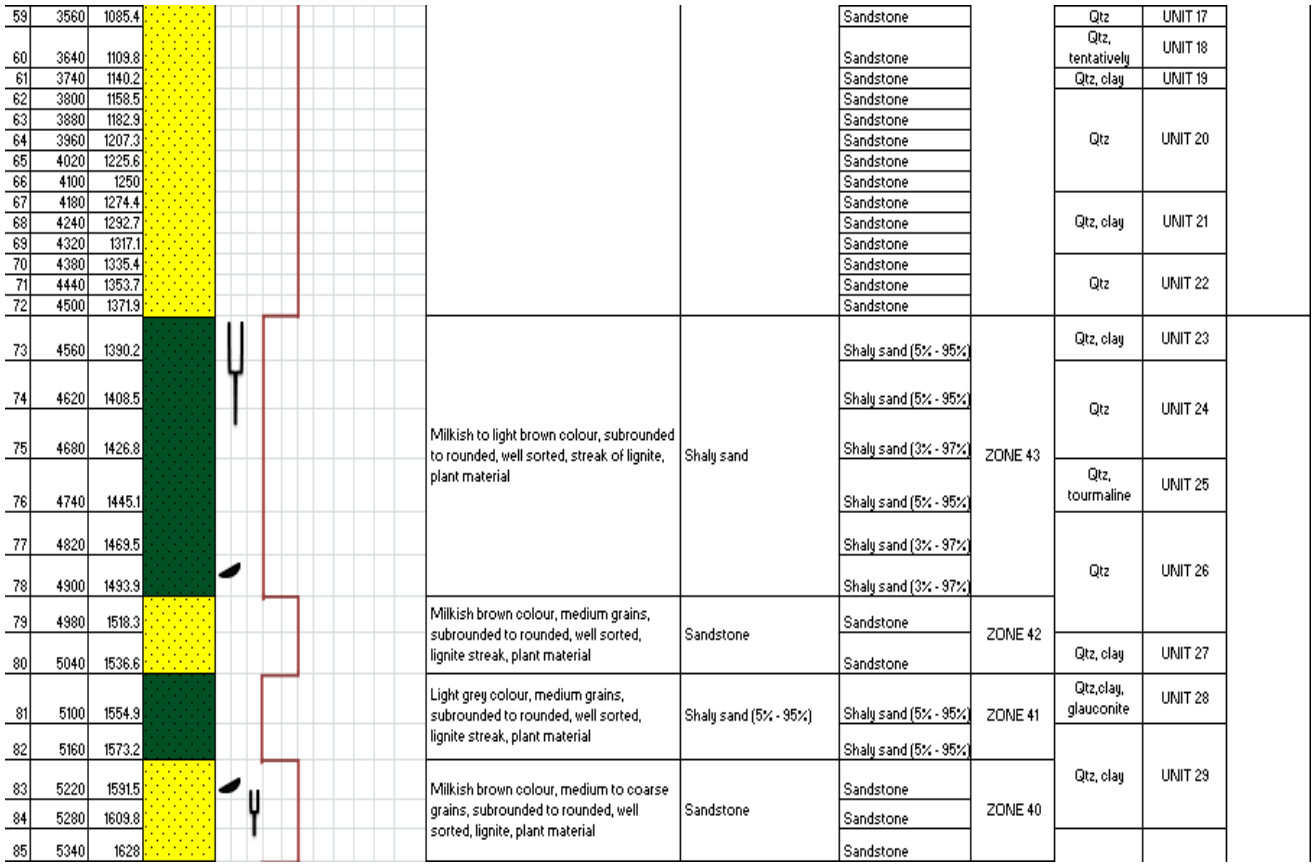
The sediment found in X2 well are mainly medium to coarse grain, subrounded to subangular, moderately to well sorted. Thus, the sediment in X2 well can be describe to be mature base on their textural and compositional properties (presence of a stable mineral i.e. quartz).

LITHOSTRATIGRAPHIC LOG OF X2 WELL

S/N	DEPTH(FEET)	DEPTH(METER)	LITHOLOGY (Shale / Sand %)	TEXTURE: Grain size and other notes (structures, paleocurrents, fossils, colour)	LITHO FACIES	Shale / Sand Percentage	LITHO ZONES	ASSOCIATED MINERALS	ASSOCITED MINERAL UNIT	FORMATION
1	20	6.09		Whitish to light brown colour, medium to coarse grain, subangular to subrounded, moderately to well sorted, plant material	sandstone	Sandstone	ZONE 49	Fe, quartz, feldspar	UNIT 1	
2	80	30.4				Sandstone		Qtz, feldspar	UNIT 2	
3	140	42.7				Sandstone				
4	200	61				Sandstone				
5	260	79.3				Sandstone				
6	320	97.6				Sandstone				
7	380	115.9				Sandstone				
8	440	134.1				Sandstone				
9	500	152.4				Sandstone				
10	560	170.7				Sandstone				
11	620	189				Sandstone				
12	680	207.3				Sandstone				
13	740	225.6				Sandstone		Qtz, mica, feldspar	UNIT 3	
14	800	243.9				Sandstone		Qtz, feldspar	UNIT 4	
15	860	262.2				Sandstone				
16	920	280.5				Sandstone				
17	980	298.8				Sandstone				
18	1040	317.1				Sandstone				
19	1100	335.4				Sandstone				
20	1160	353.7				Sandstone				
21	1220	371.9				Sandstone				
22	1280	390.2				Sandstone				
23	1340	408.5				Sandstone				
24	1400	426.8				Sandstone		Quartz	UNIT 5	
25	1460	445.1				Sandstone				
26	1520	463.4				Sandstone				
27	1580	481.7		Very fine to medium grain, sandy clay rich in carbonate	sandy clay	sandy clay (20% - 80%)	ZONE 48	Qtz, clay, carbonate	UNIT 6	
28	1640	500				clayey sand (20% - 80%)				
29	1700	518.3		milkish to light brown colour, medium to coarse grain, subangular to subrounded, poorly sorted, plant material	clayey sand	clayey sand (20% - 80%)	ZONE 47	Qtz, clay	UNIT 7	BENIN FORMATION
30	1760	536.6				clayey sand (20% - 80%)				
31	1820	554.9				clayey sand (15% - 85%)		Qtz, clay, carbonate	UNIT 8	
32	1880	573.2		milkish to light brown colour, medium to coarse grain, subrounded to angular, moderately to well sorted	sandstone	sandstone	ZONE 46	Qtz, clay	UNIT9	
33	1940	591.5				sandstone		Qtz, clay, carbonate	UNIT 10	
34	2000	609.6		milkish to brown colour, medium to coarse grain, subrounded to subangular, moderately sorted	clayey sand	clayey sand (3% - 97%	ZONE 45	Qtz, feldspar, carbonate	UNIT 11	
35	2060	628.1		Milkish to light brown colour, medium to coarse grains, subrounded to rounded, moderately to well sorted, lignite streak	Sandstone	sandstone	ZONE 44	Qtz, feldspar	UNIT 12	
36	2120	646.3				sandstone				
37	2180	664.6				sandstone		Qtz, Fe	UNIT 13	
38	2240	682.9				Sandstone		Qtz, feldspar	UNIT 14	
39	2300	701.2				Sandstone		Qtz	UNIT 15	
40	2360	719.5				Sandstone				
41	2420	737.8				Sandstone				
42	2480	756.09				Sandstone				
43	2540	774.4				Sandstone				
44	2600	792.7				Sandstone				
45	2660	810.9				Sandstone				
46	2720	829.26				Sandstone				
47	2780	847.6				Sandstone				
48	2840	865.9				Sandstone				
49	2900	884.2				Sandstone				
50	2960	902.4				Sandstone				
51	3020	920.7				Sandstone				
52	3080	939				Sandstone				
53	3140	957.3				Sandstone				
54	3200	975.6				Sandstone				
55	3260	993.9				Sandstone				
56	3320	1012.2				Sandstone				
57	3420	1042.7				Sandstone		Qtz, clay	UNIT 16	
58	3500	1067.1				Sandstone				

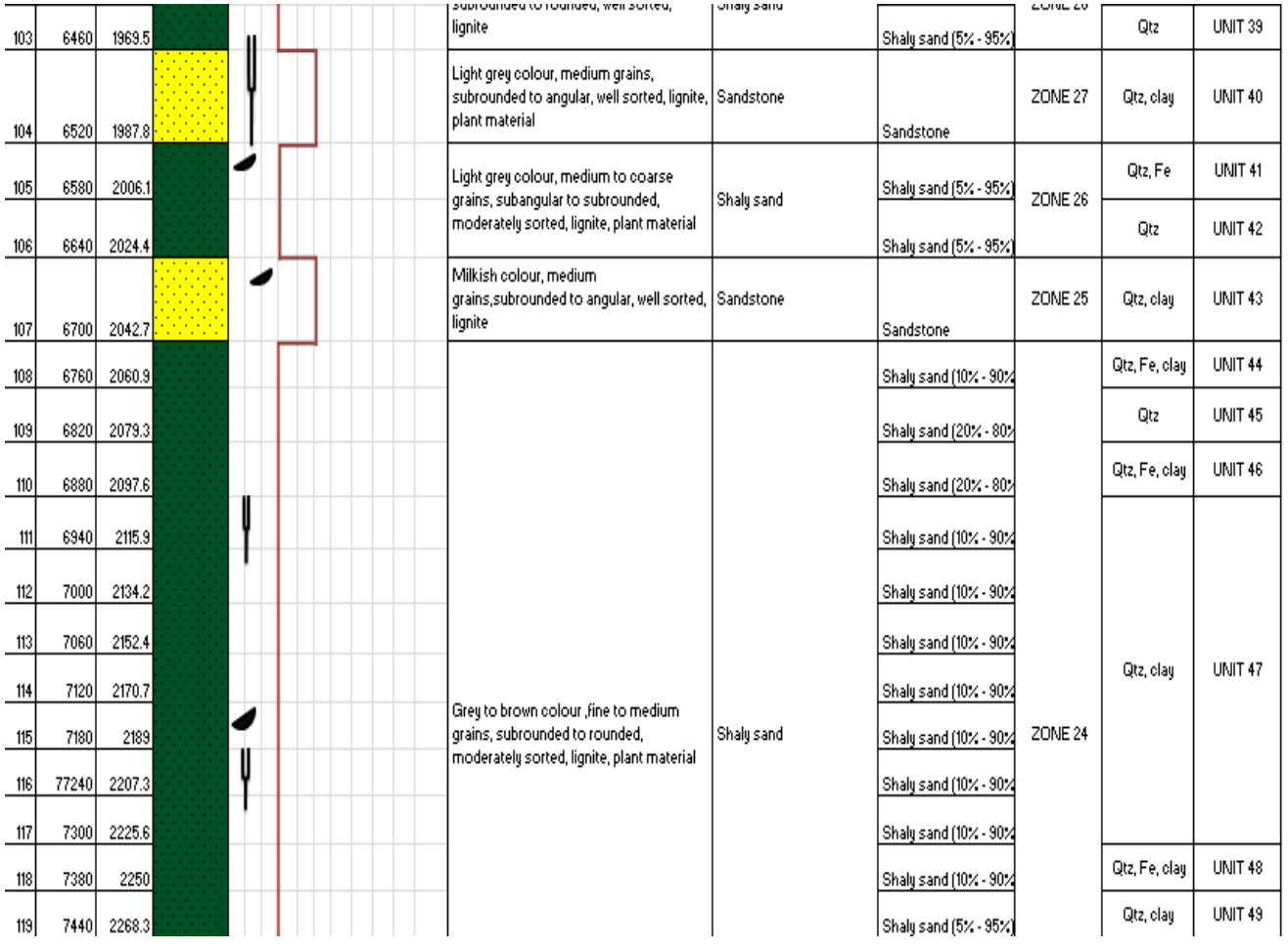
Figure 2. Lithostratigraphy analysis of samples from X2 Well, Greater Ughelli Depo-Belt(6.09m-4817m)

Figure 3. Lithostratigraphy analysis of samples from X2 Well, Greater Ughelli Depo-Belt (500m-1067.1m)



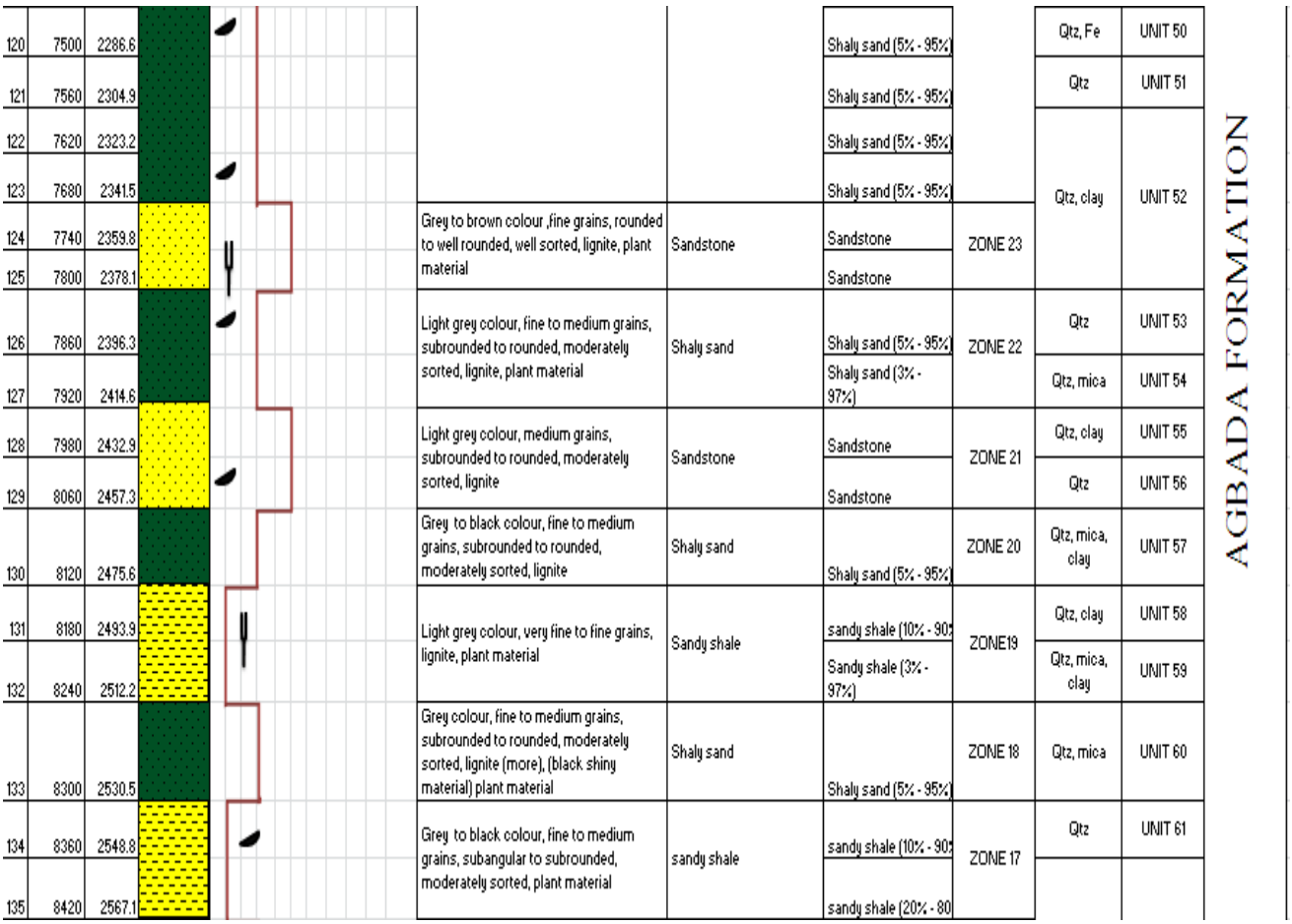
59	3560	1085.4			Sandstone		Qtz	UNIT 17
60	3640	1109.8			Sandstone		Qtz, tentatively	UNIT 18
61	3740	1140.2			Sandstone		Qtz, clay	UNIT 19
62	3800	1158.5			Sandstone		Qtz	UNIT 20
63	3880	1182.9			Sandstone			
64	3960	1207.3			Sandstone			
65	4020	1225.6			Sandstone			
66	4100	1250			Sandstone			
67	4180	1274.4			Sandstone		Qtz, clay	UNIT 21
68	4240	1292.7			Sandstone			
69	4320	1317.1			Sandstone			
70	4380	1335.4			Sandstone		Qtz	UNIT 22
71	4440	1353.7			Sandstone			
72	4500	1371.9			Sandstone			
73	4560	1390.2	Milkish to light brown colour, subrounded to rounded, well sorted, streak of lignite, plant material	Shaly sand	Shaly sand (5% - 95%)	ZONE 43	Qtz, clay	UNIT 23
74	4620	1408.5			Shaly sand (5% - 95%)		Qtz	UNIT 24
75	4680	1426.8			Shaly sand (3% - 97%)			
76	4740	1445.1			Shaly sand (5% - 95%)		Qtz, tourmaline	UNIT 25
77	4820	1469.5			Shaly sand (3% - 97%)		Qtz	UNIT 26
78	4900	1493.9			Shaly sand (3% - 97%)			
79	4980	1518.3	Milkish brown colour, medium grains, subrounded to rounded, well sorted, lignite streak, plant material	Sandstone	Sandstone	ZONE 42		
80	5040	1536.6			Sandstone		Qtz, clay	UNIT 27
81	5100	1554.9	Light grey colour, medium grains, subrounded to rounded, well sorted, lignite streak, plant material	Shaly sand (5% - 95%)	Shaly sand (5% - 95%)	ZONE 41	Qtz,clay, glauconite	UNIT 28
82	5160	1573.2			Shaly sand (5% - 95%)		Qtz, clay	UNIT 29
83	5220	1591.5	Milkish brown colour, medium to coarse grains, subrounded to rounded, well sorted, lignite, plant material	Sandstone	Sandstone	ZONE 40		
84	5280	1609.8			Sandstone			
85	5340	1628			Sandstone			

Figure 4. Lithostratigraphy analysis of samples from X2 Well, Greater Ughelli Depo-Belt(1065.4m-1628m).



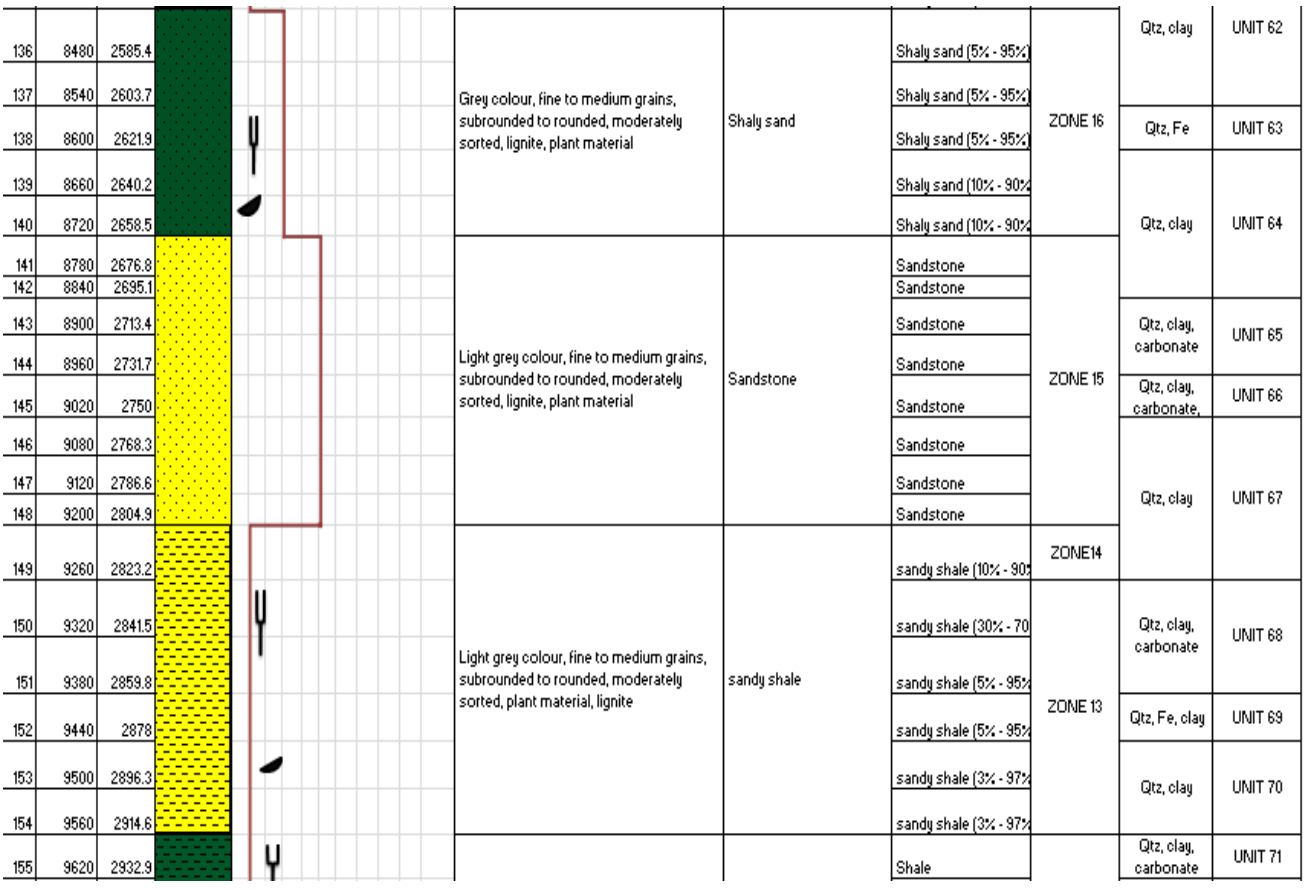
103	6460	1969.5	lignite		Shaly sand (5% - 95%)		Qtz	UNIT 39
104	6520	1987.8	Light grey colour, medium grains, subrounded to angular, well sorted, lignite, plant material	Sandstone	Sandstone	ZONE 27	Qtz, clay	UNIT 40
105	6580	2006.1	Light grey colour, medium to coarse grains, subangular to subrounded, moderately sorted, lignite, plant material	Shaly sand	Shaly sand (5% - 95%)	ZONE 26	Qtz, Fe	UNIT 41
106	6640	2024.4			Shaly sand (5% - 95%)		Qtz	UNIT 42
107	6700	2042.7	Milkish colour, medium grains,subrounded to angular, well sorted, lignite	Sandstone	Sandstone	ZONE 25	Qtz, clay	UNIT 43
108	6760	2060.9	Grey to brown colour ,fine to medium grains, subrounded to rounded, moderately sorted, lignite, plant material	Shaly sand	Shaly sand (10% - 90%	ZONE 24	Qtz, Fe, clay	UNIT 44
109	6820	2079.3			Shaly sand (20% - 80%		Qtz	UNIT 45
110	6880	2097.6			Shaly sand (20% - 80%		Qtz, Fe, clay	UNIT 46
111	6940	2115.9			Shaly sand (10% - 90%		Qtz, clay	UNIT 47
112	7000	2134.2			Shaly sand (10% - 90%			
113	7060	2152.4			Shaly sand (10% - 90%			
114	7120	2170.7			Shaly sand (10% - 90%			
115	7180	2189			Shaly sand (10% - 90%			
116	77240	2207.3			Shaly sand (10% - 90%			
117	7300	2225.6			Shaly sand (10% - 90%			
118	7380	2250			Shaly sand (10% - 90%		Qtz, Fe, clay	UNIT 48
119	7440	2268.3			Shaly sand (5% - 95%)		Qtz, clay	UNIT 49

Figure 5. Lithostratigraphy analysis of samples from X2 Well, Greater Ughelli Depo-Belt(1969.5m-2268.3m)



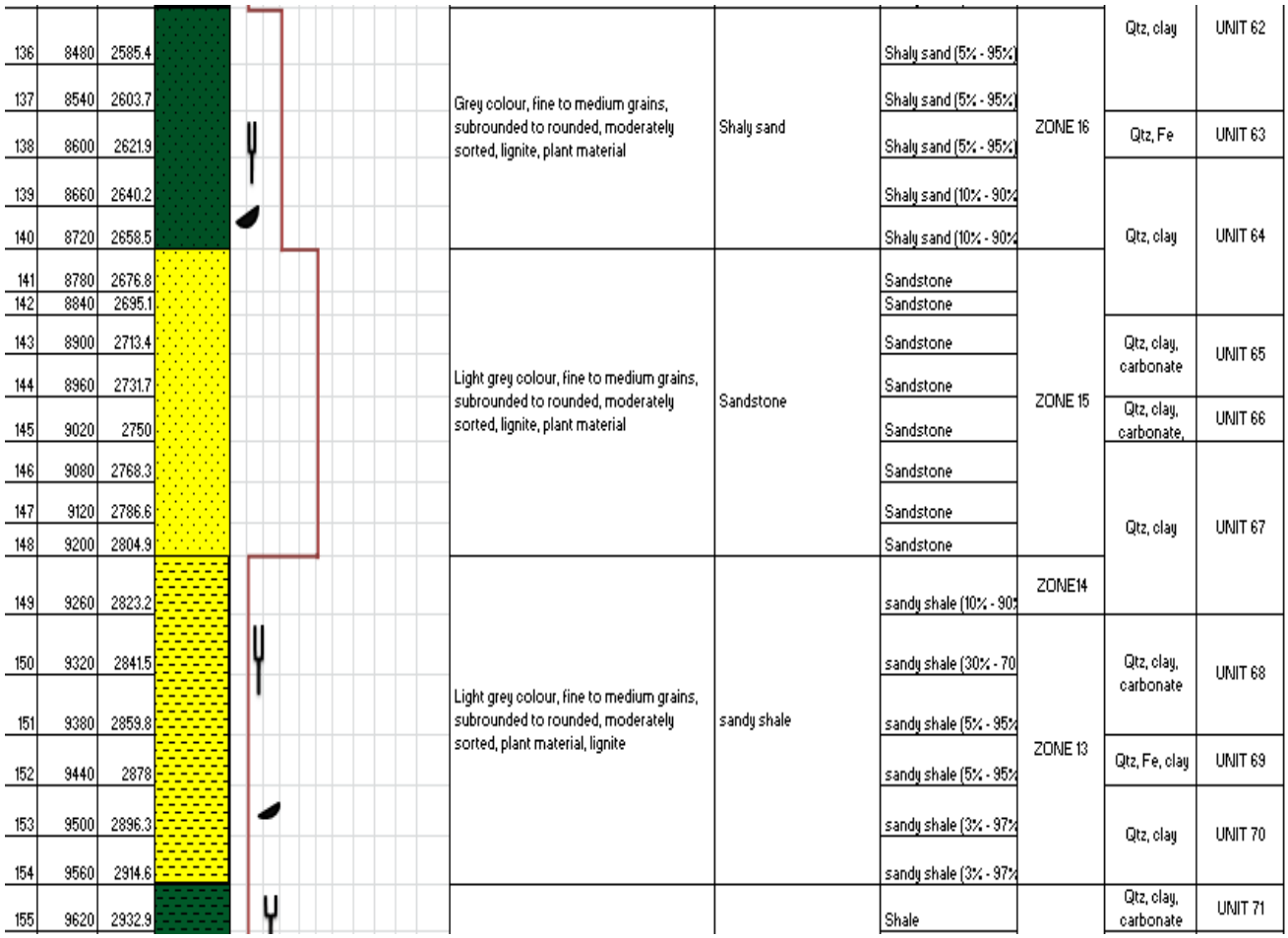
120	7500	2286.6			Shaly sand (5% - 95%)		Qtz, Fe	UNIT 50	
121	7560	2304.9			Shaly sand (5% - 95%)		Qtz	UNIT 51	
122	7620	2323.2			Shaly sand (5% - 95%)		Qtz, clay	UNIT 52	
123	7680	2341.5			Shaly sand (5% - 95%)				
124	7740	2359.8	Grey to brown colour ,fine grains, rounded to well rounded, well sorted, lignite, plant material	Sandstone	Sandstone	ZONE 23			
125	7800	2378.1			Sandstone				
126	7860	2396.3	Light grey colour, fine to medium grains, subrounded to rounded, moderately sorted, lignite, plant material	Shaly sand	Shaly sand (5% - 95%)	ZONE 22	Qtz	UNIT 53	
127	7920	2414.6			Shaly sand (3% - 97%)		Qtz, mica	UNIT 54	
128	7980	2432.9	Light grey colour, medium grains, subrounded to rounded, moderately sorted, lignite	Sandstone	Sandstone	ZONE 21	Qtz, clay	UNIT 55	
129	8060	2457.3			Sandstone		Qtz	UNIT 56	
130	8120	2475.6	Grey to black colour, fine to medium grains, subrounded to rounded, moderately sorted, lignite	Shaly sand	Shaly sand (5% - 95%)	ZONE 20	Qtz, mica, clay	UNIT 57	
131	8180	2493.9	Light grey colour, very fine to fine grains, lignite, plant material	Sandy shale	sandy shale (10% - 90%	ZONE19	Qtz, clay	UNIT 58	
132	8240	2512.2			Sandy shale (3% - 97%)		Qtz, mica, clay	UNIT 59	
133	8300	2530.5	Grey colour, fine to medium grains, subrounded to rounded, moderately sorted, lignite (more), (black shiny material) plant material	Shaly sand	Shaly sand (5% - 95%)	ZONE 18	Qtz, mica	UNIT 60	
134	8360	2548.8	Grey to black colour, fine to medium grains, subangular to subrounded, moderately sorted, plant material	sandy shale	sandy shale (10% - 90%	ZONE 17	Qtz	UNIT 61	
135	8420	2567.1			sandy shale (20% - 80				

Figure 6. Lithostratigraphy analysis of samples from X2 Well, Greater Ughelli Depo-Belt(2286.6m-2567.1m)



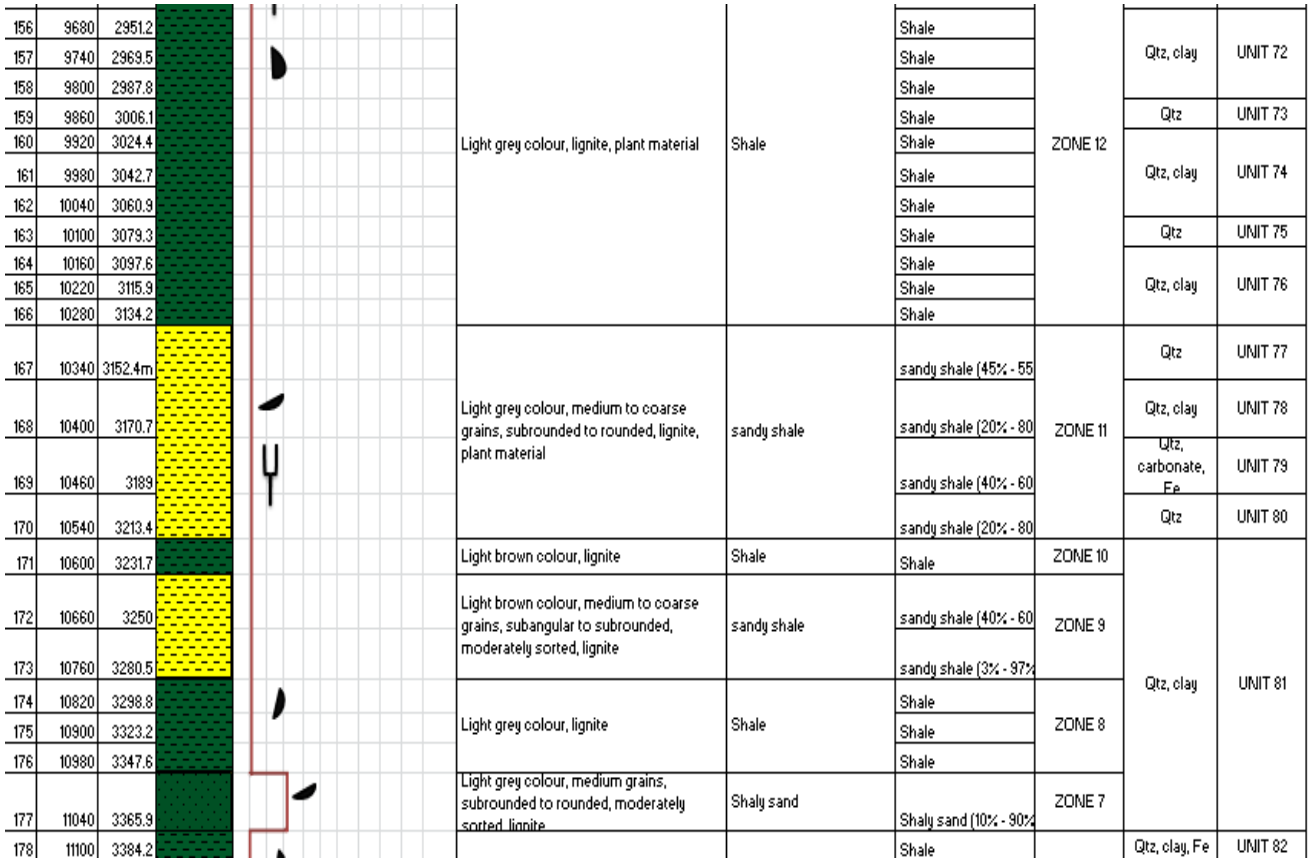
136	8480	2585.4	Grey colour, fine to medium grains, subrounded to rounded, moderately sorted, lignite, plant material	Shaly sand	Shaly sand (5% - 95%)	ZONE 16	Qtz, clay	UNIT 62
137	8540	2603.7			Shaly sand (5% - 95%)			
138	8600	2621.9			Shaly sand (5% - 95%)		Qtz, Fe	UNIT 63
139	8660	2640.2			Shaly sand (10% - 90%		Qtz, clay	UNIT 64
140	8720	2658.5			Shaly sand (10% - 90%			
141	8780	2676.8	Light grey colour, fine to medium grains, subrounded to rounded, moderately sorted, lignite, plant material	Sandstone	Sandstone	ZONE 15		
142	8840	2695.1			Sandstone			
143	8900	2713.4			Sandstone		Qtz, clay, carbonate	UNIT 65
144	8960	2731.7			Sandstone			
145	9020	2750			Sandstone		Qtz, clay, carbonate,	UNIT 66
146	9080	2768.3			Sandstone		Qtz, clay	UNIT 67
147	9120	2786.6			Sandstone			
148	9200	2804.9			Sandstone			
149	9260	2823.2	Light grey colour, fine to medium grains, subrounded to rounded, moderately sorted, plant material, lignite	sandy shale	sandy shale (10% - 90%	ZONE14		
150	9320	2841.5			sandy shale (30% - 70	ZONE 13	Qtz, clay, carbonate	UNIT 68
151	9380	2859.8			sandy shale (5% - 95%			
152	9440	2878			sandy shale (5% - 95%		Qtz, Fe, clay	UNIT 69
153	9500	2896.3			sandy shale (3% - 97%		Qtz, clay	UNIT 70
154	9560	2914.6			sandy shale (3% - 97%			
155	9620	2932.9			Shale		Qtz, clay, carbonate	UNIT 71

Figure 7. Lithostratigraphy analysis of samples from X2 Well, Greater Ughelli Depo-Belt (2585.4m-2932.9m)



136	8480	2585.4	Grey colour, fine to medium grains, subrounded to rounded, moderately sorted, lignite, plant material	Shaly sand	Shaly sand (5% - 95%)	ZONE 16	Qtz, clay	UNIT 62
137	8540	2603.7			Shaly sand (5% - 95%)			
138	8600	2621.9			Shaly sand (5% - 95%)		Qtz, Fe	UNIT 63
139	8660	2640.2			Shaly sand (10% - 90%		Qtz, clay	UNIT 64
140	8720	2658.5			Shaly sand (10% - 90%			
141	8780	2676.8	Light grey colour, fine to medium grains, subrounded to rounded, moderately sorted, lignite, plant material	Sandstone	Sandstone	ZONE 15		
142	8840	2695.1			Sandstone			
143	8900	2713.4			Sandstone		Qtz, clay, carbonate	UNIT 65
144	8960	2731.7			Sandstone			
145	9020	2750			Sandstone		Qtz, clay, carbonate,	UNIT 66
146	9080	2768.3			Sandstone		Qtz, clay	UNIT 67
147	9120	2786.6			Sandstone			
148	9200	2804.9			Sandstone			
149	9260	2823.2	Light grey colour, fine to medium grains, subrounded to rounded, moderately sorted, plant material, lignite	sandy shale	sandy shale (10% - 90%	ZONE14		
150	9320	2841.5			sandy shale (30% - 70	ZONE 13	Qtz, clay, carbonate	UNIT 68
151	9380	2859.8			sandy shale (5% - 95%			
152	9440	2878			sandy shale (5% - 95%		Qtz, Fe, clay	UNIT 69
153	9500	2896.3			sandy shale (3% - 97%		Qtz, clay	UNIT 70
154	9560	2914.6			sandy shale (3% - 97%			
155	9620	2932.9			Shale		Qtz, clay, carbonate	UNIT 71

Figure 8. Lithostratigraphy analysis of samples from X2 Well, Greater Ughelli Depo-Belt(6.09m-3603.7m)



156	9680	2951.2	Light grey colour, lignite, plant material	Shale	Shale	ZONE 12	Qtz, clay	UNIT 72
157	9740	2969.5			Shale			
158	9800	2987.8			Shale			
159	9860	3006.1			Shale		Qtz	UNIT 73
160	9920	3024.4			Shale		Qtz, clay	UNIT 74
161	9980	3042.7			Shale			
162	10040	3060.9			Shale			
163	10100	3079.3			Shale		Qtz	UNIT 75
164	10160	3097.6			Shale		Qtz, clay	UNIT 76
165	10220	3115.9			Shale			
166	10280	3134.2			Shale			
167	10340	3152.4m	Light grey colour, medium to coarse grains, subrounded to rounded, lignite, plant material	sandy shale	sandy shale (45% - 55	ZONE 11	Qtz	UNIT 77
168	10400	3170.7			sandy shale (20% - 80		Qtz, clay	UNIT 78
169	10460	3189			sandy shale (40% - 60		Qtz, carbonate, Fe	UNIT 79
170	10540	3213.4			sandy shale (20% - 80		Qtz	UNIT 80
171	10600	3231.7	Light brown colour, lignite	Shale	Shale	ZONE 10	Qtz, clay	UNIT 81
172	10660	3250	Light brown colour, medium to coarse grains, subangular to subrounded, moderately sorted, lignite	sandy shale	sandy shale (40% - 60	ZONE 9		
173	10760	3280.5			sandy shale (3% - 97%			
174	10820	3298.8	Light grey colour, lignite	Shale	Shale	ZONE 8		
175	10900	3323.2			Shale			
176	10980	3347.6			Shale			
177	11040	3365.9	Light grey colour, medium grains, subrounded to rounded, moderately sorted, lignite	Shaly sand	Shaly sand (10% - 90%	ZONE 7		
178	11100	3384.2			Shale		Qtz, clay, Fe	UNIT 82

Figure 9. Lithostratigraphy analysis of samples from X2 Well, Greater Ughelli Depo-Belt (29512m-3384.2m)

Figure 10. Lithostratigraphy analysis of samples from X2 Well, Greater Ughelli Depo-Belt (3384.2m-3603.7m)

4.3. Palynofacies Assemblages

The palynofacies components in this study are broadly classified as AOM, phytoclasts and palynomorphs, for quantitative analysis. The detailed classified methods and criterions can be referred to previous research [4,6,7]. Analysis of 50 (fifty) slide containing palynofacies were sampled from depth rang of (1640m-11760m) based on their quantitative composition of the particulate organic matter content.

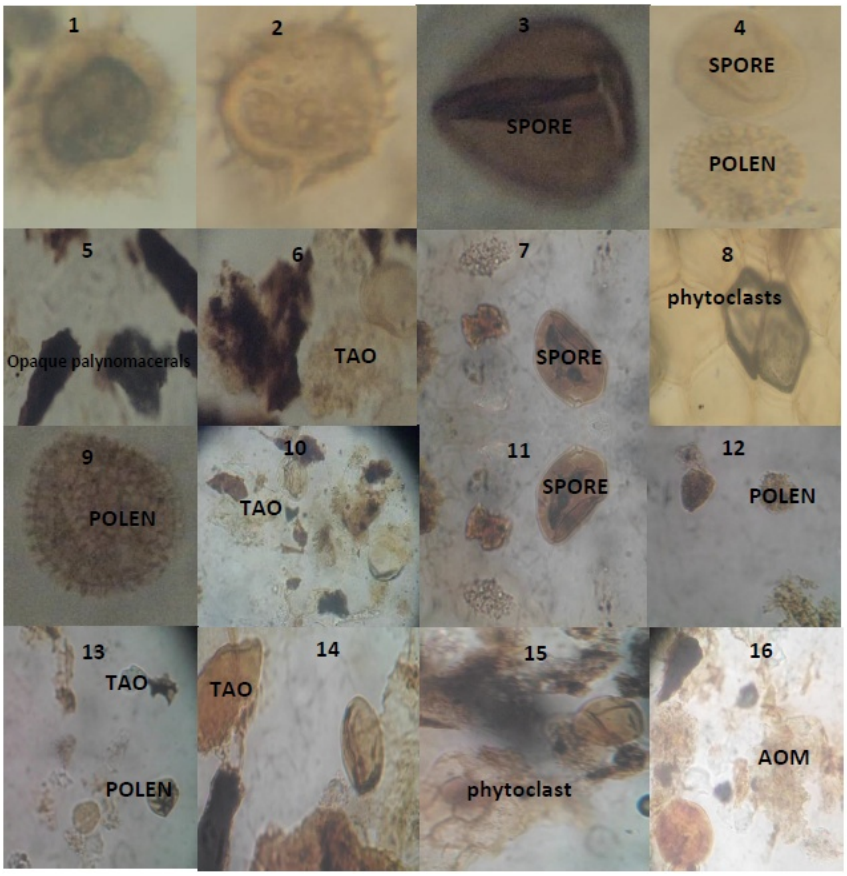


Plate 1. 1(spinizonocolpites sp), 2 S. (baculatus), 3, 4 and 9: Palynomorphs(pollen, spore and dinocyte. ,from the X2 WELL. All images ×480. Plate 3: Magnastriatites hawardi. 4: Striatmonocolpites catatumbus (spore) and Arecipites exilimuratus (280) (pollen). 5: dominated by brown and black wood. 6: AOM, TAO (transparent amorphous organic matter) and marine palynomorphs. 7: Magnastriatites hawardi. 8, and 15: phytoclasts. 16: AOM. (All Magnification X400)

Table 1. Showing Spore Color index [4]

Organic thermal maturity	Spores/pollen Color	Spore color index (SCI)
IMMATURE		1
		2
MATURE MAIN PHASE OF LIQIUD PETROLEUM GENERATION		3
		4
		5
DRY GAS OR BARREN		6
		7
		8
		9
		10

The AOM components are common and represent an important organic matter type in this study. Based on the shape, color and fluorescence, the AOM can be classified into granular or gelified forms. The granular formis mainly yellow to brown under natural light and exhibits irregular aggregated shapes formed by fibrous and ultramicroscopic organic particles [9,11]. (Plate 1).

Phytoclasts are plant-derived fragments, including cuticles, cortex tissues, woody tissues and charcoal [2,6]. This group is the dominant composition for most of the source rock samples. Cuticles are generally translucent yellow to light yellow under transmitted natural light and show typical fluorescence (Plate 1).

Palynomorphs are all discrete HCl- and HF-resistant organic-walled microfossils. E.g., spores, pollen, dinoflagellates which are light brown to brown color.

4.4. Thermal Maturity and Kerogen Characteristics

The spore color index of 50 (fifty) slide containing palynofacies sampled from depth rage of (1640m-11760m) is within the mature main phase of liquid hydrocarbon generation [4], having about four to six (4-6) spore color index for the miospore (pollen/spores) and seven to ten (7-10) spore color index for the plant materials(black wood and phytoclast). With about 75% miospore(pollen/spores) and 30% plant material(black wood and phytoclast). This is shown from some sampled depth bellow;

From the Spore Color Index, depth 1682.9m is within the mature main phase of liquid hydrocarbon generation, having about four to five (4-5) spore color index for the miospore and eight to ten (8-10) spore color index for the plant materials. This depth has about 75% miospore and 25% plant material.

Depth 1756.1m is within the mature main phase of liquid hydrocarbon generation, having about four to five (5-6) spore color index for the miospore and eight to ten (7-9) spore color index for the plant materials. Present. This depth has about 65% miospores and 35% plant material

Depth 3170.7m is within the mature main phase of liquid hydrocarbon generation, having about four to five (4-6) spore color index for the miospores and eight to ten (7-9) spore color index for the plant materials. Present. This depth has about 75% miospore and 25% plant material

Depth 3097.6m is within the mature main phase of liquid hydrocarbon generation; having about four to five (4-6) spore color index for the miospore. This depth has about 80%

Depth 3024.4m is within the mature main phase of liquid hydrocarbon generation, having about four to five (4-6) spore color index for the miospores and eight to ten (8-10) spore color index for the plant materials present. This depth has about 80% miospore and 20% plant material.

Depth 3024.4m is within the mature main phase of liquid hydrocarbon generation, having about four to five (4-5) spore color index for the miospores and eight to ten (8-10) spore color index for the plant materials Present. This depth has about 50% miospores and 50% plant material

5. Conclusion

A total of one hundred and ninety (190) ditch cutting samples from X2 Well in the Niger Delta Basin were described using lithostratigraphic and biostratigraphic methods. The sedimentological analysis reveals forty nine (49) lithozones and seven (7) lithofacies units, which were deduced based on their mineralogical composition, textural properties, fossil content, homogeneity and heterogeneity of the lithofacies units. The sand/clay and alternation of sand and shale revealed that the studied interval is within the Benin and the Agbada Formation of the Niger Delta Basin. The sedimentological results suggest sediments deposition in a high to low energy environments, which range between continental to transitional and marine environments. Hydrocarbon play elements which comprises of reservoir rocks, source rocks and traps were described in the well which include 2(two) probable reservoir rocks (Zone 7, with thickness 18.3 meters and zone 15 with thickness 146.4 meters) and six (6)probable source rocks (Zone 2, 4, 6, 8, 10, 12).

Palynofacies analysis of the Well shows that the Well can yield about 70% of oil and 30% of gas. The spore color inference of the Well is both oil and gas but more of oil. The presence of type II kerogen indicates the presence of oil and gas in the Well. The Well also stands out as an excellent source rock potential for hydrocarbon due to the presence of organic matter, which acts as parent material for oil and gas.

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