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Lithofacies and Textural Analysis of The Sequence of A Section (1490ft-3830ft) of Oml 109 Well In Niger Delta

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Abstract

The lithofacies and textural analysis was carried out on twenty five (25) ditch cutting samples in well-Y in Niger Delta within depth range of 1490- 3840ft in an interval of 90ft. The analysis method with an aim to determine the age rock and environment of deposition within the section under study, the lithostratigraphy of the sample indicate clay, shale and sandstone which are partly calcareous lithofacies analysis with a high percentage of rock fragment, ferruginized sandstone, quartz and mica flasks in few of the samples. Other lithofacies components in low percentage are rootlet, heavy mineral and fossils. Biofacie analysis showed some Gastropod, Pelecypod shell fragment. The age of the section of the well is late to middle Miocene. The presence of rootlet and some macrofauna phylum Mollusca which include Pelecypod and Gastropoda.But an increase and decrease of the macrofauna which shows a remarkable abundant with biofacies and poor benthonic marine depositional environment. The rock sample within these intervals is intercalated with shale, sandstone, siltstone and clay; the grain are poorly sorted which ranges from angular to sub angular, the rock fragment found within the lithofacies distribution chart indicates that volcanic rocks from a high mountainous area have been eroded and transported to the basin which is responsible for the abundances of quartz.

Introduction: Lithostratigrahic and Textural analysis were carried out on twenty-five (25) ditch cutting samples retrieved from x-well located offshore region of the Niger Delta. The Niger Delta is an oil province of Nigeria located on the West African continental margin popularity called the Gulf of Guinea. The Niger Delta basin lies between longitude 3° 45 '55 " E and latitude 4° 52 ' 39 " N. The growth of the delta started during the Paleoocene transgression with the formation of the proto-Niger Delta and the modern delta which has continued from Eocene to present. The Niger Delta is a coarsening upward sequences of

tertiary clastics that prograded over a passive continental margin sequence.The aim of this research work is to carry out lithofacies, textural and age of the Well.

The Niger Delta is situated on the Gulf of Guinea on the west coast of Central Africa (Figure 1.2). During the tertiary it built out into the Atlantic Ocean at the mouth of the Niger-Benue River System, and catchments area span about a million square kilometres of predominantly savannah-covered lowland (Merki, 1972). The Delta is one of the world's oil provenances with the sub-aerial portion covering about 75 000 km^2 and extending more than 300 km from apex to mouth (Figure 2.2), (Short et al, 1967). The regressive wedge of clastic sediments which it comprises is thought to reach a maximum thickness of 12 km (Murat, 1972). Accumulation of marine sediments in the basin probably commenced in Albian time, after the opening of the South Atlantic Ocean between Africa and South America Continent. True delta development, however started only in the Late Paleocene/ Eocene, when sediments began to build up beyond troughs between basement horst blocks at the northern flank of the present delta area (Ogbe, 1982).Since then, a delta plain prograded southward on to oceanic crust gradually assuming a convex to the sea morphology (Doust and Omatsola, 1990).

Throughout the geological history of the delta, its structure and stratigraphy have been controlled by the interplay between rate of sediments supply and subsidence (Murat, 1972). Important influences on sedimentation rate have been ecstatic sea level changes and climatic variations, initial basement morphology and differential sediment loading on unstable shale (Whiteman, 1982). The delta sequence is extensively affected by synsedimentary and post sedimentary normal faults, the most important of which can be traced over considerable distance along strike (Merki, 1972).

1.2.: Stratigraphy and Tectonic Setting of the Niger Delta: The tertiary lithostratigraphic sequence of the Niger Delta consists in ascending order Akata, Agbada and Benin Formations (Fig 2.4), which make up an overall massive clastic sequence of about 30000-39000ft (9000- 12000m) thick (Evamy et al, 1978).

The tectonic framework of the continental margin along the west coast of equatorial Africa is controlled by Cretaceous fracture zone expressed as trenches and ridges in the deep Atlantic. The fracture zone ridges subdivide the margin into individual basins, and in Nigeria, form the boundary faults of the Cretaceous Benue – Abakaliki trough, which cuts far into the West Africa shield. The trough represents a failed arm of a rift triple junction associated with the opening of the South Atlantic. In this region, rifting started in the late Jurassic and persisted into the middle Cretaceous (Lehner and De Ruiter, 1979). In the region of the Niger Delta, rifting diminished altogether in the late Cretaceous. After rifting ceased, gravity tectonism became the primary deformational process. Shale mobility induced internal deformational and occurred in response to two processes (Kulke, 1995). First, shale diapirs formed from loading of poorly compacted, over- pressured, prodelta and delta slope clays (Akata Formation). For the higher density delta-front sands (Agbada Formation). Second, slope instability occurred due to a lack of lateral, basinward support for the under-compacted delta-slope clays (Akata Formation). For any given depobelt, gravity tectonics were completed before deposition of Benin Formation and are expressed in complex

structures, including shale diapirs, roll over anticlines, collapsed growth fault crests, back-to-back features and steeply dipping, closely spaced flanks faults (Evamy and others, 1978; Xiao and Hospers, 1992) (figure.1.3).These faults mostly offset different parts of the Agbada Formation and flatten into detachment planes near the top of the Akata Formation.

1.3: Akata Formation: The basal major time-transgressive lithological unit of the Niger Delta complex is the Akata Formation. It is composed mainly of marine shales but contains sandy and silty beds, which are thought to have been laid down as turbidites and continental slope channel fills above (Merki, 1972). The Akata Formation is characterized by a uniform shale development as evident in gamma ray and spontaneous potential logs (Merki, 1972). These pro-delta shales are grey to dark grey, medium-hard or soft at some places and sandy or silty. The shales are under-compacted and may contain lenses of abnormally high pressured siltstone or fine-grained sandstone (Merki, 1972). Furthermore, the Akata Formation is thought to be the main source for Niger Delta complex oil and gas. The Akata Formation may be continuous with the outcrops of the Imo Shale, but continuity between the two type sections which are of very different ages is not yet proved. The known age of the Akata Formation ranges from Eocene to Recent (Murat, 1972).

1.4: Agbada Formation: The Agbada Formation is believed to be the hydrocarbon prospective sequence in the Niger Delta. It is represented by alteration of sands, silt and clays in various proportions and thicknesses, representing cyclic sequences of off lap units (Murat, 1972). These paralicclastics are the truly deltaic portion of the sequence and were deposited in a number of delta-front, delta-topset and fluvio-deltaic environments (Whiteman, 1982).The alternation of fine and coarse clastics provide multiple reservoir-seal couplets (Murat, 1972). As with the marine shale, the paralic sequence is present in all depobelts, and ranges in ages from Eocene to Pleistocene (Merki, 1972). Most exploration wells in the Niger Delta have bottomed in this lithofacies, which reaches a maximum thickness of more than 3000m (Doust and Omatsola, 1990).

1.5: Benin Formation: The Benin Formation occurs throughout the whole Niger Delta from Benin-Onitsha in the north to beyond the present coastline. It constitutes the shallowest part of the sequence and is composed almost entirely of non-marine sand predominantly massive, highly porous fresh water-bearing sandstones with local thin shale interbed which are considered, braided-stream origin (Whiteman, 1982). The sand and sandstone of the Benin Formation are coarse grained, commonly very granular and pebbly to very fine grained. They were deposited in alluvial or upper coastal plain environments following a southward shift of deltaic deposition into a new depobelt (Whiteman, 1982).

Material and methodology

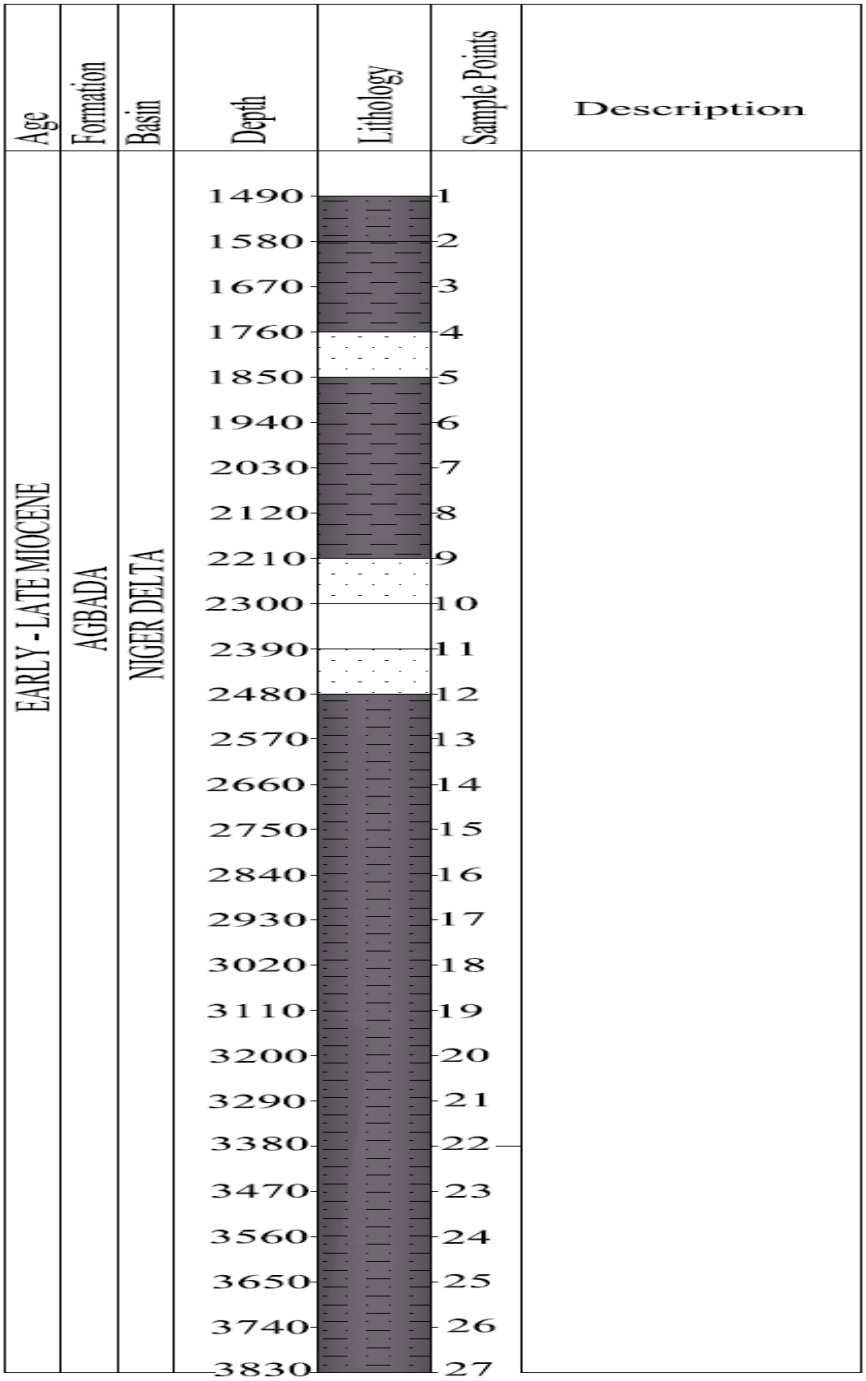
2.1 Preparation of samples: Fresh portions of each sample was taken and crushed into pieces in a mortar and was later transferred into a pan, mix and soared with water and treated with 2 gram of sodium chloride salt and was left to boil for 30 minutes on hot plate at about 250°C. All this is done in order to disintegrate the clay and, shale particles and free the fossils from the matrix.

2.2 Wet Sieving/Washing: The boiled solution from each plate is discounted into a stack of sieve meshes arranged in decreasing order 250µm, 100um and 75µm. The coarsest is placed at the top while the finest is, at the bottom. The disintegrate sample are then allowed to pass through the sieves using a shower of water. Care should be taken to ensure that no males over flows the sieve set. The washing continues until clear water observed on each of the sieves.Residues from each sieve size are collected in a filter paper tagged is label for each sample depth and allowed for some minutes for water drip off before drying on the hot plate.

2.3 Drying and Storage: The Filter paper containing the respective residual fractions of the sample is dried at temperature of 100°C on the hot plate. Excess heating usually avoided to ensure that the sample does not pour out or damaged.The three dried, fractions of the sample are then cooled and into an envelope marked with the following details.

2.4 Picking: Analysis of the dried samples was done using a stereomicroscope. The dried samples from teach pack; were gently spread on a picking tray that was placed under the stereomicroscope with a specific magnification Fossils were picked using a single trimmed brush which was constantly moistened by dipping it in water The fossils picked were placed in plastic mountain slides and sealed with cover slips so as to avoid contamination and loss of fossils. The slides were labeled according to various depths. This operation was carried out repeatedly in the same form for each sample for coarse medium and fine grains. Once the fossils are sorted or mounted, the slide are then labeled and arranged in horizontal type slide cabinet. The identified forms are sketched and the total number of each form is note down which helps to know the ones that are abundant.

Results and Discussion: The litho-description follows the standard method of describing samples as described in the methodology. Four informal sedimentary units were deduced from the analysis of the Emi-1 well. These lithofacies units are unit 1- sandy shale (900-1400ft, 1800-2000ft), unit 2- silty shale (1400-1500ft), unit 3- shale (1500-1800ft, 2000-2100ft, 2900-3000ft, 3600-3800ft, and4700-6500ft), and unit 4- clayey shale (2100-2900ft, 3000-3600ft, 3800-4700ft, and 6500-8000ft) [Figure 3]. The sandy shale unit 1 is dark grey in colour, blocky to fissile in nature, fairly ferruginized and shows presence of macrofossils in some samples; micaceous (muscovite); evidence of plant remains in some horizons and contains carbonate grains that show effervescence on acid test with dilute HCl. The sand grains vary from fine to pebble in size, angular to rounded and poorly sorted. Silty shale unit 2 is dark grey in colour and fissile in nature; no evidence of fossil remains in term of plant and animal but micaceous (muscovite). The sand is silty in nature and very well sorted. The shale unit 3 is dark grey in colour, rarely blocky but mostly fissile at some intervals; few sand grains are present and fairly ferruginized (Haematite). The clayey shale unit 4 is grey to dark grey in colour, fissile with clay interbeds; non-fossiliferous, and fairly ferruginized (Haematite). The lithologic sequence (900-8000ft) described above when dated palynologically shows equivalence to Ilaro Formation.


Age
Formation
Basin
Depth
Lithology
Sample Points
Description
EARLY - LATE MIOCENE
AGBADA
NIGER DELTA
1490
1580
1670
1760
1850
1940
2030
2120
2210
2300
2390
2480
2570
2660
2750
2840
2930
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3110
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Shale

Sand, silt, clay, Ratio

The wet-sieve analysis that was carried out on each of the twenty one (25) ditch cutting samples produced a grain size analysis table. This table is used for further lithological interpretation.

Serial number	Depth (ft)	Original weight of sample(g)	Weight of paper	A	%	B	%	C	%	D	%
1	1490	25	0.6	10	31.2	2.7	10.8	-	-	20.8	83.2
2	1580	25	0.6	8.8	2.4	2.4	9.6	-	-	18.4	73.6
3	1670	25	0.6	8.4	2.3	2.3	9.2	-	-	17.6	70.4
4	1760	25	0.6	2.3	9.2	2.6	10.4	-	-	19.6	78.8
5	1850	25	0.6	2.3	9.2	2.5	10	-	-	19.2	76.8
6	1940	25	0.6	2.4	9.6	2.1	8.4	-	-	18	72
7	2030	25	0.6	2.6	10.4	2.8	11.2	-	-	21.6	86.4
8	2120	25	0.6	2.5	10	2.8	11.2	-	-	21.2	84.4
9	2210	25	0.6	2.6	10.4	2.7	10.8	-	-	21.2	84.8
10	2300	25	0.6	2.3	9.2	2.5	10	-	-	19.2	76.8
11	2390	-	-	-	-	-	-	-	-	-	-
12	2480	25	0.6	2.5	10	1.5	6	1.4	5.6	4.6	86.4
13	2570	25	0.6	1.9	7.6	1.5	6	1.3	5.2	18.8	75.2
14	2660	25	0.6	2.3	9.2	2	8	0.9	3.6	28.8	83.2
15	2750	25	0.6	2.3	9.2	1.9	7.6	0.9	3.6	20.4	81.6
16	2840	25	0.6	3.2	12.8	2	8	0.2	0.8	21.6	86.6
17	2930	25	0.6	2.2	8.8	3.9	11.6	-	-	20.4	81.6
18	3020	25	0.6	2	8	2.1	8.4	1.4	5.6	22	88
19	3110	25	0.6	2.9	11.6	1.6	6.4	0.7	2.8	20.8	83.2
20	3200	25	0.6	2.3	9.2	2.4	9.6	-	-	18.8	75.2
21	3290	25	0.6	2	8	1.9	7.6	0.9	3.6	19.2	76.8
22	3380	25	0.6	2.2	8.8	1.9	7.6	1.1	4.4	20.8	83.2
23	3470	25	0.6	2.3	9.2	1.8	7.2	1	4	20.4	81.6
24	3560	25	0.6	2.4	9.6	1.4	5.6	1.2	4.8	20	80
25	3650	25	0.6	2.5	10	1.6	6.4	1.1	4.4	20.8	83.2
26	3740	25	0.6	2.1	10	1.6	6.4	1.1	4.4	20	80
27	3840	-	-	-	-	-	-	-	-	-	-

Lithofacies analysis: The analysis shows the percentage distribution of the rock fragment, ferruginized, quartz, mica flask, heavy mineral, rootlet, and fossils are noted. The distribution of the lithofacies component within the depth interval of 1490-3830ft of well OML 109 is tabulated below.

Sample point	Depth (ft)	Rock fragment	Ferruginized Sandstone	Quartz	mica	Heavy mineral	Calcarous	Rootlets
1	1490	20	15	50	-	10	5	-
2	1580	30	20	20	-	20	10	-
3	1670	30	25	25	-	20	-	-
4	1760	30	5	50	-	10	5	-
5	1850	30	20	45	-	-	-	5
6	1940	30	15	45	10	-	-	-
7	2030		-	45	10	15	-	-
8	2120	-	10	55	-	20	15	-
9	2210	30	20	35	15	-	-	-
10	2300	20	15	65	-	-	-	-
11	2390	-	-	-	-	-	-	-
12	2480	30	20	20	15		10	5
13	2570	50	20	30	10	-	-	-
14	2660	30	20	40	-	15	-	-
15	2750	30	10	35	15	-	-	10
16	2840	30	20	30	10	10	-	-
17	2930	-	8	50	30	12	-	-
18	3020	15	32	25	20	-	-	8
19	3110	30	20	45	5	-	-	-
20	3200	50	10	10	5	-	20	5
21	3290	30	10	50	5	5	-	-
22	3380	35	10	40	10	-	5	-
23	3470	40	20	30	5	5	-	-
24	3560	10	30	50	10	-	-	-
25	3650	30	10	40	5	10	-	5
26	3740	20	-	50	20	-	5	5
27	3830	-	-	-	-	-	-	-

Biostratigraphy: This is the differentiation and correlation of rock units on the basis of their fossils. The foraminifera species recovered from the sample are shell fragment, pelecypods, gastropod. The foraminifera microfauna of the 2480ft-2660ft, 3020ft-3200ft, 3290ft-3470ft and 3650ft-3740ft of OML 109 is predominantly of calcareous taxa. The micropaleontology distribution chart is as shown in

Discussions: From the trend of the lithofacies and textural analysis that was carried out, it is obvious that from the sediment it is of marine environment. Most of the environmental interpretations here are mainly based on the affinities of minerals which are also useful in determining the depositional environment.From sample 1-7 marks an increase in rock fragment with a little decrease in ferruginized sandstone and also an increase abundant in quartz, mica and heavy mineral is also presence within these depths on a small scale. The presences of rootlet indicate a marine depositional environment and the sediment is sub angular to subrounded which shows that the sediment has move from its provenance to the

basin. The rock sample within these intervals is intercalated with sandstone, siltstone and clay.From sample 8-11 shows a relative dominance with decrease in rock fragment over ferruginized sandstone and an increase in quartz, but within sample point 9-10 there is there is a fluctuation of mica, heavy mineral and calcareous; the sediment is subrounded to rounded which shows that the sediment has move from its provenance to the basin.From sample 12-16; marks an increase in rock fragment with a little decrease in ferruginized sandstone and also an increase abundant in quartz, mica and heavy mineral is also presence within these depths; but in sample12 shows the presence of calcareous and rootlet on a small scale, The microfauna phylum (Molluca) includepelecypod and shell fragment which provide information on environment of deposition in attributes of littoral deposit, which may be insufficient to characterize the age of the formation. The grain are poorly sorted which ranges from angular to sub angular. The rock sample within these intervals is intercalated with sandstone, siltstone and clay.

In sample 17-23; marks an increase in rock fragment with a little decrease in ferruginized sandstone and also an increase abundant in quartz, mica and heavy mineral is also presence within these depths; the presences of rootlet indicate a marine depositional environment. But within sample 19-21, the grain are well sorted and it is well rounded which shows it has traveled far from it province to the basin; but sample 22-23 is poorly sorted which ranges from angular to sub angular, at these stage they are still within their province. The microfauna phylum (Molluca) includepelecypod and Gastropod which provide an information on environment of deposition in attributes to marine deposit, The rock sample within these intervals is intercalated with sandstone, siltstone and clay. Sample 23-25 shows a relative dominance with decrease in rock fragment over ferruginized sandstone and an increase in quartz, mica and heavy mineral is also presence within these depths on a small scale. The presence of rootlet and some macrofauna phylum Mollusca which include Pelecypod and Gastropoda.But an increase and decrease of the macrofauna which shows a remarkable abundant with biofacies and poor benthonic marine depositional environment. The rock sample within these intervals is intercalated with sandstone, siltstone and clay; the grain are poorly sorted which ranges from angular to sub angular. The rock is intercalated with siltstone and sandstone,

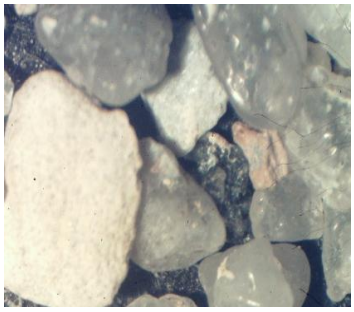
In general, the rock fragment found within the lithofacies distribution chart indicates that volcanic rocks from a high mountainous area have been eroded and transported to the basin which is responsible for the abundances of quartz.

Conclusion: The lithofacies and textural study of sedimentary basins in the Niger Delta offshore, the main study was, however, based on the 25 core sample of well-X within the range of 1490-3740. The core yielded a reasonable mineral affinities with a lithology of claystone to siltstone intercalation which is composed of poor to well sorted sediment. The present study indicates that the lithofacies and textural analysis shows a standard method whereby it denotes a marine environment. The presence of rootlet and some macrofauna phylum Mollusca which include Pelecypod and Gastropoda with an increase and decrease of the macrofauna which shows a remarkable abundant with biofacies and poor benthonic

marine depositional environment. The sea became gradually shallower to supra tidal at the beginning which resulted to a major advance of the sea resulting in the open marine association with the abundant of pollen and spore. The age of the well can be determined with the presence of some macrofaunaPelecypod and Gastropoda which is a diagnostic form of Miocene. From the sedimentological and micropaleontological studies carried out the well is suspected to have penetrated the Agbada formation, the lithofacies analysis, the rock fragment sediments deposited at the top is an indication that it was transported from a high mountainous or volcanic region and this volcanic process is responsible for the abundances of quartz, therefore the occurrence of rootlet shows it is an indication of marine environment.

PLATE 1

1a



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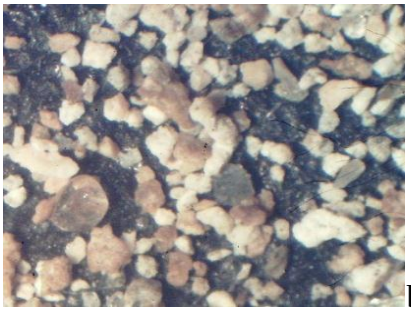

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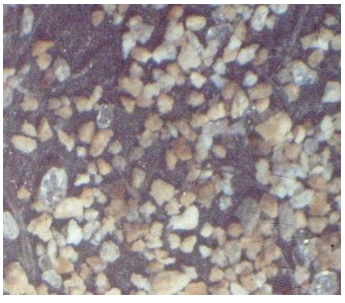
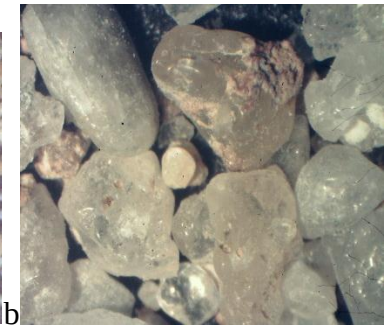
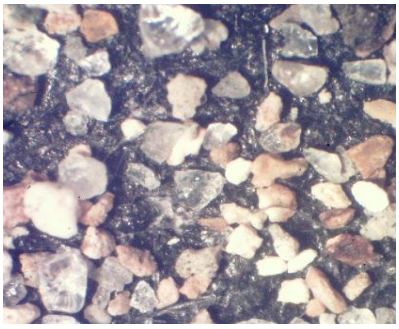
2a

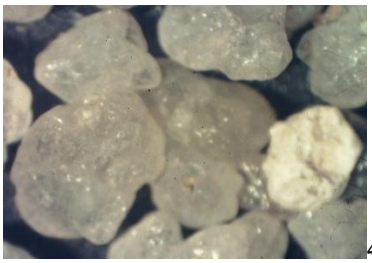


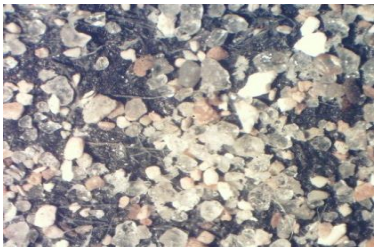
b

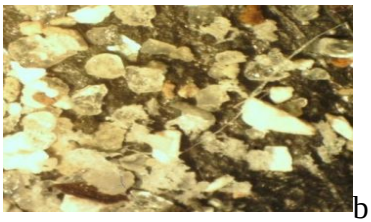
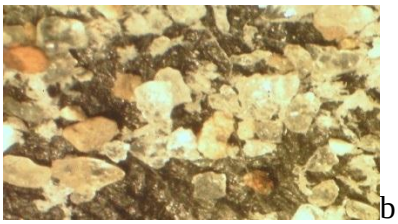
b



3a  a  b

 4a  a

 b  5a

 b  b

Explanation to plate-1

Magnification, A Coarse grains ×16, B Fine grain ×25,C Fine grains ×32

Fig 1a and b(1490ft) : Stereo photos of lithodebries of coarse grains (90µm) and medium size grains (75µm) derived from depth 1490ft showing sub rounded quarts, ferruginized sandstone, heavy minerals, calcareous, rock fragment.They are sub rounded in shape which indicates that it has been transported from their source of formation.

Fig 2a and b(1580ft): Stereo photos of lithodebris coarse grains (90µm) and medium size grains (75µm) derived from depth 1580ft showing rock fragment, ferruginized sand stone, quartz, heavy minerals, calcareous.They are sub angular which indicates that they were recently break up from their source of formation.

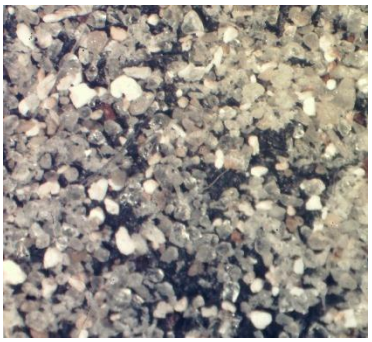
Fig 3a and b(1670ft): Stereo photos of lithodebries coarse grains (90µm) and medium size grains (75µm) derived from depth 1670ft showing some rock fragment, ferruginized sandstone, quartz and heavy minerals.They are subangular which indicates that they were recently break up from their source of formation.

Fig 4a andb(1760ft): Stereo photos of lthodebries coarse grains (90µm) and medium size grains (75µm) derived from depth1760ft showing some rock fragment, ferruginizedsandstone,quartz,heavy minerals and calcareous.They are angular which indicates that they are still within their province.

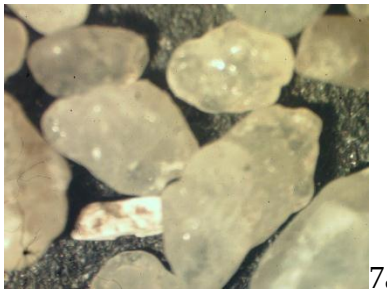
Fig 5a and b (1850ft): Stereo photos of lithodebris coarse grains (90µm) and medium size grains (75µm) derived from depth 1850ft showing rootlets, rock fragment, ferruginizedsandstone and quartz. They are sub angular which indicates that they are still within their province.

6a

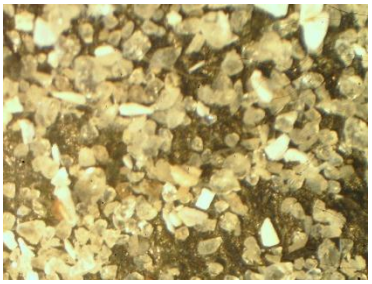
a



b



7a



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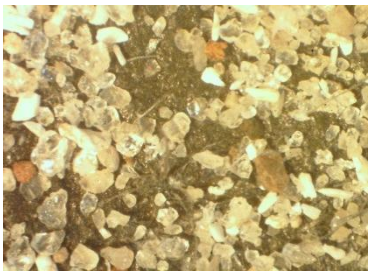

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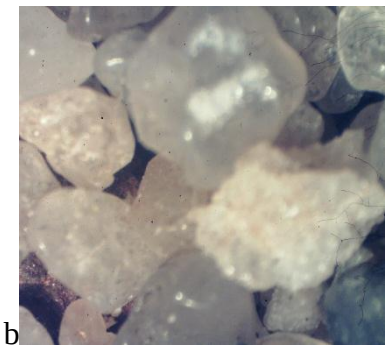
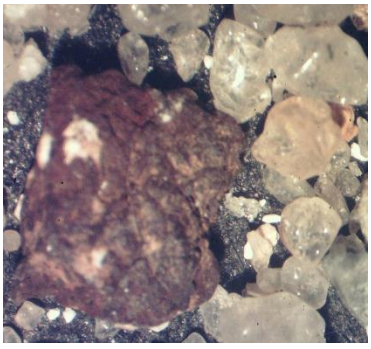
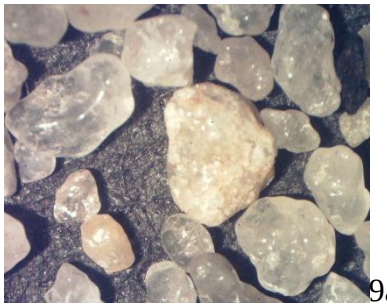
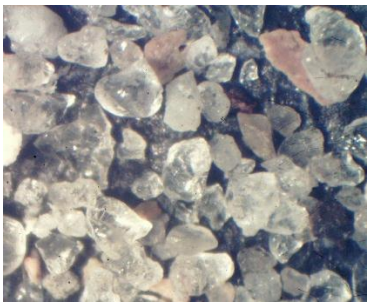
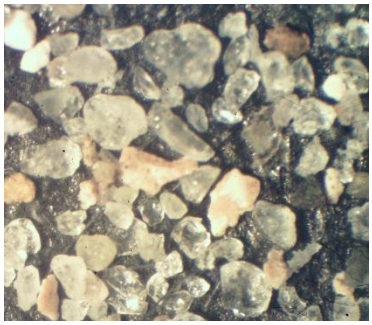
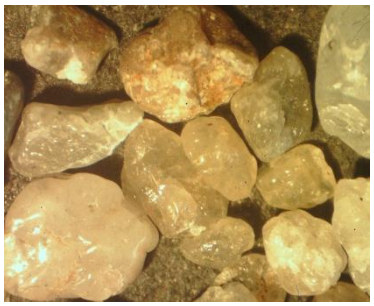


8a



a  b  9a

 b  b 

10a  b  b

Explanation to plate 2

Fig 6a and b (1940ft): Stereo photos of lithodebris coarse grains (90µm) and medium size grains (75µm) derived from depth 1940ft showing rootlets, rock fragment, ferruginized sandstone, and mica .They are subrounded in shape and this indicates that it has undergone long transportation from their source of formation.

Fig 7a and b(2030ft): Stereo photos of lithodebries coarse grains (90µm) and medium size grains (75µm) derived from 2030ft showing ferruginized sandstone, quartz, mica and calcareous. They are subrounded in shape which indicates that it has been transported from the source formation.

Fig 8a and b(2120ft): Stereo photos of coarse grain (90µm) and medium size grains (75µm) derived from depth 2120ft showing ferruginized sandstone ,quartz, heavy minerals and calcareous. They rounded which indicates history of long transportation from their source of formation

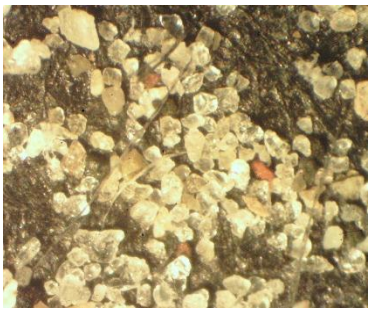
Fig 9a and b(2210ft): Stereo photos of lithodebries coarse grain (90µm) and medium size grains (75µm) derived from depth 2210ft showing rock fragment, ferruginized sandstone, quartz and mica. They are rounded in shape which tells us or indicates that it has undergone a history of long transportation from the source of formation.

Fig 10a and b(2300ft): Stereo photos of lithodebries coarse grains(90µm) and medium size grains (75µm) derived from depth 2300ft showing rock fragment, ferruginized sand stone, and quartz They are sub rounded shape which indicates that it has under gone a history of long transportation away from its source of formation.

Fig 15a,b and c(2840ft): Stereo photos of lithodrbries coarse grains (90µm),medium size grains (75µm) and fine grain (53µm) derived from depth 2840ft consisting of rock fragment, ferruginized sandstone, quartz, mica and heavy minerals .The coarse grains are angular in shape which indicates that they recently broke up from their source formation

Fig 19aand b(3200ft): Stereo photo of lithodebries coarse grains (90µm) with magnification of (×16) and medium size grains derived from 3200ft showing rock fragment, ferruginized sandstone, quartz, mica, calcareous and rootlets .They shape appears angular and it indicates that they have not undergone transportation, few Gastropod were found in this depth.

15a



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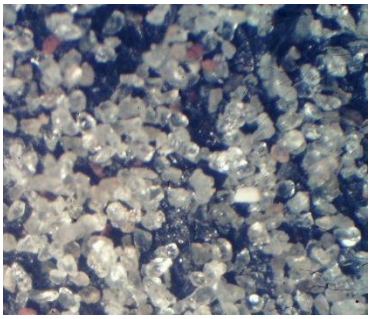
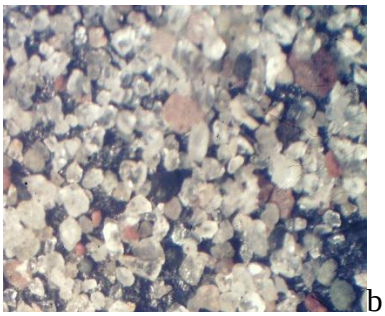


c

16a



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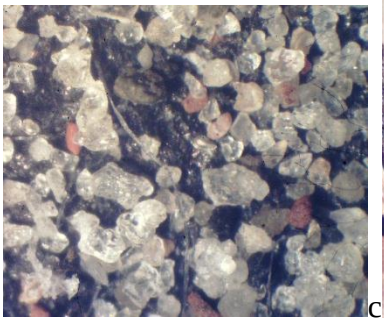
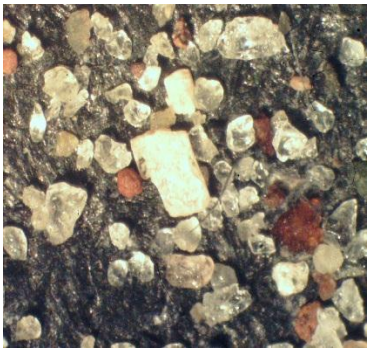


c

17a



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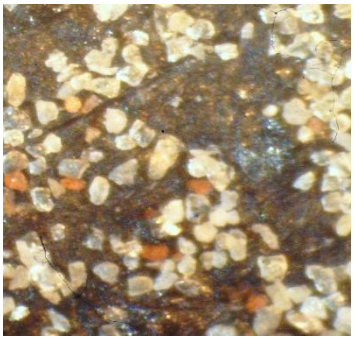

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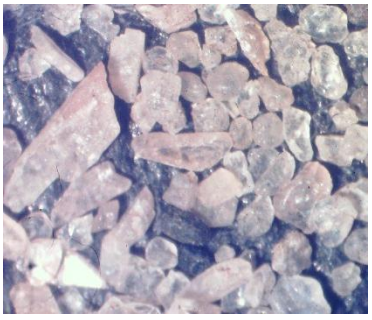
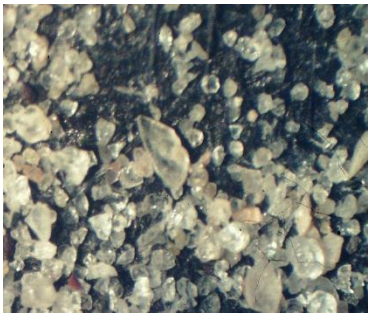


18a



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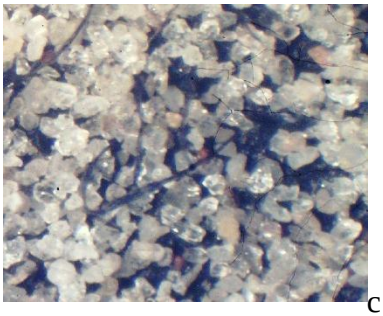
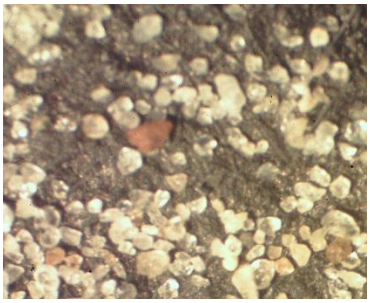


c


19a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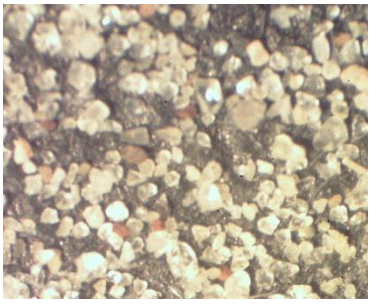
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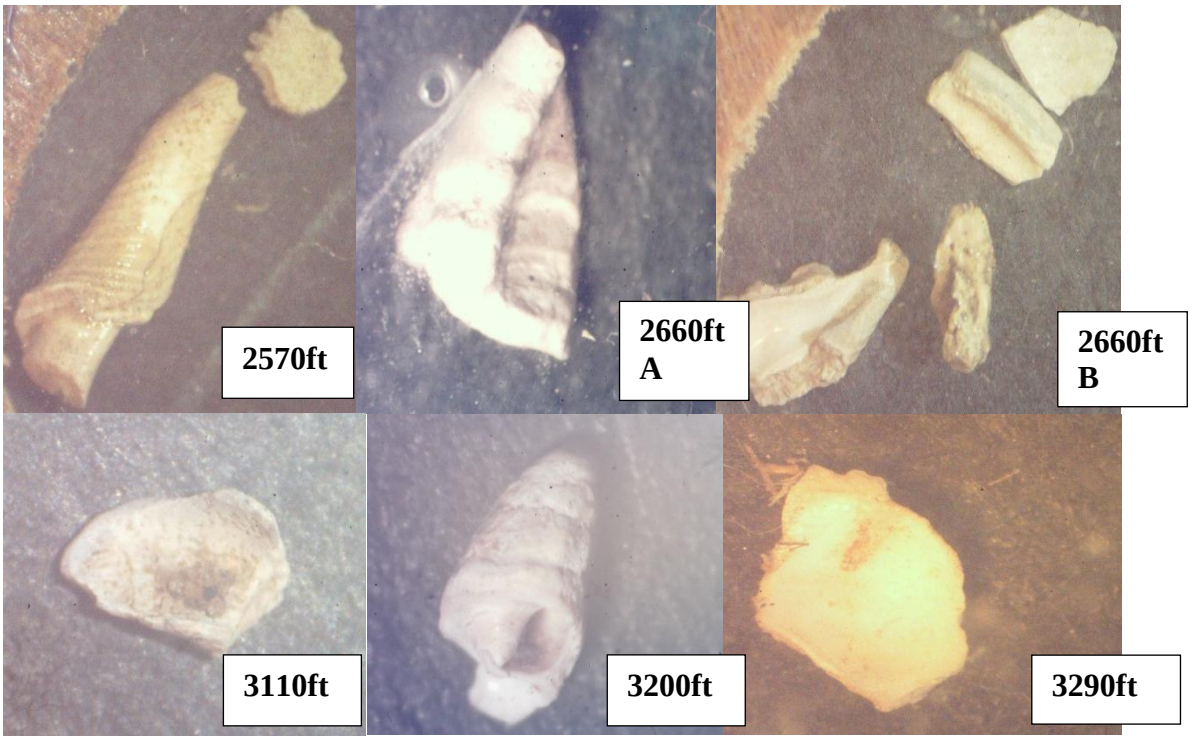

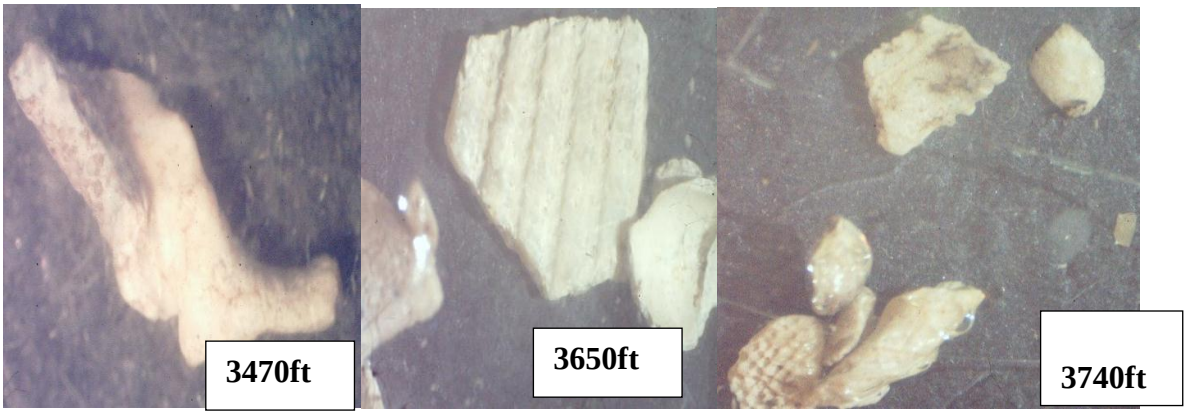

Fig 1(2570ft): Few pelecypod shell fragment found at this depth ,they are bilaterally symmetrical and their shell are calcareous.They can be distinguished from other mollusca by their bivalve shell.the soft part the soft part of the pelecypod are enclosed within a shell composed of two hinged calcareous valve.

Fig 2a and b(2660ft):pelecypod shell fragment found at this depth,they are bilaterally symmetrical and their shell are calcareous.They can be distinguished from other mollusca by their bivalve shell.the soft part the soft part of the pelecypod are enclosed within a shell composed of two hinged calcareous valve.

Fig 3(3110ft): Pelecypod shell fragment found at this depth,they are bilaterally symmetrical and their shell are calcareous.They can be distinguished from other mollusca by their bivalve shell.the soft part the soft part of the pelecypod are enclosed within a shell composed of two hinged calcareous valve.

Fig 4 (3200ft): The Gastrod found at this depth has a univalve calcareous shell in form of a simple chambered cone which is coiled in a helicoid spiral .they are terrestrial and fresh water snail, periwinkles e.t.c their shells serve as a refuge in which they can be withdrawn for protection ,the shell for Gastropod are mainly aragonite .Some Gastropod are aquatic and live in shallow marine waters while some have adapted to brackish and fresh-water environment and some have modified their breathing apparatus.

Fig 5(3290ft): Stereo photos ofPelecypod shell fragment found at this depth,they are bilaterally symmetrical and their shell are calcareous.They can be distinguished from other mollusca by their bivalve shell.the soft part the soft part of the pelecypod are enclosed within a shell composed of two hinged calcareous valve.

Fig 6(3470ft): Few pelecypod shell fragment found at this depth and they are bilaterally symmetrical and their shell are calcareous.They can be distinguished from other mollusca by their bivalve shell.the soft part the soft part of the pelecypod are enclosed within a shell composed of two hinged calcareous valve.

Fig 7 a, b and c(3650ft):): Pelecypod shell fragment found at this depth,they are bilaterally symmetrical and their shell are calcareous.They can be distinguished from other mollusca

by their bivalve shell.the soft part the soft part of the pelecypod are enclosed within a shell composed of two hinged calcareous valve.

Fig 8 a and b (3740ft): Stereo photos of pelecypod shell fragment found at this depth ,they are bilaterally symmetrical and their shell are calcareous.They can be distinguished from other mollusca by their bivalve shell.the soft part the soft part of the pelecypod are enclosed within a shell composed of two hinged calcareous valve.

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