TOPIC

THE INFORMATION TECHNOLOGY AND PETROPHYSICAL CHARACTERISTICS OF ASSA OIL RESERVIOR IN THE EASTERN NIGER DELTA OF NIGERIA

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ABSTRACT

A subsurface study of the Assa field in the Eastern Niger Delta was carried out to achieve a geological model for the oil reservoir. The work is a petrophysical contribution to the integrated study of the field.

For Assa Well - 1 porosity was calculated from derived improved sonic log for each interval of any measured transit time (Ät) log-using algorithm. The work shows that the reservoir rocks are mainly sandstones ranging from very fine to coarse grained, well to moderately sorted and generally less consolidated. Owing to rapid deposition and partial diagnosis.

Results obtained from grain size are fine to medium sand except at depth of 14674 - 14674.7pt where pebbly sands were encountered. An integrated sandy of the reservoir sold from lithology, texture, bedding structure, concentration and sonic log shape suggest that the depositional setting of the described field ranges from coastal barrier system to the estuarine fluvial channel.

The reservoir quality ranges from excellent to good depending on the coarsening and firing upward sequences of the sandstones.

SECTION ONE

INTRODUCTION

Assa field is covered with alluvial deposits of braided rivers, which occur as blankets of coarse sand. Their grains are moderately rounded and sorting is intermediate to poor. Thus, despite high gross porosity the deposits typically show a good deal of permeability variation at the same time due to sediment coarseness, inter, communications between individual sandstone bodies (channels and bars) is excellent. Due to continental setting, braided survival deposits are normally capped by an unconformity and as a result, often occupy stratigraphic positions with good reservoir potentials. This study is important to know the petrophysical contribution to enhance the study of the field. Post burial percolation of acid material waters through this type of deposits has almost an equal chance of destroying primary pore space by mineral precipitation as enhancing it through dissolution.

FIG. 1: CROSS SECTION OF BRAIDED ALLUVIAL SAND

This idealized cross section (fig. 1) shows how braided alluvial sand blanket sets as site for large accumulation on truncated horst, sourced and sealed by trangressive marine shales. In this type of setting tectonism possible rift related would generate the high heat flow necessary to mature organic material into hydrocarbons. Shale layer in this facies are usually inconsequently in terms of fluid migration blockage and therefore do not promote stratigraphic trapping.

1.1 LOCATION OF STUDY AREA

The Assa field lies in OML 21 about 62kms North of Port Harcourt. It covers an area of about 5.25km^{2}. The filed has an anticlinical structure and is affected by a south dipping east - west striking boundary fault and a north - east/west striking minor fault zone. The fault zone separates the Assa filed from the adjoining Ibigwe field.

1.2 OBJECTIVE AND SCOPE

Like the nearby Ibigwe field Assa field is relatively small, and with the little data on it. This wok is the petrophysical contribution to an integrated study of the field carried out revalidating, augmenting and documenting the fields data with the estimate goal of maximizing the exploitation of the resources therein. It consists of detailed re-evaluation of the available logs and other sources of petrophysical data such as sidewall samples (SWS) and formation interval test (Fit/FIT/FTT) results.

1.3 PREVIOUS WORK/LITERATURE REVIEW

The Tertiary Niger Delta has been under intensive studies for quite for quite sometime now, because of it's economic potentials as a petrolierous province (Nwachukwu and Chukwu 1986).

Various workers have worked on different aspects of the basins. This include short and stauble (1967) Frank and Cordry (1967), Weder and Daukoru (1975), Selley (1978), Ejadawe et all (1984), Amajor (1986) and 1990) amongst others.

Many workers have used different techniques of environmental analysis based on fire major defining parameters of a facies; sedimentary structures, lithology and paleocurrent. An attempt has also been made to map the geometry of reservoir facies from borehole data, environmental interpretation being carried out on each well as to locate the next one in a suitable position. Dorbin (1972) Harms and Takemberg (1972) and Sheriff (1976) used seismic method to determine geometric from which environmental interpretation was made. Several attempts have also made to use lithology in environmental determination. Feldlusen and Ali (1975) and Reed et al (1975) also used texture of a sediment to determine its depositional environment by comparing granulometric analysis of ancient sediments with recent sediments of known origin, although this approach of texture alone has largely proved unsatisfactory.

Granconite has been found to be diagnostic of marine rocks since it is widely believed to form only in marine environments by Porrenga (1967). Fossils have also been discovered to be one of the most important methods of identifying the depositional environment of a sediment. Reviews of this line of research have been given by Hedgpeth and Ladd (157), Greeker (1957) Ager (1963) and Imbrie and Newell (1964).

SECTION TWO

METHODS OF ANALYSIS

FOR WELL - 1

POROSITY METHOD: Porosity ΦÄt was calculated from the sonic log for each interval of any measured transit time Ät log, using the logarithm.

ΦÄt = 5 (Ät log - Ät matrix); (Ät matrix = 56μ secs)

8 Ät log

This is derived from improved sonic transit time-to-porosity transform proposed by Reymer, Hurt and Gardener 1981. For each hydrocarbon bearing interval the formation water resistivity RW, was calculated from the nearest water bearing clean sand usin the Archie equation.

Rw = Ro where Ro = water bearing formation resistivity

F

F = Φ-m = formation factor of the water sand

M = cementation factor = 1.8 historically

ΦÄt = (sonic) porosity of the water sand.

For each zone of equal transit time in the hydrocarbon bearing interval, water saturation was calculated using the Archie formula. The well - 1 has both porosity and resistivity logs so saturation were calculated using Archie method also.

WELL - 2, - 3 & - 4

Here they have later logs in addition to the Es but have no porosity logs. Extrapolation of porosity cross the field by Rt versus Φsh cross plots. This is because well - 1 which has a porosity log does not have the later logs from which Rt value could be obtained. The Es does not give accurate measurements in the resistivity ranges of the hydrocarbon sand. A crossplot of Rt LL - 3 versus an attempt to calibrate the electrical survey (Es) with the laterlog (LL - 3) or vice versa but it did not result in any simple relationship (Fig. 2)

ASSA FIELD WELLS 2, 3, AND 4

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FIG. 2: CROSSPLOT OF LATERLOG (LL - 3) VS ELECTRICAL SURVEY (Es). ΦÄt V ΦSWS ASSA FIELD

FIG. 3: COMPARES THE SIDEWALL SAMPLE WITH SONIC POROSITIES

SIDEWALL METHOD

Sidewall sample porosities are however available for most of the sands in these wells, and were used to calculated saturations by Archie and the result compares with the ration method saturations (fig. 3). It compares the SWS porosities with their corresponding sonic porosities for some of the sand in well - 1 the sonic porosities are mostly on the higher side showing that the side effect of the impact of bullets on the sidewall samples is mostly of compaction.

In this field Archie method using sonic porosity yields water saturations which do not differ by more than 4% or 0.04 from the corresponding ration method saturation. This criterion needs to be tested in other fields before it can be used to discriminate between accurate and inaccurate SWS porosities in this, the weighted average of sonic porosities in well - 1 are used for characterizing reservoir and is the ration method SW in well - 2, derived from laterlogs, and since, this well is high on the structure it is likely to have encountered representative saturations for most of the sands. Where this well did not reach the sand, or encountered it wet, the Archie saturation (SW Archie) derived from the Es in well - 1 is used as is the case with the H - sand.

DATA AVAILABILITY

The logs available are presented graphically in fig. 4. This is for clarity and ease of reference. The logs are generally of good quality but some components, especially the SP log. In the SP log, where a porous and permeable zone is invaded by mud filterate, ions migrate between the mud filterate and formation water when there are differences in the salinity. The SP curve, therefore, reflects the lithology of the rock and fluid contents which indirectly is considerable to porosity.

The SP curve is used to:

1. Dectect porosity and permeable reservoir sands.

DATA AVAILABILITY - ASSA FIELD

FIG. 4: GRAPHICAL PRESENTATION OF THE AVAILABLE LOGS.

FIG. 5: DATA AVAILABILITY - ASSA FIELD

2. Define reservoir bed boundaries for accurate correlation.

3. Determine formation water resistivity.

4. Identify depositional environments of reservoir sands.

The material used during analysis

1. Natural Gamma-ray spectrometry log.

2. Well description guide.

3. Lithofacies guide in the Tertiary Niger Delta.

4. Core description guide.

5. Sonic log.

6. Ruler, Eraser, Pencil

SECTION THREE

3.0 GEOLOGY OF THE STUDY AREA

3.1 LOCATION AND TECTONIC FRAMEWORK

The Tertiary Niger Delta in Southern Nigeria between 5o and 7o and longitude 4o and 10o. The basin is bounded in the east by the Calabar flank, which is a sub surface expression of the oban massif (Stonely, 1966, Nwachukwu and Chukwu, 1986). It is bounded to the west by the Benin flank, in the south by the galf of Guinea and in the North by older (cretaceous) tectonic elements such as the Anambra basic/Abakiliki anticlinorium and Afikpo syncline (Ejedaw, 1981).

The basin is described as having resulted from the third phase of three major techn-depositional cycles undgergone by the Nigeria South - East basins by murat (1972). The third cycle began at the end of Eocene and was marked by erosion and or non-deposition (Short and stauble, 1967).

The proto - Niger Delta was formed in the present Anambra embayment at the intersection of the present day Niger and Benue Rivers. At this intersection, which is tectonically controlled deposition was greater during the cretaceous, with the sediments attaining a thickness of about 6000m and 7000m (Macheus, 1973).

At the end of Eocene, following a major regression the build up the present day Niger Delta began it prograded southwards covering a distance of about 260km (Emery, 1975).

3.1 ORIGIN OF THE NIGER DELTA

Deltas develop in a broad range of tectonic settings, at either convergent or divergent plate margins and within plates. They may develop on continental, transitional or oceanic crust. There are many which are common to the huge prisms of sediment which accumulate in these settings.

As for the Niger Delta, it is believed that rifting was first initiated in the latest Jurassic and Albian time a wedge of sediment, varying in width and form, has developed along the developed at the position on what is now the outer Niger Delta whose failed arm in Anambra - Benue rift valley within ocean crust did not developed. The Africa and South American continents drew apart along the ridge transform system of the Gulf of Guinea and South Atlantic arms.

The Delta this owes its initiation and position to megatectonic features. The third phase of three major tectono-deposition cycles undergone by the Nigeria south eastern basins. The cycle which was the third began at the end of the Eocene and was marked by erosion and/or non-deposition (Short and stauble, 1967).

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A prograding delta implies that clastic sediment is being supplied to the coastal area and shelf more rapid than it is being removed by the Niger River which is 4, 100km long and rises in the mountains of Sierra Leone to the West.

At the end of the Eocene, following a major regression the build up of the present day Niger Delta began and its progradation Southwards continued covering a distance of about 260km (Emery, 1975).

3.1 PALEGEOGRAPHY OF TERTIARY NIGER DELTA

The main regression and the formation of the present Niger Delta began in the mid Eocene times with the deposition of the Ameki Formation on the West/East of the River Niger. The sediments constituting the Ameki Formation was derived from two main drainage systems, the Niger - Benue system through the Anambra basin North of Onitsha, and the less conspicuous Cross River system through the Afikpo sycline.

In the Eocene - Oligocene time the two systems appear to have separated from each other by the late cretaceous Abakiliki anticlinorium episode and its South Western extension (Short and stauble, 1967). The Cross River system did not late much sediment during the mid and late Eocene. The Delta built up mainly in the Bendel - Ameke are although the increasing amount of sand towards the top of the Ameki Formation indicates a possible movement of the coastline towards the South. At the same time, the Western Delta advance rapidly over the shallows Anambra shelf.

During the mid-Eocene, the Delta moved towards Onitsha, Benin area and advanced further towards the Kwale area and reached the Aboli area in late Eocene time.

Owing to the slow movement Cross River Delta system, a marine interdeltaic area name the Ihuo embayment formed between the two Deltas extending beyond Orlu area. Progradation of the Delta continued in the post Eocene and by early Oligocene. Sedimentation in the Cross River Delta became more active and a small but important and rapidly advancing Delta developed in the Olumbe 1 area. The Ihuo embayment separated the Cross River Delta from the Niger Delta and was filled by the rapidly advancing Cross River Delta and probably by Local Rivers.

In the late Oligocene - early Miocene that sediments of the Cross River merged with those of the Niger Delta. Henceforth, extensive mixing of sediments by long shore and tidal currents makes the distinction of the two deltas difficult but the later growth of the cross River Delta can be traced Southward from the Imo River field to the Luarra creek area. In late Miocene, the subaerial Niger Delta reached a position beyond the present coastline. In Pliocene - Pleistocene time, it advanced further seaward and reached its maximum extent about the edge of Continental shelf. Coarse Cannel Sands of fluvial Origin and Shallow Marine to estuarine - Lagoonal fauna have been obtained from sea floor samples taken from various Localities up to 40miles offshore (Allen 1965).

The post glacial rise in sea level caused the sea to transgress over the plio-Pleistocene to cene delta beyond the present Coastline. The old river systems were drowned and scoured by strong tidal currents and from the existing estuary systems.

MORPHOLOGY OF THE NIGER DELTA

The basic development of the Niger Delta can be described into six stages chronologically. The initial stage was the pre-cretaceous basement complex prior to the tectonic episode that separated South America and Africa. The second stage took place in the early cretaceous when the continent eventually pulled apart and the first marine transgression (in the mid Albian) occurred. By the late cretaceous the third stage of the delta development was underway with the spread of sediment deposition and growth of the proto-Niger Delta. The fourth stage was dominated by regression which marks the beginning of the modern Niger Delta in the Tertiary. By the fifth stage in the Tertiary of the delta was well developed as regression continued.

The Niger Delta has prograded into the Gulf of Guinea as a steadily increasing rate in response to the evolving drainage area, basement subsidence and eustatic sea level changes. At the initial state, the delta prograded over extensionally thinned continental crest of the west African margins as far as the triple junction, felling the base Graben and Horst topography. The convex to sea morphology did not develop until the Eocene. Since the Oligocene sediments had been deposited in increasing volumes.

The present morphology of the Niger Delta is a typical wave and tidal dominated delta. At present it appears to be constructive in the centre and destructive on either flanks. The sediments in the Niger Delta are mostly sandy as a result of the fact that nearly all the environment in the subaerial part of coastal or delta plain origin.

The sediment source area in the shield consist mainly of crystalline rocks of the Guinea Highlands basement complex together in the cretaceous and tertiary sediments derived from them, and materials from the Cameroon volcanic line. The quality and abundance of reservoirs throughout the Tertiary sequence indicates that there has always been a major sand contribution from the shield areas.

Sandy beaches formed by long shore currents carry sediments discharged at the apex of the delta in both North-West and Eastward along the Coast. Beach ridges and offshore bars are also formed (Burke, 1972). The marginal portions of the Delta are relatively starved of sands and in places, suffer encroachment from the sea. The submarine portion of the delta consist of a board shallows shelf which gradually merged into a long continental slope are rise extending as far as 250km from the coast. The upper part of the slope marked by a zone of faulted sediments clay walls and diarpris, known as the distal belt because it represents the outermost portion of the developed part of the delta.

3.5 STRATIGRAPHY

The Niger Delta is a regressive sequence of clastic sediments developed in a series of offlap cycles. All deep wells in the basin document a tripartite Lithostratigraphic succession in which the regressive sequence is here demonstrated.

SECTION FOUR

RESULTS AND INTERPRETATION

4.01 <u>GENERAL</u>

A fault (major) divides the field into an upthrown and downthrown block. There are 23 hydrocarbon-bearing intervals in this field only 3 of which are in the upthrown block fig. 6.

4.02 <u>FORMATION WATER RESISTIVELY.</u>

Table 4.1 shows the variation of water resistivity with depth. Generally the trend is that of decreasing water restivity with depth. However the trend is not strictly followed making the variation with depth irregular. The irregularities, as was suggested in a nearly field (lbigwe field) may be due to post-depositional flushing of the different aquifers while they were active by water of different salinities (Arnild, 1964).

A comparison of the log-derived resistivities with produced water and their formation test counterparts shows that there is a reasonable agreement, at least in trend between the log values and the produce water values. The difference in value could be due to the fact that the two measurements were made in different intervals and environments although their geology is the same. While the produced water came directly from the hydrocarbon-bearing intervals, the log value was obtained from neighboring water sand.

The produced water measurements took place under normal temperature and pressure environments as opposed to the log measurement which are instu-measurement at elevated temperatures and pressures.

For the field study the log derived values were used because they are insite measurement (free from the hydrocarbon saturations and provides more continuous and complete picture of the water resistivity profile in the field.

Fig. 6: Illustrates log of Assa showing a fault (Major) divides the field into

Upthrown and downthrown block.

TABLE 4.1: VARIATION OF WATER RESISTIVITY WITH DEPTH.

ASSA-1

SAND	DEPTH Ft bdf ft ss		FORMATION OF TEMP.	LOG DERIVED RW	PRODUCED WATER RW	FTT RW
C1.1	4745	6582	120	10.11	-	-
D1.2	5740	5582	128	8.59	11-6	6.8
D2.1	5940	5772	130	9.79	7.0	6.0
D3.0	6234	6071	132	8.4	-	-
D5.0	6510	6347	135	9.7	-	-
D7.0	6740	6577	137	4.49	2.4	7.5
D8.0	6835	6672	138	6.85	-	-
D8.1	6900	6737	139	8.07	-	-
E8.1	8270	8107	150	0.09	-	-
H1.0	9118	8953	178	2.72	-	-
H4.0	9962	9797	189	0.85	-	-

ASSA FIELD

TABLE 4.2: SIDEWALL SAMPLE AND SONIC POROSITIES

SAND	**SAMPLE DEPTH Ft a.h. bdf**	**SWS POROSITY SWS**	**SONIC POROSITY (ΦÄt)**
D1.2	5120 5637 5660	29.6 34.2 28.4	33 33 32
D2.1	5845 5850 5900	35.4 31.5 27.8	33 32 25
D3.0	6140 6165	21.4 28	29 28
D4.0	6336 6450	27 24.2	30 26
D6.0	6612	30.4	28
E8.1	8488 8492 8505 8507	29.2 29 22.8 24.6	31 32 31 38
H1.0	8960 9055 9082	24 18.5 30	25 26 26
H3.0	9171	21	29
H4.0	9947	27	28

Table 4.2 Compare the SWS porosities with their corresponding sonic porosities for some of the sands in well-1.

THE RESERVOIR SANDS.

The shallowest hydrocarbons in this field occur in C sands. However their saturation are mostly marginal and the fluid distribution is irregular. For instance, C2.0 is oil bearing in well-3 was drilled but the indications of its being hydrocarbon bearing in crestal wells-1 and two are doubtful. C.30 is hydrocarbon bearing in well-3 only, even though it is wet in wells-1 and well-2 as well. Apparently the areal distribution of the C-sands is irregular and not yet defined.

However, the C-Sands achieved their best hydrocarbon saturations in well-2. the C1.0 sand water saturations (SW) of 43% 13ft water contact (OWC) at 4410 ft (ss) in well-2. it has marginal saturation in well-1.

The C4.0 has SW of 45%, 9ft NOS, in well-2 and marginal saturation in all the C-sand wet.

Well-3 found the C4.5 and the C8.1 sands oil occurrence and this appears to highly restricted and limited pockets of oil.

RESERVOIRS AND RECOVERY

The trapping of a non-wetting phase depends strongly on the characteristics of the pore system, and particularly on the type and distribution of non-random heterogenerities. Consequently the recovery of hydrocarbon depends directly on the pore geometry, and especially their degree of heterogeneity.

The latter is generally lower in sandstone than in carbonates. Hence final recovery does not appear to show good correlation with pore geometry in the case of carbonate reservoirs. In other case, the existence of good correlation between mercury injection and porosity may constitute a correlation factor with recovery (wardlaw, 1976, 1980).

ACTION OF GEOLOGICAL FACTORS

The present characteristics of a reservoir are the result of the geological history of the basin and more specifically of the conditions of deposition, digenesis and catagenesis. To a certain degree, the present qualities of a reservoir are merely a "snapshot" whose explanation lies its geological history.

INFLUENCE OF THE DEPOSITIONAL ENVIRONMENT.

The characteristics of the depositional environment closely conditions the shape, extension structure and nature of a reservoir. As a rule, rocks exhibiting good porosity and permeability characteristics correspond to deposits in high energy environment if detrital components have been deposited. An agitated environment, devoid of detritus, often favours the development of carbonates especially reef structure and their Debris, offering good matrix porosity characteristics.

From the geometric saundpoint, two main depositional categories may be distinguished: great detrital spreads of the blanket type, exhibiting fairly uniform thickness and characteristics over vast area in a far greater number, sand and carbonate bodies, essentially intermittent in space which are defined by their geometry of deposition in terms of from, size and orientation, with the understanding that the subsequent geologyical history can make sweeping changes in their original morphology.

Observations tend to show that the continuity of the reservoir very often varies its porosity and permeability characteristic. From a geological sandpoint, the following will be dealt with in succession: detrital bodies, build up units.

DETRITAL BODIES:

Depending on the paleogeographic and paleoceaographic conditions, deposits of sand or carbonate particles may correspond to; well individualized bodies, eolian dunes or offshore bars on the continental shelf, fluviatile or submarine channels, deltas or turbidities, great blankets with fairly constant thickness and characteristics, sometimes made up of vast turbidities spreads.

Environments with relatively high energy, generally shallow, favor the deposition of 'clean' sands, or more generally detrial bodies often find their well characterized depositional forms made gradually uniform by compaction and diagenetic mechanisms. In a section, the characteristics forms of a levee or a channel fill assumes a lens shape as burial proceeds see fig below.

Fig. 7: The diagram fig 6 shows the effect of 50% compaction of shales on

two types of sand bodies: sand bar and channel.

Influence of diagenesis/ catagenesis cementation and pore destruction of reservoirs. Like all other components of sedimentary basins are never static for a long time. Their 'fixedness' is mercy the expression of an instaneous observation on the geological time scale. The characteristics of the depositional environment directly influence digenetic transformations. Small differences in burial or uplift may give rise to zones of porosity protection or destruction.

Pore destruction in sandstones generally develops beyond a thermal diagenesis threshold depending on the petrophysical characteristics, and also because sandstones tend to show greater resistance to loss of porosity if it is 'cleaners'. This thermal threshold is expressed by the vicinity reflectance (rv), which may vary widely from 0.6 to 1.75 for different sandstones in the coastal basis of equatorial Africa, (cassan 1978). Since paleotemperatures very independently of maximum burial depth and in accordance with geothermal gradients, good reservoir characteristics may be maintained at considerable depths.

LITHOLOGY

The refers to the rock types encountered in the well described, about 90% of the interval studied is mainly sandstone reneging from very fine to medium-grained sand. The shale contents is as low as 50% and well sorted to moderate, where the shale percentage is above 40%, and shale giving rise to the heterolithics with moderate to poor sorting.

TEXTURE

The given size trend used in this work range from, fine-coarse sand. It includes shales, very fine, silt, fine sand, medium and coarse sand, very coarse sand. Each of these grain size are fine to medium sands except at depth of 14674-14674.7ft where pebbly sands were encountered. Also a few cases where the shale percentage is as high as 80%. The contact between the regimes are either sharp where coarse sand overlie sharp or erosive where coarse grianed sand overlie fine or very fine sands.

THE INFLUENCE OF TECTONISM

Tectonic deformations (mainly tension and shear mechanism, but also folding can cause the fraction of compact rocks and give them secondary porosity and permeability. The action of fracture, of whatever origin, through the succession of deposits, tends to open new paths for the circulation of water, which is liable to penetrate into deep horizons.

A positive or uplift movement also gives rise to a decrease in pressure and temperature, by the erosion of the overlying series which may be reflected by chemical transformations of the reverse type, the instruction and circulation of meteoric waters and the revial of movement, mainly along permeably beds, of the aquifiers which act by subtraction or by addition depending on their characteristics and those of the environment. in fact, certain anticline reveal a decrease in reservoir properties with an increase in flexuration and dip.

In the case of massive beds in particular, the decrease is caused by pressure dissolution and stylstilization before the start of folding.

SANDSTONE RESERVOIRS.

Detritial reservoir, generally consisting of stale components exhibit fairly uniform porosity and permeability of the water granular type, conditioned by grain size and the degree of cementation. The relations between porosity and permeability are good decreases in one or the other with burial are fairly uniform as a function of temperature forms statistical analysis prepared in 1960 covering 7241 sandstone reservoirs in the United State, ranging from the Cambrian to the Pleistocene, shows that these formations cover a limited area generally less than 260km2 and exhibit an average thickness of 12m. Whatever the trap involved, sandstone reservoirs with a limited local extension clearly predominate over the continuous detrital reservoirs that extends over vast areas.

FLUVIATILE SANDS

Deposits of this type correspond chiefly of meander or braided streams of the alluvial plain. They are represented by sand bodies 250m to 20km long (average 4km), with thickness of 6 to 75m (average 30km). Their porosity ranges as a rule from 10 to 25% and their permeability from 60 to 2000md (Conybeare, 1976, Janison et al, 1980).

ALLUVIAL FAN DEPOSITS

These deposits show extreme variations in geometry and are often very sensitive to diagenetic effects. These type of environments include the alluvial sands of the lower cretaceous.

SPECIAL FEATURES OF ASSA FIELD

A resistivity anomaly occurs between 7052 - 7256ft (a.h. bdf) - (6882 - 7062ft (ss)) in well - 6 where it is most obvious. This zone covers the "Un-named" D8.2, D8.3 and D8.4 sands. The maximum resistivity in the zone is found in D8.1 and is approximately 3.8 and 40 times than the water bearing formation resistivity immediately above and below the zone respectively.

Fig. 8: Log of Field showing zone of Resistivity Anomaly.

The SP in this zone is clearly more strongly reversed than at other intervals immediately above the zone. The high resistivity as well as the increased reversal in SP is due to fresh water or hydrocarbon presence. The fact that this anomaly is most emphasized in well - 4 which is down dip from all indications is mostly likely due to fresh water. Future wells, should attempt to test this hypothesis fig. 8

SECTION FIVE

CONCLUSIONS AND RECOMMENDATION

Adequate evaluations of the available data on the reservoirs with the exception of the C - sands have been carried out and the necessary documentation has been accomplished. The results of this study have been placed on an updated sandfile. The diagnostic logs have been digitized and evaluation in future can be done on PARASOL. A few major differences were found between this and the previous evaluations with respect of porosity and water saturations.

Fluid distributions in the C - sands are not well defined probably due to structural and or sedimentological irregularities yet unmapped. Future open hole logo should however include FDC/CNL as well as DLT/MSFL/GR so that the density and type of hydrocarbon can be evaluated to confirm the past SWS results. SWS should be taken from the one of anomalous resistivity, see fig. 7 to confirm the fluid properties. The GOC or GWC in the H - sands has not been found and may be found in future wells.