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Depositional Environment, Reservoir Characteristics and Extent of Sediments of Langpar & Lakadong+Therria in Chabua Area of Upper Assam Basin.

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Introduction

The Upper Assam Basin is a well known petroliferous sedimentary basin of India. Exploration for hydrocarbon started way back in 1866 and commercial oil was first discovered in 1889 in Digboi. Thereafter exploration continued and a number of oil and gas fields have been discovered in Oligocene and Miocene formations. In the year 1991 a very remarkable event in the history of petroleum finding in the basin took place, the discovery of Eocene /Palaeocene reservoir in the Basement High area which shifted the focus of petroleum exploration from Oligocene /Miocene dominancy. Thereafter, at least 10 Eocene/Palaeocene fields have been discovered within a span of 15 years with commercial production. Generally, the reservoirs in Palaeocene /Eocene formation are thin and discontinuous in nature but with good reservoir characteristics. Sand to sand correlation in Eocene reservoir are very much inconsistent but as a group they seems to be consistent and traceable in large part of the area. An attempt has been made to identify different genetical groups in a centrally located oil/gas field have identical depositional environment, lateral distribution and possible extension etc.

Geological Setting

The Upper Assam basin is bounded in the north by the Main Boundary Fault (MBF), in the south by an imbricate thrust belt while in the east it is bounded by the Mishimi Thrust and in the west by the Mikir Hill Massif. A thick pile of sediment ranging in age from Cretaceous to Pleistocene has been deposited in the Basin. A Basement High trend parallel to River Brahmaputra and running along the southern bank of it, is an important structural feature of the basin. The sediment thickness also increases on either side of the high trend. The generalized stratigraphic succession within the study area is given in Text Table-1.

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Age		Group	Formation
Pleistocene		Alluvium	
TERTIARY	Pliocene	Dihing Group	Dhekiajuli Formation
	Miocene	Dupitila Group	Namsang Formation
		Tipam Group	Girujan Formation
			Tipam Formation
	Oligocene	Barail Group	Argillaceous Unit
			Arenaceous Unit
	Eocene	Jaintia Group	Kopili Formation
			Sylhet Formation
	Palaeocene		Langpar Formation
Pre Cambrian		Basement	

Text Table-1: Generalized Stratigraphic Succession of Upper Assam Basin

The Chabua oil/gas field is a part of Greater-Tengakhat area in the Central Basement High of Upper Assam Basin. (Fig.1) and is in the early stage of development. The presence of commercial hydrocarbon had been established in this structure in 1999. Hydrocarbon prospects of the area are mainly confined to the Sylhet and Langpar formation of Eocene /Palaeocene age.

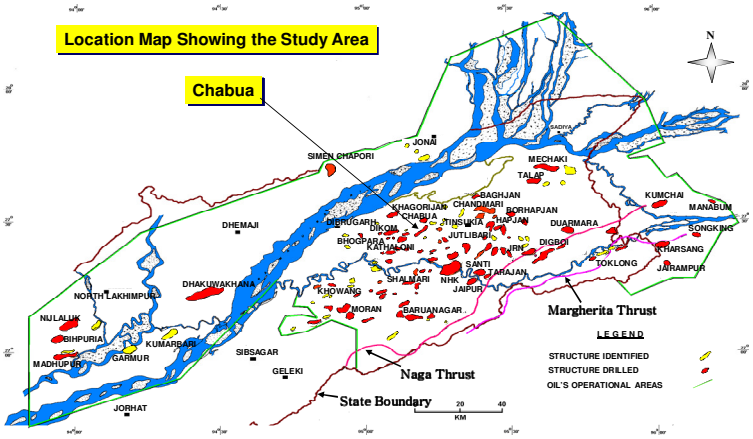

Fig-1: Chabua Location Map

All together 13 wells have been drilled so far in the area. Multistacked clastic deposits hold the hydrocarbon prospects in the field. These clastics consist of bluish grey shale, brownish grey carbonaceous shale, whitish claystone ,fine to coarse grained sandstone, fine grained calcareous sandstone, occasional coal deposit and few limestone/calcareous band with thickness range from 140-170m. Sandstone beds are very thin to thin and range from 0.60 m to 8.0 m in thickness. Individual sand units do not seem to be connected in all cases even though they are present in same stratigraphic position. However, as sand groups they can be well correlated and can be traced for a longer distance.

Brief Description of the Study Area

The Chabua structure is situated in the crestal part of Basement High and bounded by two NE-SW trending major faults in the northern side and southern side of the structure. These two major faults make up a horst block that contains another structure (Dikom-Sealkati) in the flank part of Basement High. The structure is affected by few minor faults dipping both in the north and south direction trending almost parallel to the main fault. The main Chabua structure has been divided by these faults and virtually makes three fault blocks. The central block has 11 wells whereas the northern and southern blocks have one well each. A Depth contour map on top of Langpar is presented as figure-2 shows the structural configuration of the field. The areal extent of Chabua structure at Langpar top level is around 16 sq.km.

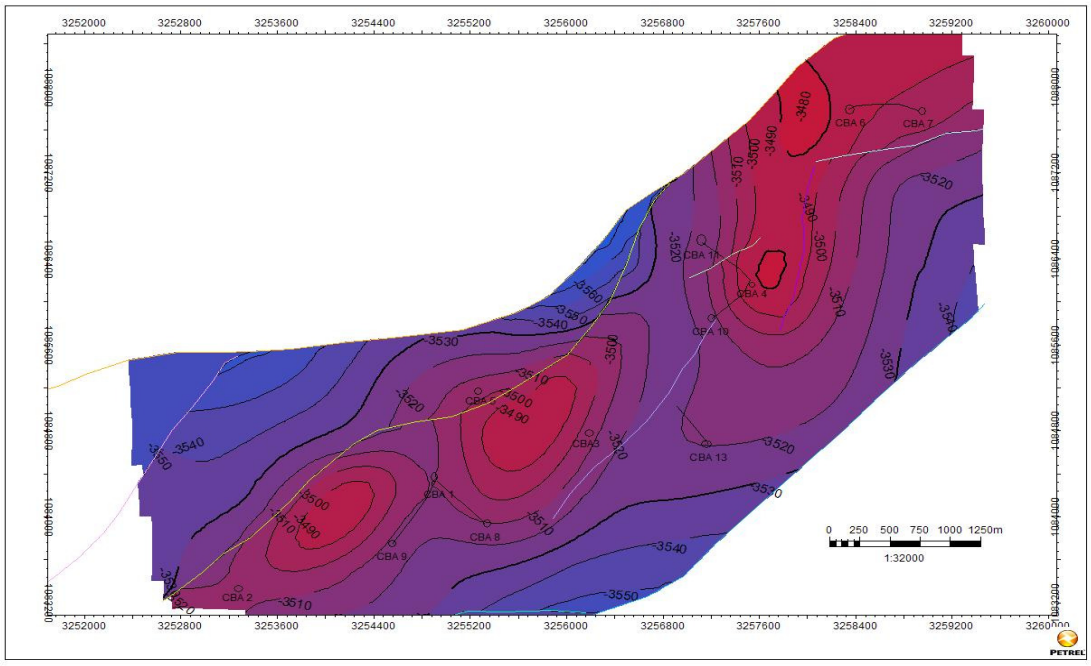

Fig-2: Depth contour map on top of Langpar Formation

This case study is focused mainly on the depositional environment, sand development and hydrocarbon distribution pattern of Palaeocene/Eocene reservoirs of Chabua area

Well Correlation:

A geological correlation of Lakadong +Therria unit of Sylhet formation and Langpar formation part has been prepared across the field and presented in figure 3 . The entire LK+TH unit has been divided into five sub units and the Langpar formation grouped as one sub unit. A total of six horizons H-1 to H6 have been identified below the LK+TH top to Basement part to differentiate genetic groups based on log signature, core lithology and environment of deposition. It is evident from this correlation that all these sand units are present in the drilled wells and are almost at the same stratigraphic level but may not have lateral connectivity. Different fluid content in the sand units also indicate the lack of connectivity in strata.

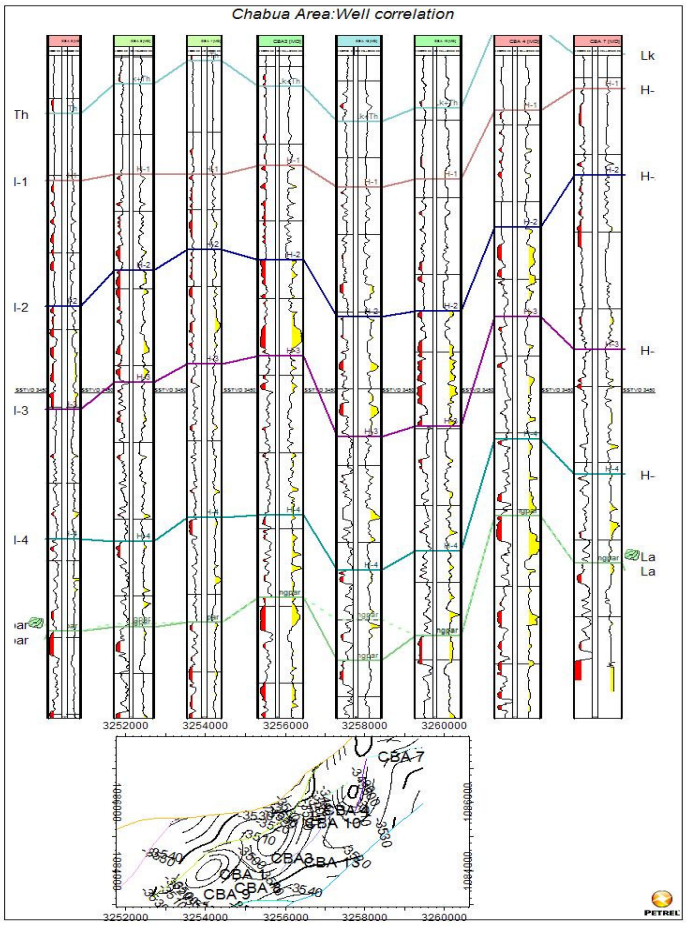

Fig-3: Sand Group correlation of Chabua area

Depositional Environments, Sand Distribution Pattern:

Based on the sand development pattern, vertical distribution, wireline log characteristics and depositional model in the light of sequence stratigraphic concepts, the sediments of Langpar and LK+TH formation have been divided into six lithologic units.

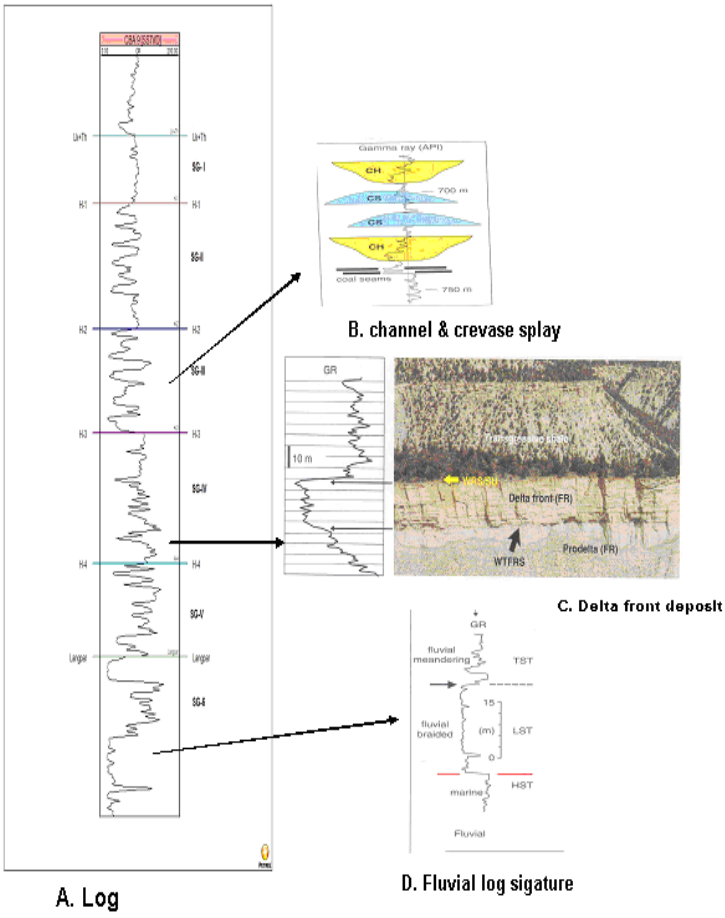

Fig-4: Log signatures and depositional environment {quote from principles of sequence stratigraphy by O. Catuneanu, P.45 fig-2.35(4b),p158 fig-4.58(4c), p136 fig4.32 (4d)}

The topmost group is bounded by LK+TH top and Horizon 1, consists of mainly bluish grey shale with minor sandstone streak and calcareous bands deposited in shallow marine quite /lagoonal environment.

Sediments bounded by Horizon-1 and Horizon-2 are calcareous sandstone layers within grayish shale deposited in shallow marine quiet environment which are grouped as Sand Group II.

Sandstone beds belonging to Sand Group-I & II are very tight with poor quality reservoir rock and do not seem to be good in hydrocarbon accumulation point of view.

The Sand Group III is bounded by Horizon-2 and Horizon-3 , consists mainly of coarse to fine grained sandstone with grayish splintery shale and occasional presence of coal bands. Log characteristics indicate a fluvial deposit with both finning upward and coarsening upward sequence. Log signatures and sedimentary information derived from core samples indicate that sandstone were deposited in delta plain area and are characterized by channel sand and crevasse splay deposits (Fig-4B). The onset of regression is marked by the deposition of these sediments. The sandstone in this Group have very good reservoir quality and are part of three bar deposits (refer Fig-5) and are expected to extend towards NE and SW direction.

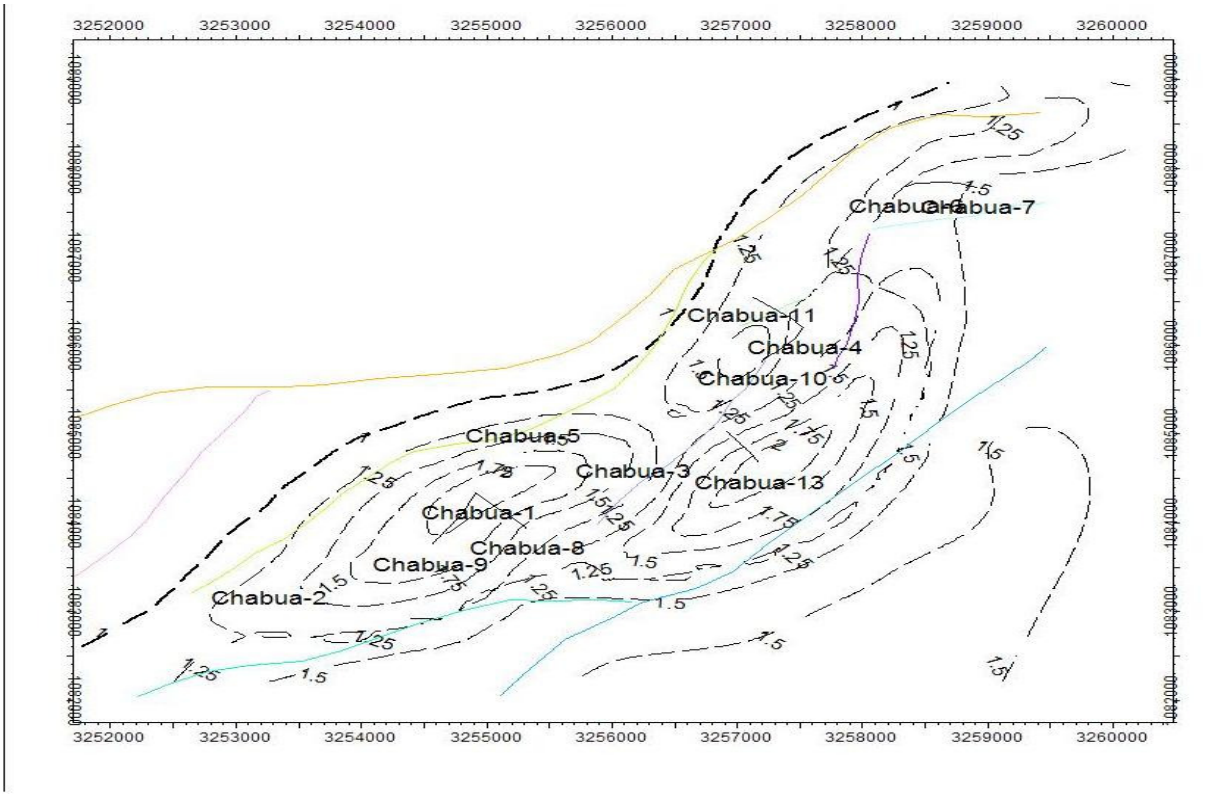

Fig-5: Sand shale ratio map of Sand Group III

Immediately underlying Sand Group-III, a more shaly formation deposited in shoreface/inner shelf area and characterized by lower deltafront deposits is present and have been grouped as Sand Group-IV. Sandstone layers within this Group are thin and log characteristics suggest to have been deposited on channel edge. Sandstone deposits in this Group are part of two possible tidal bar deposits (fig-6) and having good reservoir quality.

The underlying the Sand Group-V is a more shaly formation deposited in shoreface/inner shelf area and characterized by upper deltafront deposits and are grouped as Sand Group-V. This group consists of greyish shale with fine grained sandstone beds. Sandstone beds are thin and log characteristics is bow trend (symmetrical) which is the result of prograding & retrograding deposits (Fig-4c). Sandstone deposits in this group have good quality reservoir rock, and are part of two tidal bar deposits (Fig-7).

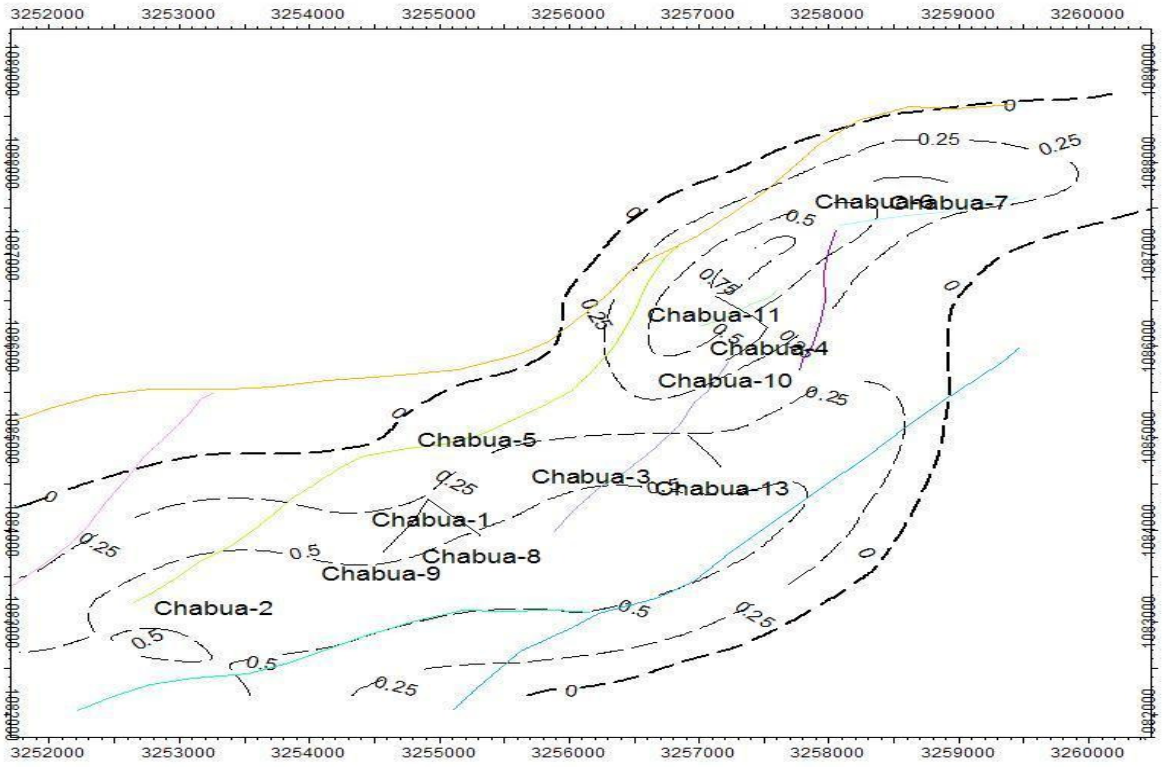

Fig-6: Sand shale ratio map of Sand Group IV

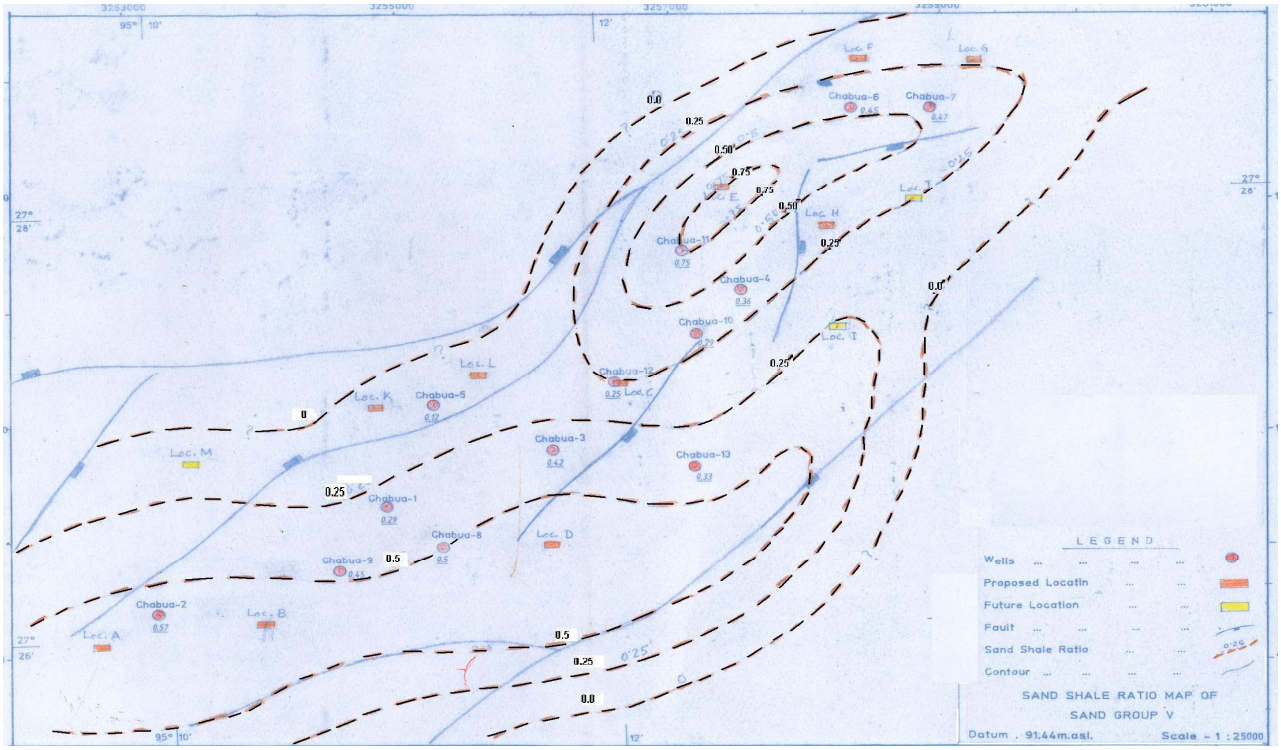

Fig-7: Sand shale ratio map of Sand Group V

The Sand Group VI (Langpar) is characterized by coarse to fine grained sandstone deposits with greyish shale and minor coal beds, mostly fluvial channel deposits (Fig-4d). The deposition of these sediments took place in a delta plain area and the transgression started during the last phase of deposition of these sediments. Sandstone deposits in the Group are part of two bar deposits running almost parallel to the present structural pattern and expected to extend towards NE and SW direction (Fig-8). Sandstones in this group have very good reservoir quality.

The lowermost lithological unit (Group VI) deposited over the Precambrian Basement is fluvial (braided) channel deposit. There had been a relative sea level increase (transgression) during the last stage of deposition of this Group. On the other hand the overlying lithological units (Group IV&V) had been deposited in shallow marine condition with frequent fluctuation of sea level. Regression started during the end of Group IV deposition and resulted in deposition of deltaic/shoreface deposits which is identified as Group III. Water depth again increased and deposition of Group I & II took place during this phase. Following this, there was no major fluctuations of water depth till the end of the deposition of Lakadong+Therria Unit.

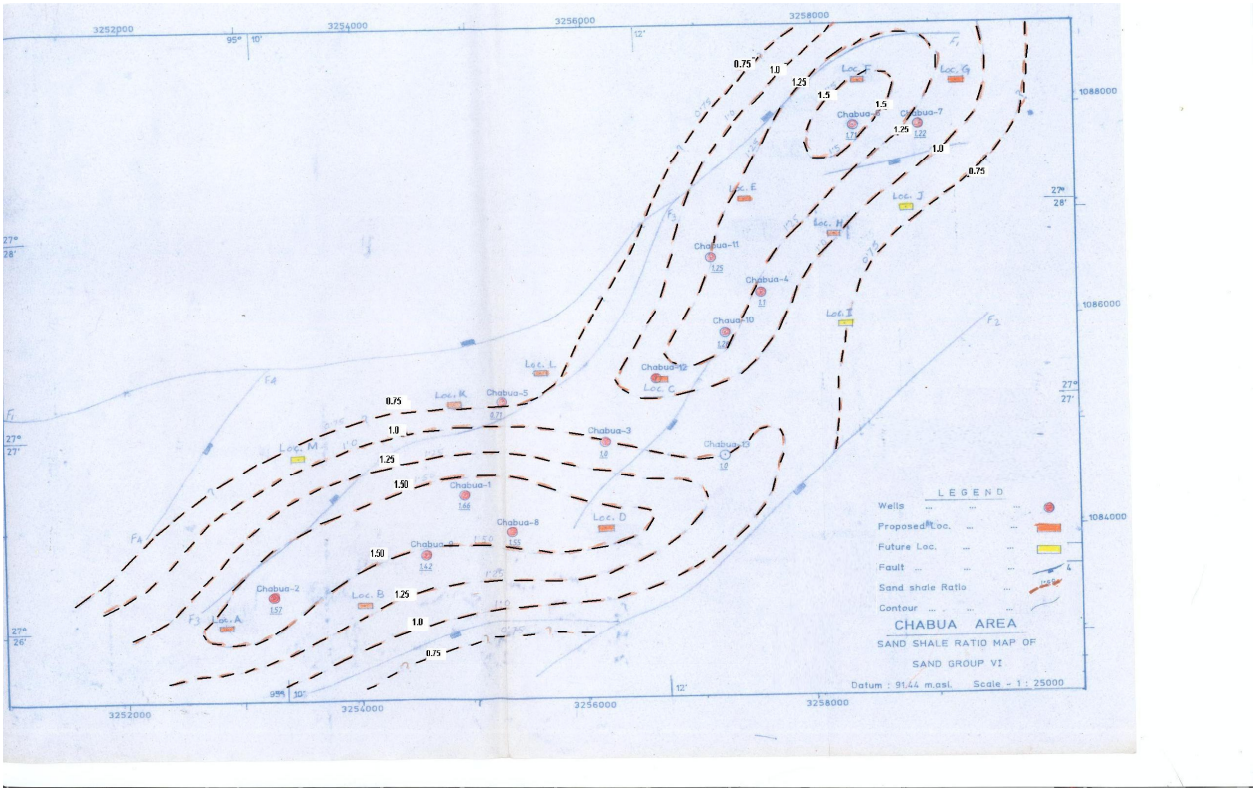

Fig-8: Sand shale ratio map of Sand Group VI

Sand-shale ratio maps have been generated for four zones (Gr-III to Gr-VI) for better understanding of depositional pattern of those sediments. All four zones show that the sediment supply direction was NE-SW. Group-III and Group-VI showed similar sand shale ratio, indicating towards continental facies deposits where as Group IV and Group V show low sand-shale ratio indicating towards more marine facies deposits. There was no major change in sediment supply direction throughout the entire period of deposition.

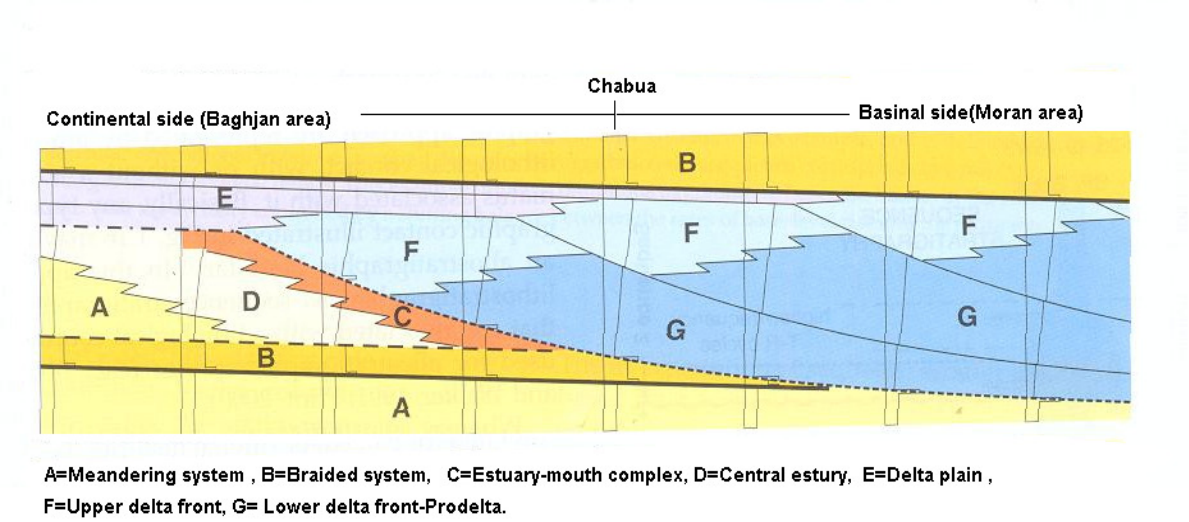

Figure- 9: Sequence stratigraphic framework, facies contacts and palaeo-depositional environments

Figure 9 shows the basic sequence stratigraphic depositional concepts related to fluvial through shallow marine environment, fits well in our present study area which has almost similar set of deposition. It can be inferred from the Figure that a good sand development in Lakadong+Therria and Langpar formations in this basin is expected to extend in the northeastern direction (towards continental facies direction). Better sand development in Group-II , Group IV and Group-V should have taken place in the shallow marine condition/ towards the continental side.

Conclusion

Sand to sand correlation in Palaeocene -Eocene sediments in the Basement High area of the basin has been very difficult and inconsistent . But as sand groups they have been found to be consistent and extend laterally for a long distance.

Sediments of Langpar and Lakadong+Therria of Chabua area have been grouped into six lithologic groups based on depositional environment. All the six lihtologic units are present in the entire Chabua structure and might extend beyond the study area. The sediments belonging to Langpar formation were mainly deposited in fluvial environment but the Lakadong +Therria unit seems to have been deposited in marginal marine to fluvial conditions. It is evident from sand-shale ratio map, core lithology and log signatures that the fluctuation of sea level were very frequent during deposition of these sediments. Although, there were no major change in sediment supply direction during the entire period of deposition. Sediment belonging to Group-I & II were deposited in quiet environment as evident from the presence of calcareous materials in these Groups.

Reservoir quality of the Sand Group vary from very good to poor. The sand Group III & VI sediments have very good quality reservoir rock, whereas Sand Group IV & V can be termed as good but in case of Sand Group I & II are relatively poor. From the above discussion it is clear that all the sand units present in Chabua area could extend beyond the present area of study. Possibility of encountering similar/better reservoir development beyond Chabua area towards NE and SW direction.