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3D Facies Modeling of Baramura Structure Integrating Seismic and Log Data

Abstract

Baramura structure is proven gas bearing fields in Tripura,India. The structure is surrounded by other gas fields like Kunjaban in west, Gojalia in south, Khubal in east and Habiganj in north which is one of the largest gas field of Bangladesh. The present study is focused on generating 3D Facies Model by integrating seismic and log data. Well to seismic tie of various wells in study are has been prepared and regional markers were identified and correlated. Time maps close to Upper Bhuban, Middle Bhuban and Lower Bhuban were prepared. Velocity model based on well and seismic data was prepared and used for Time to Depth conversion. Depth horizons and faults were used for the preparation of 3D Structural Frame work. Layering and zonations was done for the creation of zones within which layers were generated. Log data and lithofacies were correlated and interpreted for facies classification at well location. For distribution of facies in 3D structural framework facies logs were upscaled and upscaled logs were used in property modeling to generate the facies model. Due to lesser log data and lesser seismic data availability only variogram analysis was used to populate the facies along all the layers of the respective three zones. Shortage of data compile us not to use secondary study such as AI and RMS amplitude in data analysis.Facies model and electrofacies logs study suggested facies extent are limited and discrete in nature except few extensive sands. Entire Upper Bhuban and Middle Bhuban sands shows relict nature and limited extension, evident by abrupt termination of sand bodies.

Introduction:

The Baramura is the second largest structure mapped in the Western Tripura and is one of the important structures for the accumulation of hydrocarbons. The anticline is doubly plunging asymmetric anticline with a pronounced steep dip in the eastern flank and gentle dips on the western flank and wider in the central culmination. Trending NNW-SSE with slight convexity to west. It is 95 km long and 13 km wide. The aerial closure of the structure is 400 Sq.km. The eastern limb is steeper usually the amount of dip varies between 50º to 60º while up to 70º to 80º dip and occasional reversed dips also occur near the thrust zone in the east. The reverse fault runs almost parallel to the axis of the anticline. From the topography of the area it is inferred that the rocks of the Baramura range were first folded and then affected by the thrust in the eastern part. Baramura anticline shows a plunge to the north and south of the structure. In northern plunge area of the Baramura structure, the dip varies from 7º -8º.The structure is also affected by number of cross faults. The eastern limb of the structure is dislocated by the Baramura thrusts with maximum stratigraphic throw of 800m at the central culmination. The structure is divided broadly into the northern culmination, the central culmination and the southern culmination. Bokabil Formation is exposed at the crestal part of the anticline whereas, Tipam Formation is exposed on the flanks of the structure and also in the northern and southern plunge areas (Mitra et.al 1967). Geological map showing Baramura anticline is depicted in Fig-1.

Drilling activities started over the Baramura structure during July 1972 (BM-A) and the commercial gas discovery was made during June, 1975 when gas struck in the well at about 1900m depth. The Baramura field is under commercial production since 1986. Present study area falling on the entire part of Baramura anticline

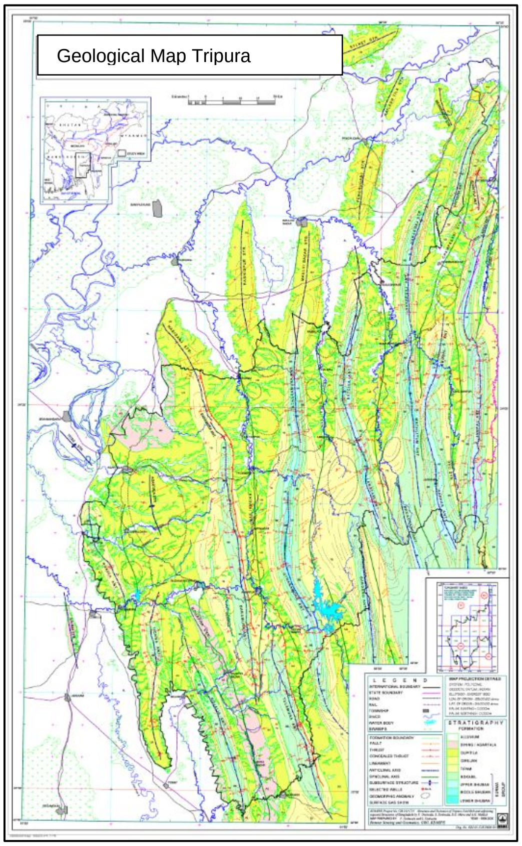


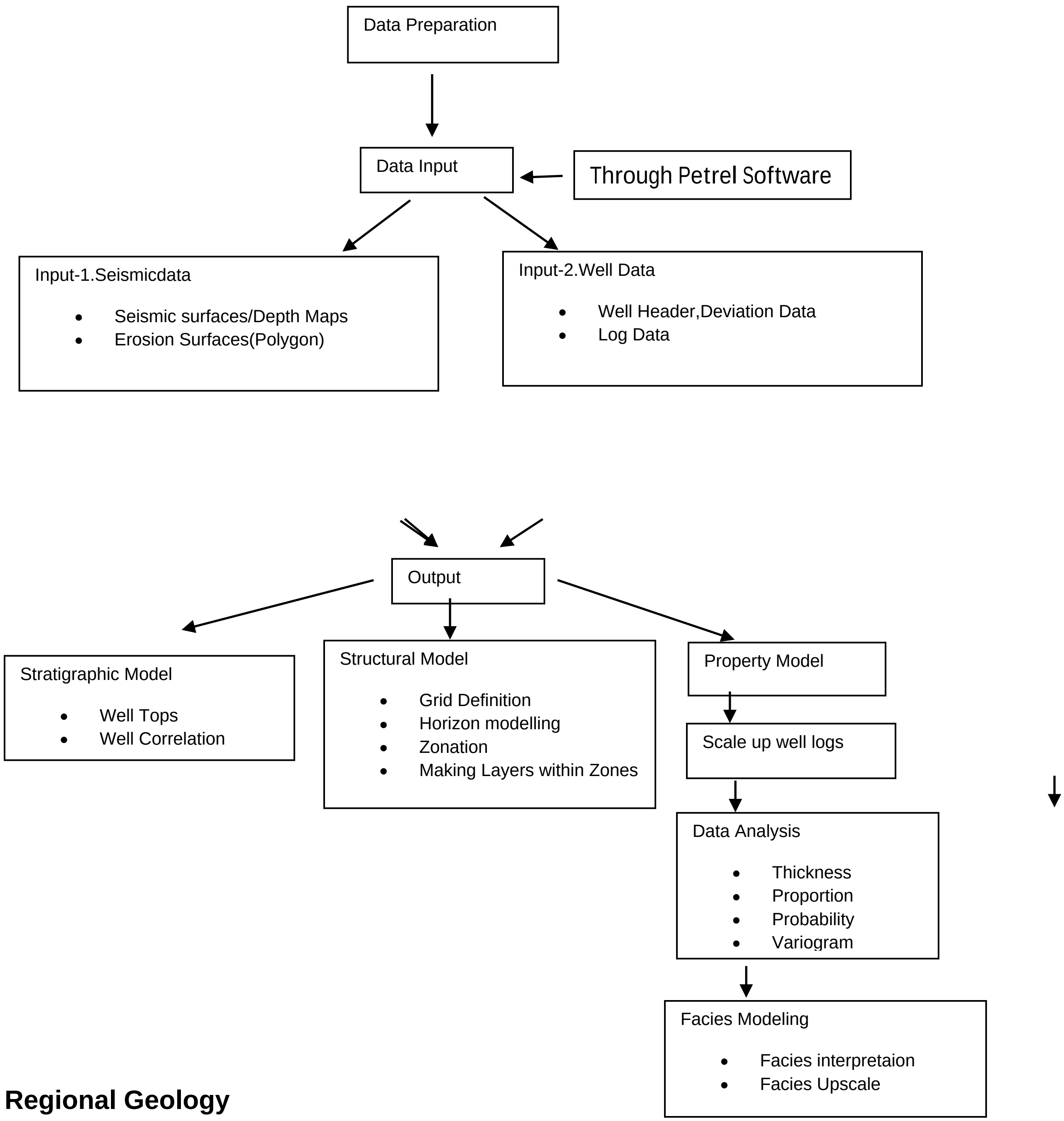
Fig-1: Structure and Tectonics of Tripura Fold Belt and adjoining exposed structure of Bangladesh by F.Dotiwala and S.Dotiwala

Objective of the Present Study

The objective of the present study is to study the distribution of facies along the structure G&G model of the Baramura based on the available G&G data.To mitigate the risk of exploration and development of Baramura field through understanding of facies distribution as well as structural disposition.

Data and Method:

All relevant data were utilizied in computer supported form (softcopy).2D seismic data and well logs data were used for this work. The workflow of the work is given below:



Regional Geology

Tectonic and Basin Architecture

The Assam and Assam Arakan Basin evolved as a result of rifting and drifting of the Indian Plate towards north and then north east after the break up from Gondwanaland. Drifting of the Indian subcontinent during Cretaceous time led to subduction of Indian plate margin below the Burmese plate. Oblique subduction of the Indian plate initiated closing of the Neo-Tethys Ocean on the northeast and then gradually progressed southward. Intervening ocean became progressively narrower towards south. Subsequent to the closure of the Neo-Tethys Ocean along Arakan Yoma Suture, collision of the continent plates resulted in the development of the Arakan-Burmese Mountain Range. Further compression initiated thrusting and stack of thrust sheets (Schuppen Belt) in the north eastern part. At about 10 Ma, all the oceanic crust in the Assam region along the margin of the Indian continent had subducted under the West Burma Plate and initiated extremely oblique collision of the Indian and West Burma Plates. The Assam-Arakan ophiolite belt marks the obducted oceanic crust during collision and marks the boundary between Indian and Burmese plates.

The Tripura and Cachar area had undergone severe folding, faulting and thrusting during different phases of post collision orogeny, the intensity of which increases eastward (Kunte, 1989). Initiation of structuration considered to be started in middle Miocene during deposition of Surma Group (Goswami et. al, 2002, Choudhury et al. 2011).

Tectonically, the Tripura-Cachar fold belt comprises a series of sub-parallel elongated en-echelon anticlines trending NNW-SSE with slight convexity towards west. The anticlines are bounded by longitudinal reverse faults on one or either limbs (Kunte, 1989).Geographically, the Tripura region is situated in the north–eastern sector of India, and is surrounded by Bangladesh and Burma, except in the north–eastern part, where it is bordered by Assam and Manipur. Geographically, it is bounded by the latitudes 22˚00'N and 24˚30'N and the longitudes 91˚10'E and 93˚30'E.

In Tripura, through remote sensing studies and systematic geological mapping, 24 structures (18 exposed and 6 concealed) have been identified. 18 structures have been probed out of which 11 are established as gas bearing in Bokabil, Upper Bhuban, Middle Bhuban and Lower Bhuban reservoirs. Presently, 07 structures are under production.

The stratigraphy involves Tertiary rocks. Mio-Pliocene and younger sediments are exposed on the surface. Proven gas producing reservoirs are mainly within the sandy facies of Bhuban formations. However, potential of Barail and deeper sediments are yet to be proved.

Stratigraphy

A generalized stratigraphy of Tripura area is given as Table-1.

CHRONOSTRATIGRAPHY		LITHOSTRATIGRAPHY		GENERALISED LITHOLOGY	THICKNESS (M)	ENVIRONMENT
PERIOD	EPOCH	GROUP	FORMATION			
QUATERNARY	PLIESTOCENE TO RECENT		Dihing	Pebble beds, conglomerates and sandstones with thin bands of clay.	400	Fluvial
	~~ unconformity ~~~					
NEOGENE	PLIOCENE	DUPITILA	Dupitila	Coarse, pebbly sandstone & mottled clays.	1000	Fluvial
	~~ unconformity ~~~					
	MIO - PLIOCENE	TIPAM	Girujan	Variegated soft & sticky clays, often silty.	1500 - 1700	Fluvial
			Tipam	Sandstone with sandy clays & claystone.		Fluvial
	MIOCENE	SURMA	Bokabil	Claystone & siltstone with thin beds of fine grained sandstone.	700 - 1500	Brackish water marginal marine
			Upper Bhuban	Sandstone & sandy claystone laminations.	650 - 1200	
			Middle Bhuban	Shale & occasional fine grained sandstone.	650 - 1200	Outer shelf to open marine.
			Lower Bhuban	Alternation of sandstone and shale.	700 – 1000	
	~~ unconformity ~~~					
PALEO - GENE	UPPER EOCENE TO OLIGOCENE	BARAIL	Renji	Dominantly sandstone with thin shale beds.	700 – 1000	Brackish water marginal marine
			Jenam	Shale & occasional fine grained sandstone.	900 – 1500	
			Laisong	Altrnation of thin bedded sandtone & shale	1500 – 2400	
	EOCENE	DISANG	Disang	Dark grey shale with thin beds of sandstone.	1750	Reducing marine

Table-1 Generalized stratigraphy of Tripura area

Depositional Regime and Facies Analysis

At the time of G&G studies all available core data and sedimentological input were taking into consideration which indicate the depositional model of a tide dominated delta with distributary channels, tidal channels, bars and relicts. In Tripura area sedimentological studies indicate that Middle Bhuban sediments in the area were believed to be deposited in the mouth bar to distal bar to pro-delta regime (Dutta et.al. 1993). The Upper Bhuban sands are deposited under marginal marine to lower deltaic regime under fluctuating sea with tidal influence. The Bokabil sediments are deposited in shallow marine/brackish environment.

Output of work carried out during the project execution Depth structure map (Fig-2), fault framework (Fig-3), facies maps (Fig-4) are prepared based on recently acquired 3D seismic data, available 2D seismic data and drilled well results. The depth structure map shows major N-S Structural trend evident by a prominent structure bounding longitudinal fault heading towards west which is also observed by earlier workers in geological field mapping. Besides this many prominent cross trends are also observed in present study which leads the undulating surface relief of the structure. These cross faults may act as separate fault blocks for hydrocarbon accumulation. Detailed electro-log facies correlation were carried out along the N-S direction to understand facies variation in lateral as well as vertical dimensions (Fig-6). Sand percentage map of Upper Bhuban and Middle Bhuban formations shows a good amount of sand distribution with in the structure.

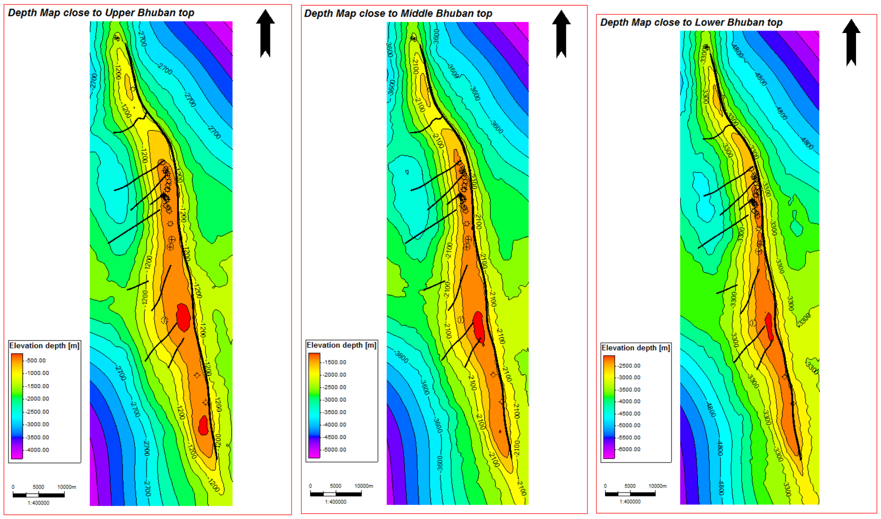
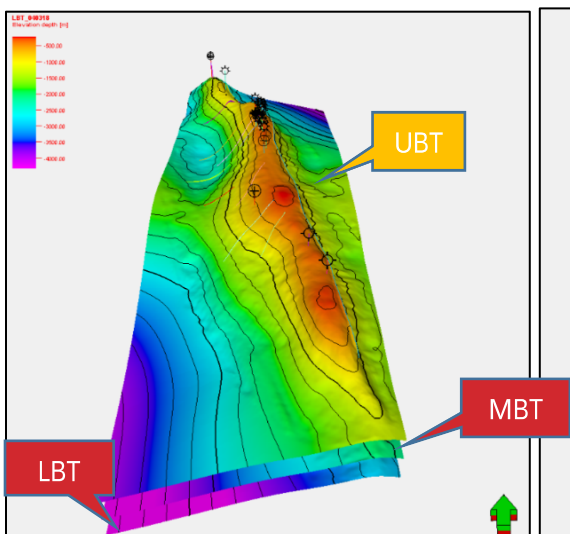


Fig-2: Depth Map close to Upper Bhuban, Middle Bhuban and Lower Bhuban



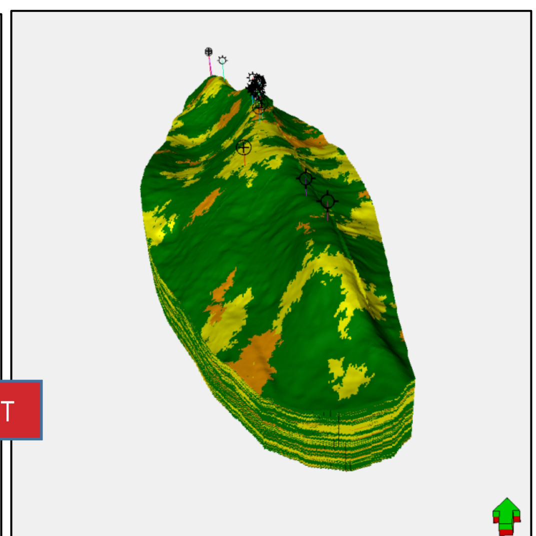


Fig-3: Structural Frame work

Fig-4: 3D Facies maps

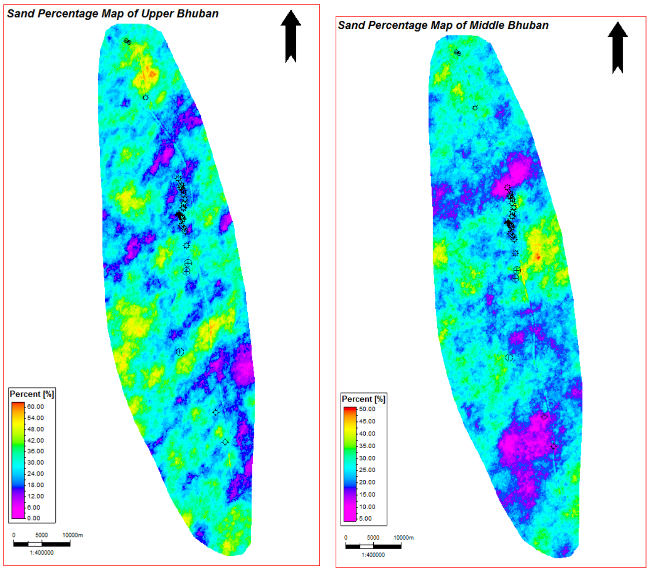


Fig-5: Sand Percentage Maps of Upper Bhuban and Middle Bhuban

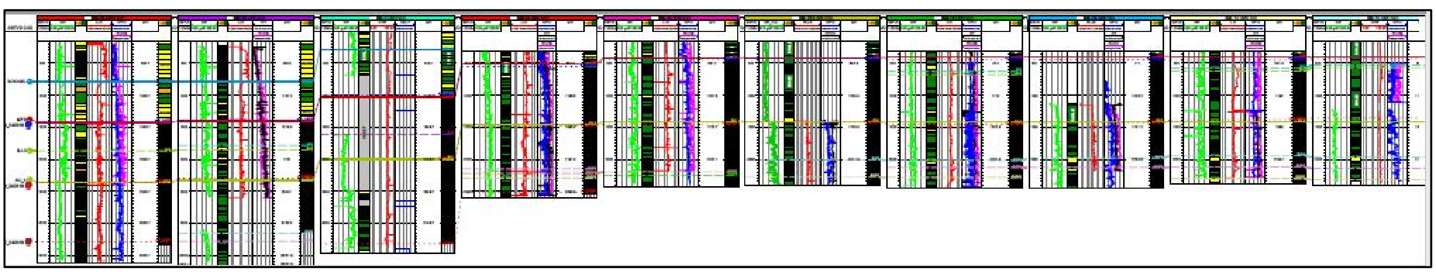


Fig-6: N-S Stratigraphic Log Correlation at Upper Bhuban Top showing facies variation across the structural part
.

Conclusion

Electro-log facies studies suggests that in general facies extent are limited and discrete in nature except few extensive sands. Entire Upper Bhuban and Middle Bhuban sands shows relict nature and so on limited extension, evident by abrupt termination of sand bodies observed in drilled wells. A few Middle Bhuban sands are quite extensive and shows fair development over quite large area in Baramura Structure. Electrolog records and other available data, it is inferred that the sediments (Upper and Middle Bhuban sequence) in the study area were deposited in a delta front part of a tide-dominated deltaic environment. Frequent sea level fluctuation/minor transgression brought the incursion of mud flats over the sand facies or may be prodeltaic deposits over the these typical delta front deposits represents the intervening argillaceous facies. Moreover, tectonic setup and depositional environment indicates that the sediment entry direction is from the north-east. In view of limited facies extension and data limited over Baramura Structure, further exploration strategy should be step by step avoiding fault block exploration strategy to mitigate further exploration and development risks.

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