Paleo History of a Deeper Level Tidal Lobe and its Facies Analysis : A Case Study

V Chaganti*, T B Singh*, J K Bora*, Dr. Mahendra Pratap*

Abstract

Hydrocarbon exploitation is a play to exploit the Paleo depositional features having the reservoir facies which helps to holds the hydrocarbons. 3D Seismic data is very well known to identify these sub surface depositional features.

This case study is explaining investigation of one of the deeper level tidal lobe geometry to establish a good potential candidate for further probe.

Methodology adopted for this investigation is based on the seismic interpretation techniques such as Structural Analysis, Attribute Analysis, Horizon Slices Analysis and Waveform Facies Classification techniques. Prior this stage conditioning of the data was done to establish primary reflection nature of these events. In conclusion an exploration interest is generated to probe this deeper level prospect.

_____

* Oil and Natural Gas Corporation Ltd, India

Fig: 1 Location Map of the Study Area

Introduction

Study area (Fig: 1) consists of three satellite fields, which are South West of Mumbai High Field. Considering the success of both the exploratory and development wells, this marginal field comes into focus for increasing the production of the Western Offshore basin.

Western Shelf which is characterized by passive continental margin, where the Bombay Offshore Basin developed. Multi cyclic Carbonates of Middle Eocene to Miocene Post rift sequence developed in this shelf are the main hydrocarbon reservoirs.

Present study is to aim and to identify the reservoir bodies and their facies in the geological setup after erosional affects along with their vertical as well as horizontal extensions. One of the deeper level has taken up which is interesting seismic point of view. The stratigraphic position of these deeper levels in the regional point of view is explained below.

The generalized stratigraphy of this offshore is Panna/ Devagarh,Bassein/ Belapur/ Diu,Panvel/ Alibagh,Mahim / Bombay/ Ratnagiri,Bandra/ Ratnagiri formations overlying one over the other from bottom to top. L-III & L-IV lithological layers belonging to Mahim / Bombay / Ratnagiri formations correspond to early-middle Miocene shallow marine carbonate cycle are established with hydrocarbons. (Figure 2)

Interest of present deeper level is lying at Late Oligocene geological age. (Indicated with red arrow in the fig 2) Presently basement level is falling in this age and established hydrocarbons in this stratigraphic column. Deeper levels referred in this paper are below this presently established basement level. The lobe explaining in this paper is falling around 2750m to 3000m depth interval.

Seismic signatures are prominent and showing the tidal lobe like stratigraphic features below present basement level. Though, these levels are below basement level, needs exploration interest to understand these features for their detailed lithological and petro physical characters. There is a possibility of localized reservoir zones due to weathered nature of the basement in this area.
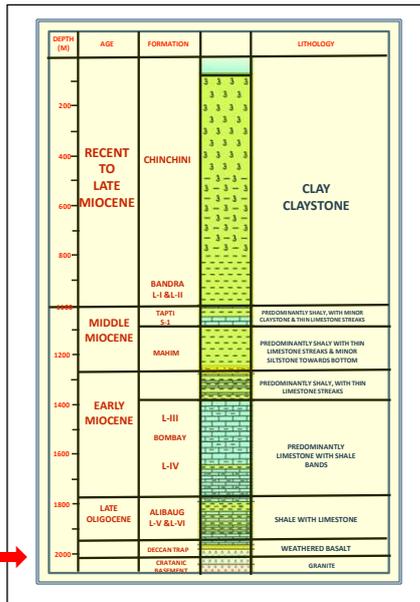
Fig: 2 Generalized Stratigraphy of the Area

Need of hour raised to study these deeper levels in detail by considering the latest data for integrating with the seismic interpretations. There are three seismic vintages available in this area. Using one of the PSDM data, seismic attribute volumes RMS, Signal Envelope and Variance cubes were created with Petrel software. For seismic facies analysis used Stratimagic Paradigm's TOTAL software.

Methodology

In order to know these deeper beds' reflection genuinety, special processing studies were conducted. The ultimate outcome of the study is to guide the exploration activity by targeting deeper levels in order to draw maximum production from this unknown stratigraphic level.

In the initial stage the structural aspects of the various levels correlated in the depth domain and structural aspects were studies in detail. This stage is essential to know how the reservoirs are rested after deformation by various sedimentalogical processes on the structural platforms at various stratigraphic levels.

The second stage is to observe the 3D cube in various ways like chair cut, slice, horizon slice and propositional slice views. For confirming this study, various seismic attributes were used and observed the aerial extent of various stratigraphic features at deeper level-1.

Third stage is to analyse the facies classes with in the lobe and related to the regional geology. This stage guides to identify exploration and development areas both vertically as well as horizontally.

Present work

Figure: 3 are showing four deeper levels of the correlatable reflector below presently explored basement level. These four levels were correlated and mapped. Structural maps are indicating gently dipping towards Western side. The chances of the primaries has also investigated by applying RADON filter and established the reflection nature of primaries.
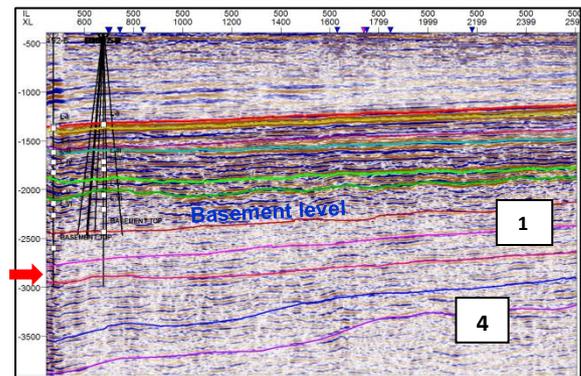

Fig: 3 Correlatable Four Deeper

Before applying RADON , velocity analysis was conducted for establishing the primary nature of the reflection events. Figure 4 is showing the semblance of a CDP gathers after applying RADON filter for suppression of multiples. The Semblance plot is showing free of multiples at the deeper levels and the black line trend is the new velocity trend applied on the gather.
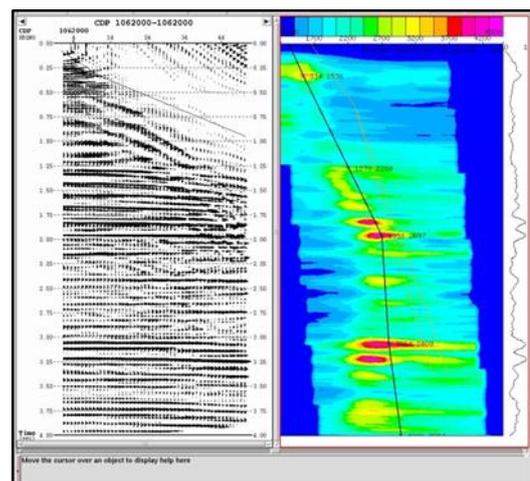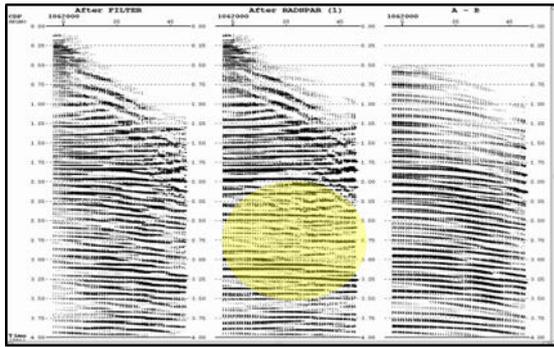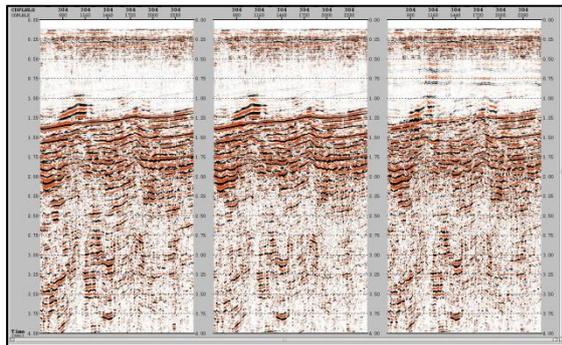

Fig: 4 Semblance Responses with New Velocities

11th Biennial International Conference & Exposition

PSTM gathers   After Radon Gathers   Multiples

Fig: 5 Effect of RADON Filter on the Gathers

**Fig: 6 Comparisons of the Stacks after Before Randon
Left Initial, Middle-Randon, Right- Randon
With New Velocities**

Figure 5 is showing the gathers before and after applying the Radon filter. The suppression of order of multiples is showing in the right side figure.

Figure 6 is showing all the three stacks for comparison how the multiples were removed at every stage. (From left to right)

It is concluded that the reflections appearing at this deeper levels are primaries. The stratigraphic features appears at these level can be taken for exploration of hydrocarbons.

Upon investigation of the sesimic, a tidal lobe appearing at the deeper level-1 observed on horizon slices. Figure 7 is showing horizon slice at +90m created with variance cube derived from sesimic P volume using the horizon tracked at deeper level -1.

The complete lobe is developing since +60m to +100m downwards (fig: 8) from the deeper level-1 showing in the seismic section of figure 3. (shown with red color arrow)

This figure 8 is showing four horizon slices generated from the interpreted deeper level horizon just below the present basement level. The attribute shown in this figure is variance and the top to bottom figures shown the lobe from shallow position to

deeper positon at its stratigraphic level. This lobe is having an areal extent of 115 Sq Km with more than 50m vertical thickness.
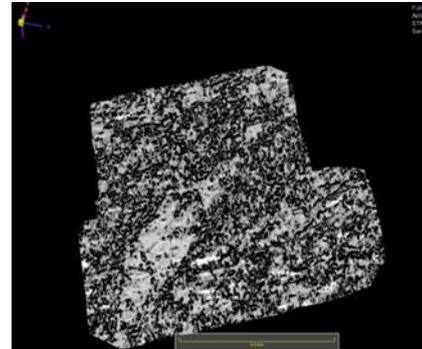
**Fig: 7 Morphology of the Lobe below Deeper
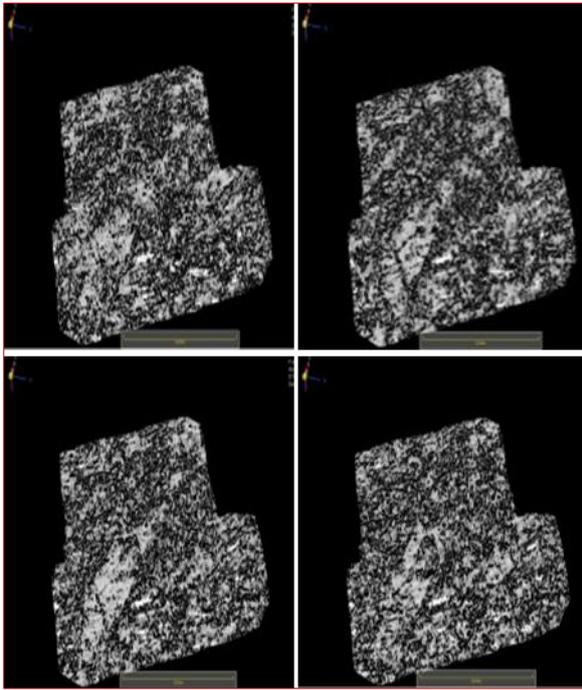Level 1 at +90m Horizon Slice**

These horizon slices of figure 8 are inferring the paleo histroy of the lobe. This lobe started developed much below +100m down deeper level-1 which is below to basement level which geological age correspons to Late Oligocene. The lobe entered into this area from SSW and exists up to +200m down to basement level. The other three deeper levels shown on the seismic lines are also showing fluvial trends which are out of scope of this study.

These horizon slices infers the thickness and the aerial extents of the lobe approximately for about 60m vertical depth column. The entrapment conditions pertaining to the reservoirs within the lobe are stratigraphic in nature and the geometrical boundary of the lobe itself acts as seal.

There are no wells drilled up to this deeper depth and these levels can as well considered virgin in the exploitation point of view. The reservoir litho facies of the lobe inferred through facies analysis based on the regional geological setup.

Analysis of kind of lobe:

There are three kinds of lobes appear in the depositional setups. Fan lobes, Wash over Fans and Deltaic lobes are comes under lobe category. Fan lobes are those away from the influence of the free surface body of the water, which is ruled out since near shore features are visible. Wash over fans develops sub aerially and one time activity. This possibility is also ruled out. Tidal channels are ends up with shape of convex away from the landward, lobes are destroyed in nature and shifts repeatedly; the deeper lobe of this study comes under this criteria.

**Fig: 8 Different Horizon Slices from Deeper Level-1
with Variance Seismic Attribute
UL +60m UR +80m LL +90m LR +100m**
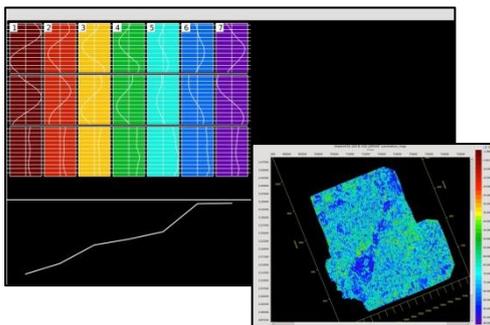
**Fig: 9 Wave Form Classification Results, Blue
is 90% Correlation in the Lobe Area**
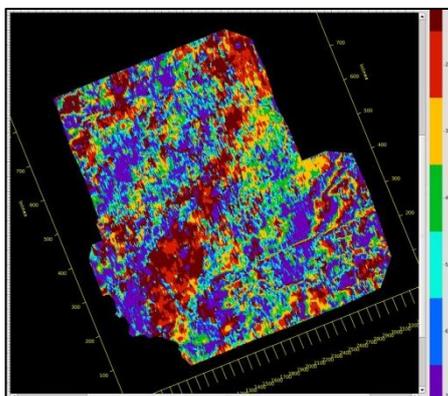
Fig: 10 Facies Classification Map

Waveform based faceis analysis is conducted over this lobe interval. Seven classes are defined and used for classification of the waveform within the lobe interval with approximately 60m thickness window.

Figure 9 is showing the seven neurons along with the confidence of correlation map of the various nerons. Blue color where the lobe is extending towards NW-SW showing the 90% confidence level. This is also one clue of primary nature of reflections at these deeper levels.

Distribution of the these seven facies classes during the interval (window +60m) period is shown in the figure 10. The lobe area is showing three prominent different classes of distribution in its geometrical extents.

These three classes may represent three different types of lithofacies. Since no exploration is taken place in this deeper level, the type of lithofacies is not able to ascertained.

Based on the regional geology of the area, the tidal lobe inferred to be developed in the shallow marine conditions. Since frequent intervention of the marine conditions with the terrain events, these deeper level may be enriched with both the shallow marine and terrian lithology. The envisaged reservoir lithofaceis with the knowldege of the surrounding areas correspons to the three facies of classes- 1,2 and 3, are probably marginal marine sediments.

Source of the hydrocarbons are next phase of interest after establishing the oil fluids in these deeper level reservoirs pertaining to the lobe from the geochemical studies.
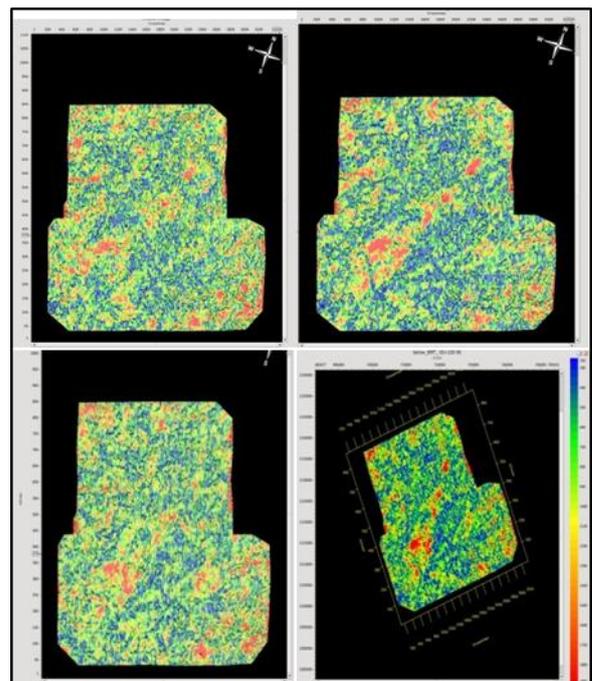

**Fig: 11 Horizon Slices from Deeper Level-1 with RMS
and Variance Mix
UL +65m UR +85m LL +95m LR +100m (With RMS Only)**

11th Biennial International Conference & Exposition

4

Figure 11 is showing the mixing of variance and RMS applitude of the various horizon slices from +65m to +95m from deeper level-1. Lower Right figure is only RMS applitude horizon slice at +100m indicating the red color as high amplidue. The response of the RMS amplitude is showing the extents of the red color varies from one level to other level indicating the thickness variation of the high amplitude layers within this interval window.

Spectural decomposition response is also observed at this level-1. The frequency decomposition is taken from 5Hz to 20Hz low frequency range. Apearance of lobe during the frequency decomposition process is varied and can be clearly seen at particular frequency level 17.5Hz. Figures 12,13 are showing the spectral response at two freqency levels. The tidel lobe is very clearly visible at 17.5 Hz frequency response.
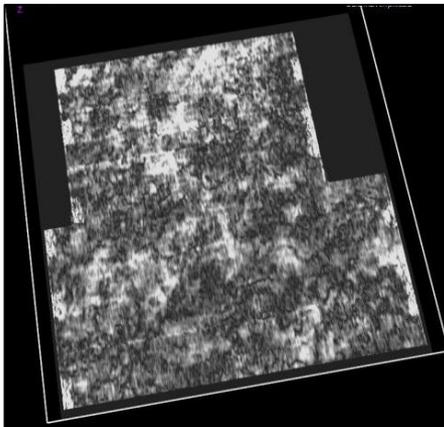
Fig: 12 Horizon slice showing the frequency response at 10Hz
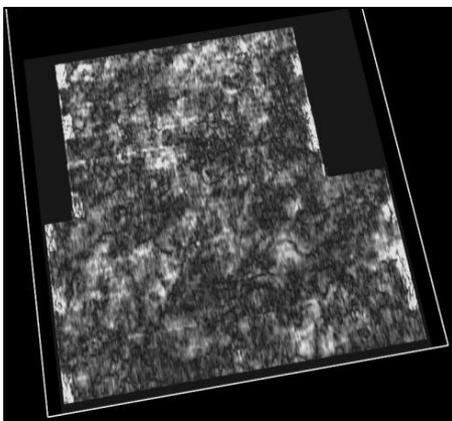
Fig: 13 Horizon slice showing the frequency response at 17.5Hz

Conclusion

The processing, interpretation of waveforms within the lobe appearance window and also the frequency decompositin study of the area suggesting that the events appearing below presently established basement level are primary in nature.

Paleo history of lobe is inferring through the horizon slices indicating the deltaic lobe nature. In the regional geological point of view these shallow marine deposits are very important for the localized marginal marine sediment reservoir sequences. The geometry of the lobe is an order of 115 Sq Km with 50+ vertical thickness column, if proved hydrocarbon bering which opens up an entirely new exploration play. And also it is understood that the producing basement wells of these areas are having good potential, may expect the same potentiality at this levels also.

It is concluded that the deeper level stratigraphic features need to be exploit based on this study. An exploration interest hence generated for these deeper levels.

Acknowledgements

Contact details

clveeresh@gmail.com, 62681@ongc.co.in