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HIGH AMPLITUDE ANOMALY - PLIOCENE CHANNEL PROSPECT IN BENGAL ONLAND BASIN

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Keywords

Amplitude quantification, amplitude scaling

Abstract

Bengal basin in India is a polycyclic basin, evolved through distinct tectonic episodes. The basin, is well known for the development of a thick (~22 km) early Cretaceous to recent sedimentary succession and has been of interest from the hydrocarbon exploration point of view for both thermogenic and biogenic accumulations, since long (Kingston, 1996). Though the basin is not a category-I basin, as on today, a couple of wells, show gas indications from Plio-Pleistocene section. The present study deals with a high amplitude seismic anomaly pack and its geological significance in the study area by amplitude quantification process. Finally, it led to a drillable prospect in the area.

Introduction

Bengal basin is mainly dominated by Pliocene channel levee complex (CLC) system, in the shallow time level as indicated by seismic interpretation. The sporadic occurrence of the high amplitude represents reservoir facies. In the present case, high amplitude feature is masked by other overlapping amplitudes, which create difficulties to delineate the body. Amplitude scaling and different seismic attributes are tried to understand the morphological feature of the anomaly. The feature turns out to be coalescing channel system, encompassing a broad area, mainly dominated by sandy reservoir facies. The envisaged petroleum system is mainly Neogene biogenic play with Pliocene channel sand as main reservoir facies. The lateral facies variation act as a lateral seal and presence of regional shale on top of reservoir as top seal. Earlier wells in the nearby area indicated gas in testing from Plio-Pleistocene section which proves the generation of hydrocarbon in the basin. Geochemical studies have established the presence of biogenic gas (dominantly methane) in the area and recently 3D petroleum system modelling results also corroborates the same.

Methodology

The main challenge is to bring out the amplitude stand out in the seismic section which is masked by other amplitudes due to reflection coefficient variation in different geological layers. The process involves various attributes analysis, amplitude scaling, spectral decomposition, reservoir modelling, and quantification of amplitude, generation of facies maps, time structure maps, facies ranking, and finalisation of prospect area. In the present study, Pliocene channel system is seen in the seismic section **(Fig.1),**

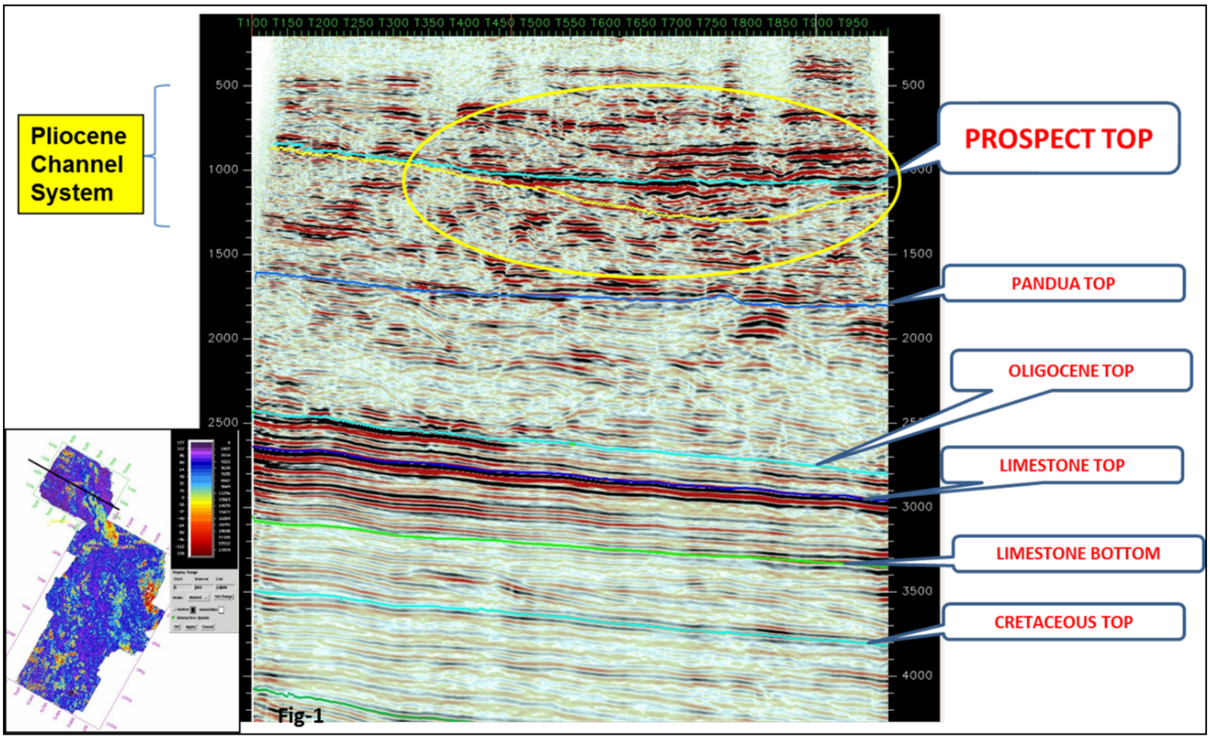


Fig.1 Seismic section showing Pliocene CLC

which is overlapped by different high amplitude layers. Attributes like reflection strength, phase and perigram-cos-phase are run to identify the amplitude anomaly **(Fig.2)**.

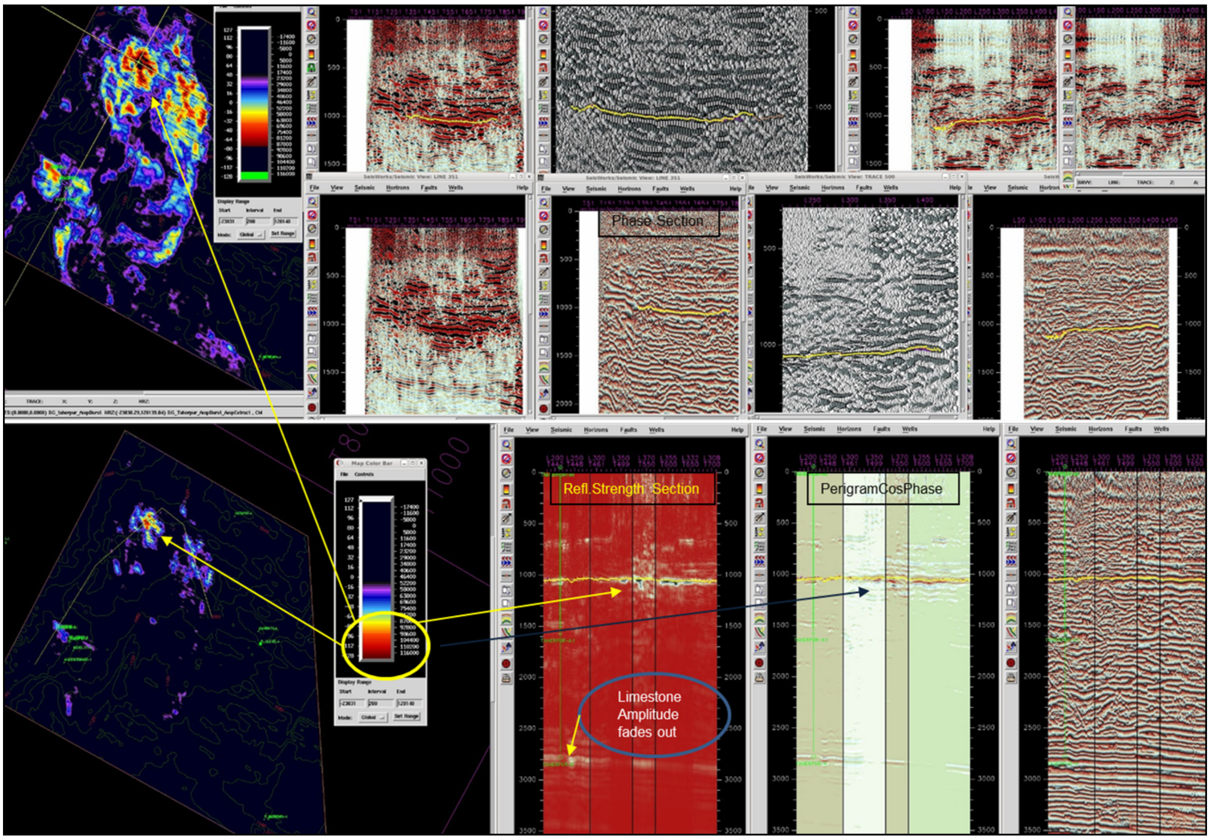


Fig.2 Reflection Strength, Cos-phase, Perigram-Cosphase

This is followed by, amplitude scaling in different seismic panels. Amplitude stand out is seen in the data with respect to the amplitude of Eocene limestone in deeper layer (**Fig.3**).

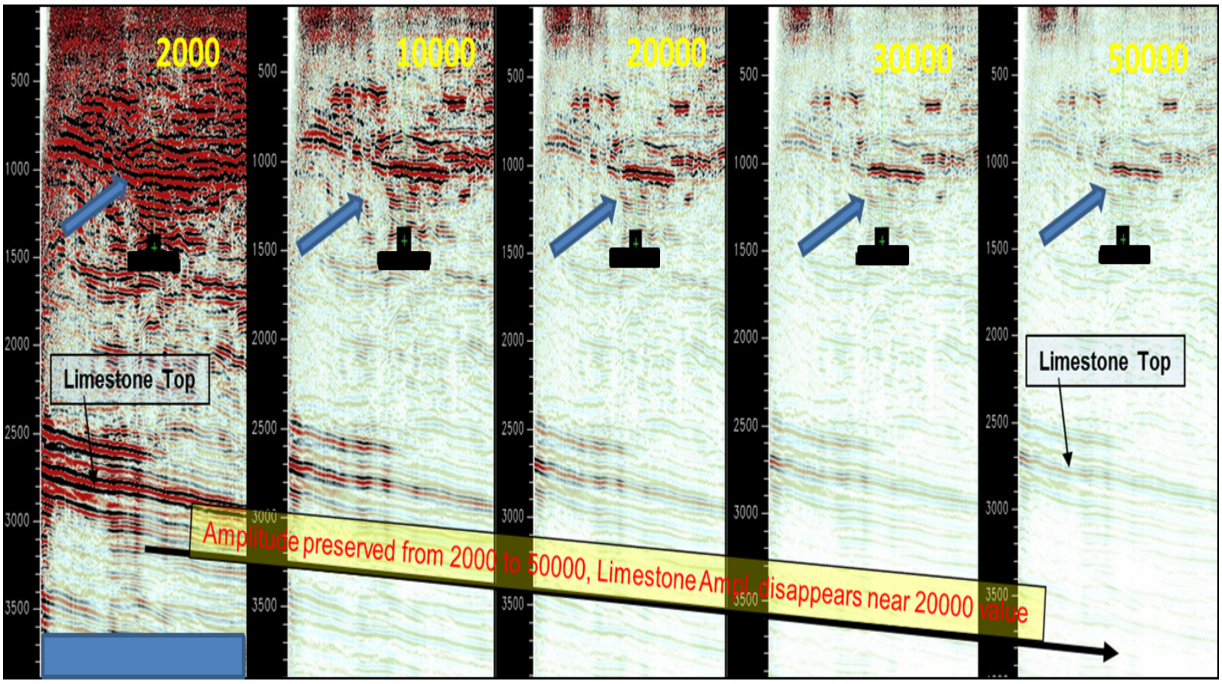


Fig.3 Amplitude Scaling of Seismic data

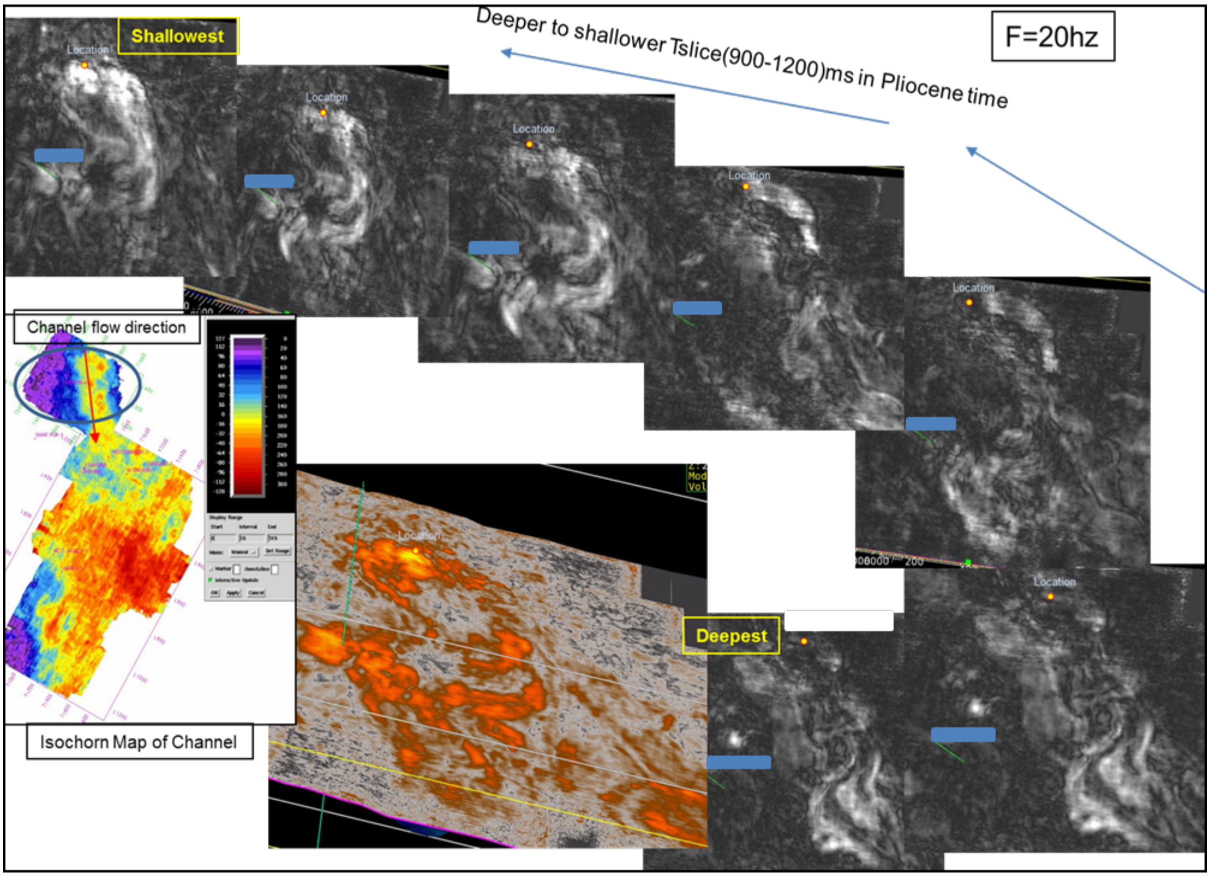


Fig.4c Spectral Decomposition showing coalescing channel activity

This layer is mapped and amplitude is extracted along the horizon along with sweetness attribute to see the effect of variation in the data (**Fig.4a, 4b**).

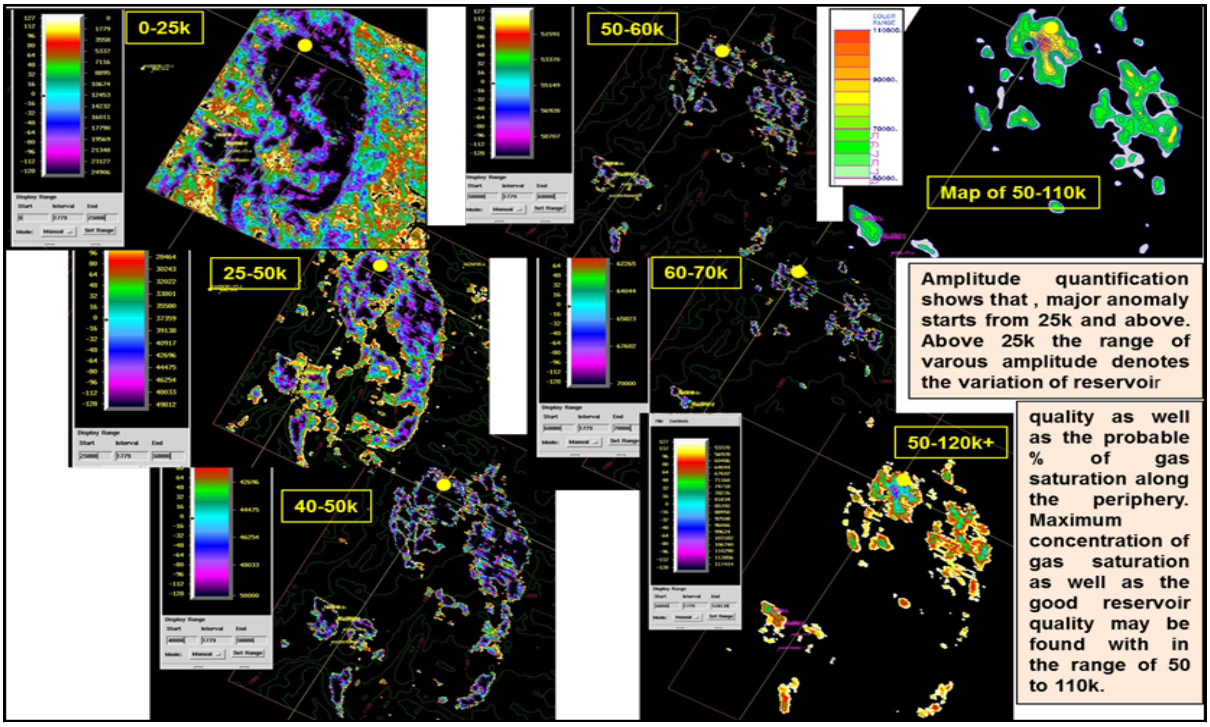


Fig.4a Amplitude Quantification

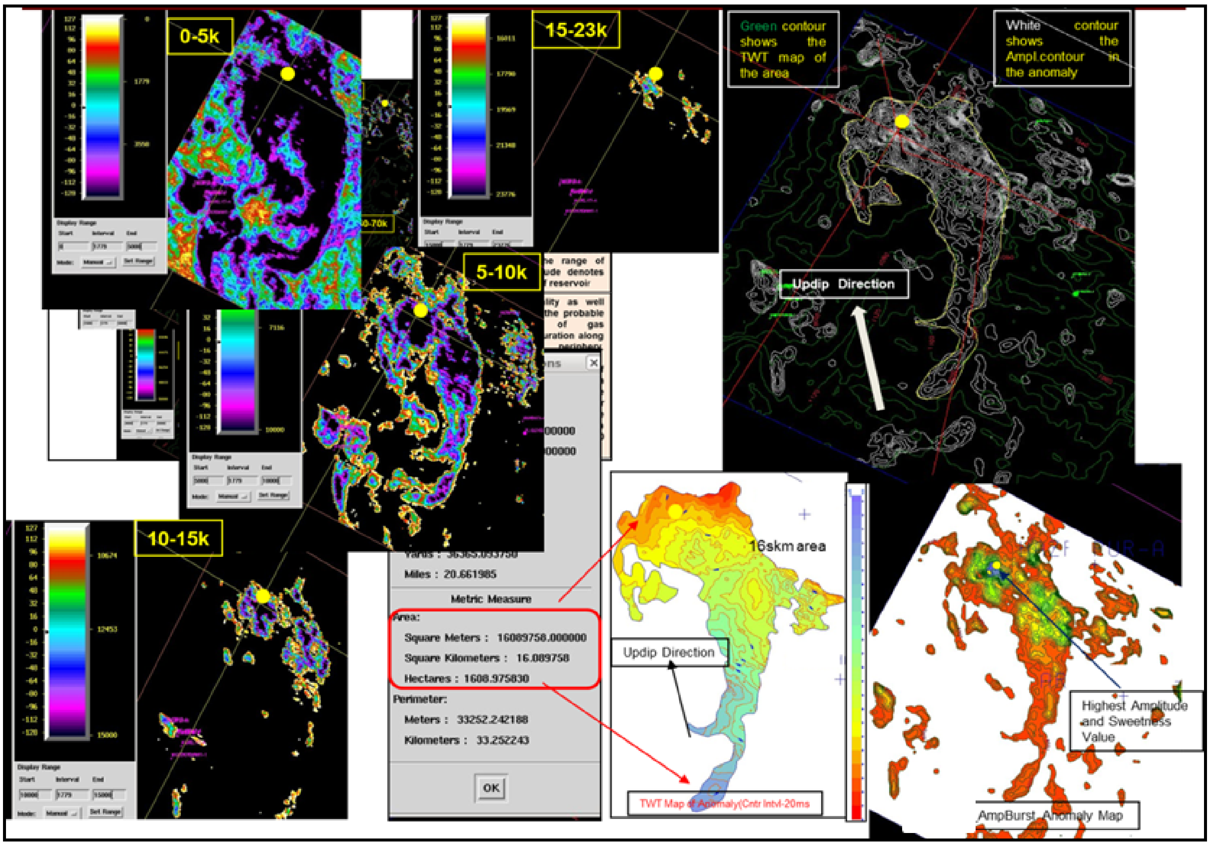


Fig.4b Sweetness Quantification

Amplitude quantification shows different zonation of amplitude of different ranges which may describe the variation of reservoir quality in the area. The shape of the derived high amplitude anomaly is clearly depicted by the spectral decomposition at different time slices suggesting channel amalgamation, typically a high energy braided river system **(Fig.4c).** Facies analysis is carried out by wave form classifier which clearly separates out few distinct facieses. Paleo-environment analysis has been tried for possible reservoir architecture with the help of facies map, seismic data, seismic attributes and geological understanding **(Fig. 5a,5b,5c).** Facies ranking is carried out in the scale of 1 to 5 on the basis of amplitude quality, structural gain, area and shape similarity with the other attributes along with their quantitative value (**Fig.6)**. In all, five facies are identified, and among them facies-1, is ranked as no.1. Based on this ranking, the best prospect area is demarcated.

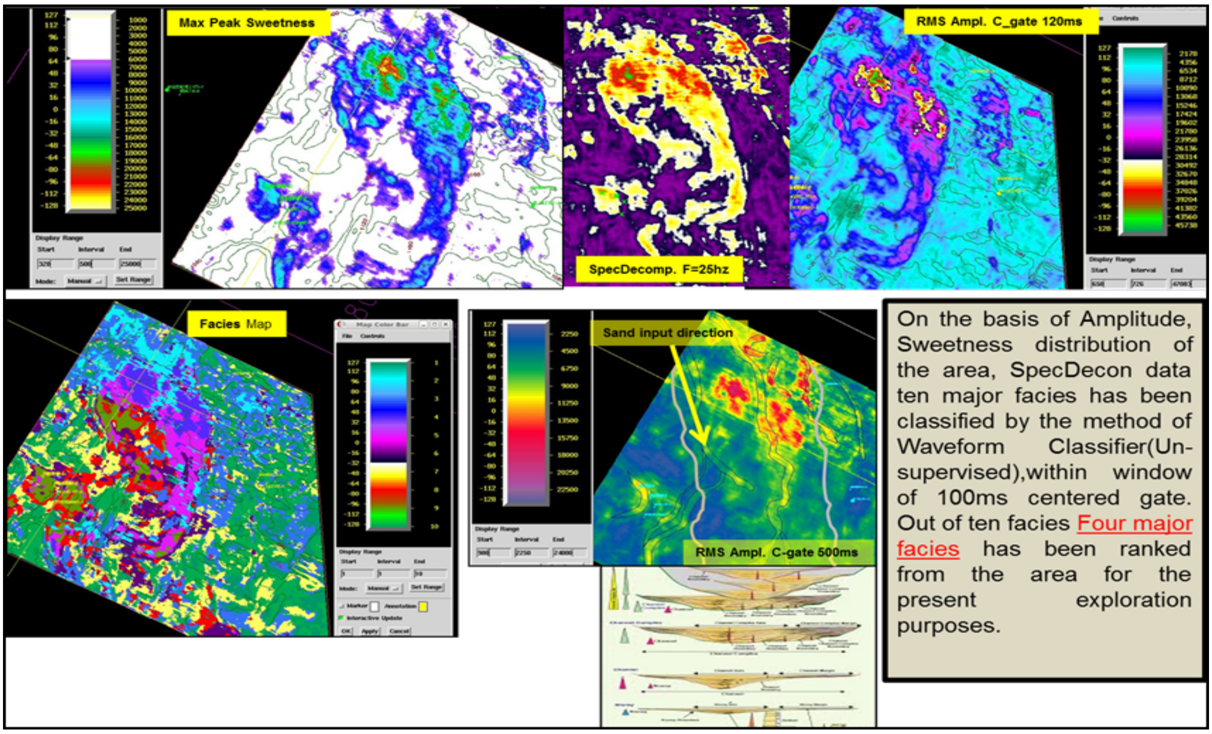


Fig.5a Facies map generation

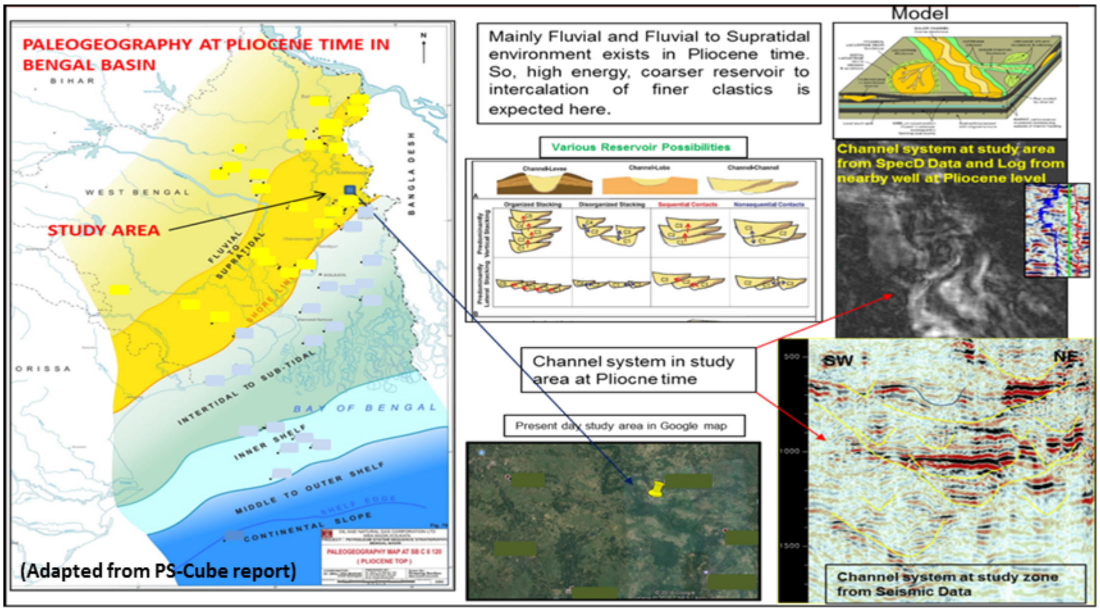


Fig.5b Paleogeography in Pliocene time and probable reservoir possibilities in the area

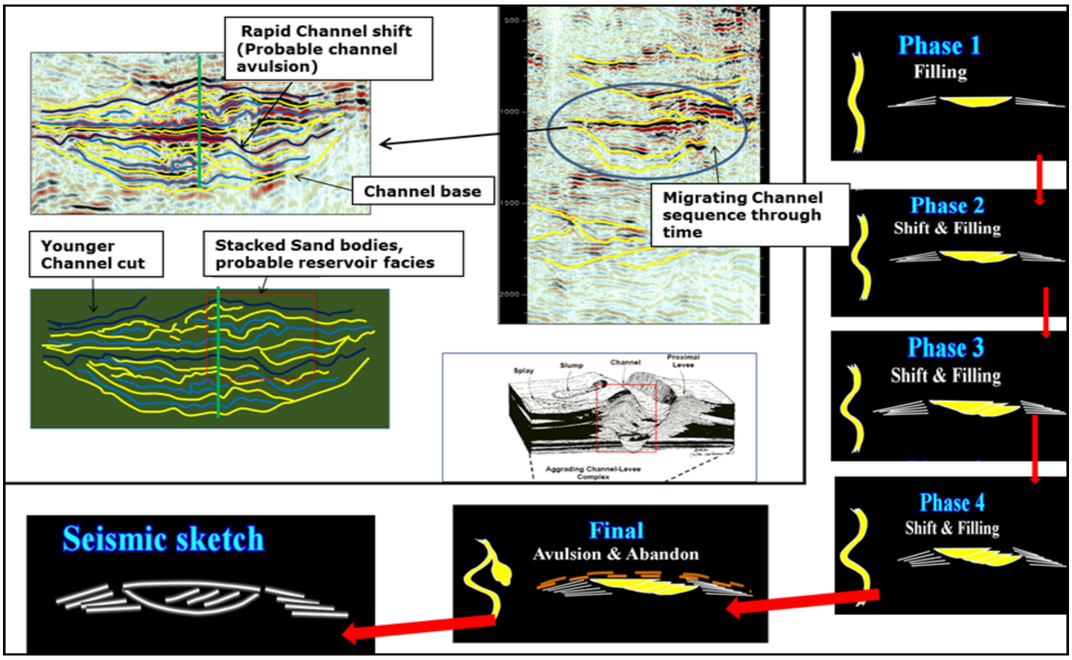
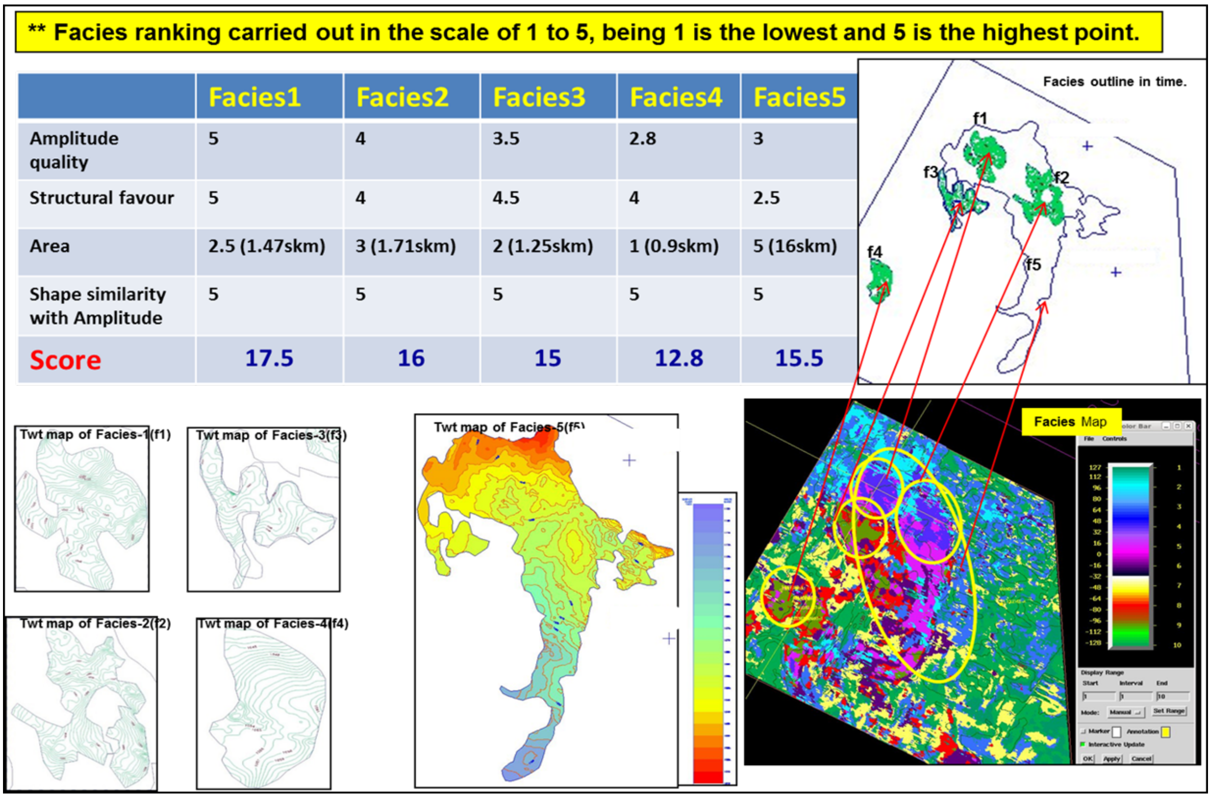


Fig.5c Reservoir model as per seismic data


** Facies ranking carried out in the scale of 1 to 5, being 1 is the lowest and 5 is the highest point.

	Facies1	Facies2	Facies3	Facies4	Facies5
Amplitude quality	5	4	3.5	2.8	3
Structural favour	5	4	4.5	4	2.5
Area	2.5 (1.47skm)	3 (1.71skm)	2 (1.25skm)	1 (0.9skm)	5 (16skm)
Shape similarity with Amplitude	5	5	5	5	5
Score	17.5	16	15	12.8	15.5

Fig.6 Facies ranking to identify best location point

Interpretation

Amplitude scaling in the data shows gradual amplitude stand out in the prospect zone, and it is much stronger with respect to the Eocene limestone. It is the highest amplitude burst in Bengal basin observed in the seismic data so far. This amplitude is interpreted as gas saturated reservoir, with variation of gas saturation, reservoir quality, and reservoir thickness in the different parts of the reservoir. Lowering of frequency is seen in the data which may indicate the probable gas saturation in the zone. Detailed analysis of the iso-angle gather shows discrete overlapping sand bodies and polarity reversal with respect to the limestone top, which is a very positive indication (**Fig.7)**.

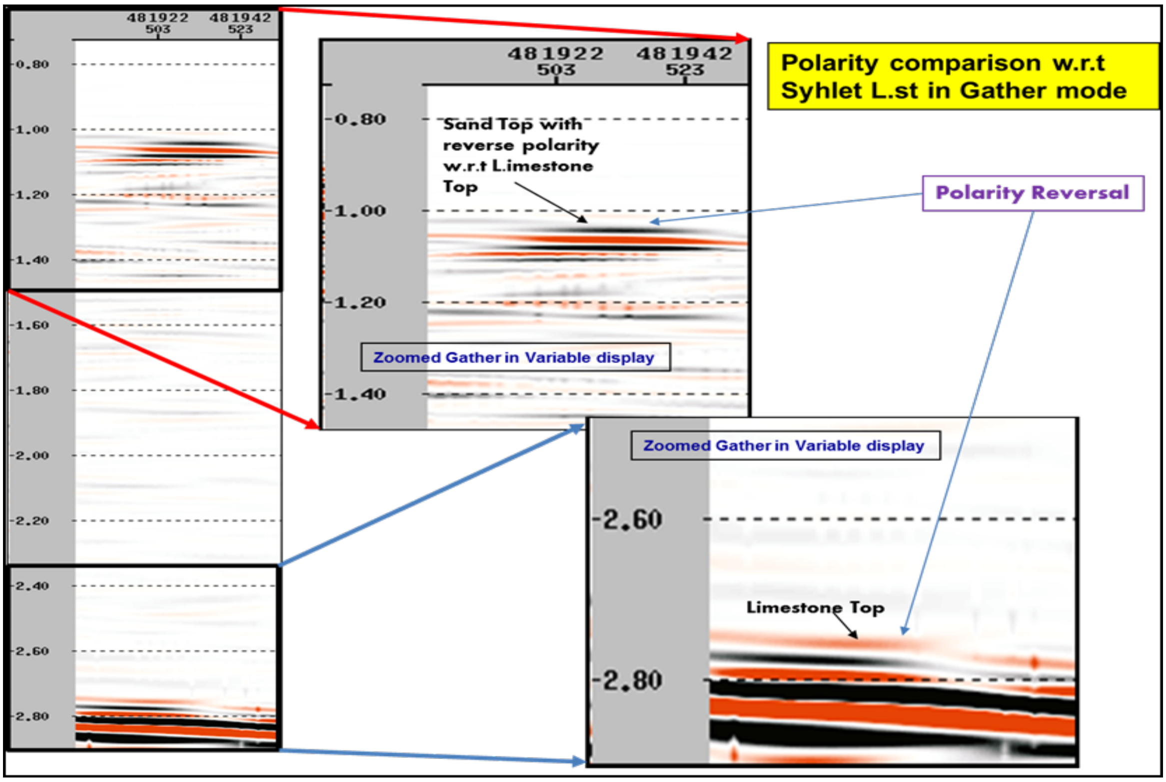


Fig.7 Polarity reversal with respect to limestone top is seen in anomaly

Well-A in the nearby area flowed gas in correlatable zone (**Fig.8)**. A transects connecting wells and proposed area shows amplitude distribution in Pliocene level (**Fig.9)**.

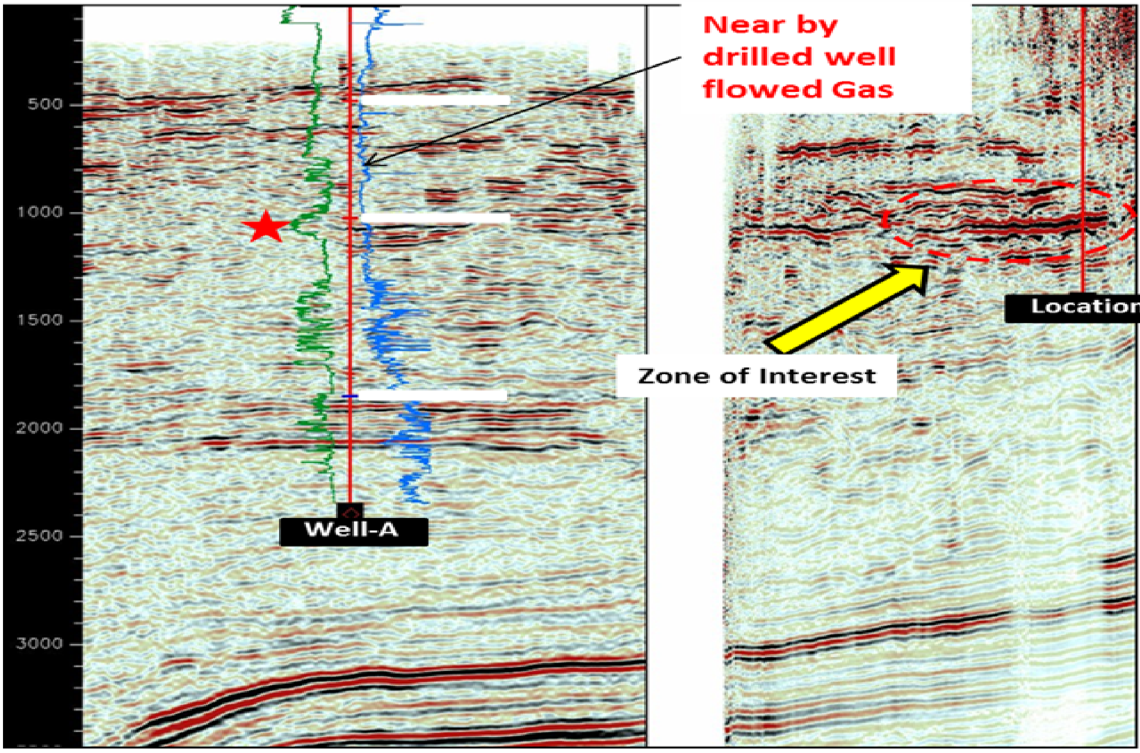


Fig.8 Correlatable zone in well-A flowed gas from Pliocene

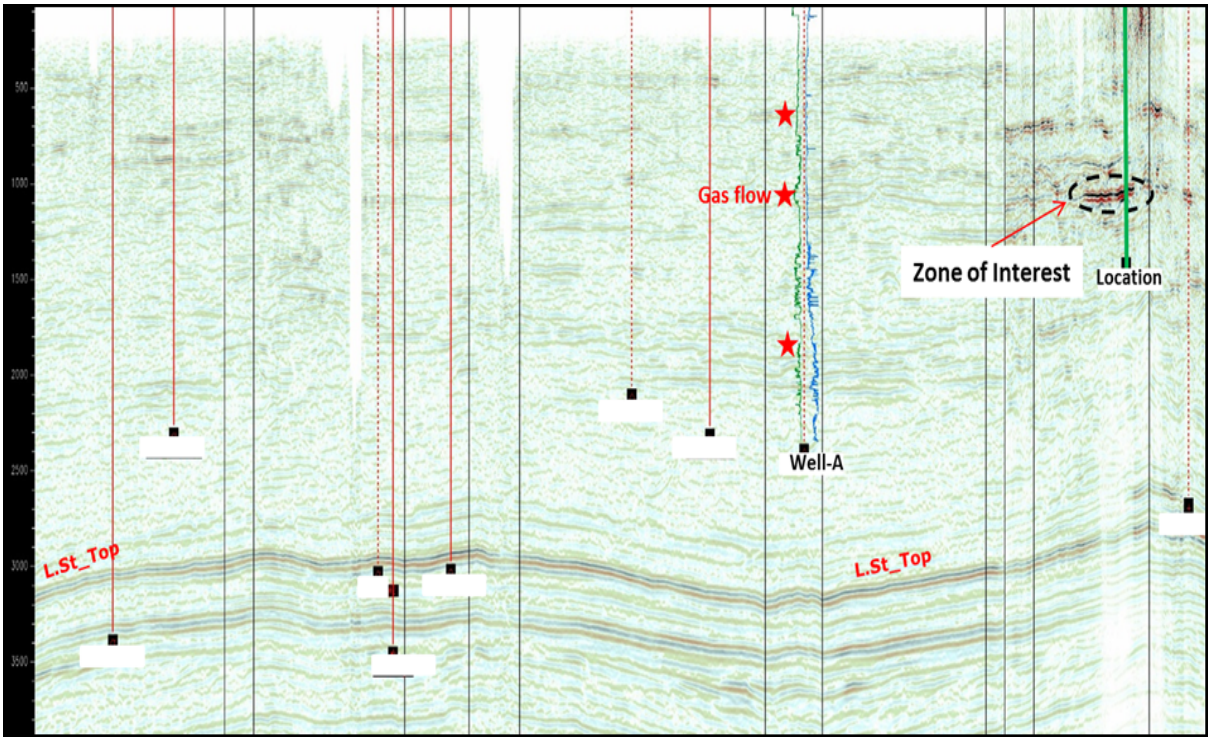


Fig.9 RC line showing amplitude distribution in drilled wells and present study area at Pliocene level.

High amplitude in seismic is mainly caused due to the impedance contrast between two layers, so it may be due to the following reasons. It may because of i) a low gas saturated reservoir ii) may be coal layers iii) thick water saturated porous rock iv) tight sand/siltstone/high impedance layer/igneous body v) calcification in rock or presence of calcareous material vi) presence of carbonaceous matter

vii) variable density shale compaction viii) presence of high pressure, ix) processing issues and x) thin bed tuning effect. Now other possibilities of high amplitude may be discarded in the light of scientific study and existing geological knowledge of the area from well and other G&G data. First, the possibility of low gas saturation in the reservoir is less as there is frequency absorption seen in the layer. Chances of coal are less as from spectral decomposition analysis it is evident that it is mainly a high energy fluvial environment and so far in the shallow level coal is not present in the area. Chances of porous water saturated rock, tight sand, siltstone, high impedance layer, presence of carbonaceous matter, variable density shale compaction are there, but whether these will cause so much of high amplitude at this shallow depth? Igneous body is not reported in Pliocene levels in any of the wells. High pressure is also not encountered in this area so far. Amplitude due to processing issue is negated after discussing threadbare with the processing people. Gas charged thin bed tuning may be possible in this case but this cannot generate so much of amplitude. Inversion shows lowering of impedance in the zone of interest (**Fig.10)**. Therefore the detail study and analysis suggest the area as prospective for hydrocarbon exploration.

Conclusions

The present study brings out a shallow level gas (mainly biogenic) prospect in Bengal basin. Previously drilled locations in the area show the indication of gas in the Pliocene sections against high amplitude, in the present study the amplitude contrast in the data is really encouraging and not been encountered earlier. Causes of bright spot in the study zone are discussed at length, which leads to a

probable shallow gas accumulation. Probing such prospects in future may open up the opportunities to bring the Bengal basin in the hydrocarbon map of India.

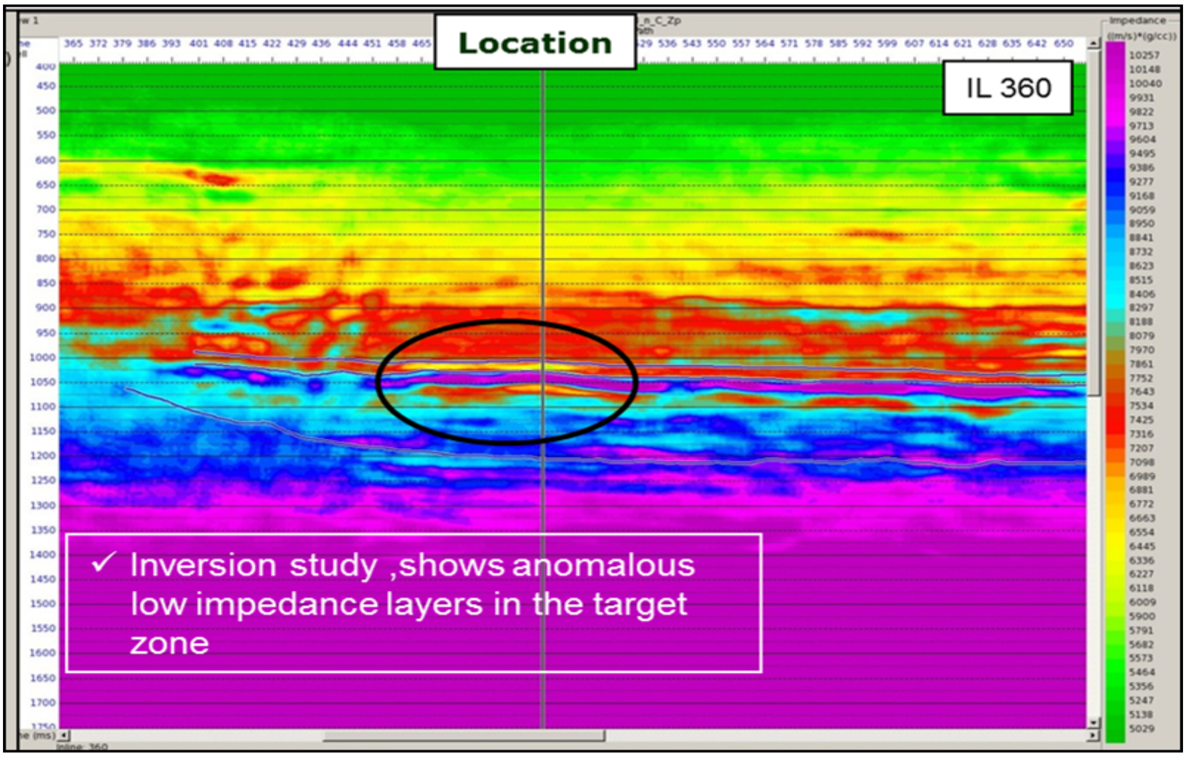


Fig.10 Inversion result showing lowering of impedance in the zone of interest

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References:

1.Kingston John (1996), Bengal Basin evaluation and exploration recommendations

2. PS Cube report of Bengal, ONGC internal report.

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