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Seismic Inversion: Reservoir Characterization of Thin Sand below K-IX Coal in Nardipur Low Area of Cambay Basin

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Summary

The area of study lies in the Nardipur Low between Kalol and Limbodra Fields towards west and east, respectively (Fig.1).In this area, K-IX sand is the main producer (Eocene age) and K-V is of marginal interest. K-IX sand was deposited in deltaic environment and is seen as channel feature. It is also characterized by marshy-swampy environment marked by coal, shale, sand and silt. An attempt has been made to understand the reservoir facies distribution over the field through seismic inversion study of the 3D seismic data in the area (Fig.2).

The seismic inversion study has brought out channel pattern and it is possible to identify the reservoir facies distribution which was corroborated with pay thickness observed in the drilled wells. On analyzing the acoustic impedance sections, it has been observed that K-IX coal layer with low impedance has been clearly brought out. K- IX sand is developed immediately below the K-IX coal with intervening thin shale varying in thickness.

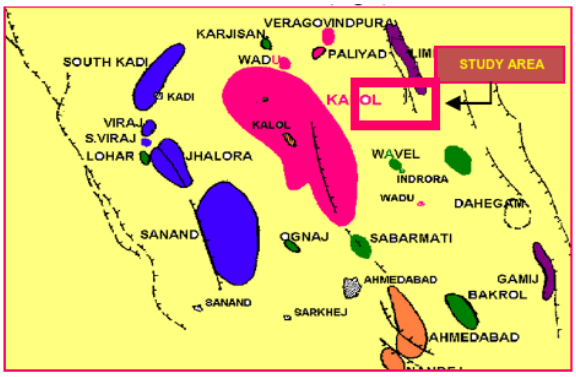

Fig.1 Index Map

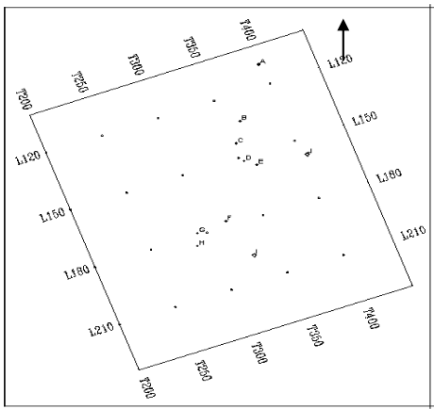

Fig.2 Basemap of Study Area (Nardipur)

Introduction

In this area, structure is not solely playing the role in hydrocarbon entrapment; rather the presence of reservoir facies seems to hold more significance. The Lithology of K-IX Unit of Kalol formation consists of mainly alternating coal, silt, shale and fine to medium grained sand as channel bars and point bars deposited in lower delta plain environment. The log motifs indicate that the K-IX sand deposited in deltaic environment (Fig.3).The sand is dispersed through distributaries and winnowing action by tidal influence making sand dispersal geometry complex. Better development of reservoir facies at K-IX level is observed in the Nardipur Low and the rising flanks of Nardipur Low area as observed in the wells B, Well E and Well D. OWC has not been observed in any of the wells.

The paper presents a detailed analysis of K-IX sand reservoir through integrated study of 3D seismic data.

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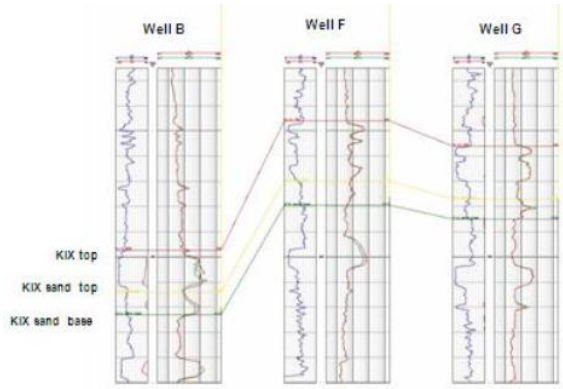

Fig 3. Log Correlation of Well B,F and G of KIX sand

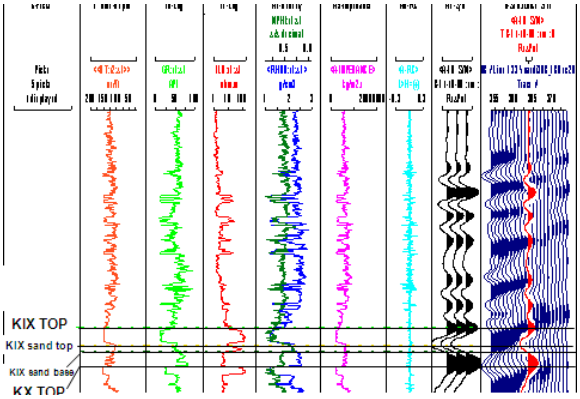

Fig 4. Synthetic seismogram of well B

Methodology

Integrated 3D seismic interpretation was carried out on PSTM data. Seismic correlation was done at the top of Kalol and K-IX Formation, respectively on the wavelet processed data. Synthetic seismograms were generated for 20 wells for well-to-seismic tie, by calibrating seismic events with well data using sonic logs, available check-shot and VSP data (Fig 4& 5). Display of Well F on seismic inline 177 with correlation of K-IX unit is shown in Fig.6.

The principal objective of seismic inversion is to transform seismic reflection data into a quantitative rock property for the description of the reservoir. Inverted volume of seismic data shows the lateral variation of the facies and helps the determination of reservoir unit. The Hampson-Russell software was used to invert the seismic volume into impedance volume. A few wells evenly distributed in the area were taken for correlation of formation boundaries with seismic marker events. Subsequently, correlated wells have been taken up for creating the initial model i.e. velocity model and this velocity model was used to invert the seismic data.

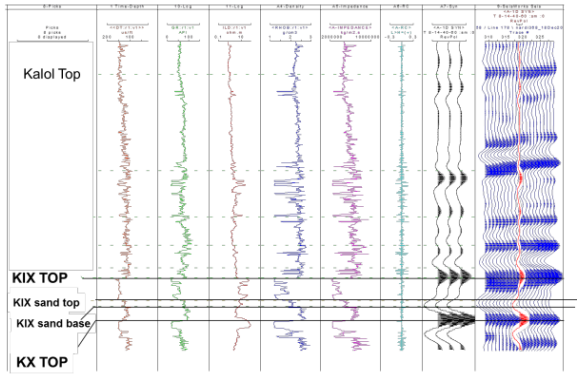

Fig 5. Synthetic seismogram of well F

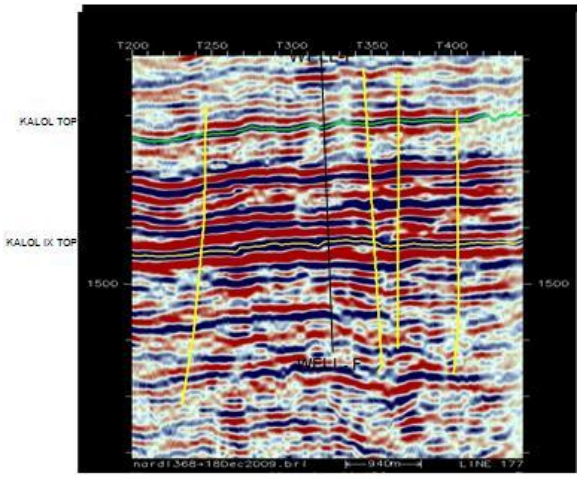

Fig 6. IN LINE Passing through Well F

Mapping of K-IX sand

Mapping of K-IX sand unit was carried out on inverted volume i.e. impedance volume. K-IX sand is marked by a thick coal unit deposited at the top which gives rise to a prominent peak on the seismic section (Fig.4). Thin shale and sand unit comprising K-IX reservoir interval lie at the base of the K-IX coal. Model based seismic inversion was performed using Hampson-Russell software to bring out the thin K-IX sand development pattern. On analyzing the acoustic impedance sections it has been observed that K-IX coal layer with low impedance has been clearly brought out. K-IX sand is developed immediately below the K-IX coal with intervening thin shale varying in thickness (Figs. 7 to 9A). RC line passing through wells to show the poor and good reservoir facies (Fig.9B)

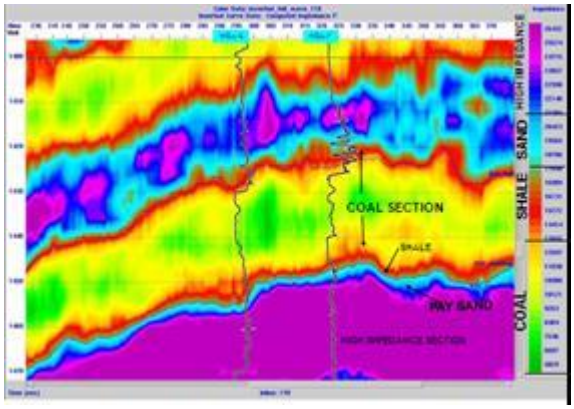

Fig 7. Impedance section through Well F overlain by Impendance log

The top and bottom of the K-IX sand, marked by the occurrence of the reservoir impedance, were tracked manually in the impedance volume to avoid the interference of K-IX coal layer above and high impedance shale below the K-IX reservoir sand. The sand distribution has been brought out by taking horizon slice in impedance volume (Within 6ms equivalent to approx. 9m window below the sand top, corresponding to maximum observed sand thickness, Fig.10). Facies and structure maps at top of K-IX sand unit were superimposed to understand facies vis-a- vis structural trend of the area. The longitudinal faults are oriented mainly in the NE-SW direction cut across by transverse faults trending E-W (Fig.11). Pay thickness are also superimposed on facies map to understand the thicknesses trend with facies (Fig.12).

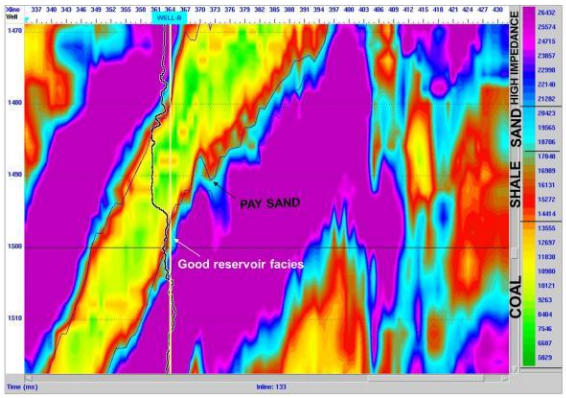

Fig 8. Impedance section through Well B overlain by GR log

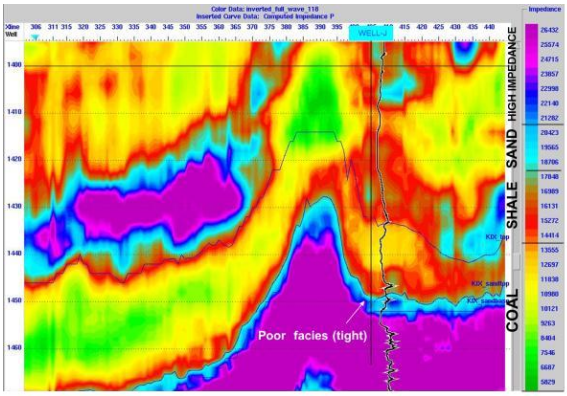

Fig 9A. . Impedance section through Well J overlain by Impedance log

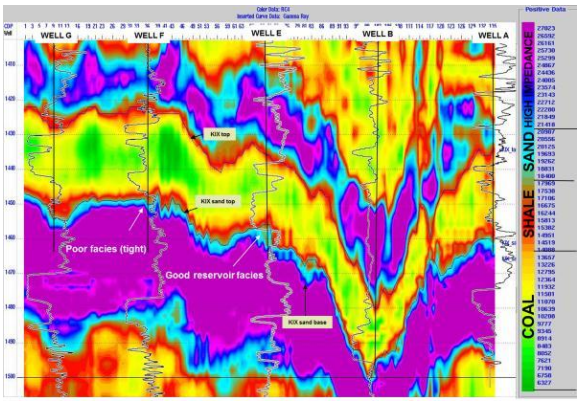

Fig 9A. . Impedance section through Wells G,F,E,B & A overlain by GR log

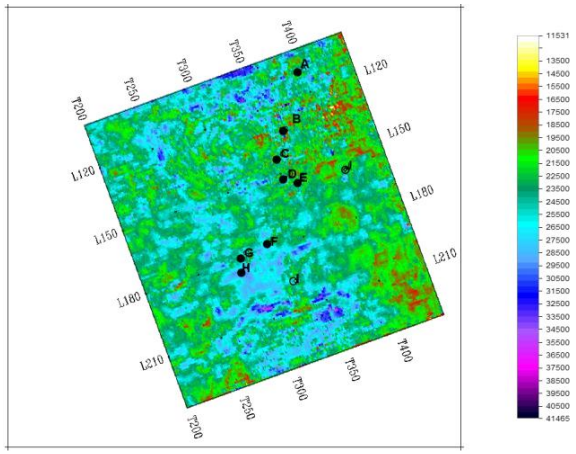

Fig 10. Amplitude Map of KIX sand (0 to 6ms from sand top)

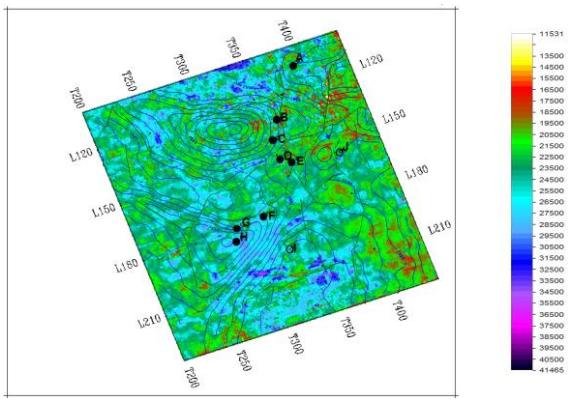

Fig 11. Amplitude Map of KIX sand (0 to 6ms) overlain by structure at KIX sand.

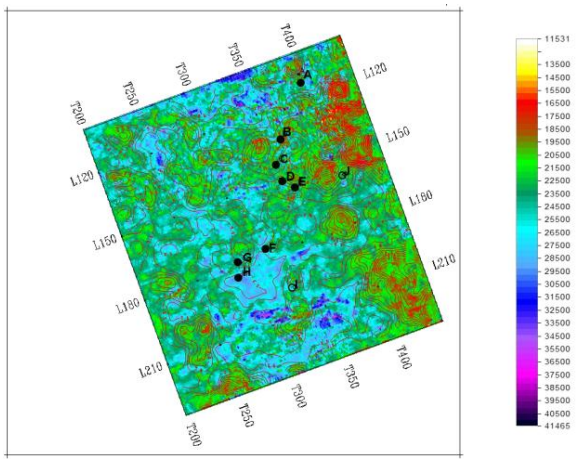

Fig 12. Amplitude Map of KIX sand (0 to 6ms) overlain by thickness at KIX sand.

Analysis and Findings:

On the basis of this study, K-IX reservoir sand seems to have a limited development in south-western part of Nardipur Low area as observed in the hydrocarbon proven wells F, G, H and Well I, and Better development of reservoir facies at K-IX level is observed in the low and the rising flanks of Nardipur Low area as observed in the wells B, Well E and Well D.

On the acoustic impedance slice it was identified that K-IX sand facies is well developed near the wells B, Well E and Well D whereas area further south is characterized by poor reservoir facies. Well F has initially produced oil @8m3/day but subsequently has been a poor producer on SRP @2-3m3/d. Well G is a producer on SRP. The study has clearly brought out the differentiation between good and poor reservoir facies. The present facies map explains the K-IX sand distribution encountered in most of the wells of Nardipur Low.

In impedance section, the range of impedance in coal is below 14000 units, Shale 14000-18000, sand 18000-21000 and high impedance shale layer more than 21000 units.

Conclusion

Seismic inversion has produced a broad-band, high frequency image of the subsurface even in the presence of thick K-IX coal layer above and has enabled mapping of the underlying rather thin K-IX sand along with the facies distribution.

References

Dr Gupta A.C. et.al , October 2010, Proposal for release of three exploratory Location, Nardipur low area (Unpublished IRS.ONGC, Ahmedabad)

Dhillon B.S. et.al, Feb 2011, Report on Review of Nardipur 3D data.

Bhardawaj B.M, April 2011, A Report on Reservor Distribution of Kalol unit in Nardipur low, Cambay basin.

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