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Seismic Inversion: Reservoir characterization of K-IX sand in Mahelaj, Naika and sadra area of Cambay Basin.

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Summary

The study area comprising Mahelaj, Sadra, and Naika fields is located in Ahmedabad Mehasana tectonic block of Cambay Basin (Fig.-1). These fields are located on the North-Westerly rising flank of Tarapur depression believed to be the kitchen of hydrocarbon generation in this Basin. A number of pays at various stratigraphic levels have been discovered in these fields which includes pays in deeper Olpad of Paleocene age, and Cambay shale to Kalol formation of Eocene age.

The K-IX and X units of Kalol formation are present in the entire study area. However the K-VIII unit is developed locally in some places. In this area, K-IX and KX sands are the main producer. K-IX sand was deposited in deltaic environment and can be 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 of the area through seismic inversion study of the 3D seismic data (Fig.-2) It can be observed that K-IX coal with low impedance can be visualised along with the high impedance sand/silt layers. From well log correlation it can be observed that K-IX sand is developed immediately below the K-IX coal with intervening thin shale (Fig.-3). The seismic inversion study has indicated channel pattern within Kalol formation and it is possible to identify the reservoir facies distribution within K-IX unit while analysing the acoustic impedance sections.

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

***Keywords**: Seismic Inversion, Cambay Basin*

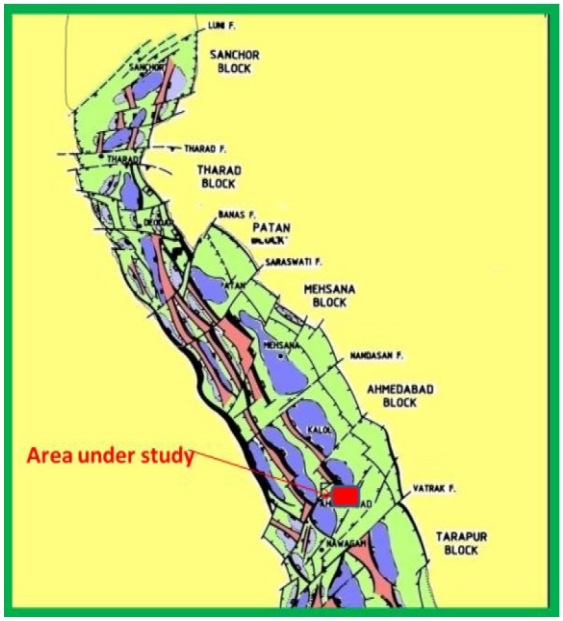

Figure 1: Tectonic Frameworks of Cambay Basin.

Introduction

In this area, though structure has a role in hydrocarbon entrapment; presence of reservoir facies has a dominant role in Mahelaj area in accumulation of hydrocarbon. Hence 3D review interpretation was carried out at regular interval with

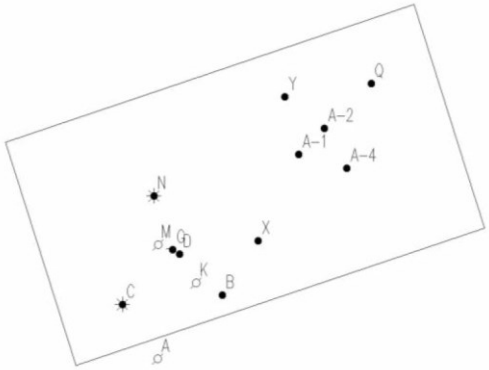

Figure 2: Base map of the study area.

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integration of additional subsurface data in development of the field for increased production.

The K-IX unit has regional spread and is the main oil bearing reservoir. No oil water contact is encountered in any of the wells. The K-IX consists of alternate coal - silt / sand and shale bands. K-IX coal marker can be picked up easily from the logs which is a prominent coal marker lying below K-VIII. This prominent coal marker is consistently developed laterally and could be correlated in the entire area except the one well, where the coal section is absent. The log motif indicates that the K-IX sand deposited in deltaic environments (Fig.-3).

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

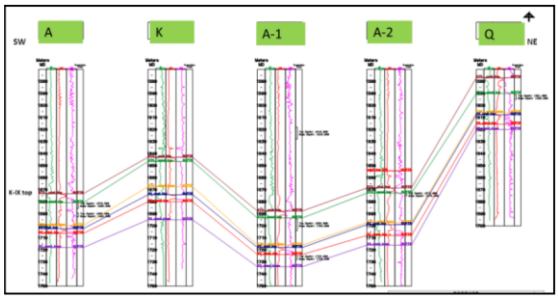

Figure 3: Log Correlation profile well A, K,A-1,A-2 and Q.

Methodology

Integrated 3D seismic interpretation was carried out on PreSTM data. Synthetic seismograms were generated for well and seismic tie up (Fig-.4 & 5). Seismic correlation was done for the top K-IX and K-X units (Fig. -6).

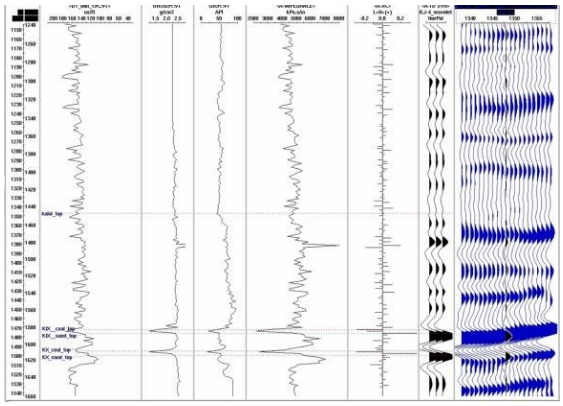
Figure 4: Synthetic Seismogram at well D.

Hampson russel software was used to invert the seismic volume into impedance volume. A few wells evenly distributed correlated in this area are the basis for correlating seismic marker boundaries and have been input for creating the initial model i.e impedance model On analysing the impedance section derived from inversion, it has been observed that K-IX coal layer with low impedance (range 3500 to 4700 approximately (m/s)(g/c)) has been clearly brought out.

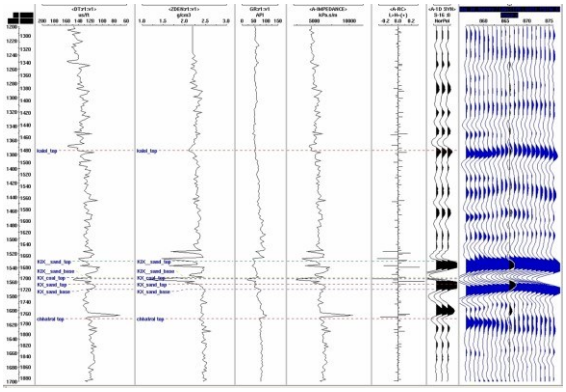
Figure 5: Synthetic Seismogram at well A-4.

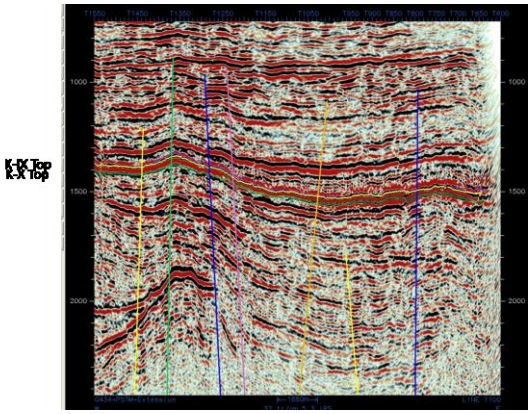

Figure 6: Seismic Correlation of top K-IX and K-X.

To remove the effect of coal, the correlation was again done on impedance section on K-IX coal base (K-IX sand top). K-IX sand is developed immediately below the K-IX coal layer in wells G and D (Fig.7-8), whereas in wells M and C the facies is not developed properly (Fig.9-10). The sand distribution has been brought out by taking average impedance over 10ms window below K-IX sand top equivalent to approx.15m window.

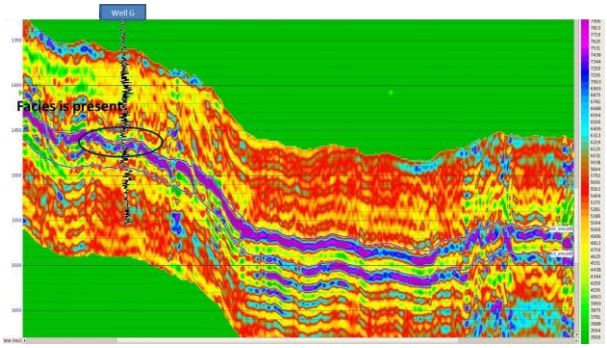

Figure 7: Well G oil bearing in K-IX (Facies is present).

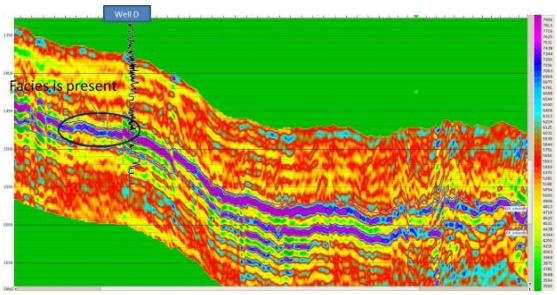

Figure 8: Well D oil bearing in K-IX (Facies is present).

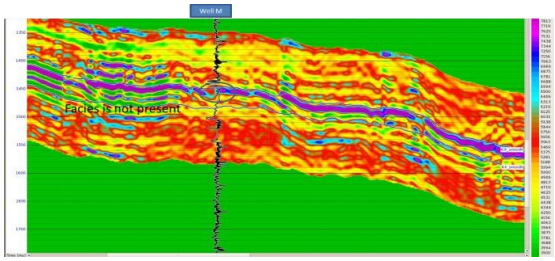

Figure 9: Well M Facies is not present in K-IX.

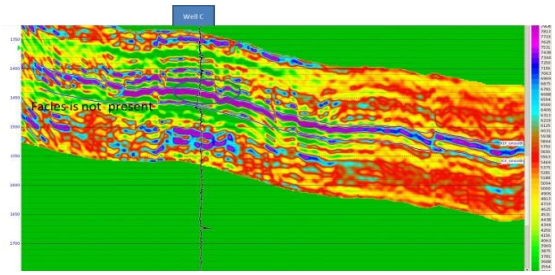

Figure 10: Well C Facies is not present in K-IX.

Analysis and Findings

On the basis of study of map generated from acoustic impedance volume over 10ms window below base of K-IX coal. Higher impedance values are interpreted to given by the tight sand whereas lower impedance values by the carbonaceous shale. Intermediate impedance values are interpreted to be the representative of reservoir facies. Map validates the most of the existing wells in the study area of Sadra, Mahelaj and Naika. The well which are falling in the channel are good producer whereas the wells are outside the channels are facies is not developed or very tight reservoir (Fig.11).

K-IX reservoir seems to have a limited development of reservoir facies around the wells D and B in Mahelaj area. In Naika area, though wells M, N and C are at structurally higher position (Fig.12.) but are not promising for drilling the wells for K-IX reservoir as facies are not present. In sadra area wells A-1, A-2,A-4 and Y facies are interpreted to be moderately shaly.

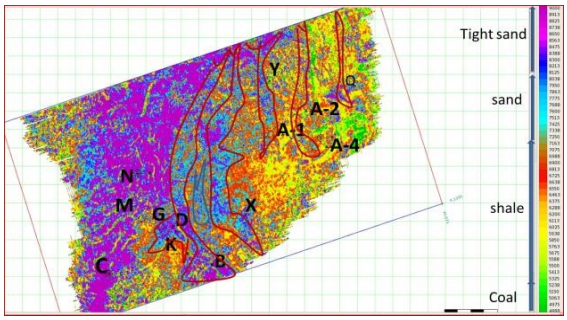

Figure 11: Average impedance sand map over 10ms below K-IX coal base.

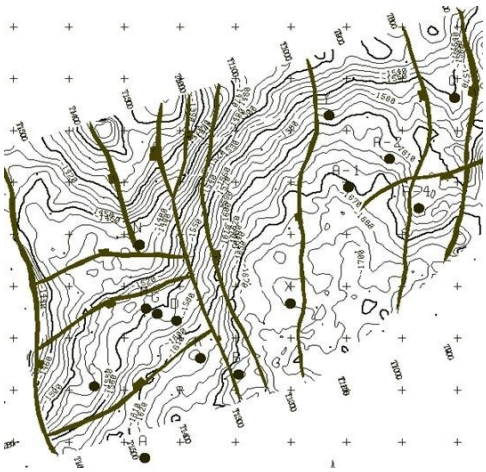
Figure 12: Structure map of K-IX top.

Structure map and facies of K-IX are put together to understand facies as well as the structural trend of the area (Fig.12.).

Conclusion

It is quite impossible from normal seismic data bring out about the reservoir facies due to presence of adjacent coal. It could be possible only after seismic inversion study.

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 enabled mapping of the underlying thin reservoir of K-IX leading to mapping of facies distribution.

Acknowledgement

We are thankful to my organization ONGC for allowing me to publish this work. The views expressed in the paper are author only. Authors are extremely grateful to Shri R.K.Sharma, Head IRS, ONGC Ahmedabad for his constant guidance for carrying out this analysis of reservoir characterization.

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