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Reservoir Properties of Daman Formation, South Tapti Basin evaluated from Well Log and Seismic Data

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Summary

Well log and seismic data obtained from Daman formation of late Oligocene formation of South Tapti field are used to evaluate petrophysical properties of reservoir. This paper follows the integrated approach to petrophysical evaluation. From the log data analysis the hydrocarbon bearing zone is in the depth range of 1865 - 1875m. The water saturation varies between 10% - 30%. The correlation of synthetic seismogram with stacked seismic section confirms the presence of hydrocarbon and appears to be of Daman Formation age. The pre-stack synthetic gather shows the amplitude decrease with offset. Since the amplitude decreased with offset, plots of P-wave, S-wave, Acoustic Impedance, Poisson ratio suggests hydrocarbon (gas) bearing reservoir and verified the class I AVO anomaly.

Keywords*: Well Log, Daman Formation, Reservoir.*

Introduction

Tapti field covers an area of 1471 sq km and lies north-northwest (NNW) of Mumbai. The block comprises of South Tapti, North Tapti and Mid Tapti, which occur in two large structural culminations (Saha et al. 2009). The South Tapti Field is located at the entrance to the Bay of Cambay, approximately 160 km NNW of Mumbai, off the west coast of India. Off the various stratigraphic units present in South Tapti Basin, sediments of Panna formation are considered to be the source facies, whereas the sandstone layers present in Mahuva and Daman formation are found to host the hydrocarbons (Wandrey, 2004).

The petrophysical properties of the reservoir - porosity, permeability and water saturation are computed from the well log data. Well logs have been successfully used in exploration and development wells and are routinely used to identify depth and thickness of productive zones following the integrated approach (Adeoti et al., 2009). The logs have also been used to distinguish between oil, gas and water in reservoir and to estimate hydrocarbon reserves (Asquith and Gibson, 1978).

In this paper, well log analysis was performed on the logs obtained from wells comprising the clastic sediments of late Oligocene Daman formation in South Tapti Field. The quality of reservoir in terms of parameters like shale volume, effective porosity, water and hydrocarbon saturation, permeability are evaluated and results are discussed.

Methodology

The well log data from South Tapti Field (STA-1 well) was made available for research work by BG India. The quantitative analysis was done for the logs obtained in the depth range of 1830 – 1930 m. An essential step in formation evaluation process is the determination of amount of shale present in the formation (Mimonitu, 2010; Ulasi et al., 2012). This helps to calculate the correct formation porosity and fluid content within the pay zone. Volume of shale is calculated following the integrated approach by utilising the Gamma ray log, SP log, Neutron-Density log and Resistivity log data (Adeoti et al., 2009). Porosity is calculated from density log. From the qualitative observation of logs, the crossover in neutron-density log, low value of gamma ray log, separation in shallow and deep resistivity log values, suppression in SP log and higher value in sonic log suggested the hydrocarbon bearing zone. This led to the detailed quantitative analysis between depths 1865-1875 m within the reservoir zone (Fig-1).

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Water saturation was calculated using Archie's equation which led to the estimation of hydrocarbon saturation. Permeability was calculated using the Timur equation in which irreducible water saturation was calculated from the Bulk Volume Water (BVW). This was based on Bulk Volume Water calculated at several depths. A constant or near constant values indicate a single rock type bearing zone at irreducible water saturation. When a zone is at irreducible water saturation, water in the uninvaded zone (*Sw*) does not move as it is held on grains by capillary pressure.

Reservoir evaluated at this depth was correlated with seismic stacked section using a two-way travel time calculated from VSP data. Based on the two-way travel time of 1714 ms and at inline calculated from the well location, the reservoir zone was evaluated and is shown in Fig -2.

Seismic to Well tie

Hampson-Russell seismic and well log data processing software was used to generate synthetic seismogram with the use of density and sonic log data. The minimum phase equivalent of Ricker wavelet was used to correlate with seismic section corresponding to reservoir zone calculated using VSP data. Pre-stack synthetic gather was generated to produce an AVO anomaly.

The processing steps in Hampson-Russell software involves – Well data loading, generation of synthetic seismogram by selecting minimum phase equivalent of Ricker wavelet at 20 Hz, 25Hz and 30 Hz, selection of AVO modelling module to create AVO synthetics, finally using different Ricker wavelets, pre-stack synthetic gathers were generated as shown in Fig -3.

Finally, using Well log data, plots of P-wave, S-wave, Acoustic Impedance and Poisson's Ratio were generated. This analysis led to the estimation of AVO class anomaly and fluid type (Fig-4).

Conclusions

The methodology follows an integrated approach to the evaluation of reservoir properties such as shale volume, porosity, water saturation, permeability. The total porosity of late Oligocene Daman formation estimated from the log analysis is approximately 40% and the pay zone is in the depth range of 1865 - 1875m. The water saturation varies between 10% - 30%. The results confirm the hydrocarbon bearing zone at depth of 1865m-1875m and indicates the zone to be within Daman Formation (Fig-2). The correlation of synthetic seismogram with seismic section as shown in Fig-3 confirmed the presence of hydrocarbon. The pre-stack synthetic gather shows the amplitude decrease with offset and from the plots of P-wave, S-wave, acoustic impedance, Poisson's ratio (Fig-4), AVO anomaly turns out to be type-I. The decrease in Poisson's ratio, Pwave velocity and slight increase in acoustic impedance and S-wave velocity indicates the presence of hydrocarbon (gas) bearing reservoir in the region.

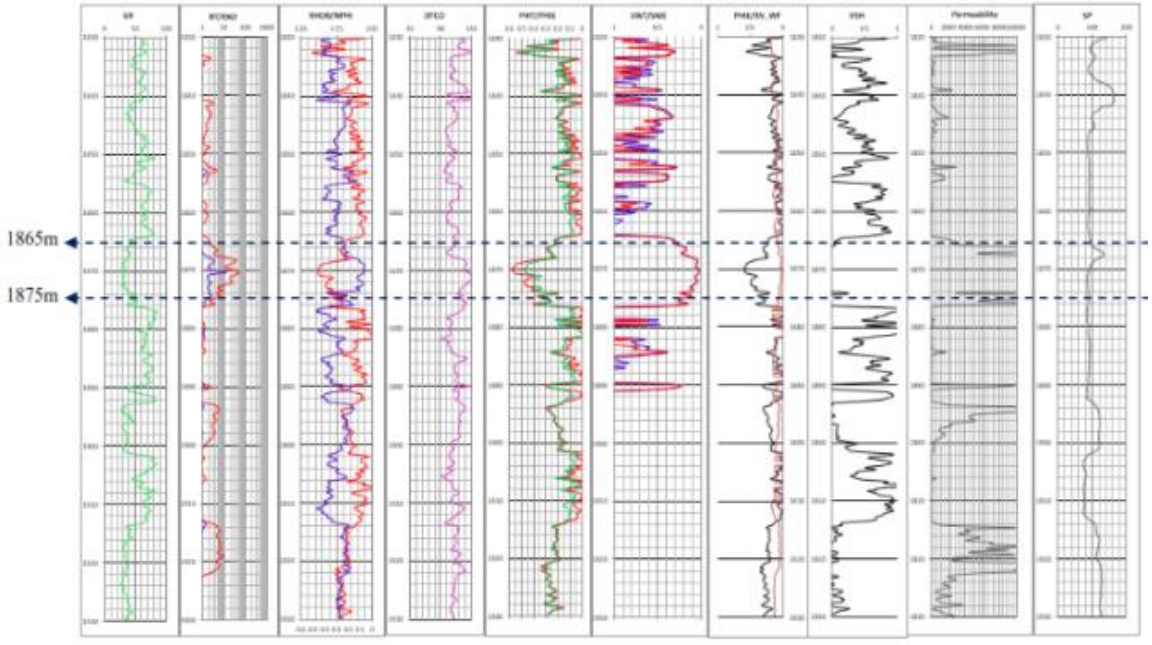

Figure 1: Various Logs of Well (STA-1) of South Tapti Basin.

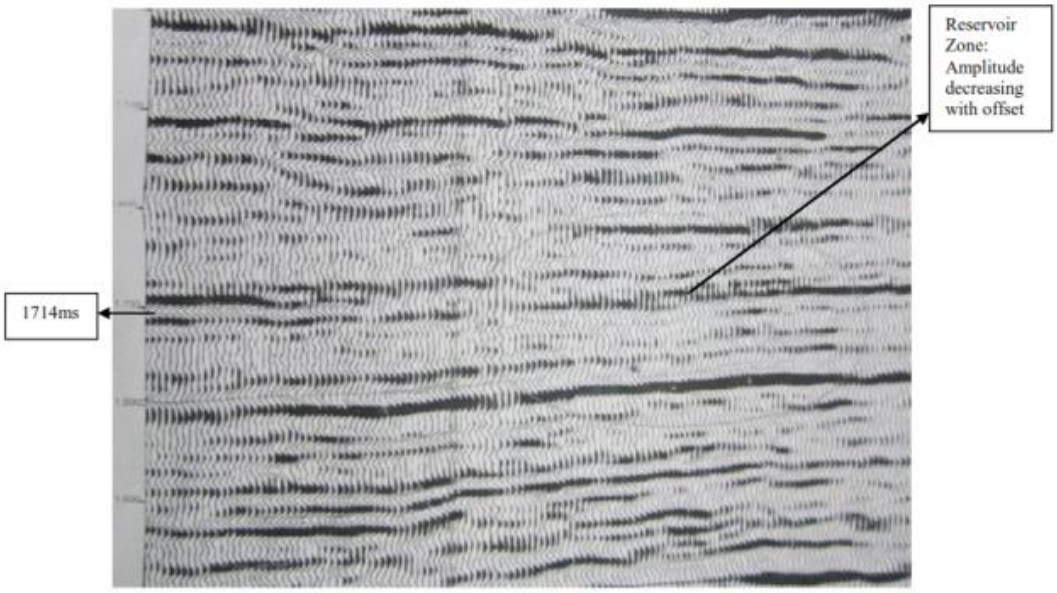

Figure 2: Stacked seismic section corresponding around the well (STA-1, South Tapti Field).

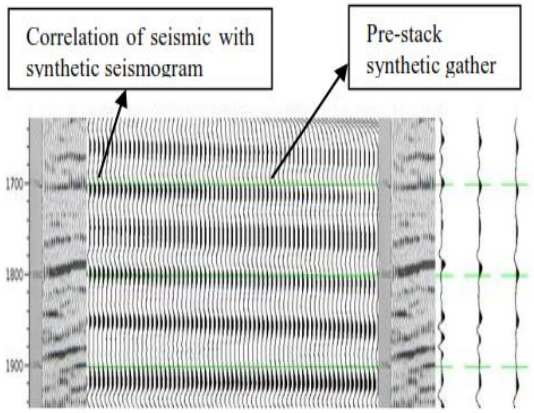

Figure 3: Correlation of synthetic seismogram with seismic stacked section (Offset: Zero offset at 30Hz, 25Hz, 20Hz Synthetic Seismogram)

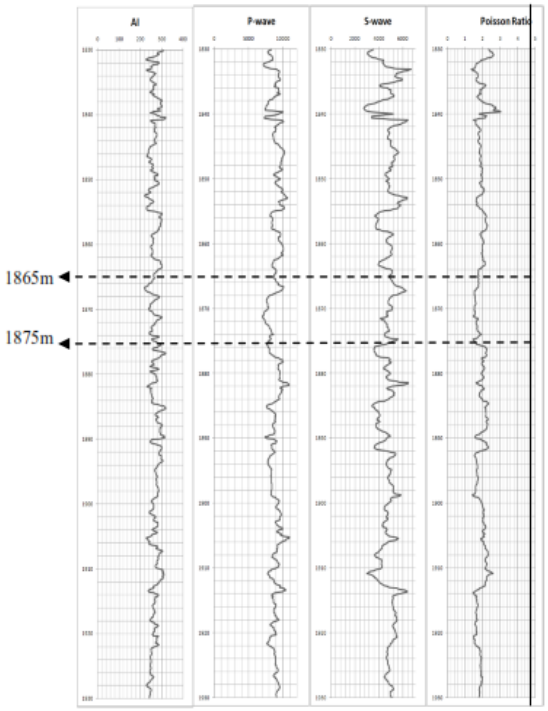

Figure 4: Variation of P-wave, S-wave, Acoustic Impedance, Poisson ratio with Depth.

Acknowledgments

I extend my sincere gratitude towards my supervisor Dr. K. Hemant Singh and invaluable suggestions from Dr. C. H. Mehta which immensely benefitted me in completing the project work. BG India is kindly acknowledged for providing the stacked seismic sections and the well log data to IIT Bombay for research and development purposes; and CGG Veritas for providing the Hampson-Russell software.

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