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Improved Formation Evaluation In Thin Beds Using Hi Tech Logs

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***Abstract* — Evaluating the hydrocarbon potential of thin beds plays a very important role in the development of a field consisting of complex reservoirs. Even if the zones are detected, evaluation of the reservoir parameters like oil saturation, porosity, etc is influenced by the nearby beds and may not be comparable with the actual reservoir parameters. Conventional logs, namely, Dual Latero log, Density-Neutron log and sonic logs are influenced by thinly laminated sand shale sequences as the thickness of these beds are below the resolution of the tools. To assist the interpretation of such hydrocarbon bearing zones which might otherwise have been overlooked by limiting oneself within the framework of conventional logs, logs recorded from high resolution tools like FMI are used more frequently. FMI logs help in clearly demarcating bed boundaries of thin hydrocarbon bearing zones from the adjacent low resistivity shales as the vertical resolution of the tool is of the order of 0.2 inches. Other hi tech tools viz., NMR and Full wave sonic tools further aid in determining the reservoir parameters of permeability, porosity, nature of the fluid and its producibility.**

The producing sands of Cauvery Basin of Southern India are conspicuous by the presence of laminations and lenticular bedding and are relatively thinner with alternations of silt and shales. The porosity of these sands is moderate to good and it ranges from 9 to 18 per cent while the permeability is poor as derived from NMR and Full Wave Sonic logs. A case study of an exploratory well of the Basin using special logs has been presented and a number of thin hydrocarbon bearing zones were identified. Upon testing, these zones produced commercial quantities of hydrocarbon.

INTRODUCTION

The case study is taken up in the pay sands of Andimadam formation belonging to the Lower Cretaceous age of a well in Pallivaramangalam in the Cauvery Basin. A number of sand layers are developed in this formation and are interesting from hydrocarbon point of view. The formation is characterized by alternations of sand, silt and shale. A wide variation in sand unit thickness ranging from 0.05m to 1m interspersed with faults/fractures and soft sedimentary features. Logs recorded using High Resolution Tools like FMI were used to unravel the Hydrocarbon potential of the pay sands which could have been overlooked if analyzed only with conventional logs.

ANALYSIS USING HIGH RESOLUTION LOGS

FMI images help in understanding the reservoir structure, identify and evaluate sedimentary features like bedding, fractures and visualize rock structure.

In the case study, three intervals, viz., xx78-xx82m, xx32-xx36.5m and xx41-xx75m are processed and are presented along with observations. The above intervals were processed using ELAN Plus software of Geoframe module covering all the sands developed in Andimadam formation. Clay typing and mineral selection is based on regional geology and inputs provided by petrography studies by the Regional Geosciences Lab. In Andimadam formation, Chlorite, Montmorillonite and little amount of Illite are taken as clay minerals. Indonesian equation has been used for water saturation calculations. The paralogs generated are presented alongside the processed outputs of FMI for comparative study.

Sl No.	Interval	Rt Ωm	Φe	CMR Free fluid Φ	K CMR md	Sw
1	xx78.5-82	13-40	10-19	10-13	30-80	40-50
2	xx32-36.5	20-30	13-15	7-8	6-10	50-60
3	xx37.5-41	30-35	14-17	9-11	20-35	45-50

Table 1: Petrophysical characters of the intervals

The interval xx78.5m-xx82m produced about 25 m^3 of oil during activation. The intervals xx32m-xx36.5m, xx37.5m-xx41m has confirmed the presence of oil, but did not come up on self flow though.

The processed FMI results aid the interpretation and processing by addressing the thin laminations more specifically thereby enhancing the reserve outlook and arriving at more optimistic values of oil saturations. Further, the fractures identified within the pay sands may have been a contributing factor for the improved permeability evident in the flow of hydrocarbon upon initial testing.

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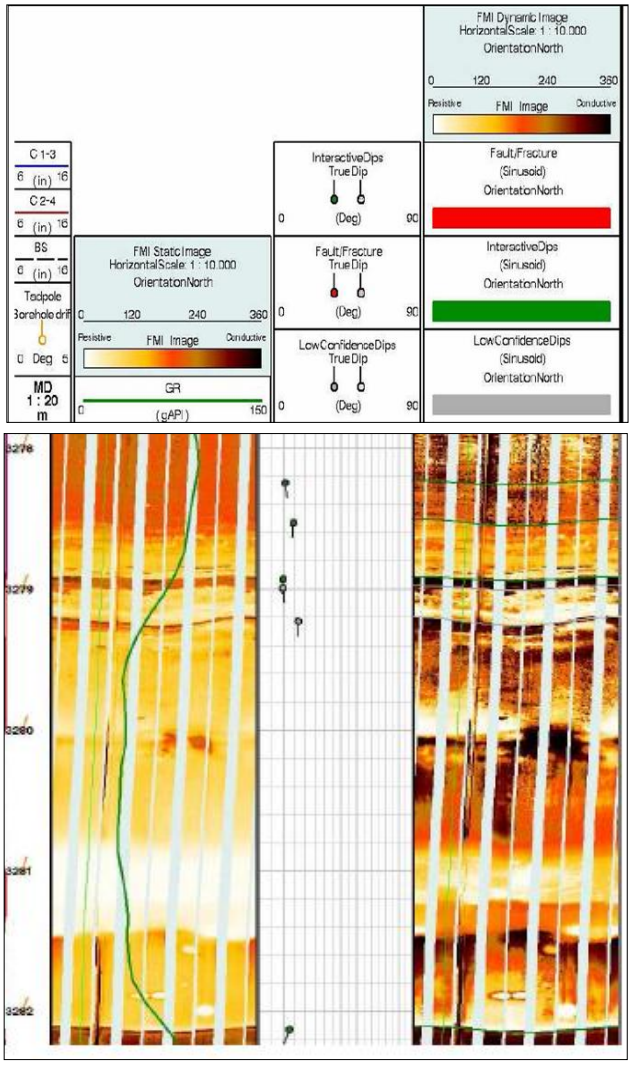

Fig. 1. Interval xx78m-xx82m

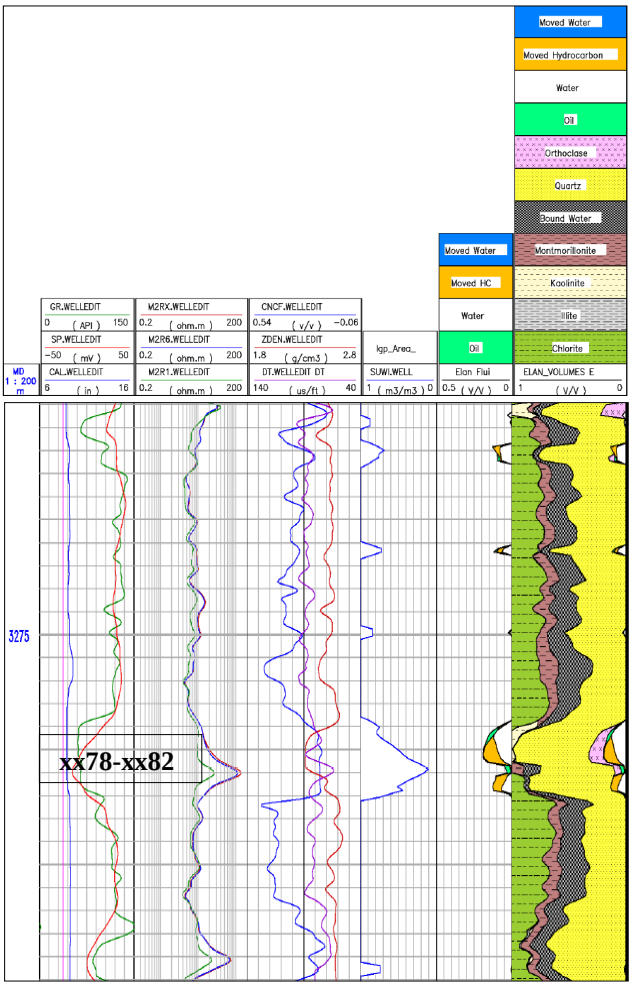

Fig. 2. Paralog containing the interval xx78m-xx82m

This interval (xx78m-xx82m) shows a sandstone dominated facies characterized by sharp base (dipping 10° → SSW) and blocky nature of Gamma Ray log. Upper part of the interval exhibits alternation of sand and shale layers. The bed boundaries identified are mostly dipping 10-12° towards south. The sand shows no visible damage to the porosity and permeability.

The interval (xx32m-xx36.5m) is characterized by deformation features which may have resulted in the destruction of porosity and permeability. Fractures identified in this section are resistive in nature indicating that they are healed and hence not contributing to production. The fractures are mostly dipping 45°- 65° towards SE. Breakouts can also be identified in this interval; which are trending NE-SW.

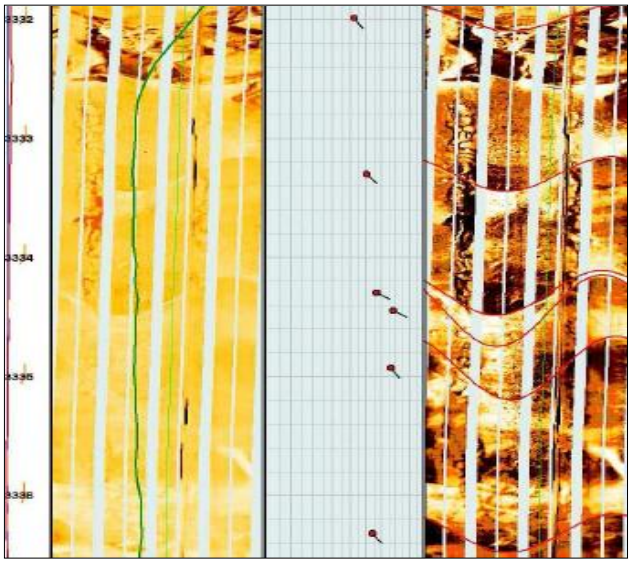

Fig. 3. Interval xx32m-xx36.5m

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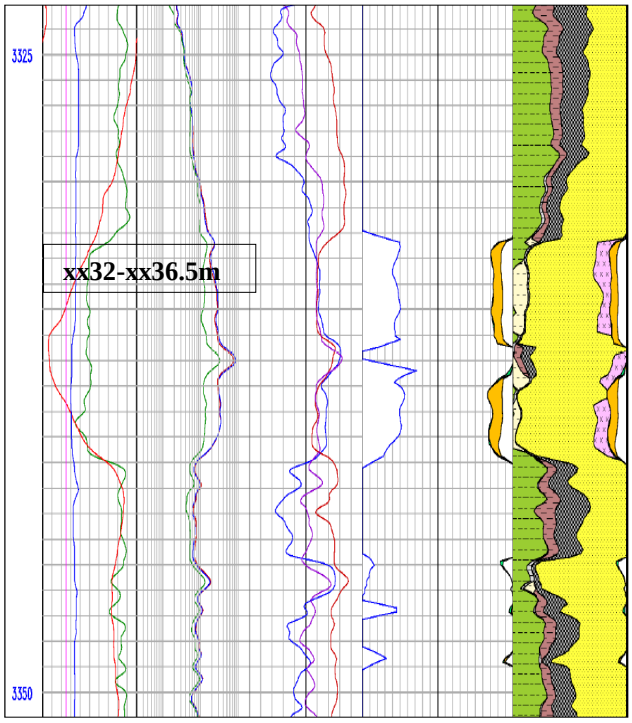

Fig 4. Paralog containing the interval xx32m-xx36.5m

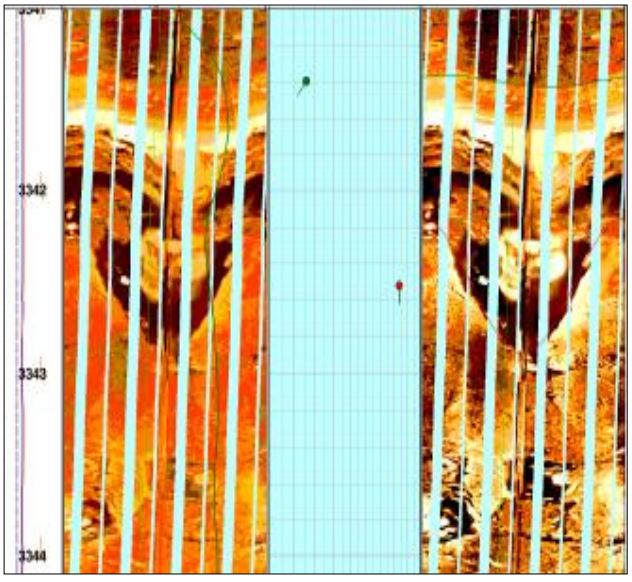

Fig 5: Interval xx41m-xx44m

This interval (xx41m-xx44m) shows argillaceous dominated facies resulting in considerable reduction of effective porosity. There is feeble development of bedding surfaces towards bottom part of the interval. A fault can be observed at xx42m, which is dipping 72° → South

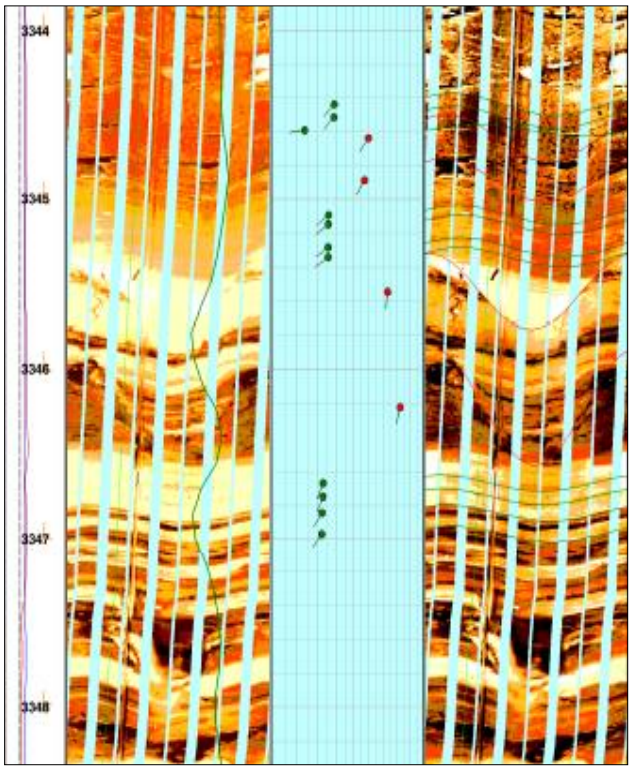

Fig 6: Interval xx44m-xx48.5m

This interval (xx44m-xx48.5m) shows heterolithic dominated facies comprising of alternation of sand, silt and shale. The section is characterized by wide variation in sand unit thickness (i.e. 0.05m-1m), presence of faults/fractures and soft sedimentary deformation features. The bedding surfaces are mostly dipping 20°-22° towards SW. Fractures/Faults identified in this interval are striking NW-SE.

CONCLUSION

The well taken as case study, located in Pallivaramangalam area of the Cauvery Basin is producing from the Andimadam formation of the lower cretaceous age. Even though the ELAN Plus processed results have helped in interpreting the presence of hydrocarbons in the pay sands, the processed FMI results have enhanced the reserve estimates and presented more realistic Sw values in conjunction with the testing results.

The interval xx78.5m-xx82m produced oil on activation and the processed FMI results corroborated the ELAN processed Interpretations. The interval xx32m-xx36.5m,

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did not contribute in production as evident from the FMI results that the deformation features were detrimental in assessing the porosity and permeability of the formation. The healed fractures were also of no help either.

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