

Prospectivity of Red Bed Reservoirs in KG-PG Basin, India – A Petrophysical perspective
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Keywords

Red Beds, KG Basin, Facies analysis

Summary

Mandapeta Field was discovered in 1988 within pre-rift sediments of Permo-Triassic age. The gas production of this field was established from Mandapeta sands and further enhanced with the sands within Gollapalli sandstones of Cretaceous age. The Red bed sediments are underlain by Mandapeta sandstone and overlain by Gollapalli sandstone. Red bed deposition marks a hiatus in the geological cycle. The Red bed sections are mainly reddish brown/grey colored shales with sand development at places. Red beds act as cap rock for Mandapeta sandstone but the reservoir layers developed towards the bottom as well as towards the top of the Red beds may be considered for hydrocarbon accumulation. A focused and systematic evaluation has been carried out for Red beds integrating all the available data to identify the potential layers in Mandapeta field.

Introduction

Krishna Godavari Basin is a continental passive margin pericratonic Basin. The Basin came into existence following rifting along eastern continental margin of Indian Craton in early Mesozoic. Hydrocarbon potential has been established in the pre-rift (Mandapeta), syn-rift (Gollapalli), drift (Raghavapuram, Tirupati sandstone) & post-drift (Pasarlupudi, Rava) sediments.

The Red bed formation which occurs between Gollapalli sandstone and Mandapeta sandstone consists of considerable reservoir development and is comprehensively characterized for its depositional patterns, reservoir properties and hydrocarbon potential. The red bed characteristics vary from well to well indicating a high degree of alteration of sediments after deposition.

The Red beds in KG basin are interpreted to be in-situ deposits and formed in an oxidizing environment. Reddening of sediments progressed as the diagenetic alteration advanced with time as suggested by the mineral assemblages deduced from petrographical studies.

Methodology

The significance & formation of red beds and the possible hydrocarbon entrapment in the Mandapeta field are analyzed with the available data within Red beds. The unconformable nature of Red bed top and laminated nature of the reservoirs within red bed are systematically brought out from Image data. Borehole failure as interpreted from Image logs and presence of chlorite due to its hygroscopic nature are reasons for bad borehole conditions observed in Red beds.

The MRGC model prediction has been used for facies analysis through conventional logs. The log curves Density, Neutron, Sonic & GR were taken as inputs to determine the facies and have been trained & normalized. The MRGC different clusters were analysed and 10 facie cluster found to be defining all the characteristics and was taken for propagation to all other wells. Lithofacies analysis for precise unit identification and Reservoir facies analysis for identifying producible facies made the study more robust for characterizing the sand layers for their hydrocarbon potential (Fig1).

The dip patterns identified from Resistivity image log identified the top of red bed formation to be an unconformity surface (Fig 2). The resistivity image data available in two wells located in two different blocks, show different depositional patterns of Red beds. (Fig.3).

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A comprehensive petrophysical model is developed from inferences on petrographical core analysis and open hole log responses. Elemental Capture data is successfully utilized for validating the prepared petrophysical model. The cased hole neutron recorded was also analyzed for separation in far and near counts to confirm the prospectivity of the layers for their gas potential. Far and near counts were normalized in the shale layers and the gas bearing intervals shown a deviation of far counts curve from near counts (Fig 4).

To assess the flow potential of a reservoir, it is important to estimate Flow Zone Indicator (FZI) value for each sand unit. An approach is used to compute FZI from intrinsic permeability (KINT) and porosity (PIGN) computed from ELAN processed output. FZI is computed dividing RQI with NPI. Reservoir Quality Index (RQI) is computed using KINT & PIGN and Normalized Porosity Index (NPI) which is computed using $PIGN / (1 - PIGN)$ equation. The RQI and PHIZ plot identifies four reservoir facies with different FZI values (Fig 5).

The ELAN model has been validated with available CMR porosity and permeability output in a well. Most of the good potential reservoir layers are developed above the Mandapeta pay sand. The zones are prioritized based on reservoir quality and other geological evidences to tap the potential of the zones (Fig 6).

Conclusions

Red bed section is encountered in all the wells drilled in the field with varying thickness ranging from 56 m to 415 m. The thickness of Red bed section is found to be decreasing towards south of the Mandapeta field and increasing towards east. Reservoir facies analysis in red bed formation defined presence of good facies in 3 wells. Total 15 no. of zones within Red bed section in 7 wells are identified for testing and prioritized on the basis of reservoir facies analysis. Close monitoring and evaluation of Red beds is required during drilling and post drilling follow ups for establishing the hydrocarbon potential of this formation as separate focused exploration campaign may not be feasible.

References

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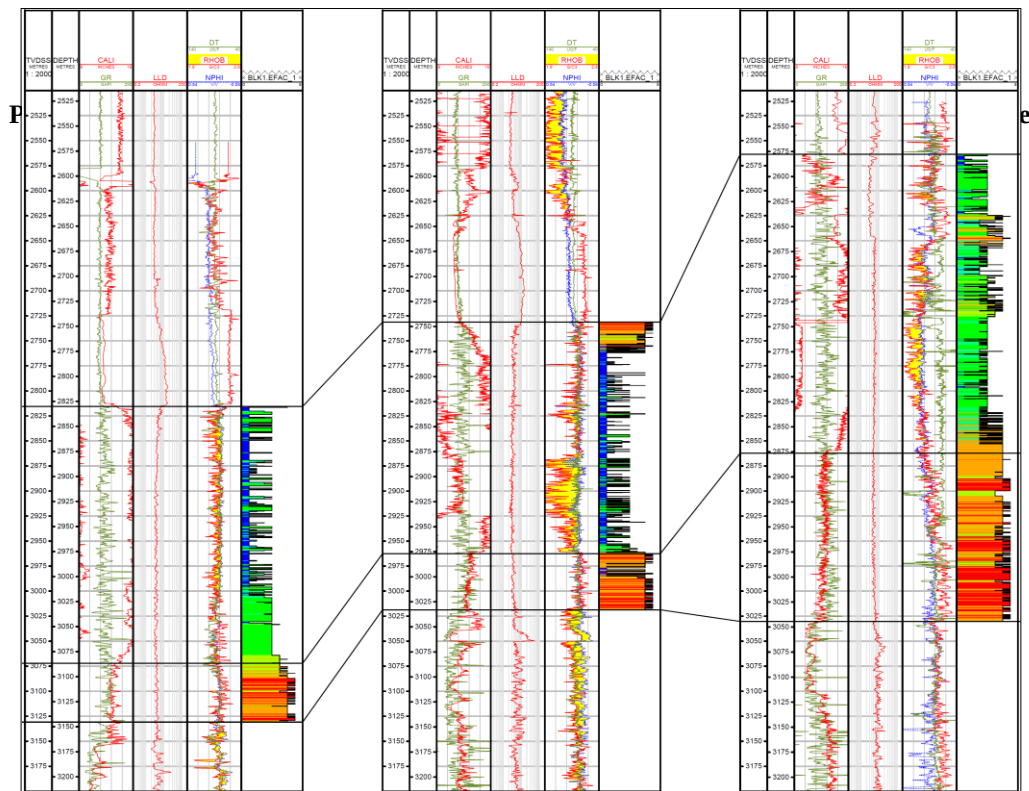


Fig.1 Red bed top demarcation using Litho-Facies

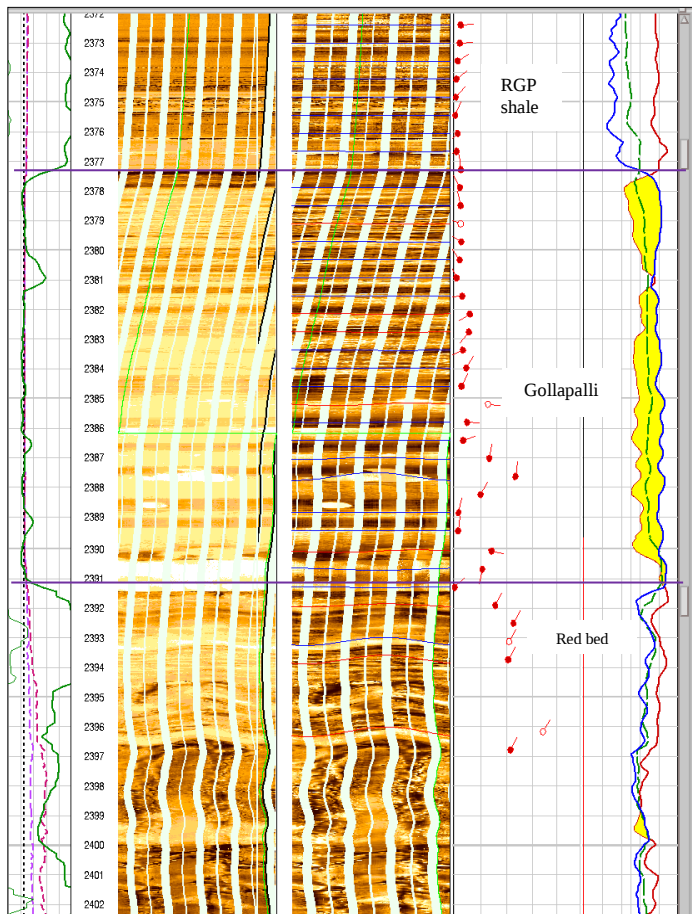


Fig.2 Red bed Unconformity

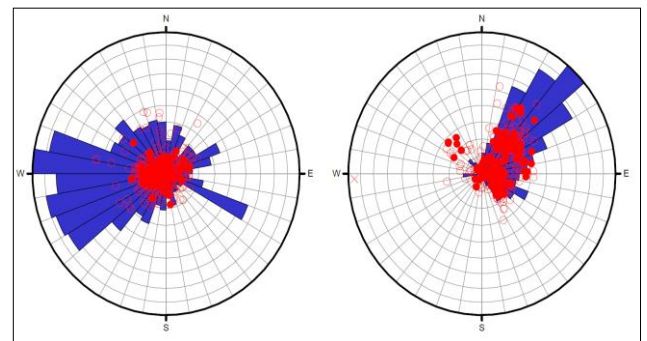


Fig.3 Dip directions in both the wells indicate different depositional patterns

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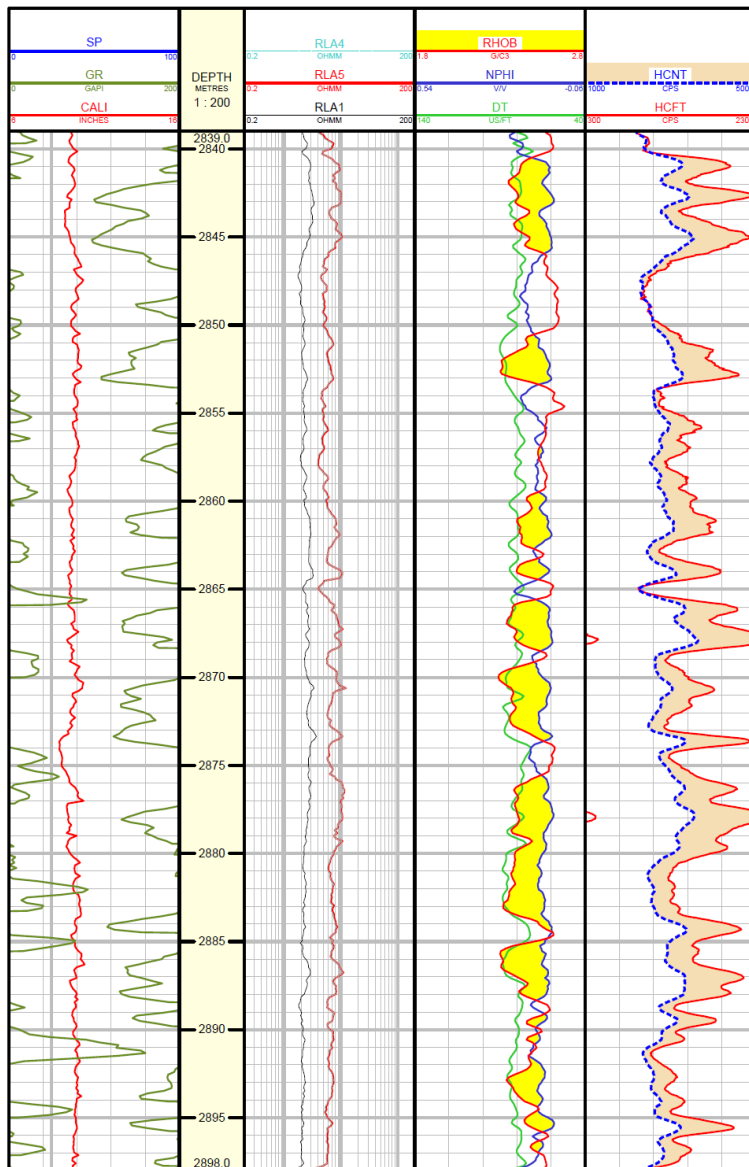


Fig.4 Neutron Far & Near counts showing gas presence

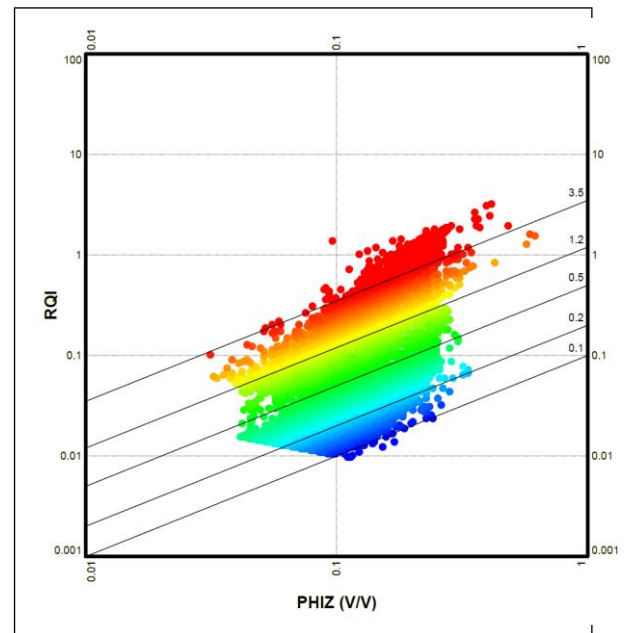


Fig.5 FZI plot used for identifying best reservoir layers

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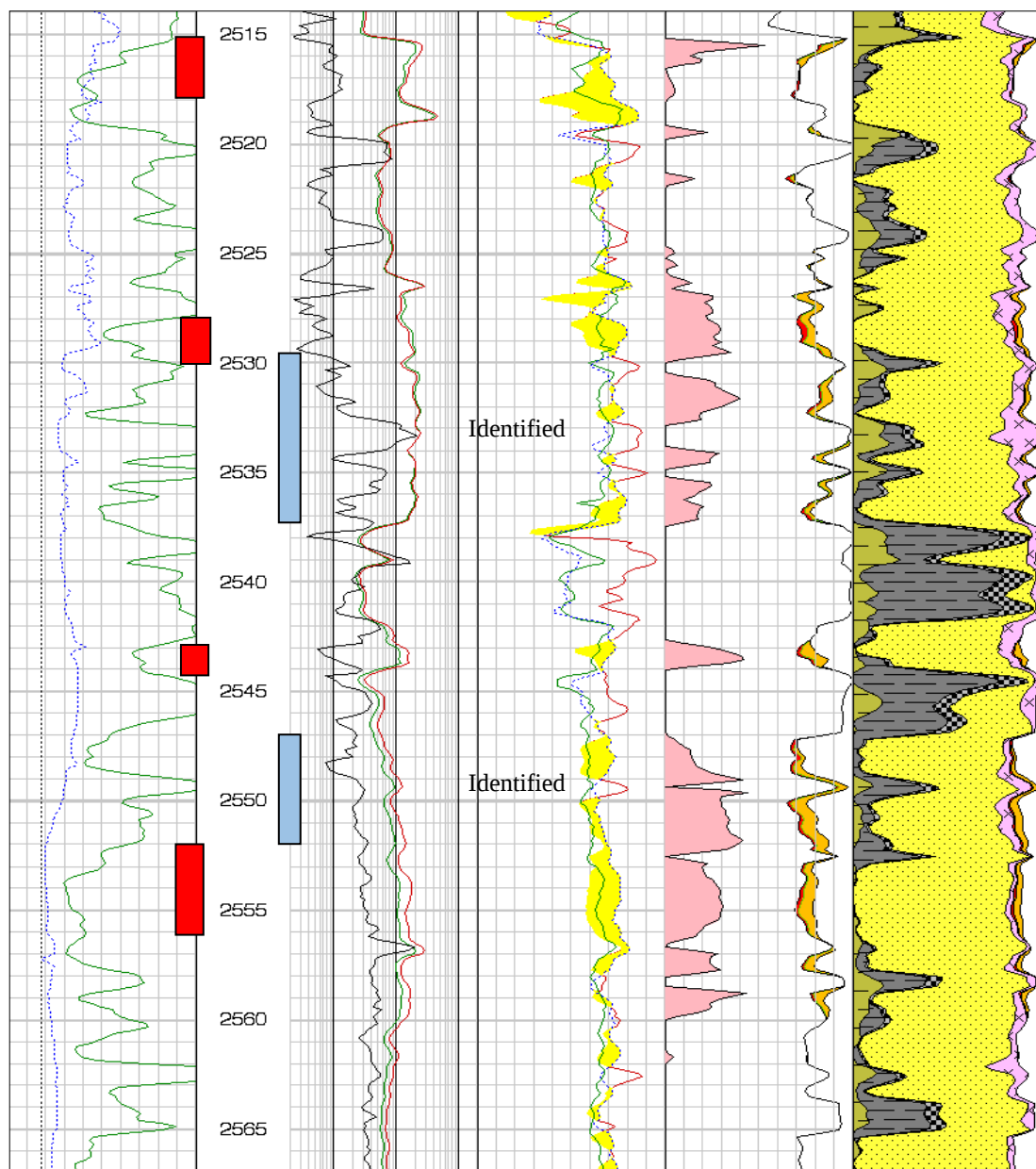


Fig.6 Processed output with identified additional intervals