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Electro-facies analysis through Conventional logs in Panna Formation in Northern part of HPB sector, Mumbai offshore Basin: A Model based approach

Abstract: Panna formation forms the oldest Tertiary sedimentary unit of the Bombay Offshore Basin and attains importance for hydrocarbon exploration due to presence of source rock, reservoir and seal within it. Panna shales and coals are acknowledged as the established source rock in the basin. Panna Formation consists of trap-wash, sandstone, siltstone and clay stone at the bottom, overlain by a section of coal-shale-sand alternation in the middle and by shale at the top. The sandstones are grey to yellowish, coarse to medium grained and poorly sorted. The shale is grey to bluish-grey moderately hard carbonaceous and pyritiferous. Based on the laboratory findings, cores, well cuttings, electro-logs and other data, the entire Panna Formation has been divided into three sections.

The present study is mainly focused on study of the facies analysis of Panna formation in northern part of HPB Sector using conventional log data. Facies which are generated using electro log measurements are supported by Elan processing results. MRGC (Multi-Resolution Graph based Clustering) technique using clustering methodology with SOMs (Self Organizing Maps) is used in this study. Electrofacies of Panna formation are classified into five facies namely Coal/carbonaceous, Shale, Silty shale, Silty sand and clean sand.

Introduction: The study area is bounded by Mumbai high to the West, Central Graben to the East, Dahanu Low to the North and Mukta Platform to the South. The geological history of the Mumbai Offshore basin commenced in the Late Cretaceous with breakup of Gondwanaland and the eruption of Deccan traps. The Mumbai Offshore basin witnessed wide spread eruption of basalt preceding the rift fill phase flooded the entire basin leaving granitic /metamorphic inliers in the paleohigh blocks. Thus Deccan Trap forms the floor of the basin for the overlying Tertiary sediments, except in a few areas of prominent paleo-highs like Bombay High, Heera, Bassein, Panna etc. where the basement is granitic. The Cenozoic stratigraphy has signatures of all stages spanning pre-rift to syn-rift to post-rift environment of basin cycles.

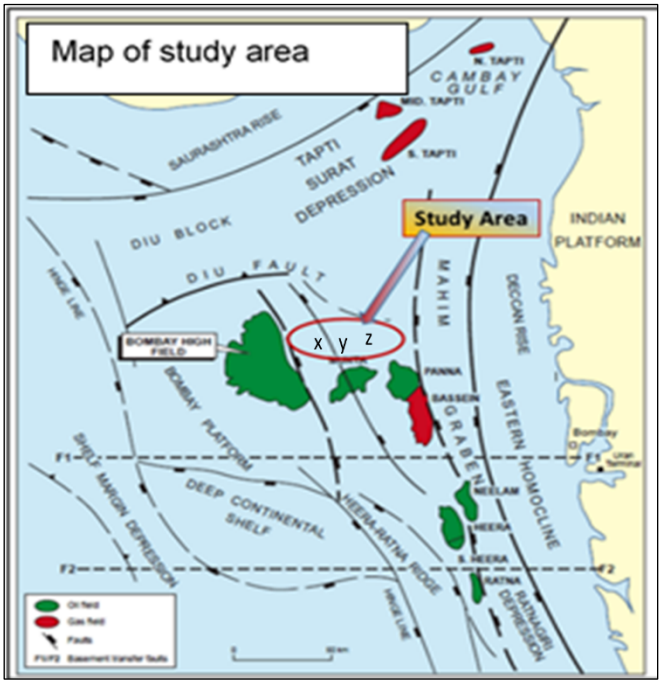


Figure: 1 Map of study area

In the study area, the structures like B-157, B-15, B-15A & BNP are transpressional in nature and were formed during Mid Miocene inversion tectonics. The other anticlinal structures like B-59, B-127 etc. are associated with paleohighs.

The present work is mainly focused on study the facies analysis of Panna formation in northern part of HPB Sector using conventional log data. Facies which are generated using electro log measurements are called electro-facies. An electro-facies is a class defined by a unique set of log responses. The log signature of a given electro-facies indicate the physical and chemical properties of the rock and fluid contained within. Electro-facies are generally used to predict the variation of lithology from well logs, in order to better predict the reservoir heterogeneity. The selection of log data and the definition of electrofacies are optimized for characterizing the rock type.

General geology of Panna formation: The Bombay Offshore Basin is a pericratonic rift (Biswas, 1982, 1987, Naini and Talwani, 1982) characterized by sets of longitudinal extensional faults giving rise to series of horst and graben features. During the initial time of rifting these half grabens accumulated thick pile of clastic sediments derived from the adjacent basaltic and granitic horst blocks.

The onset of Panna sedimentation is marked by the deposition of trap wash and sediments derived from granite erosion during Paleocene. A wide spread fluvial system dominated the area during Late Paleocene to early Eocene time depositing sand, silt, shale and coal and hosts the main producing horizons. It is followed by wide marine transgression leading to the deposition of marine shales at the top. Huge thickness of Mid Eocene to recent sediments consisting of Bassein, Mukta, Alibag, Bombay, Mahim, Tapti and Chinchinin Formations were also deposited in this area over the Panna Formations.

Study approach: MRGC (Multi-Resolution Graph based Clustering) technique using clustering methodology with SOMs (Self Organizing Maps) is used in this study. In this study. Panna facies are classified into five facies namely Coal/carbonaceous, Shale, Silty shale, Silty sand and clean sand. A facies correlation has been prepared for well A, B, C, D, and E (North West –South West direction). Panna Formation in the study area is marked by presence of coal/carbonaceous layers towards the top of the Formation. Panna formation is wedging out in the West and South-West of the study area. In the North Eastern part of study area, the thickness is more and is mainly consisting of more carbonates compared to clastics with lesser porosity. Panna formation is prospective towards east of the Mumbai high and west north-west of study area encompassing the fields B-157, B-158, B-154 and B-127.Facies analysis has been carried out for two structures encompassing ten wells where Panna Formation is thick and prospective.

Facies correlation: A facies correlation has been prepared for well A, B, C, D, and E (North West –South West direction). Panna Formation in the study area is marked by presence of coal/carbonaceous

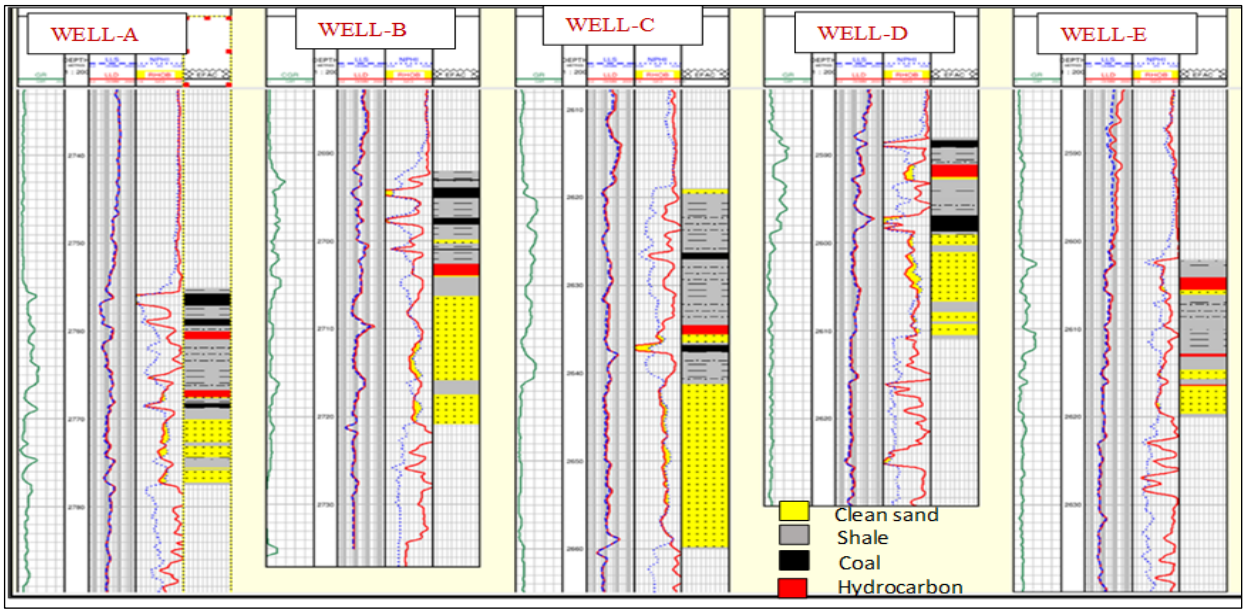
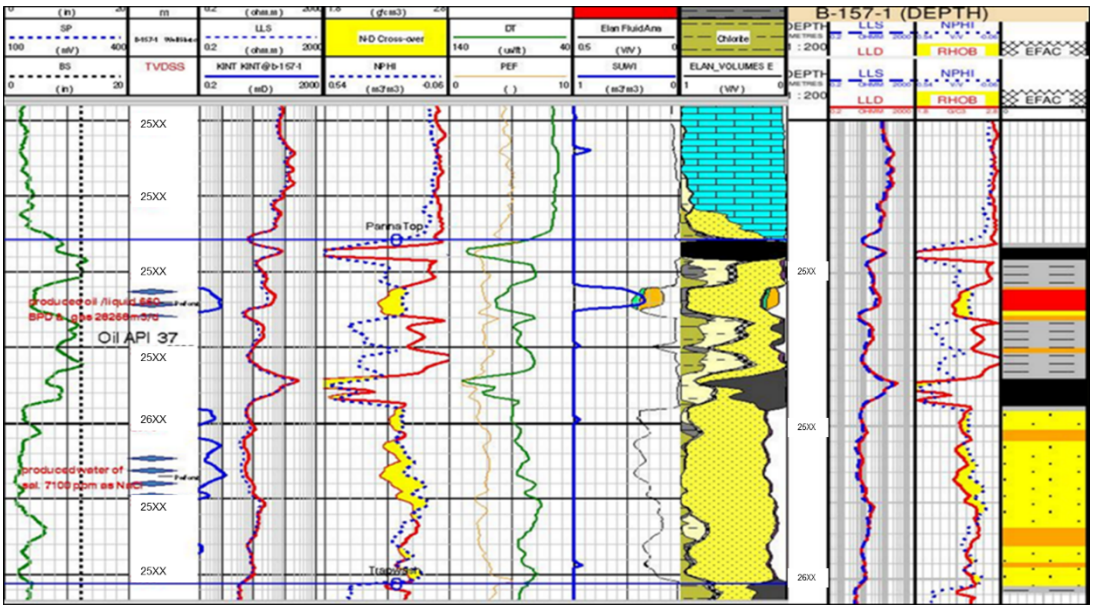


Figure: 2 Facies correlation for Well A, B, C, D, and E (North West –South West direction)

layers towards the top of the Formation. Panna formation is wedging out in the West and South-West of the study area. In well-E, coal facies are not developed at the top part of Panna and a good shale also not observed. This well is having poor reservoir facies with low permeability and marginal hydrocarbon saturation.

Facies analysis in Well -A:

Electro-facies are generated for Panna formation in the interval 25 xx-26xxm. In this interval facies consists of good sandtone, coal layers, shale, silty sandstone and clean sand. Normal litho logs (GR, NPHI and RHOB) are not able to distinguishing silt and sand facies individually while including resistivity log it is easy to distinguish silt and sand facies separately. In this well resistivity log including for facies



analysis has indicated the hydrocarbon bearing sand facies distinctively. Top of the interval in this well is tested and produced hydrocarbon. In the lower section facies are developed but resistivity is not good and the Well produced water. This is well observed in facies analysis.

Figure: 3 Facies analysis in Well –A

Facies analysis in Well-B: Electro-facies are prepared for Panna formation in the interval 26xx-26xxm. Facies consists of good sandtone, shale and silty sand. All facies are present in this well. Including resistivity log in facies analysis it is easily to distinguish silt and sand facies separately. The layer in the interval 25xx-xxm is having Red facies; however this layer is marginally hydrocarbon saturated in this well. Silt layers are easily distinguished in bottom part of the section.

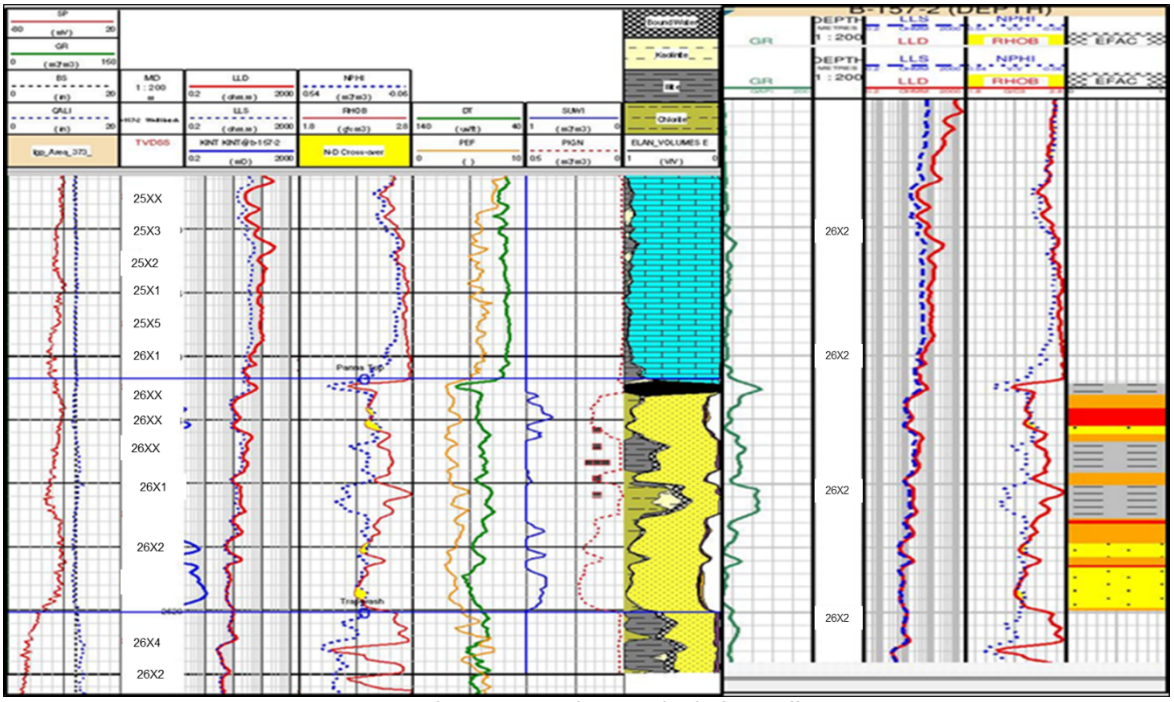


Figure: 4 Facies analysis in Well -B

Inferences: The log signature of a given electrofacies indicate the physical and chemical properties of the rock and fluid contained within. Electrofacies of Panna formation are classified into five facies namely Coal/carbonaceous, Shale, Silty shale, Silty sand and clean sand. Normal litho logs (GR, NPHI and RHOB) are not able to distinguish silt and sand facies individually while including resistivity log it is easily to distinguish silt and sand facies separately. However, as Resistivity log is affected by fluids its usage is to be limited. In favorable conditions the use of resistivity log in facies analysis brings out hydrocarbon bearing sand facies.

Observations & Conclusions:

1. A facies correlation has been prepared for well A, B, C, D, and E (North West –South West direction).
2. Good sandstone facies are developed in well -A which is oil and gas producer. Coal facies are observed in all wells except Well-B.
3. Panna Formation in the study area is marked by presence of coal/carbonaceous layers towards the top of the Formation. Panna formation is wedging out in the West and South-West of the study area.
4. Normal litho logs (GR, NPHI and RHOB) are not able to distinguish silt and sand facies individually but including resistivity log it can easily distinguish silt and sand facies separately.

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