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Integrated approach using Maximum Positive Amplitude attribute and Electro log signature to delineate thin reservoir facies within LCM (Lower Clay Marker) in Rudrasagar Field, Upper Assam Shelf, A&AA Basin, India

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Abstract

Rudrasagar field is one of the oldest oil field discovered by ONGC way back in 1960 in North-East India. Later it was put on commercial production in 1966 through 12 wells. Main producer of this field is arenaceous unit (BMS) of Barail Group of Oligocene age. Apart from BMS, sands within Barail Coal Shale (BCS) of Oligocene age have also contributed to the field production. Tipam Sand-IV (TS-IV sand within LCM) of Miocene age has also produced through 2 wells (W-A, W-X) in Rudrasagar main field and through one well (W-H) in North Rudrasagar field. Deposited under the low energy fluvial environment, TS-IV sands are discrete in nature and are established as pay sands only in north-eastern part of the Rudrasagar field. In order to chase the success in TS-IV sand, seismic attribute analysis coupled with analysis of log signature was adopted to identify potential areas for TS-IV exploration. This study has resulted in identification of potential prospective area for TS-IV exploration in the south-west of established field.

Introduction

Assam shelf is a poly-historic basin formed due to movement of Indian plate from southern hemisphere towards northern hemisphere during Cretaceous to present age and subsequent collision with Eurasian and Burmese plates. Sediments deposited give the imprints of rifting, drifting and subsequent collision with the two plates. The study area and generalized stratigraphy are given in Figure 1 and Figure 2 respectively.
Rudrasagar field, the present study area of Assam shelf is the first oil field discovered by ONGC way back in 1960 and later put on production in 1966. The main producing reservoir in this field is Barail Main Sand (BMS) of Oligocene age. Apart from BMS pay, sands within Barail Coal Shale (BCS) of Oligocene age and TS-IV (Tipam sand) of Miocene age have

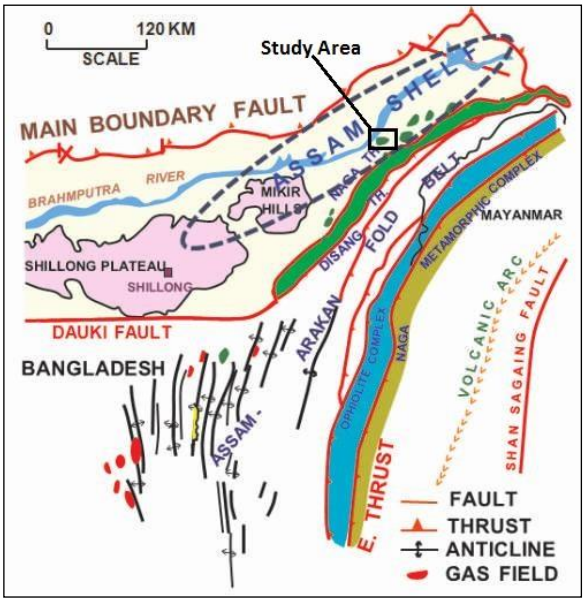

Figure 1: Tectonic map of Assam and Assam Arakan Basin showing study area

also contributed to the production through few wells. Tipam sands (TS-IV & TS-V), which are the main producers in nearby Charali and Changmaigaon fields, have met with limited success and are expected to hold significant resource in the present study area. Presently only one well (W-X) is producing in the field through TS-IV sand whereas other two wells (W-A, W-H) are commercial hydrocarbon bearing in nearby area. Thickness of Tipam formation in this area is more than 700m and are divided into six subunits - TS-I to TS-VI. Except TS-IV, all other Tipam sands were deposited in high energy fluvial environment, either as braided bar or main channel deposits. TS-IV sand is sandwiched within lower clay marker (LCM). Due to limited production history, discrete nature of TS-IV sand and strati-structural entrapment makes its exploration very challenging in Rudrasagar field. So far more than 200 wells, mostly targeting BMS, have been drilled and penetrated through LCM but could establish commercial HC only in three wells for TS-IV sands in the study area. This therefore requires deliberate search for distribution of TS-IV sand facies coupled with suitable entrapment situation for future exploration of TS-IV sand in the study area.

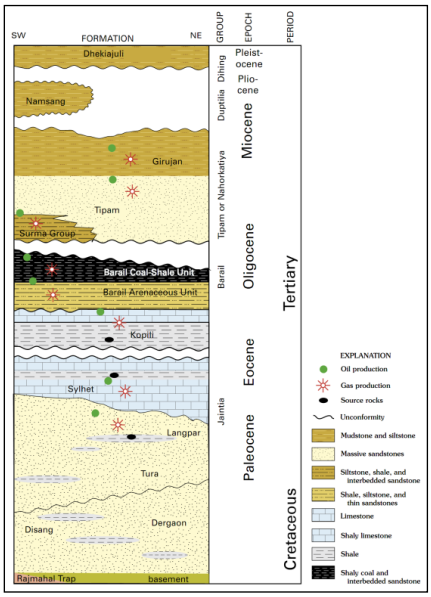

Figure 2: Generalized stratigraphy of Assam Shelf (after Mathur et al. 2001).

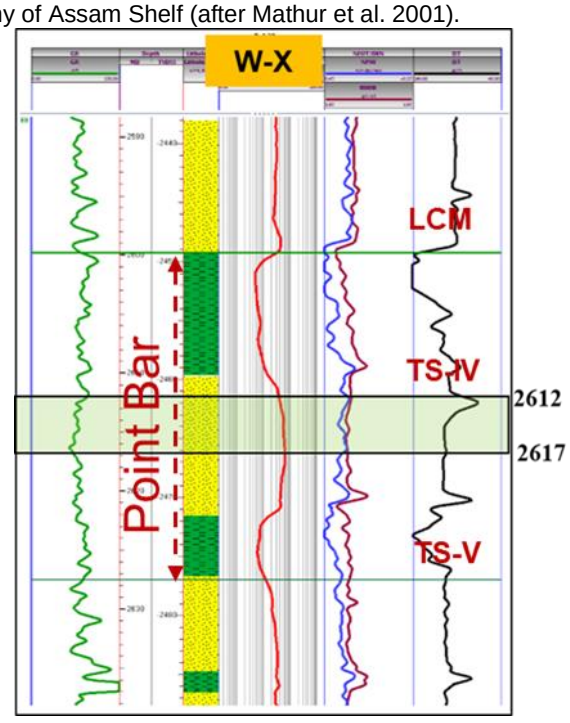

Figure 3: Log motif showing the lithologies

Depositional Set-up of TS-IV sands

Tipam Group is sandwiched between underlying Barail Group and overlying Namsang Formation. The massive arenaceous unit of Tipam Group is known as Tipam Sandstone Formation. Overall, the sands are deposited in fluvial environment and comprises of thick, moderately coarse, ferruginous sandstone with some alternations of blue and mottled clay, mudstone, shaly sandstones and sandstones. TS-IV sand is deposited as a point bar or overbank deposit within flood plain. The TS-IV channel sands are thin to moderately thick bedded and are encased within LCM clay sediments (Figure 3) in entire Upper Assam Shelf area. The channel activity prevailed for shorter duration as compared to overlying TS-III and underlying TS-V sheet sand units. In Rudrasagar area, thickness of LCM unit is around 25-30 m in the northern part and thickens to 40-45 m in southern part (Figure 4). Thickness of TS-IV sand with in the LCM pack varies from 0-25 m (Figure 5). In our study, we have made an attempt to understand the extension of TS-IV reservoir facies, as it has discrete nature.

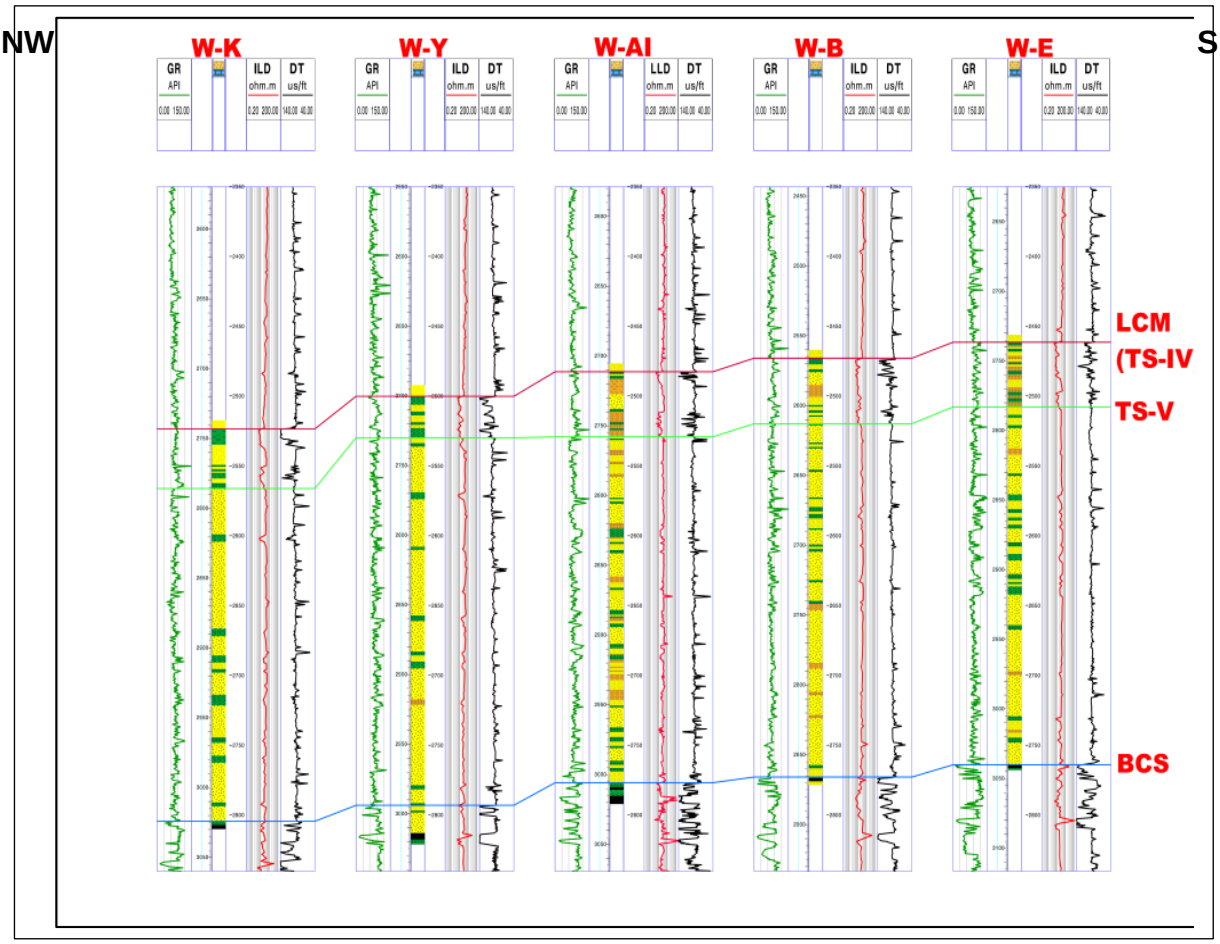

Figure 4: Log correlation along dip direction

Main challenges in the study area are:

- Producer wells of TS-IV sands viz. W-A, W-H and W-X fall either in no seismic zone or low seismic foldage zone which makes well to seismic calibration uncertain however, few wells viz. W-O and W-BD which has given hydrocarbon indications are well within the seismic zone (Figure 6).
- Since most of the wells are producer from BMS sands, drill cuttings, sidewall cores and conventional cores were studied mostly focusing Barail sands. Such studies are not available for TS-IV sands for the wells in the study area.
- Density and neutron porosity logs for TS-IV sands are also not available which also constrains the study.

To overcome this situation integration of all the available geo-scientific data for TS-IV sands in the

field was done.

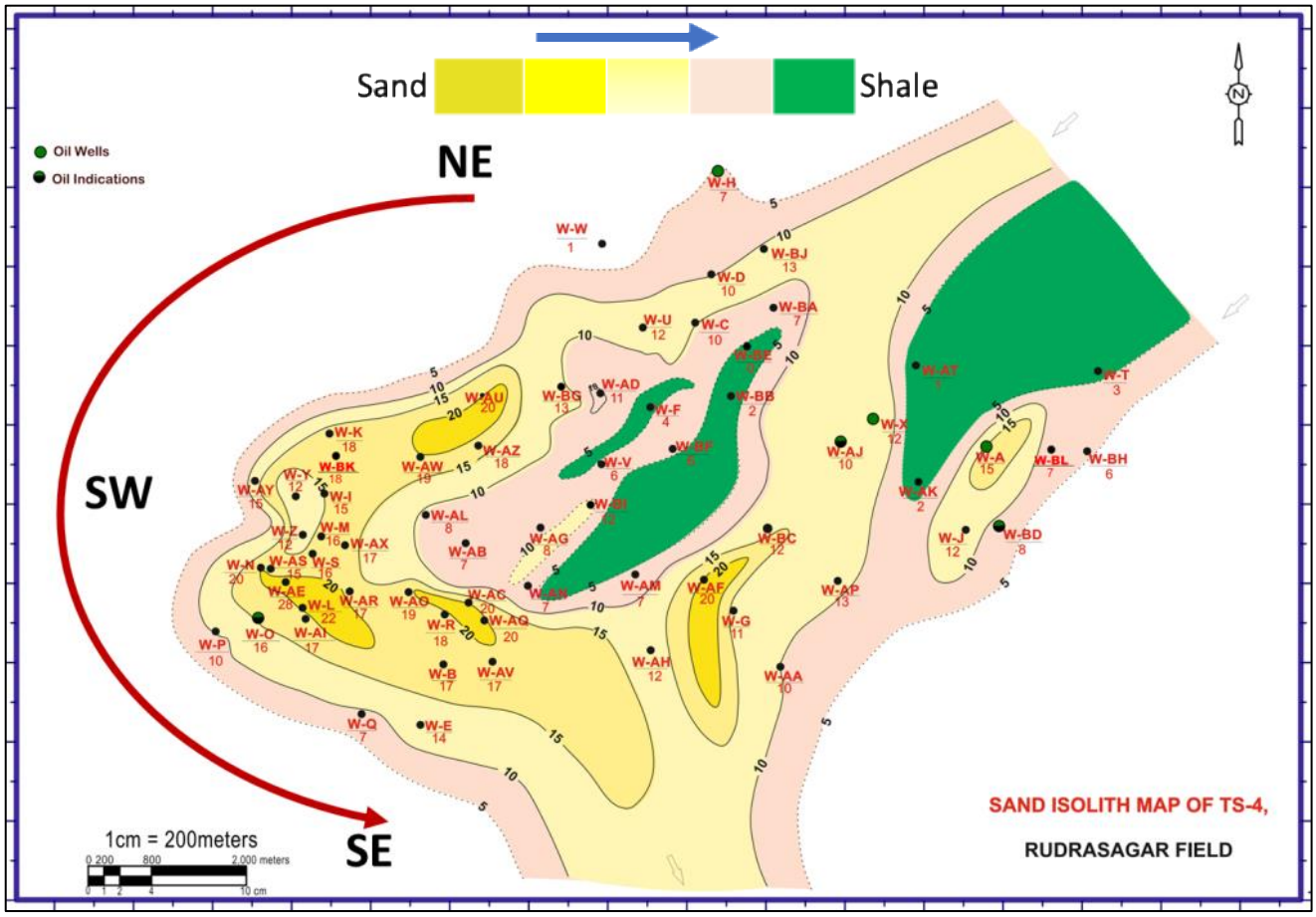

Figure 5: Sand isolith map of study area.

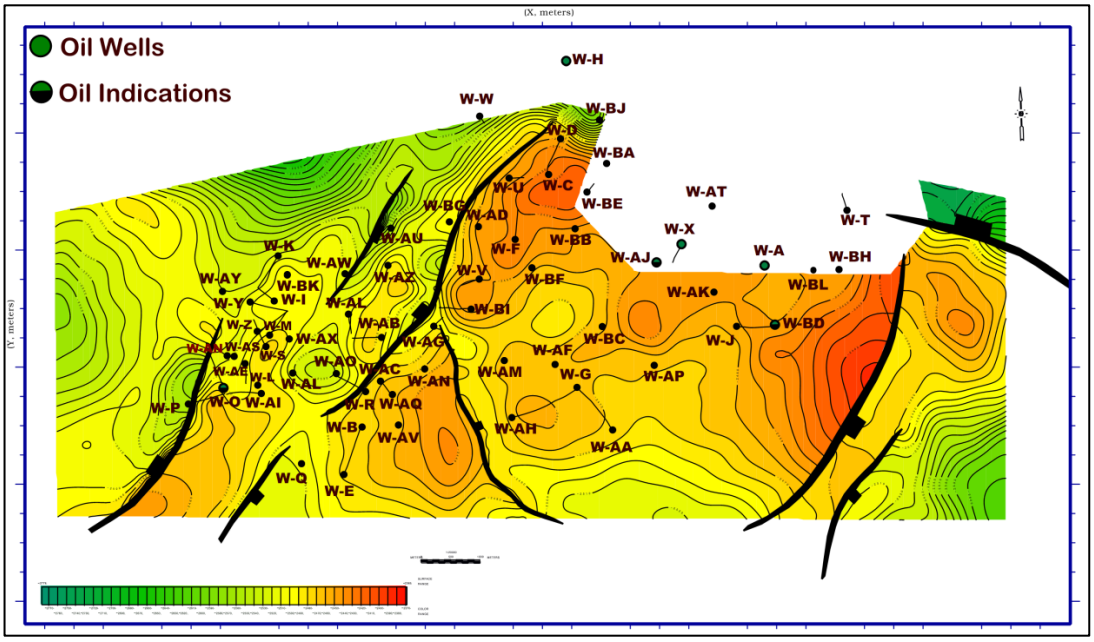

Figure 6: Structure Map at LCM level in study area.

Present Exploration status of Tipam in Rudrasagar

Tipam pays are established only in isolated pockets in this area. So far seven wells (W-H, W-X, W-BK, W-J, W-A, W-AA, W-BL) have been tested and only three wells (W-H, W-X, W-A) are producers from TS-IV pay and hydrocarbon shows were reported in few wells viz. W-BD, W-O and W-AJ.

Methodology

- Log correlation (Figure 4) has been done across the Rudrasagar field to understand the pack thickness variation of LCM in the field. Based on log signature, sand thickness has been evaluated and sand isolith map was generated (Figure 5).
- Seismic data in the field has been calibrated with the drilled wells and interpreted to generate the structure map at LCM top level (Figure 6).
- Maximum Positive Amplitude (MPA) attribute has been generated along LCM Top in the window of ±8 milliseconds (Figure 7).

Analysis

Electro log correlation (Figure 4) clearly shows that the pack thickness of LCM (LCM top to TS-V top) varies from 25 to 45m. The log signature (Figure 3) clearly depict that TS-IV is deposited in flood plain environment. Also it shows that channel is meandering around the structural high and changes its direction from south-west to south-east (Figure 5). Structure map (Figure 6) shows four structural high axes trending in north-east to south-west direction dissected by three faults trending in same direction. In Maximum Positive Amplitude attribute the presence of sands within TS-IV (LCM) pack is depicted by lowering of the amplitude. As TS-IV sands are discrete in nature, Maximum Positive Amplitude (MPA) map help in bringing out gross litho-facies distribution in the study area. MPA attribute highlights the sand encased within the clay of LCM as sand present within the LCM decreases the amplitude compared to non-sandy areas. The yellow to red color in the MPA map (Figure 7) represents lowering of amplitude corresponding to presence of good quality of sand facies and blue to violet color represents high amplitude corresponding to silt to clay facies. MPA map shows two channels, one on the west side of the study area which shows meandering channel changing its direction from SW to SE and other is meandering in the direction NE to SW in the middle of study area.

Sand isolith map overlaid on Maximum Positive Amplitude attribute map (Figure 7) shows congruency and clearly confirms presence of two channels and their attitude with varying sand facies varying amplitude of MPA. Sand isolith map overlaid on structure map (Figure 8) shows two structural high, marked as X and Y. The structure represented as X shows channel divergence,

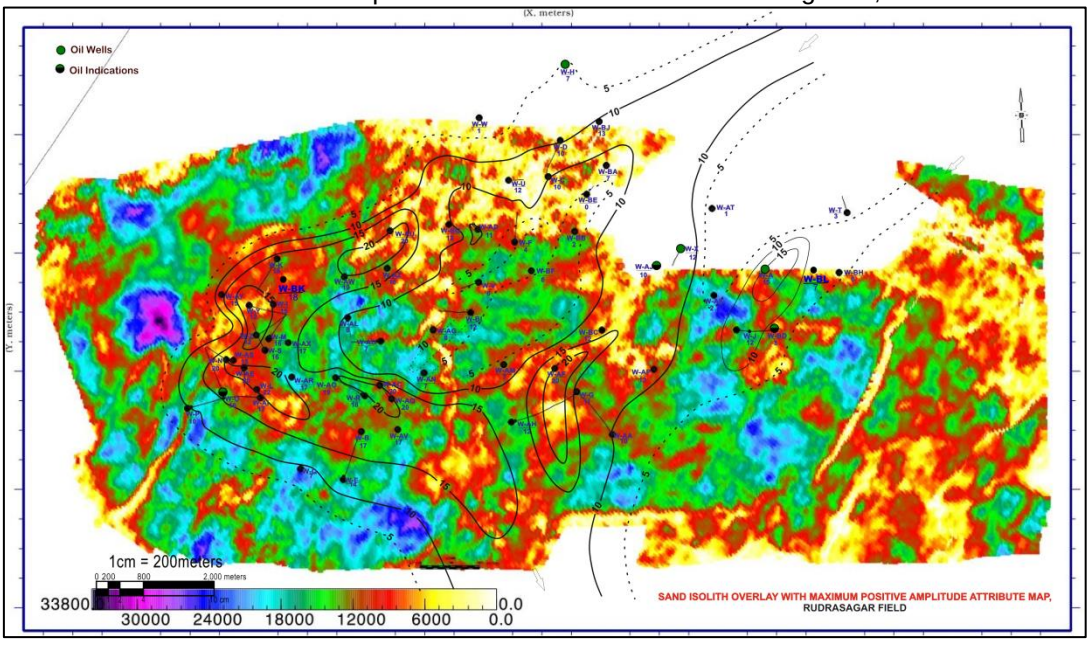

Figure 7: Sand isolith map overlaid on Maximum Positive Amplitude attribute

having poor reservoir facies, as MPA amplitude increases, and other structure high, marked as Y, shows channels convergence, having good reservoir facies, as MPA amplitude decreases. It may be inferred that the structural high Y can be a good locale for exploration of TS-IV sands. As oil has produced in W-H, W-X and W-A along NW-SE direction and hydrocarbon shows have been encountered in W-O in west, W-AJ and W-BD in north-east of the field, it depicts that oil has migrated through the field and has entrapped at favorable locales.

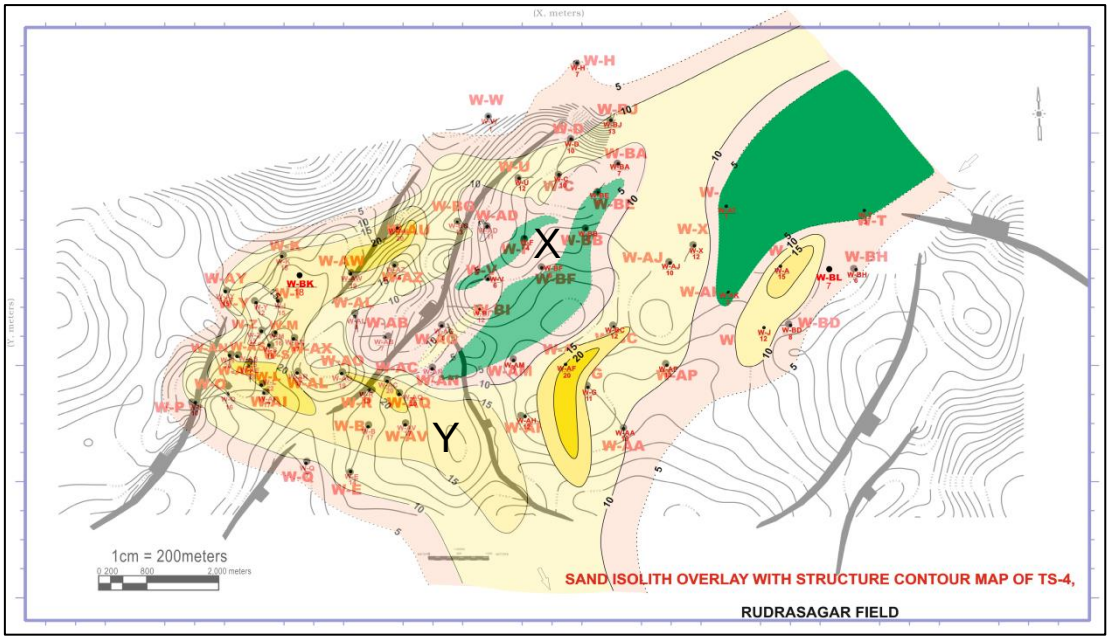

Figure 8: Sand isolith Map overlaid on Structure Map.

Conclusion

- Log signature reveals that TS-IV deposited in low energy flood plain environment.
- Sand isolith map reveals that channel grossly flowed from NE to SW direction where channel splits in two channel and meander around the high.
- One distributary channel in west in study area forms point bar with maximum sand thickness of around 20m and converges after changing its attitude from NE-SW to SE direction to form a single channel.
- Maximum Positive Amplitude attribute map delineates the sand facies, as lower MPA corresponds to sandy facies and higher MPA corresponds to shaly facies within LCM pack and its geometry that corroborate with sand isolith map.
- The study has helped in identifying potential area which is structurally favorable, has good development of reservoir facies and falls in the migration path for exploration of TS-IV sand.

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