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Adding value by continuous monitoring and Placement of Horizontal drain holes- case studies from North-East India

1. Abstract

The study pertains to Geleki field which is a major oil producing field of Assam Asset.The field was discovered in the year 1968 and since then it is producing oil from multiple pay-zones.The field has undergone several rounds of development with improved understanding of the reservoirs.

Pay sands in the study area are facing production challenges viz. high water cut, water coning due to substantive up shift of OWC, pressure depletion requiring secondary lift mechanisms, which are typical of brownfields in production for more than five decades. All these phenomena are resulting in decline in production. With the availability of new technology these days, the focus now is on finding bypassed oil and isolated hydrocarbon pockets present due to reservoir heterogeneity. Drilling of horizontal wells/drain-holes has provided the much needed push in increasing production efficiency.

This case study showcases two wells where successful drain-hole placement have been made in the first by using LWD(VisionResistivity-GR)-Motor combination, in second by LWD (ARC-ADN-GR)-RSS combination.

2. Introduction

The current case study discusses two wells drilled in TS-3 reservoir. Drilling horizontal wells in these mature brown field reservoirs have proved to be preferred option to produce remaining oil and thus improve recovery through better exposure to reservoir with higher productivity index. With this in mind, drilling of horizontal wells in this field started about a decade back. The objective then was to place drain-holes in clean hydrocarbon bearing section in sands with good vertical permeability. However with further movement of OWC over the years and in view of early water breakthrough in these wells, the drainhole completion has moved up in the less permeable silty layers typically existing at top of many of the sands in this area.

Drainholes drilled in these silty layers are giving sustained production with lesser or no water cut. However the well placement in silty zone is becoming more and more challenging for the following reasons:

a. Drainholes have to be placed within a thickness of 1.5 to 2m TVD within a zone having unpredictable lateral heterogeneity.

b. Very low contrast in log signatures from the shale layer above the zone.

Role of latest advancement in horizontal well drilling like RSS, bed boundary detection tools become very prominent to ensure drilling of a successful landing section and drainhole. This paper brings out some of these aspects through case studies. LWD technology was judicially used during drilling of landing and drain-hole sections. A 24 X 7 real time monitoring of LWD data helped to execute the drilling plan and making necessary mid-term corrections arising due to local geological variations.

The production results of horizontal wells have been encouraging and more horizontal wells are being planned for this as well as for other pay-sands.

3. Optimum Log Suite for Evaluation and Steering of Horizontal wells:

Over the years as the placement objectives became constrained in thickness and lateral continuity, placement services have improved by leaps and bound. Real time monitoring of LWD data along with Rotary Steerable Systems have made placement through complex structural dispositions and varying geobodies, a reality. Decision making regarding steering has become a proactive activity rather than a reactive one. Image logs and ahead of bit logs have removed lot of uncertainties and are facilitating complicated drainhole geometries with longer lengths leading to perfect placement in the sweetzones.

Drilling a successful horizontal well requires real-time coordination between Drilling Crew, Horizontal Drilling experts, Geoscientist including geologists and logging expert. A detailed well trajectory is planned beforehand based on the geological model at hand, requirements of DLS that the incumbent formations will support. Right decisions have to be made at right occasion while drilling both the landing section and the drainhole section.

The role of a Petrophysicist is a very challenging one and continuous monitoring is required for proper landing and placement. The choice between MWD/RSS and between using different LWD combinations is made based on various factors including the geological model envisaged, contrasts seen on different logs between the objective sands and beds above and below. The availability and cost-benefit analysis of different combinations is also very important as the time involved for mobilization is also a key factor.

This case study showcases two wells where successful drainhole placements have been made in first by using LWD (Vision Resistivity-GR)-Motor combination and LWD (ARC-ADN-GR)-RSS combination in the second case.

4. Discussions on case studies :

Well A1: The well A1 was drilled to exploit hydrocarbons from pay-sand 'TS-3A' by placing 6" horizontal drain-hole. As is clear from the correlations with nearby wells, good resistivity contrast exists between objective zone and the shale above. Most of the nearby reference wells were drilled long back and had only old vintage logs (No Density- Neutron). It was therefore decided to lower Vision resistivity-GR for the landing section.

The landing section (8 ½" section) was drilled with LWD-Motor (Vision resistivity-GR) and terminated at 2602m (2428m-TVD) to an angle of 78^0 based on the real time monitoring of the LWD logs (Figures 2a,2b, 3a & 3b) and increase in sand cut along with GYF. The sand top was encountered 7m (TVD) shallower than the expected (Figure 1). Subsequently use of LWD-Motor (Vision Resistivity-GR) ensured smooth drilling of drainhole of 301m (2602m to 2903m) within TVD of 2m (2428-2430m).

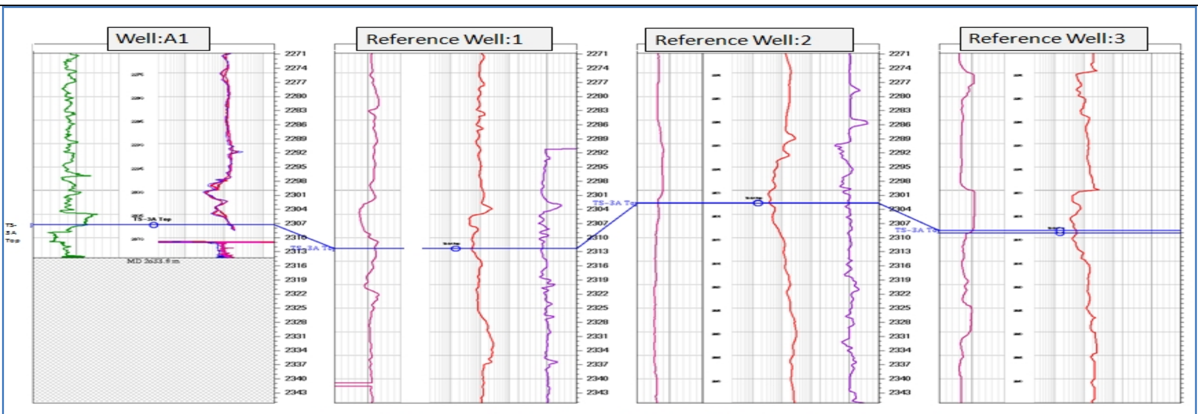

Figure 1: Log correlation of well:A1 at TS-3A level w.r.to nearby wells

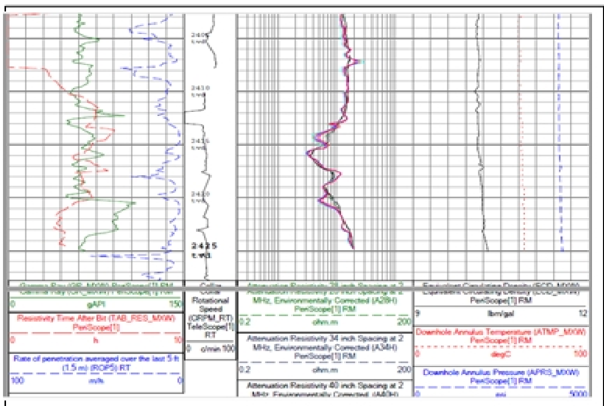

Figure 2a: Vision Resistivity-GR log in TVD: Landing section (8.5”) of Well:A1

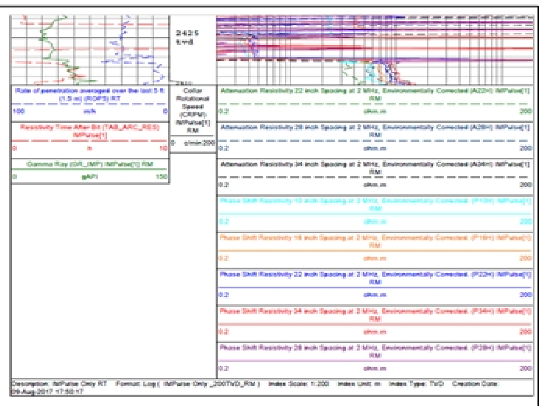

Figure 2b: Vision Resistivity-GR log in TVD: Drainhole (6”) of Well:A1

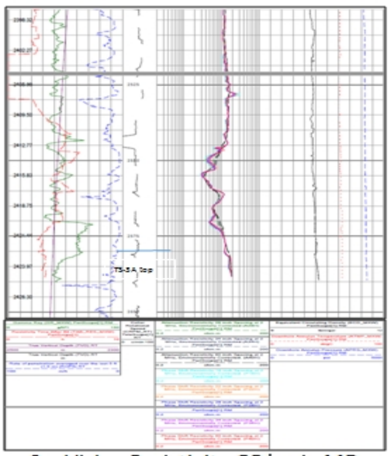

Figure 3a: Vision Resistivity-GR log in MD: Landing section (8.5”) of Well:A1

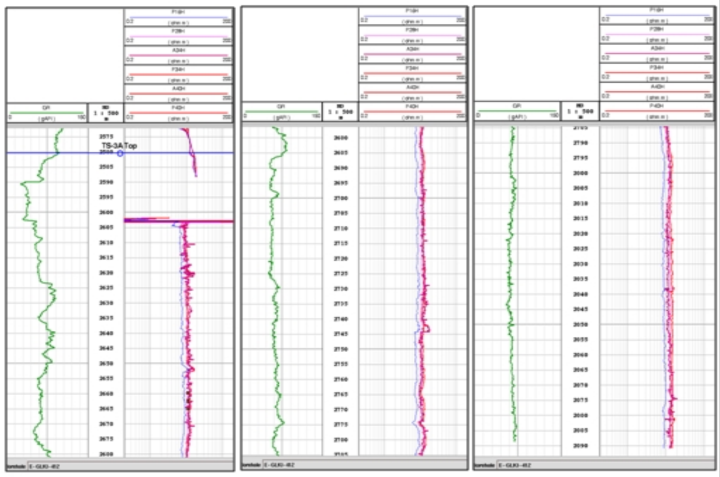

Figure 3b: Vision Resistivity-GR log in MD: Drain hole (6”) of Well:A1

With LWD deployed, for enhanced production, the drain-hole was adequately steered in clean and potential part of the reservoir. The well was completed with 280m of 3½” EUE perforated tubing and a swell packer (length: 6.5m).On activation, the well flowed oil with initial reported rate of 32m3/d. Presently, this well is producing oil at flow rate Q_L=24m3/d, Q_o=24m3/d with 1% water cut.

Well A2:The well A2 was also drilled to exploit hydrocarbon from pay-sand ‘TS-3A’ by placing 6” horizontal drain-hole.As the correlation shows, the resistivity contrast between the objective zone and shale above was good in some wells while not so good in others. It was therefore decided to lower ARC-ADN in the landing section to utilize the flexibility provided by the Density image. In view of problems in achieving appropriate DLS by motor in scenario where sudden change in formation tops occur, it was further decided to lower RSS along with LWD for smooth steering.

The landing section (8 ½” section) was drilled with RSS-LWD (ARC-ADN) and terminated at 3216m (2801m-TVD) at an angle of 86^0based on the real time monitoring of the LWD logs (Figures 5a,5b, 6a &6b) and increase in sand cut along with GYF. The sand top was encountered 5m (TVD) deeper than the expected (Figure 4). DEN-NEU logs along with Density image provided clarity in decision making.

Subsequently use of LWD-RSS (Vision Resistivity-GR-ADN) ensured smooth drilling of drainhole of 300 m (3216m to 3516m) within TVD of 4m (2801-2805m) in top part of the reservoir which is silty /shaly. The well was completed with 272.6m of 3½” EUE perforated tubing and a swell packer.

On activation, the well flowed oil with initial reported rate of 12m3/d with no water cut. Presently, this well is producing oil at flow rate Q_L=20m3/dwith no water cut.

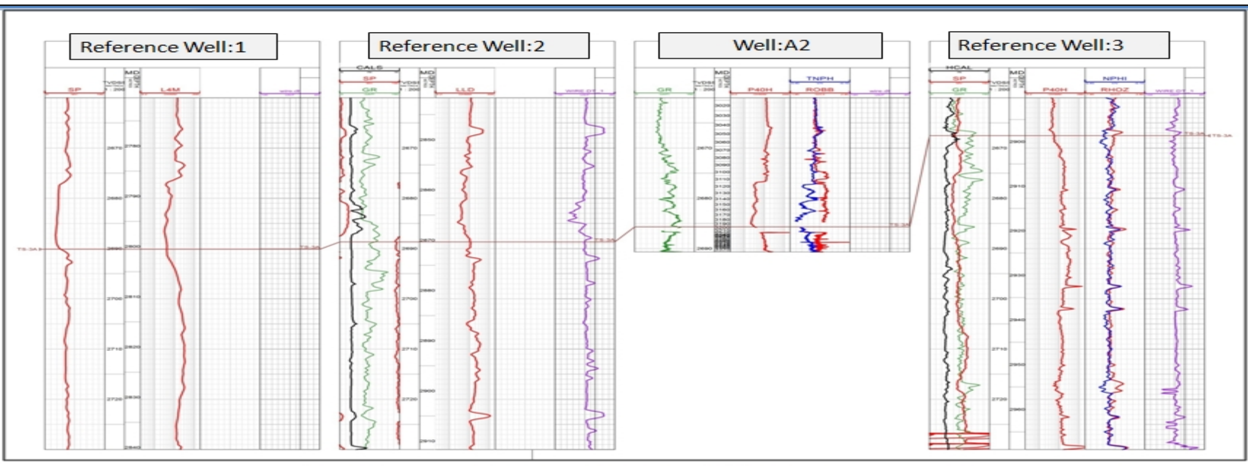

Figure 4: Log correlation of well:A2 at TS-3A level w.r.to nearby wells

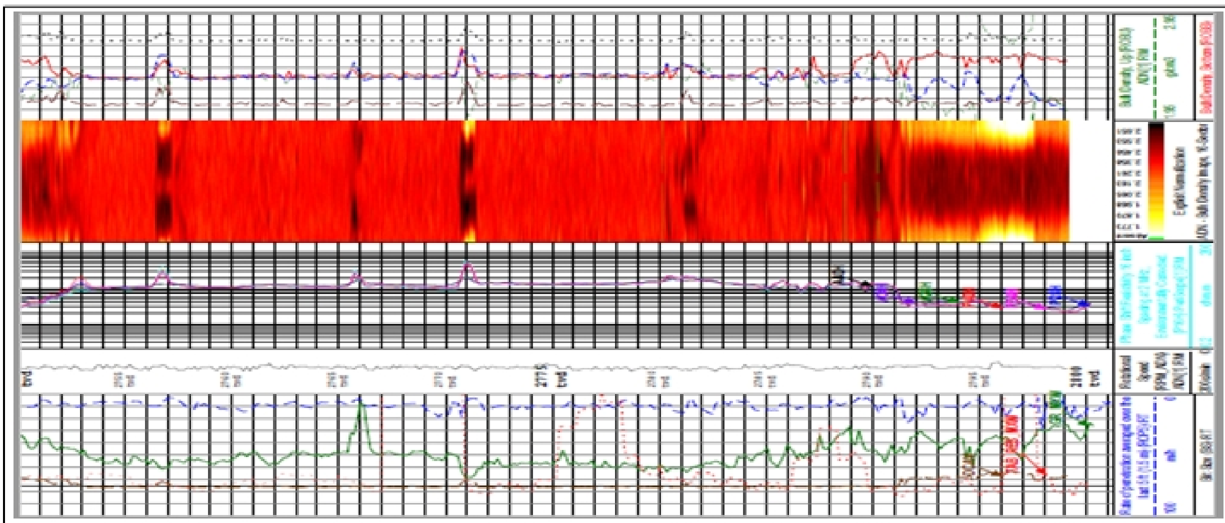
Figure 5a: 8.5”-LWD-Vision resistivity-Density Image(in TVD): Landing Section of Well:A2

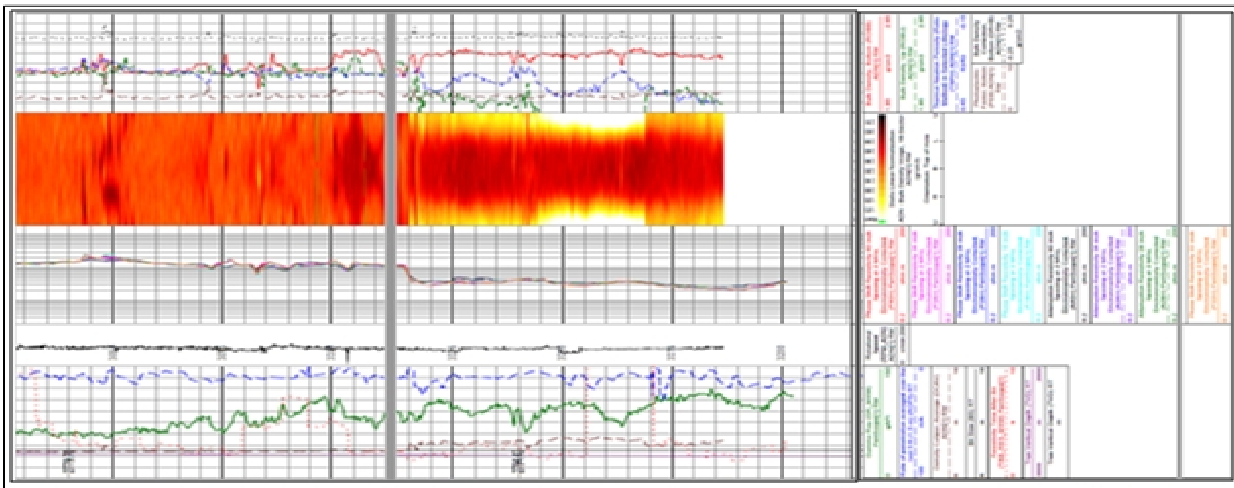
Figure 5b: 8.5”-LWD-Vision resistivity-Density Image(in MD): Landing Section of Well:A2

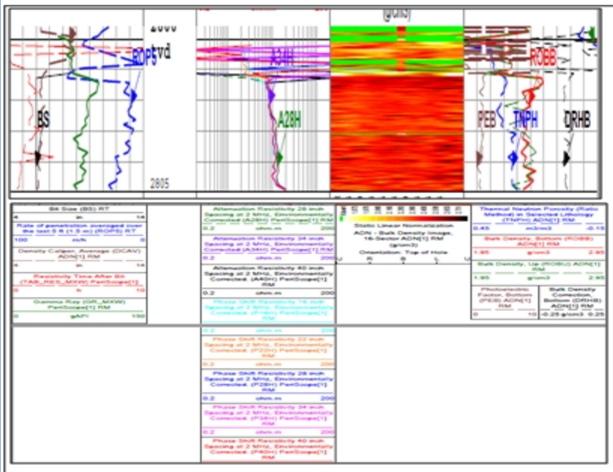

Figure 6a: 6"-LWD-Vision resistivity-Density Image (in TVD): Drainhole of Well A2

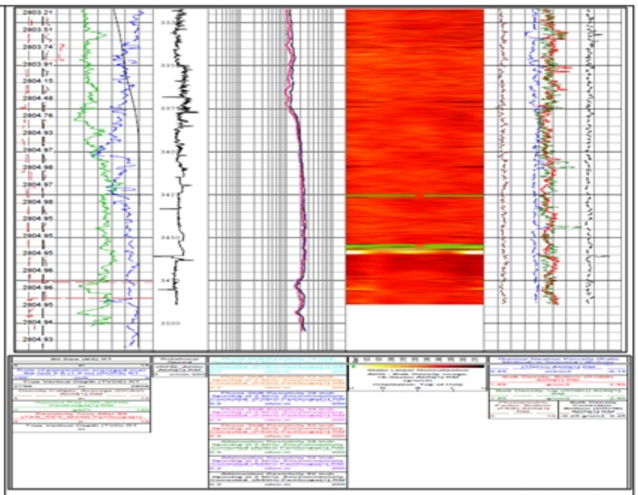

Figure 6b: 6"-LWD-Vision resistivity-Density Image (in MD): Drainhole of well:A2

5. Conclusions :

Horizontal wells in the silty part of the major producers in the study area are providing better productivity than the conventional wells. This provides not only more exposure to the reservoir and lesser drawdown pressure thereby suppressing water production but also facilitating production of bypassed oil left out due to low permeability of the silty zones. The horizontal wells A1 and A2 produced oil at good flow rate with water cut less than 5% whereas the nearby conventional wells had been producing with more than 95% water cut.

It has been observed that the drain-holes placed in the top silty part of the reservoir, with poor vertical permeability have given more sustained production (Wells AandA2) compared to the drain-holes placed in lower cleaner part.

While the different LWD tools available have tobe used judiciously, the real time monitoring and decision making while using various combinations increases the success rates of horizontal wells. In areas with complex Geology or lesser control on Geological model, ahead of bit recording capability adds lot of value.

6. Acknowledgements:

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7. References :

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