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Reverse modeling based on testing results using log overlay technique provides insight into non Archie Reservoirs of Ankleshwar field in Cambay Basin, India.

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Summary

Identification of potential hydrocarbon bearing zone in non Archie reservoirs i.e. silty/ shaly reservoirs always poses problem because of log characteristics which usually does not show any meaningful results on conventional log evaluation. For this reason most of the silty/ shaly layers usually been left out or interpreted as non reservoir.

In Ankleshwar field of Gujarat, India some of the similar silty/ shaly zones within Hazad and Ardol members have been tested and found to be oil producer. So the main objective of the study was to search for other prospective zones within the non Archie reservoirs, mainly by integrating the log signatures along with the testing results and other geological information using reverse modeling.

Since conventional log processing/ evaluation techniques are not much useful in this type of reservoirs, so it was quite challenging to identify the prospective zones only by studying the log responses, testing results and other geological information. For this purpose, different log overlays mainly SP–Resistivity, Resistivity–GR and Density–GR have been used. Out of these combination first two overlays along with other log information was useful for identification of good facies, whereas the innovative overlay of Density Vs GR (in reverse scale) found to be a good identifier for prospective zones as it shows cross-over against the porous and permeable zones. This overlay technique has also been validated in other clean reservoirs developed in Hazad and Ardol members of Ankleshwar field.

Non Archie reservoirs of more than fifty wells of Ankleshwar field have been studied, which reveals that SP, GR and Density logs, supported by caliper data plays a vital role in identifying the porous & permeable layers within the silty/ shaly zones. More than thirty porous & permeable layers have been identified using the above technique, which appears to be promising from hydrocarbon point of view and recommended for testing.

Introduction:

Ankleshwar field which is doubly plunging anticline with multilayered sandstone reservoirs of deltaic origin. The oil bearing rocks of Ankleshwar were classified into three groups viz. lower, middle and upper. The main oil pools are confined to middle and upper sand groups, stratigraphically they are known as Hazad and Ardol members respectively.

Present study is confined to re-evaluation of non Archie reservoirs viz. Sand-A of Hazad & Sand-B of Ardol with main emphasis on the available nine wells testing data of Sand-A, out of which seven wells are oil producer. For this purpose signature matching of different logs and their overlays using reverse modeling technique have been tried to identify different sand facies within Sand-A & Sand-B and to know their likely potential from hydrocarbon point of view.

Methodology:

Analysis of different logs, geological information and core study result reveals that Sand-A & Sand-B are mainly shaly/ silty and having high density, low resistivity (2 to 4 ohm-m). In this type of formations having such log responses, facies analysis found to be more useful to

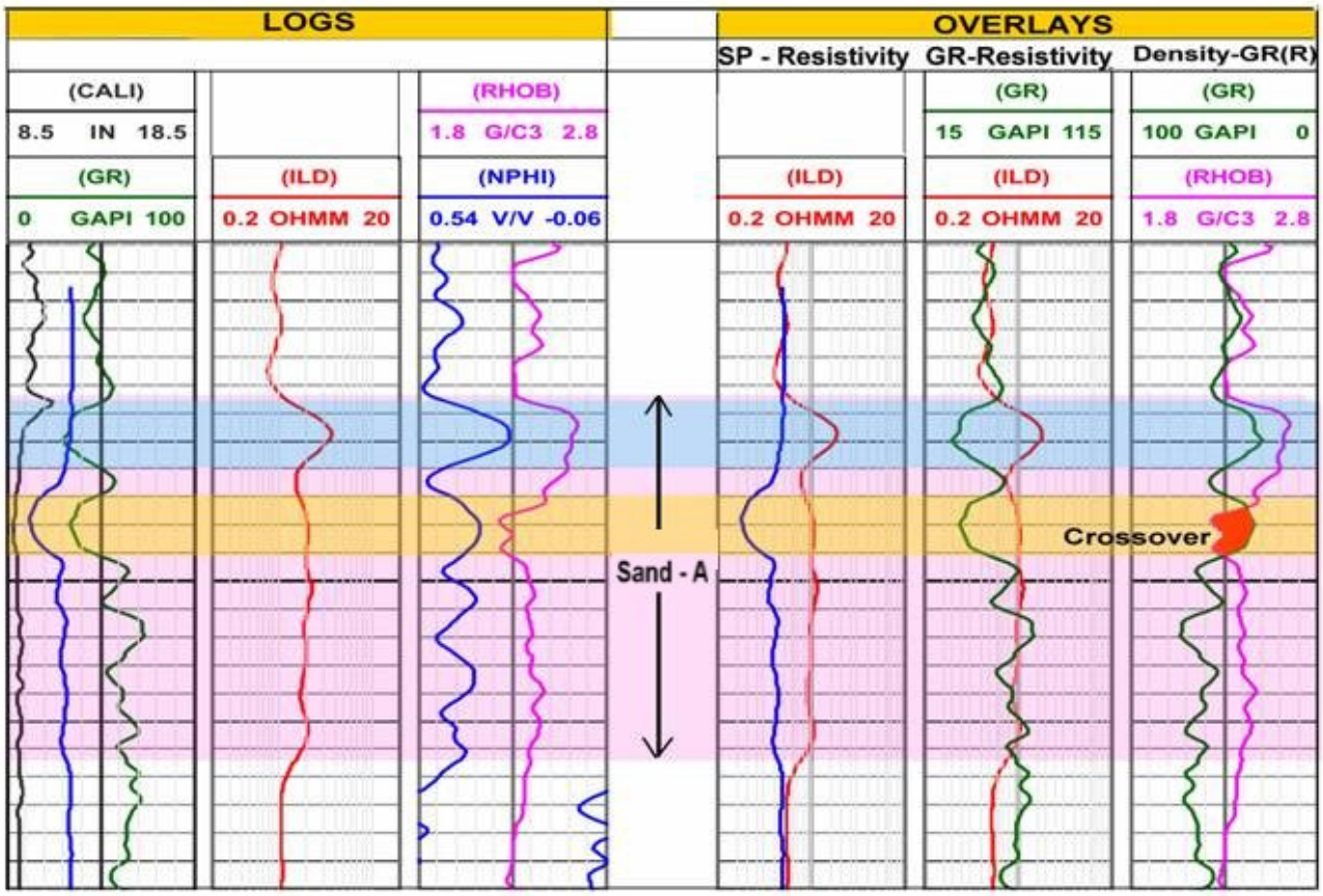
pinpoint the areas for delineation. So for identifying the good and prospective facies, each log responses along with different overlays have been used.

Since one overlay is not sufficient to identify facies, different overlays like SP–Resistivity, GR–Resistivity and Density–GR (in reverse scale) have been used. The main emphasis has been given to normalised the log responses in shale section so that any aberration/ anomaly can be judged against the good/ prospective facies.

Density–GR (in reverse scale) which is little innovative and of unorthodox type, where GR has been plotted in reverse scale to get a crossover against the zone where both GR and Density values are low so as to identify the porous and permeable zone from shaly and tight zones.

The presence of Density–GR crossover along with reasonably good SP anomaly and moderate resistivity became the most useful and authentic identifier of good/ prospective facies and the same has been validated with available testing results of seven wells in Sand-A. This methodology has been used to delineate the good/ prospective zones for both Sand-A & Sand-B in more than 50 wells of Ankleshwar field during the course of this study.

A pictorial example of all the overlays along with different log responses is shown below.



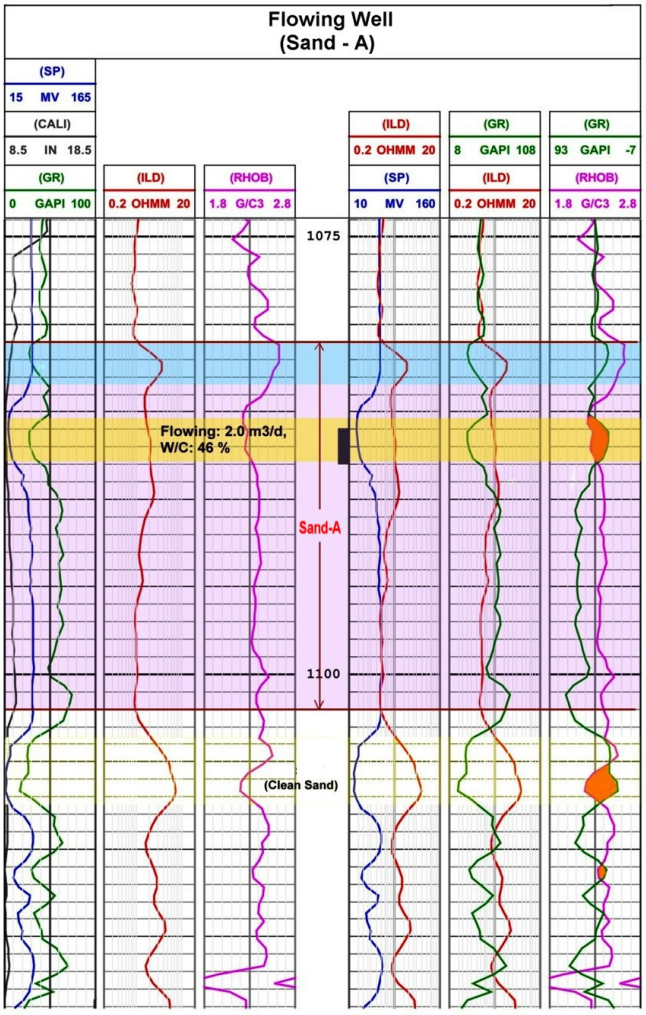
Reverse modeling based on testing results using log overlay technique

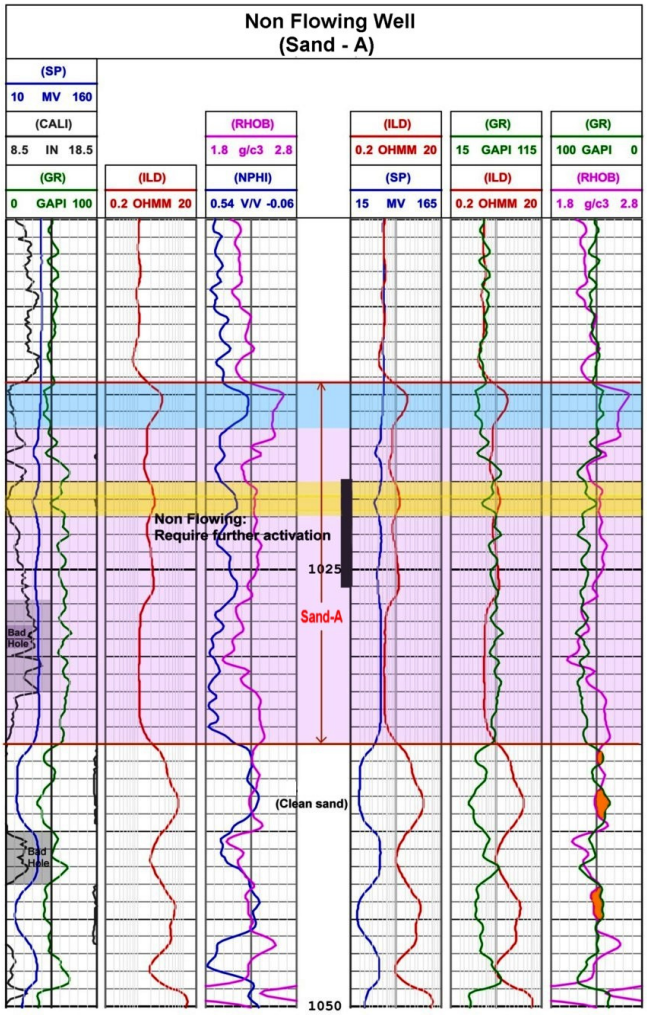
Discussion of Results:

After analyzing the individual log signature in conjunction with different log overlays of about 50 wells the following qualitative/ quantitative criteria have been adopted for identifying a prospective sand facies which appears to be interesting from hydrocarbon point of view.

- The zone should have significant SP development and moderately clean (preferably GR<30 API).
- Presence of mudcake from caliper log is also desirable which indicates the presence of porous/ permeable zone.
- Resistivity should be > 2 ohm-m, Density should be < 2.3gms/cc and Neutron should have a tendency to match with density.
- Several good sand facies both in Sand-A & Sand-B have been identified using the above methodology out of those few zones have been identified as prospective from hydrocarbon point of view and recommended for testing.

The examples of logs and overlays in flowing and non-flowing wells of Sand-A are shown below.





Conclusions / Recommendations:

- It is observed that the prospective zones should have at least significant SP development, moderately clean and having moderate resistivity of about 2-3 ohm-m. The zone should have density lower than 2.3gms/cc. The presence of mud cake may give an additional indication of porous/ permeable zone if available.

- The presence of crossover or the tendency towards cross-over supported by good SP & Resistivity found to be the most effective identifier of prospective facies from hydrocarbon point of view.

- Total 21 wells have been identified as prospective candidate for testing clustered mainly in three different areas.