7th International Conference & Exposition
on Petroleum Geophysics

"HYDERABAD 2008"

P - 428

Identification of Hydrocarbon Bearing Zones in Basement Reservoirs from Well Logs – A Case Study

Dr.V.V.Subba Rao,
IRS, ONGC, Ahmedabad, India, E-mail: vvsubbarao@rediffmail.com

Summary

A log overlay method is proposed for identification of hydrocarbon bearing zones from well logs. It has been found that resistivity-sonic overlay and neutron-sonic overlay give positive separation against hydrocarbon bearing zones. In case of dry wells, these overlays in the entire basement track each other without showing any separation. The method is explained with examples from both hydrocarbon and water bearing wells.

Introduction

Basement rocks of volcanic origin contribute appreciable amount of reserves and production to hydrocarbons worldwide since a long time. Yet, formation evaluation in basement is still a nascent subject. Initially, the objective of log interpretation in basement reservoirs was confined to identification of fractured zones in granites and basalts. Even though fractures affect many logs, some special logs like open hole VDL and borehole image logs give a clear picture about fractured zones. In fresh basement which is hard, the sonic wave trains are very clear and continuous. Against fractured zones, broken waves or no waves are seen depending on the fracture intensity. Fractures can be seen as thin bands on borehole image logs.

Apart from fractures, basalts are also subjected to alterations. This is again of 2 types. One is chemical which results in altering of original minerals to secondary minerals. Another is chemical-cum-physical which is also called weathering. In this case of physical weathering, the rock warms up and cools down during day and nights. This is called thermal movement that creates cracks gradually in the rocks. This action goes on and a stage will come when tiny volumes of rock will be surrounded by cracks. This results in fragmentation of rock and creates porosity and permeability in the rock. If it is juxtaposed against a source rock, hydrocarbons will migrate in to it and the rock becomes a reservoir. In the present study, a method is evolved to identify hydrocarbon bearing parts of the basement from log overlay techniques.

Methodology

The present study deals with Deccan Trap reservoir consisting of basalt from Gujarat state of India. It was reported that the fractures in the trap are filled with secondary minerals and do not contribute to production. It is the weathered basalt which is contributing wherever there is production. Identification of weathered portions on logs is not difficult. Fresh (unaltered) basalt consisting mainly Olivine and weathered zones consist mainly minerals altered to Serpentine. Specific gravity of Olivine $[(Mg,Fe)_2\ SiO_4]$ is 3.2 to 4.4 and that of Serpentine $[(Mg,Fe)_3Si_2O_5(OH)_4]$ is 2.2 to 2.6. This contrast is good enough to distinguish fresh and altered basalts on density log. Similarly, resistivity is very high in fresh basalts and it falls against weathered portions. The neutron porosity and sonic travel time increase in weathered portions. Thus it is not difficult to identify weathered portions on well logs. But it is really difficult to distinguish hydrocarbon bearing and water bearing parts of the reservoir from visual inspection alone since the log response looks similar in both the cases. Some experiments were made with data processing in the present study to distinguish both cases. It was found that the resistivity-neutron overlay and sonic-neutron overlay give useful results. The plots are made such that both curves overlay each other against unaltered hard basalt. In case of water bearing formations, both curves track each other even in weathered portions. In case of hydrocarbon bearing portions, a positive separation was found between the two curves. This is a common feature in both the overlays. These results are matching with testing results.

Examples

The methodology described above is illustrated with a few examples below.

Well-A:

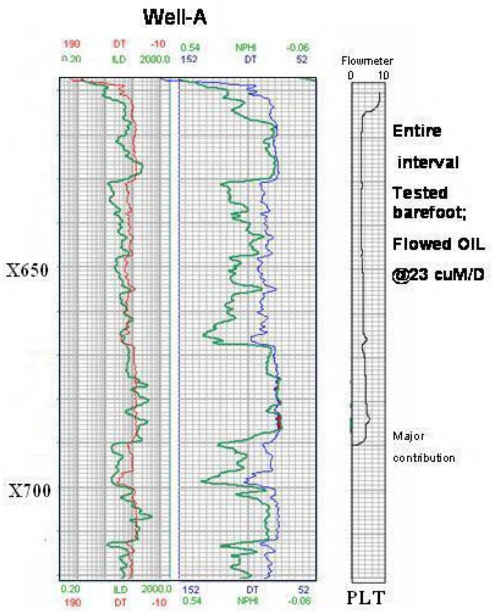

Figure-1: Example showing positive separation indicating hydrocarbon bearing zones

As can be seen in figure-1, both resistivity-sonic overlay and neutron-sonic overlay are showing positive separation in selected zones indicating the presence of hydrocarbons. The well has flowed oil @ 23 cuM/D. Production logging was carried out in this well. The flowmeter log shows the contribution of production is against zones of positive separation on log overlays.

Well-B:

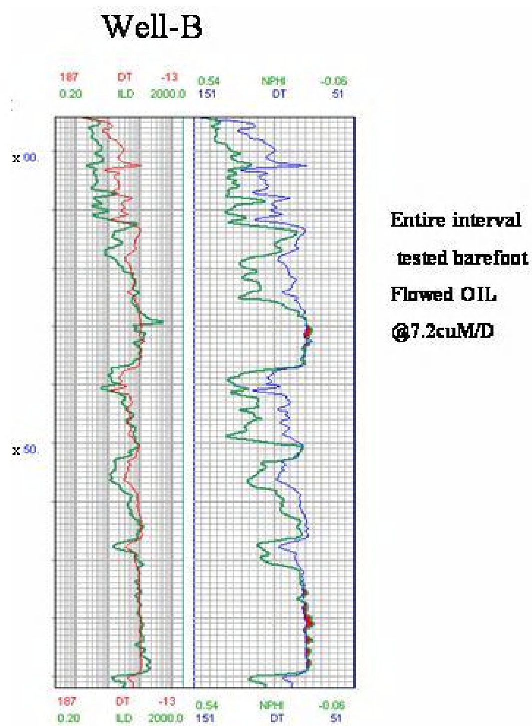

Figure-2: Example showing positive separation indicating hydrocarbon bearing zones.

Figure-2 shows log overlays which show positive separation indicating hydrocarbons. The well has flowed oil @ 7.2 cuM/D.

Well-C:

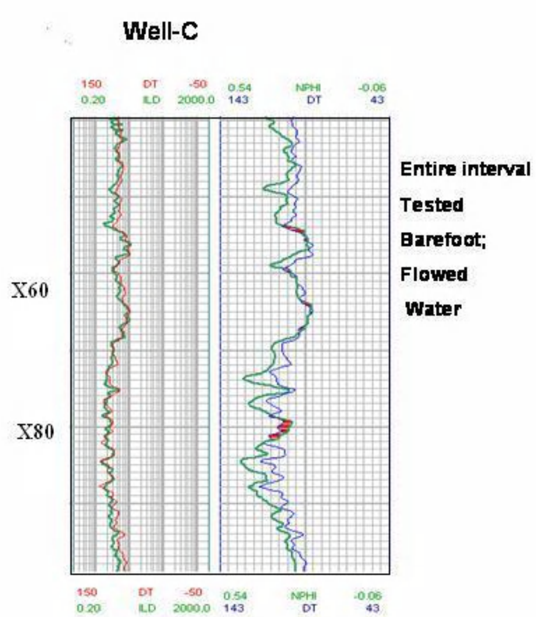

Figure-3: Example of a dry well where no separation on log overlays.

Figure-3 shows log overlays where both logs are tracking each other without any separation on both overlays indicating the absence of hydrocarbons. The well flowed water.

Well-D:

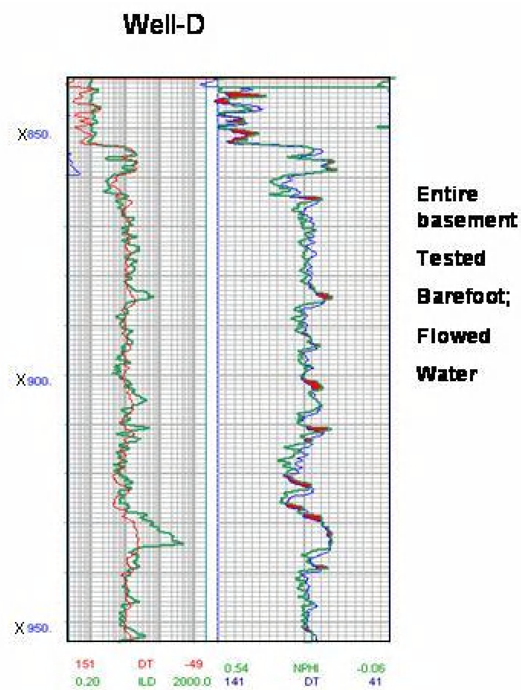

Figure-4. : Example of a dry well where no separation on log overlays

Figure-4 shows log overlays where both logs are tracking each other without any separation on both overlays indicating the absence of hydrocarbons. The well flowed water.

Conclusions

1. A procedure is proposed for formation evaluation of volcanic reservoirs.
2. In this method, resistivity-sonic overlay and neutron-sonic overlay are used to identify hydrocarbon bearing zones from the curve separations.
3. Examples showing hydrocarbon as well as dry wells show the efficacy of the proposed method.

Acknowledgements

The author thanks Oil and Natural Gas Corporation for providing facilities to carry out this work and permitting for a presentation.