P 071

Identification of Hydrocarbon Potential of Cambay Shale by Overlay Technique and P-Half Method using Log Data

Ramyani Mukhopadhyay

Summary

Hydrocarbon potential of shales have been studied extensively worldwide by various methods. e.g Vitrinite Reflectance(Ro), Thermal Alteration method etc. In the present study P-half method and Overlay technique have been applied to different fields under Cambay basin using well log data. Both Producing wells and Abandoned wells of different fields in Cambay basin have been selected and different logs of these wells have been used. Testing results particularly in Shale sections have also been corroboroted in the study. Differentiating Trend for producing and non-producing wells were found to have emerged. These methods can be applied to take a measure of HC potential of the vast Shale sections of Cambay as well as other Basins

Keywords*: Log Interpretation, Cambay Shale*

Introduction

Shale-hydrocarbon potential of shales have been studied extensively worldwide by various methods.

Geochemists use Vitrinite Reflectance(Ro) measurement, Thermal Alteration method, Spore colour Index, Hydrogen Index etc. to take a measure of thermal maturity level of HC producing Kerogens. These are direct measurements, but have their own limitations like level of polishing , type of Kerogen etc. Above all availability of core samples, that too in Shales have limited their applicability.

Petrophysicists using Log data offer few methods e.g Arps Equation, Correlation between Uranium content and TOC, P-half method, Overlay Technique etc. to find the HC potential of shales. Overlay method as proposed by Passey even offer formula to calculate Total Organic Content of the shales and have been found in good agreement with those measured by Geochemists.

In the present study P-half method and Overlay technique have been applied to different fields under Cambay basin using well log data. Both Producing wells and Abandoned wells of different fields in Cambay basin have been selected and different logs of these wells have been used. Log data of wells, tested particularly in Shale sections have also been studied. Differentiating trend for producing and non-producing wells was found to have emerged. These methods can be applied to take a measure of HC potential of the vast Shale sections of Cambay as well as other Basins.

Methodology: In Overlay method overlay between Deep Resistivity and Sonic travel time (DT) and in some cases that between Rt and Density with proper scaling have been used. Gamma ray logs used to delineate Shale sections and Caliper logs used to identify Bad Hole sections. All log data have been taken for Cambay shale section from different wells of different fields of Cambay basin. TOC an be calculated using Passey's formula.

GSPC, AHMEDABAD
ramyani.m@gspc.in

TOC = (ΔlogR)*10^(2.297-0.1688*LOM), where ΔlogR=log10(R/Rshl) + 0.02*(DT-130), (DTshl=130), LOM from curve.

P-half method (P-Statistical parameter) was introduced by Porter, Picket & Whitman, it was found P has normal distribution in 100% water bearing zone, but deviates from Normal distribution in HC bearing zone. This method works well in Shales. P is defined as
P= Rt*(ρmat-ρb)^m or P= Rt*(ΔT-ΔTmat)^m
Pmat =2.65, m=1.2, m is derived from log-log plot in shale section.
P is plotted against its cumulative frequency; departure from Straight line indicates presence of HC. It is a Straight line in zones devoid of HC.

Results & Discussions

Some of the Overlays and P vs Cum. Freq plots are presented. It is seen for well A , which is an abandoned well, Rt & DT are perfectly overlain on each other in the Cambay shale section. P vs Cum. Freq plot is a single slope line for the same shale section of the same well, indicating absence of HC. Well A is situated in a field where east-west as well as north-south faults are present.
Upper sands are devoid of HC in the same abandoned well as no HC is present beneath (Source rock), and lateral migration is restricted by faults. In the well B and C, where Shale section has particularly been Perforated & tested and no activity was observed, Overlay and P-plot show similar result like well A. For this well B Vitrinite Reflection coefficient data is available and is of the range of 0.5 to 0.55, which just touches onset of HC generation value but fall short of commercial generation of HC, as given in the Table I.

D, F, G, H are the wells which have been tested in the Cambay shale section and produced HC. Positive separation is observed between Rt and DT (or between Rt & Rhob). P-plot also shows change in slope.

In the well D (Fig.6, 7, 8) it is observed at the lower part X000-X075, in the Cambay Shale section.

Rt & DT coincide with each other. Also P-Plot shows single slope, indicating absence of HC. The zone was tested and observed NO Activity. In the upper part X800-X850 of the same well D a positive separation exists and the P-Plot shows change in slope. This section was tested and proved to be HC bearing. Wells have been selected from different fields of Cambay basins. Subsequent figures are self explanatory.

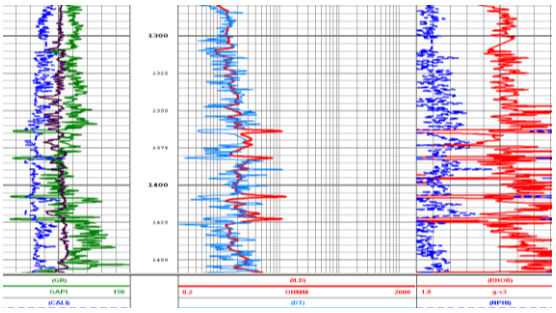


Fig.1 Well #A, Abandoned Well, Rt v/s DT

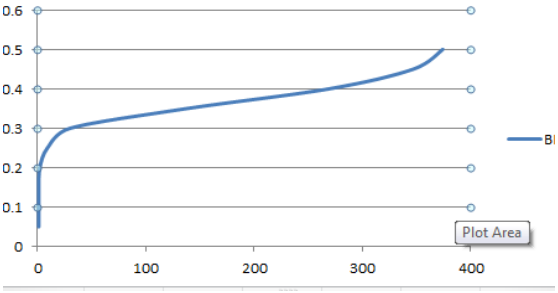


Fig.2 Well# A, P v/s Cumulative Frequency

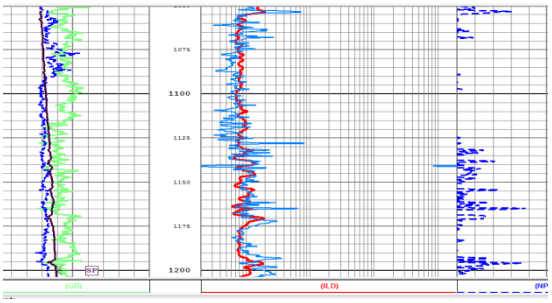


Fig.3 Well# B, Rt vs. Rhob Coincidence

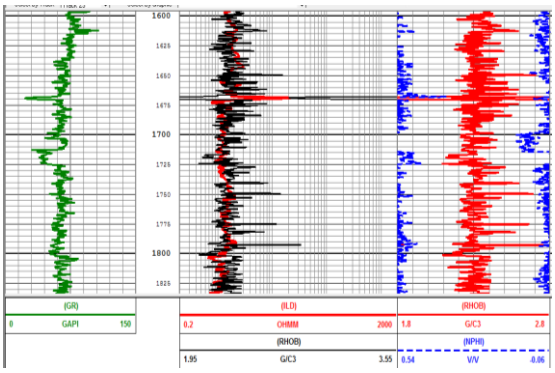


Fig.4 Well# C, Overlay Rt vs RHOB

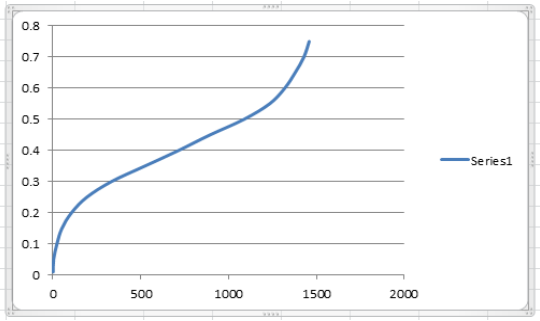
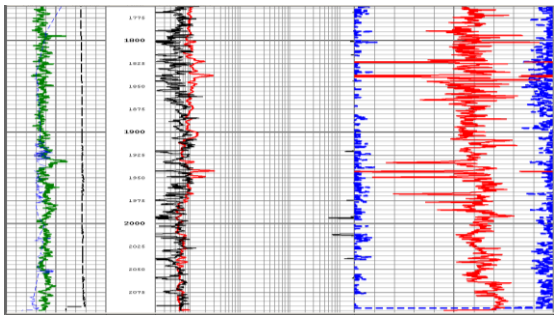


Fig.5 Well# C , P vs cum.Frequency Coincidence, No HC , Single slope



Gamma Log, Caliper Log DT log, Rt log
Density log, Neutron Porosity

Well# D, Overlay Rt vs DT
Lower part (X000-X075m), both coincides
Upper part (X800-X850m), positive separation

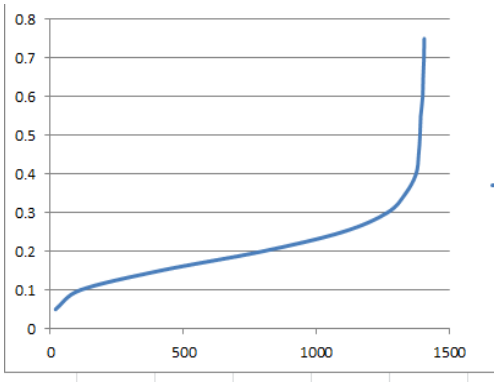


Fig.7

Well# D, P vs Cum.Freq, ,
X800-X850m
change in slope

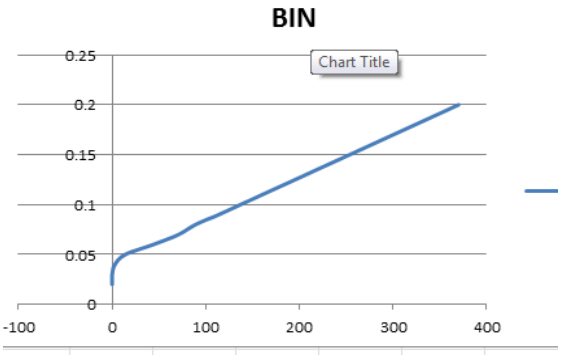


Fig.8

Well# D, P vs Cum.Freq, ,
X000-X075m
No change in slope

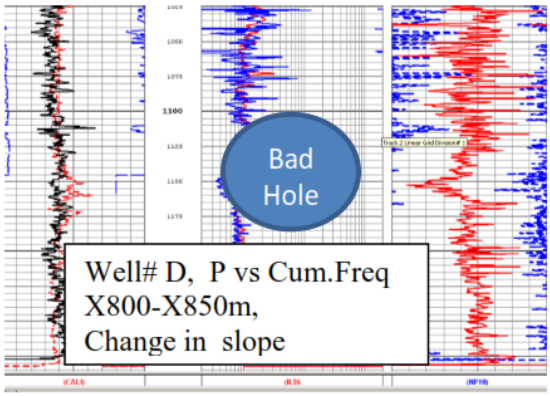


Fig.9 Well# E, Rt-DT, Total Coincience

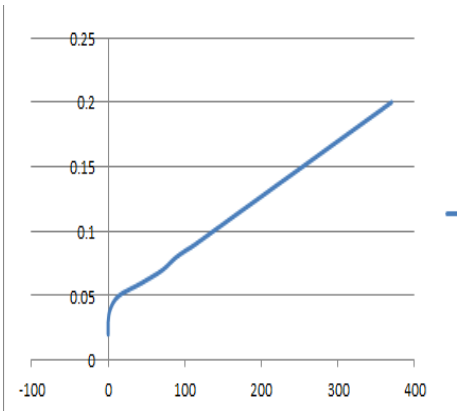


Fig.10 Well# E, P vs Cum Frq, single slope

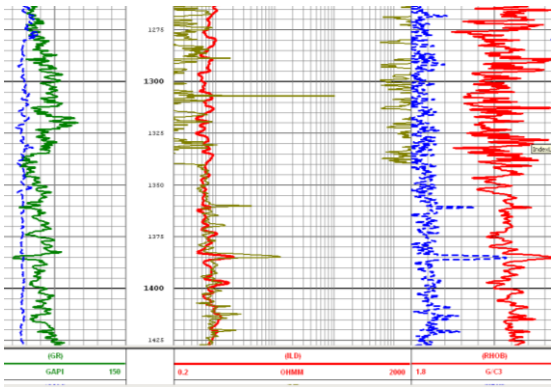


Fig.11 Well# F103, Rt-DT, Positive Separation

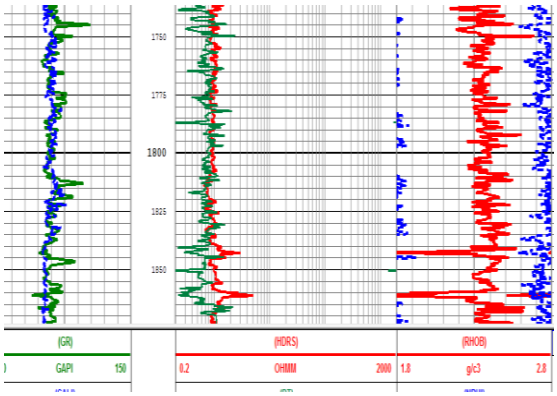


Fig.12 Well#G, overlay Positive Separation

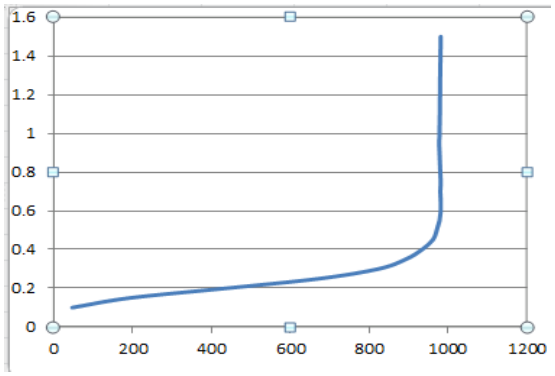


Fig.13 Well#G, P-half graph

Conclusion

1. Log data is available for Cambay shale section over almost entire Cambay basin, above observations may be applied to take a stock of HC potential for the same.
2. Overlay technique is very simple to apply, using a wide no. of possible combinations of logs.
3. With Positive separation in overlays or change in slope in P-plot, but if testing results are negative, i.e. no activity in the well, Geochemical and paleontological studies may throw light on type of Kerogens, i.e. Humic or Saphrophytic etc
4. High Geothermal Gradient (Av.4.5 degC/100m) in Cambay basin enhanced Thermal Maturation at relatively lesser depth. (Geo Gradient of KG basin is app. 6 deg F/100m).

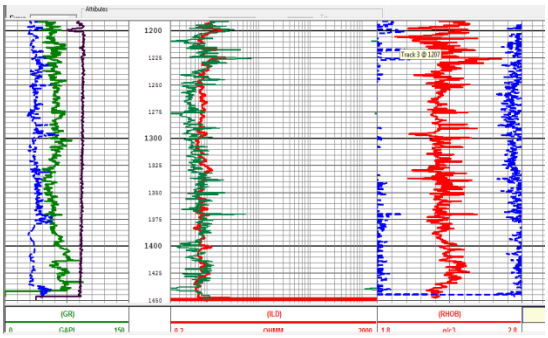


Fig.14 Rt v/s Dt, Well#H overlay, Positive Separation. This well has been tested and it produced Hydrocarbon

Thermal Maturity Table

Table-1

	Temerature In Degree C	Vitrinite Reflectance(Ro)	Thermal Alteration Index(TAI)	Spore colour Index	Tmax 0C
Immature	<60 C	<0.5	<2	<3.5	<435
Early Mature	60-80 C	0.5-0.6	2..2	3.5-5.0	435-445
Mature	65-120 C	0.6-0.8	2.3	>5.0	
Peak Oil Generation	120-160 C	0.8-1.0	2.3-2.6	5.0-7.0	445-450
Gen. of Condensate/Wet Gas	>160 C	1.0-1.35	2.6-3.1	7.0-8.0	450-470
Gen. of Dry Gas		1.35-3.0	3.1-3.5	>8.0	>470

Acknowledgement

Author is thankful to Mr.S.P.Singh for encouragement and discussions at various stages, also indebted to Mr.MVK RAO, Hd G&G for various suggestions and corrections from time to time. Author expresses her gratitude to GSPC management for granting permission to present the paper.

References

Passey Q. R et al. 1990, AAPG Bulletin, v 74, p 1777-1794.2)

Ramyani Mukhopadhyay, of Identification TOC/Shale Gas by overlay method , Inter University meet, SPE-2009, PDPU