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EVALUATION OF FRASNIAN SHALE RESERVOIR, CASE STUDY WELL DAK-1, AHNET BASIN, SOUTHERN ALGERIA

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ABSTRACT

The evaluation of unconventional reservoir in term of future exploration plan where the geochemical data are not unavailable making us different results from logging and Gas Data However this paper aim to define Potential zone throught the estimation of total organic carbon(TOC) using Δ log R Method and thermal maturity by mean of gas ration technique combined with gamma-ray data of Frasnian shale formation encountered in DAK-1 well drilled in Ahnet Basin from 1552m to 1728m.

The results suggest that the frasnian shale have fair to good potential genration with TOC ranging from 2% to 4%, with mature organic matter who producing wet gas,The potential zone positioned in the lower frasnian over a thikness of 10m.

Keywords: Unconventional Reservoir; Evaluation;Total organic carbon (TOC), Thermal maturity, Gas Ratio; DAK-1 well; Ahnet Basin.

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1. INTRODUCTION

Unconventional resources exploration made a revolution in the oilfield activity with launch of many project in different countries where Algeria is among.

Frasnian shale and Silurian represent the principal unconventional resources (shale reservoir) in Ahnet basin, Algeria, the main parameters for his evaluation and characterization is; organic richness (TOC), thermal maturity, thickness and occurred depth.

The shale rock contain an amount of mineral and organic fraction as solid with water or free hydrocarbon as fluid (Passey et al, 1990), the organic fraction is expressed as TOC (total organic carbon), the shale containing less than 0.5% TOC are considered as insignificant potential, TOC between 0.5% to 1% poor potential, 1%-2% fair potential and between 2% - 5% of TOC shale rock is considered as good potential, over than 5% very good (oilfield review schlumberger,2011).

The thermal maturity is the degradation state of organic matter with burial depth under pressure and temperature, is a very important parameter in the formation of hydrocarbon (Hood et al, 1975), in this paper we will try to perform a quick method to determine maturity using data of free gas expelled while drilling cross shale section by mean of gas Ratio technique at a given depth and thickness (Hawroth et al1985).

Unfortunately No much study was performed in Frasnian shale of Ahnet previously as hydrocarbon potential in Algeria except some syntheses report from Sonatrach searchers (Kaced.M et al,2013), (Kaced et al.2012), (Rahmani.M et al,2012).

In this present paper Frasnian shale in the study well was investigate in view of characterization and evaluation in order to determine: TOC% continent in shale rock using Log R method , maturity by gas ration technique, hydrocarbon potentiality zones.

The study area (Ahnet Basin) situated in the West-Central of Algerian Sahara. Borded to the north by Timimoun basin, in the west by reggane basin, to the east and to the south by Moudir basin and famous Hoggar Massif, with a superficie around 75.000Km2, this basin is far about 1200Km from capital, positioned between the following geographic coordinates (Fig.1)

Easting: 01° 00’ – 03° 00’

Northing: 24° 00’ – 27° 00’

Our study carried out on the Frasnian formation encountered in well DAK-1 Drilled in Ahnet basin tagged @ 1552m drilled until 1728, with an average thickness of 180m. materialized by Shale, black to dark grey, grey in part flaky micaceouse, silty carbonaceouse in part, with

fine intercalation of sandstone white, transparent to translucide siliceous to silico quartzite, medium hard to hard and limestone, light blue to grey, white in part, pasty, ductile, presence traces of pyrite(fig.2).

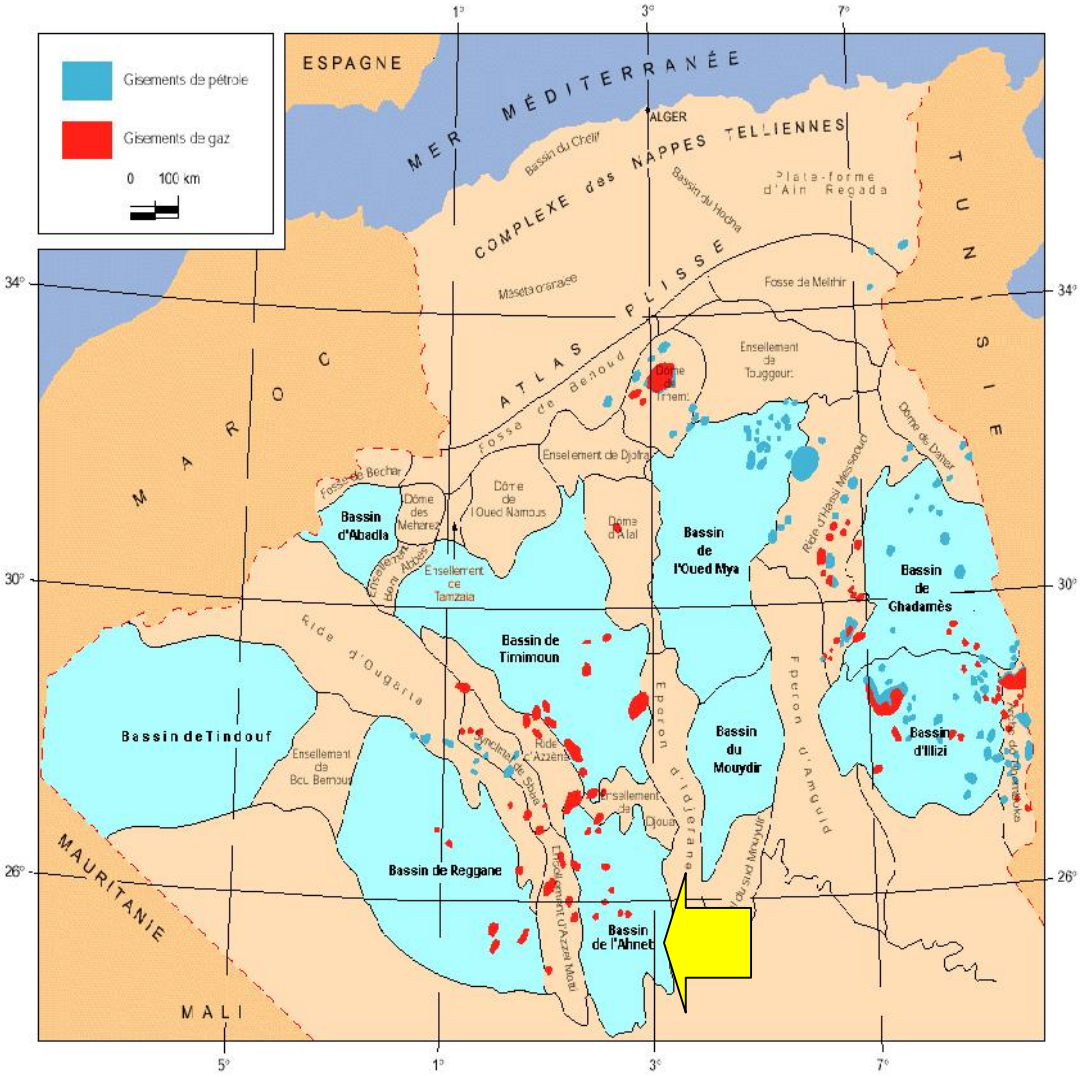


Fig.1. Geological and Geographical Map of Ahnet Basin, Algeria

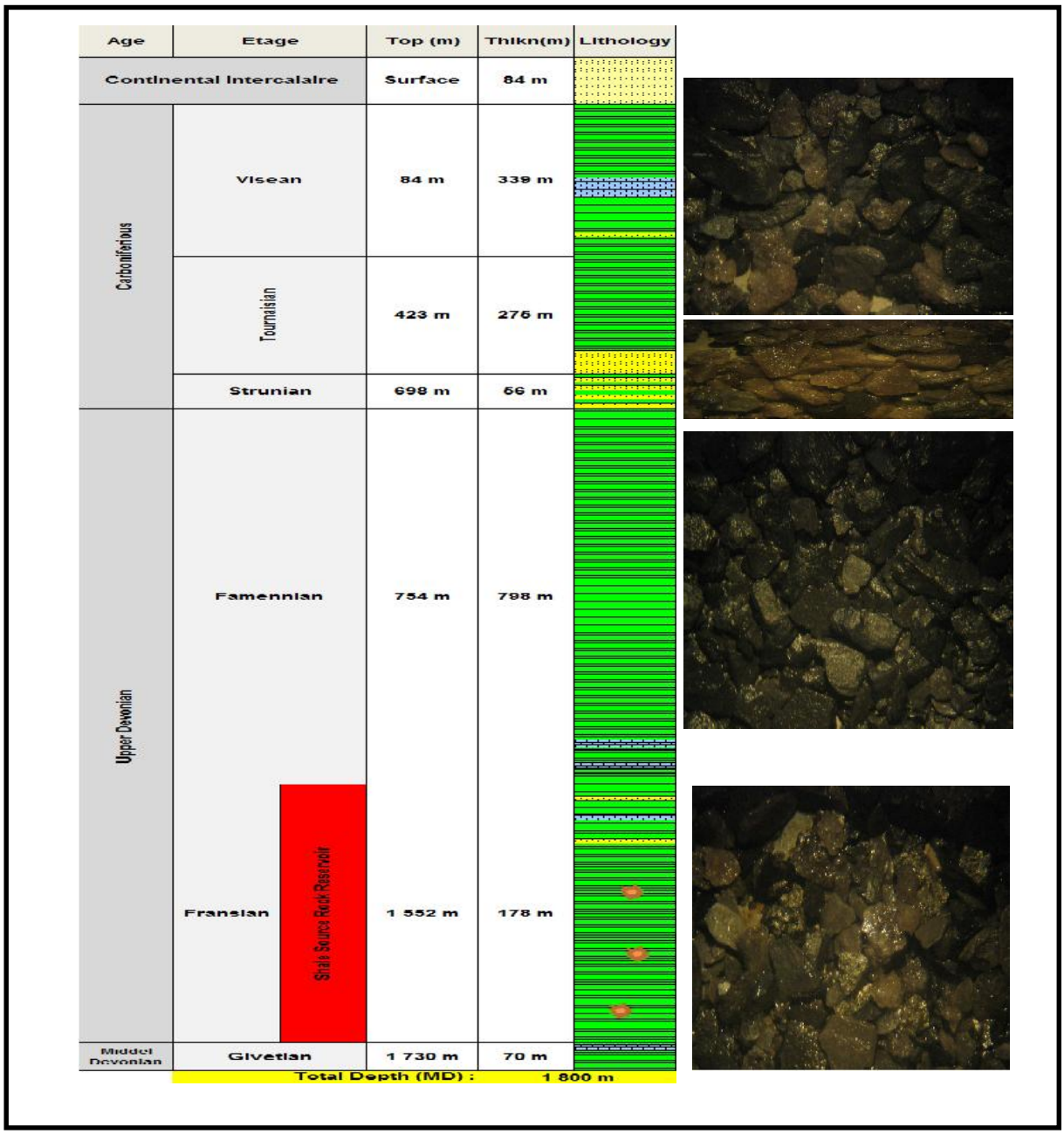
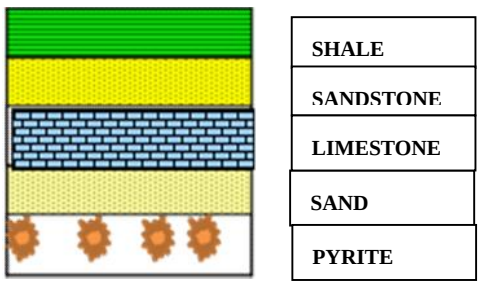


Fig.2. Stratigraphy column of DAK-1 well



2 EXPERIMENTAL

The interpretation of logging data in Shale reservoir will provide us a precious key for the evaluation and characterization where the geochemical data are not available..

2.1. Δ Log R Methode

For the estimation of organic carbon richness interval using Passey approach, we use sonic and resistivity curves, the scaling is 100 microseconds/foot = 2 logarithmic resistivity cycle, the critical point in this method is the baseline condition who suggest that the two curves should be overlie each other at a significant depth The separation between them designated Δ Log R related proportionally with TOC, and we can calculate the TOC if the thermal maturity is determined.

The algebraic expression for the calculation of Δ Log R is:

$$\Delta \text{ Log R Sonic} = \log10(R/R_{baseline}) + K \times (\Delta t - \Delta t_{baseline}) \text{ where:}$$

Δ Log R Sonic: is curve separation

R: is measured formation resistivity

$R_{baseline}$: is the resistivity of non-sourced shales

Δt: is sonic log reading

$\Delta t_{baseline:}$ is the sonic log reading in non-sourced shales

K: is a scale factor dependent on porosity log measurement units

K = -0.02 for sonic, 2.5 for density, and -0.04 for neutron logs

The empirical equation for calculating TOC content in rocks from Δlog R is:

$$TOC = (\Delta \log R) \times 10\,(2.297 - 0.1688 \times LOM)$$

LOM: is the level of organic maturity.

2.2.Gas Ratio Methode

In this paper the LOM is estimated using gas ratio method, this technique is based on three equations function of gas recorded while drilling.

$$\text{Gas wetness ratio (GWR)} = \frac{C2 + C3 + C4 + C5}{C1 + C2 + C3 + C4 + C5} X100$$

$$\text{light to heavy Gas ratio (LHR)} = \frac{C1 + C2}{C3 + C4 + C5}$$

$$\textbf{Oil character ratio (OCR)} = \frac{C4 + C5}{C3}$$

The gas ratio flow chart (fig.3) adopted by Baker Hughes Company is used for the interpretation to know the nature of free hydrocarbon produced at each depth who give us an idea about the maturity of organic matter at this interval, a immature organic matter will produce the microbial dry gas, a mature state will produce oil and wet gas, the post mature state generate a dry gas (Rice, 1993).

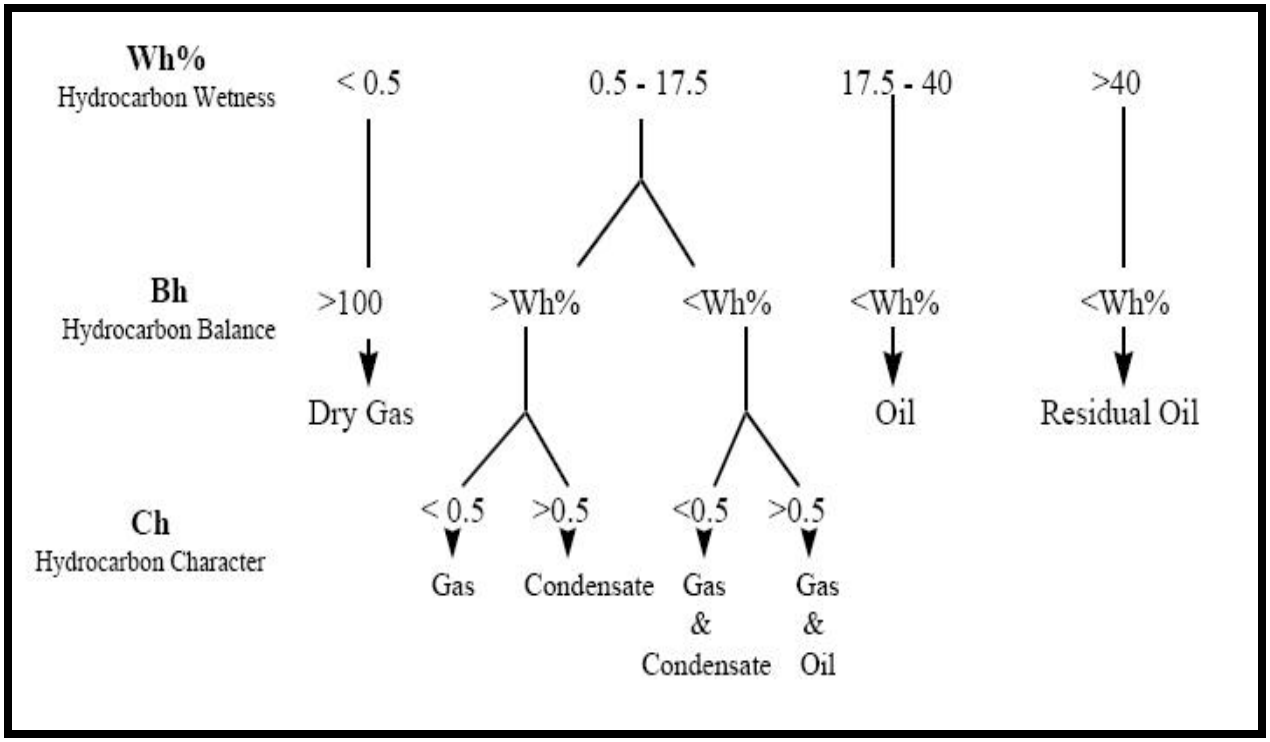


Fig.3. The Gas ratio flow chart (Baker Hughes)

3. RESULTS AND DISCUSSION

3.1 The Thermal Maurity of organic matter,

The maturity was determined using gas Ratio method; in this present study the gas data recorded while drilling Frasnian shale formation show that the wetness ranging from 3.04% to 12.06%, the balance is higher than wetnees in all intervals even the character from top to the bottom of frasnian shale is lower than 0.5 (Fig.4), according to the Gas ratio flow chart of Baker Hughes the frasnian shale formation product wet gas, which indicate that the trapped organic matter in Frasnian shale is mature.

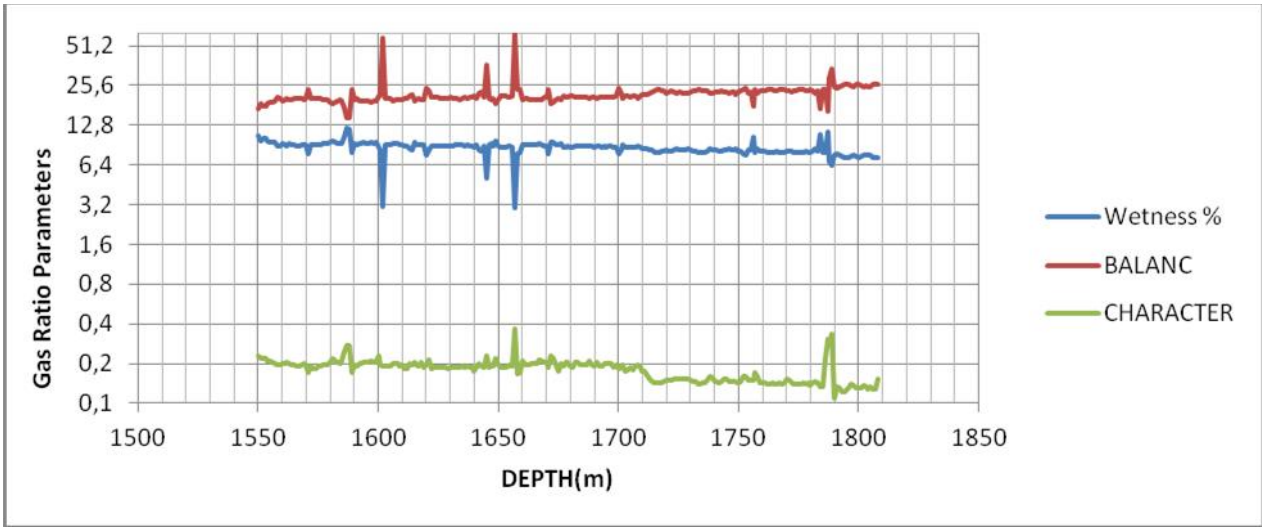


Fig.4. Gas Ratio Plots

3.2. The quantity of Organic Matter

The quantity of Organic Matter in frasnian shale was estimates using **Δ Log R** method, the plot of both resistivity and sonic values Vs depth in the study well (DAK-1)l show that, Δt and R baseline values is respectively 69.24µsecond/feet and 6.5 ohm-m, the level of organic matter metamorphose is in wet gas statut, therefore we use the value LOM=12.

The results of TOC calculation show that the frasnian shale in DAK-1 well hase fair to good organic matter richness with values ranging from 1.49% to 4.22%.

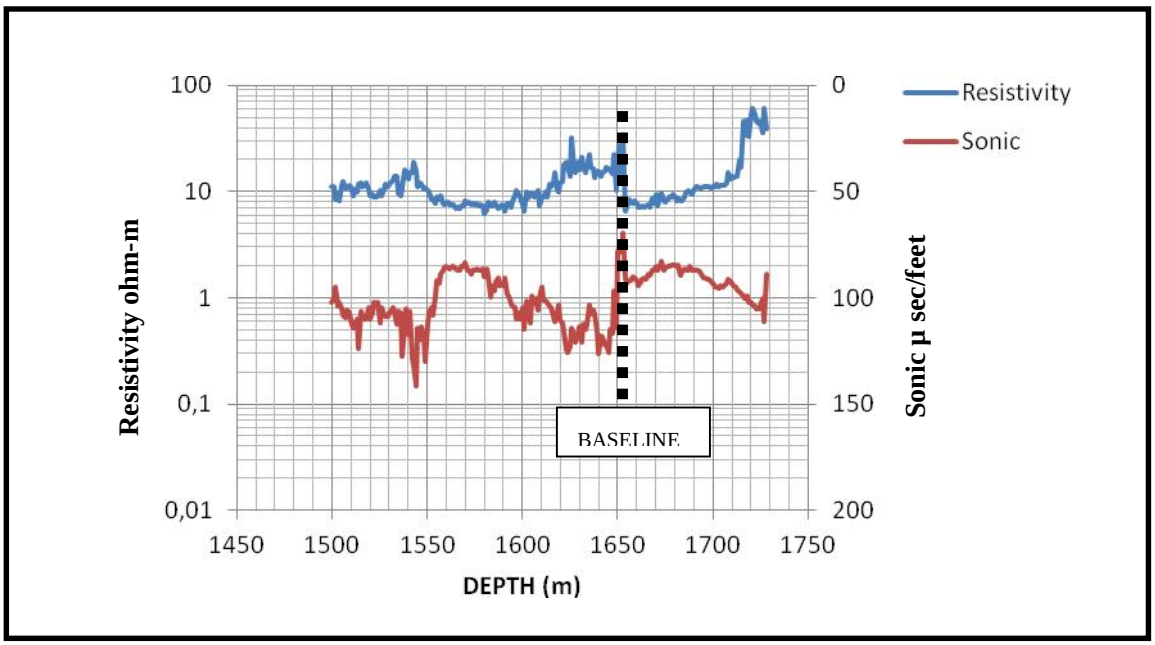


Fig.5. Sonic/Resistivity overlay showing Δ Log R separation

3.3. Potential Zone

The evaluation results of Frasnian shale based on TOC amount combined with Gamma ray spectre, show that the potential zone located in the lower part from 1717m to the bottom 1728m with good TOC (3%-4%) and high gamma ray ranging from 150 API to 285API(Fig.6)

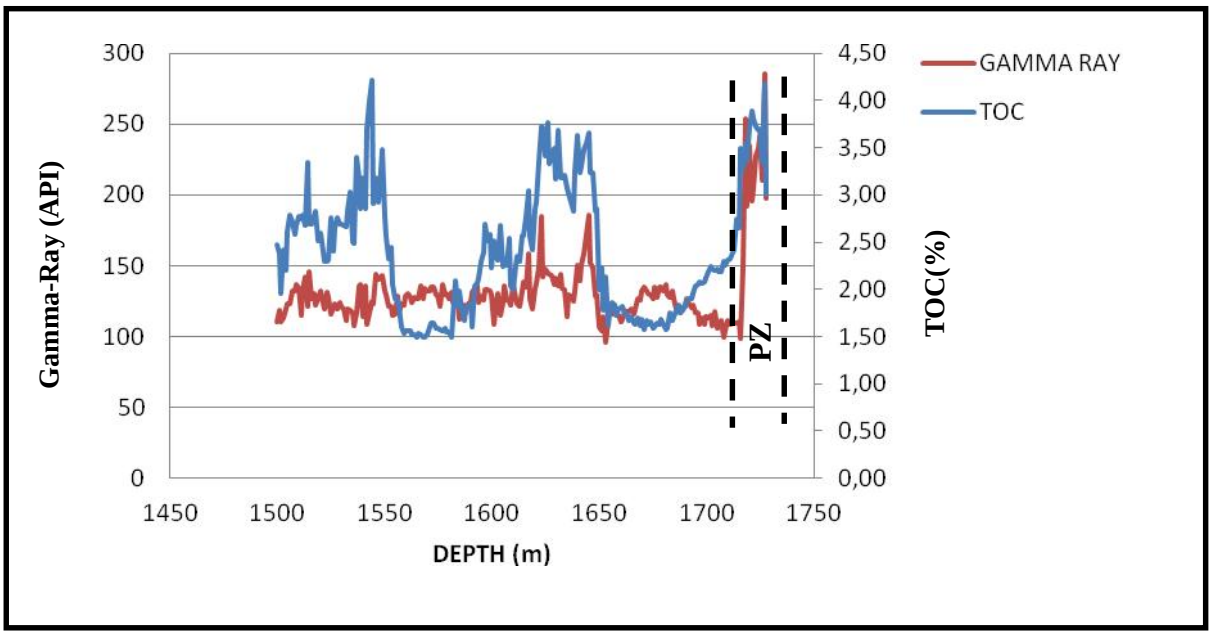


Fig.6. Gamma-ray/TOC overlay showing Potential Zone (PZ)

Table 1. Δ Log R and TOC Calculation of Case study well

DEPTH	Resistivity	Sonic	Gamma	R/Rbase	S-Sbase	Log R/Rbas	K*(s-sbase)	Δ Log R	TOC
1552	8,45	104,47	121,67	1,30	35,23	0,11	0,70	0,82	2,33
1562	7,51	86,60	128,09	1,16	17,36	0,06	0,35	0,41	1,56
1572	7,99	87,19	134,89	1,23	17,95	0,09	0,36	0,45	1,64
1582	7,87	89,51	123,86	1,21	20,27	0,08	0,41	0,49	1,71
1592	7,83	98,37	133,85	1,20	29,13	0,08	0,58	0,66	2,04
1602	9,85	101,65	125,87	1,52	32,41	0,18	0,65	0,83	2,35
1612	9,94	101,74	123,08	1,53	32,50	0,18	0,65	0,83	2,36
1622	17,60	116,08	149,04	2,71	46,84	0,43	0,94	1,37	3,36
1632	16,86	112,28	144,41	2,59	43,04	0,41	0,86	1,27	3,18
1642	14,95	118,30	150,60	2,30	49,06	0,36	0,98	1,34	3,31
1652	14,27	78,53	114,40	2,20	9,29	0,34	0,19	0,53	1,78
1662	7,12	92,36	117,43	1,10	23,12	0,04	0,46	0,50	1,74
1672	9,17	85,19	132,30	1,41	15,95	0,15	0,32	0,47	1,67
1682	8,52	84,41	129,11	1,31	15,17	0,12	0,30	0,42	1,59
1692	11,04	87,06	123,21	1,70	17,82	0,23	0,36	0,59	1,89
1702	11,73	95,14	114,92	1,80	25,90	0,26	0,52	0,77	2,24
1712	13,94	95,15	109,76	2,14	25,91	0,33	0,52	0,85	2,39
1713	13,83	96,15	109,46	2,13	26,91	0,33	0,54	0,87	2,42
1714	19,95	97,15	109,77	3,07	27,91	0,49	0,56	1,05	2,75
1715	16,79	98,15	110,67	2,58	28,91	0,41	0,58	0,99	2,65
1716	45,44	99,15	98,52	6,99	29,91	0,84	0,60	1,44	3,49
1717	33,44	100,15	149,57	5,15	30,91	0,71	0,62	1,33	3,28
1718	47,40	99,23	253,83	7,29	29,99	0,86	0,60	1,46	3,53
1719	33,26	102,36	191,85	5,12	33,12	0,71	0,66	1,37	3,36
1720	52,63	102,00	234,59	8,10	32,76	0,91	0,66	1,56	3,72
1721	60,55	103,57	196,18	9,32	34,33	0,97	0,69	1,66	3,89
1722	53,18	104,12	203,99	8,18	34,88	0,91	0,70	1,61	3,81
1723	46,26	105,13	227,31	7,12	35,89	0,85	0,72	1,57	3,73
1724	43,77	105,10	233,03	6,73	35,86	0,83	0,72	1,55	3,68
1725	46,47	104,12	241,02	7,15	34,88	0,85	0,70	1,55	3,70
1726	36,17	100,12	210,69	5,56	30,88	0,75	0,62	1,36	3,34
1727	60,74	111,12	285,35	9,35	41,88	0,97	0,84	1,81	4,17
1728	39,18	89,12	197,63	6,03	19,88	0,78	0,40	1,18	3,00

4. CONCLUSION

The evaluation of the case study well using logging and gas Data show that the Frasnian formation, coumpound mainly by shale, black to dark grey, silty micaceouse with pyrite traces have fair to good generating potential with mature organic matter producing wet gas.

The potential zones located in the lower part with a thickness on the order of 10m. In terms of shale gas exploration, these results are not encouraging to process to frac-operation for the extraction of gas shale.

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