Hydrocarbon Type Estimation Using the Synthetic Logs: A Case Study in Baba Member, Gulf of Suez, Egypt*

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Abstract

Lack of pressure data and/or one curve of the essential well logs such as density, neutron, sonic, resistivity or gamma ray curves in some reservoirs is not a preferred situation for the petrophysicist and will affect the petrophysical evaluation process and the reservoir characterization study. Four wells (A, B, C and D) in the area of interest penetrated the Baba Sandstone zone in the Badri Field, and the main challenge in this study zone is the absence of pressure gradients and the density-neutron separation is not clear enough to judge the hydrocarbon type in all wells in the reservoir where they are needed for the estimation of the hydrocarbon type (oil or gas) in the untested area, so it is preferred to use the three porosity logs to investigate the hydrocarbon type. The second challenge is using the synthetic logs in the absence of the three porosity logs. In this study, all available data were used to estimate the hydrocarbon type in two studied wells in the Baba Sandstone zone, firstly by using well logging relations between the density and sonic curves in the wells which have sonic logs at the zone of interest, and secondly by applying special petrophysical studies to help in estimation of hydrocarbon type.

The Crossplot technique was used to estimate the hydrocarbon type in the zone of interest using the synthetic sonic curve, original density curve, original neutron curve plus their derived porosity and variables values such as M, N, DTMAA and RHOMAA. These include M-N and MID Crossplots, which can help in this situation. The results of this study reveal that firstly the synthetic logs play a great role in solving petrophysical and geological problems, secondly there was a good relation between the density and the sonic logs in the analogue A and D wells which have a complete set of logs, thirdly the obtained synthetic sonic log from the derived empirical equations makes sense with lithology and other logs (neutron and gamma) and it is recommended to be used in Badri Field for the zone of interest level, and fourthly the synthetic sonic log, with the density and the neutron logs, using crossplots can help in estimation of fluid type of the studied wells. The final result that the most likely hydrocarbon type in well B is oil, while it is a gas signature in well C.

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Aim of study

*This study is aiming for investigate the hydrocarbon type in the studied zones using the conventional and synthetic logs.

*The challenges in the studied zone are the unavailability of pressure data, the separation of density-neutron crossover is a questioner in some wells, the missing of one curve of the essential porosity logs (Neutron, Density and Sonic).

*The last mentioned conditions represent a challenge in the petrophysical evaluation and reservoir characterization process. In addition, the targeted reservoir is not tested yet before in the studied wells, so there is no real data about the reservoir fluid.

Area of Study

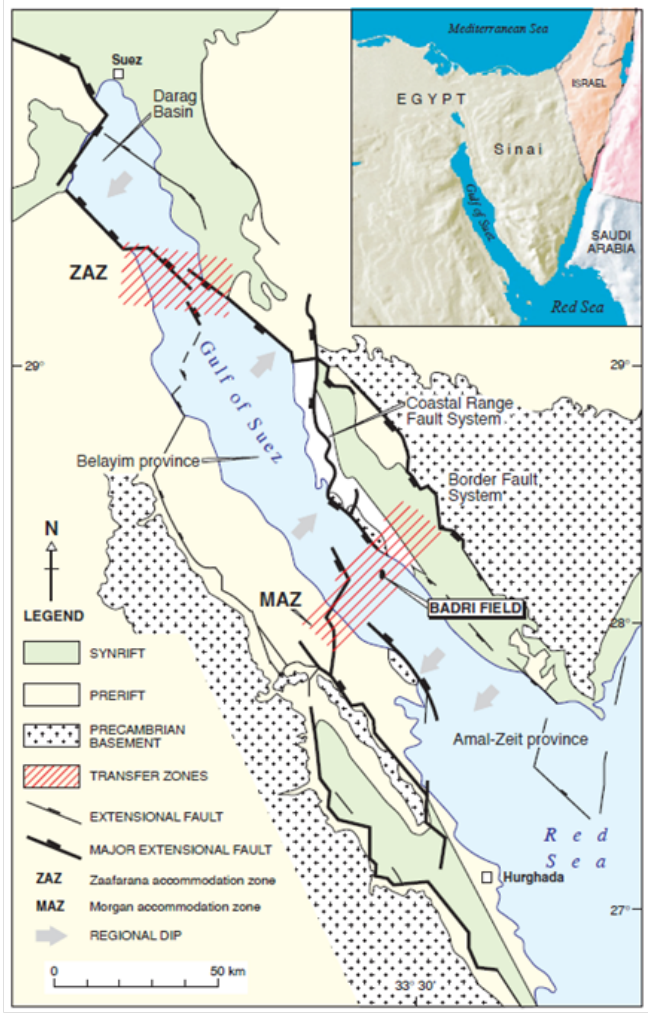


Fig.1; Tectonic element of the Gulf of Suez where the studied field location illustrated (Radwan, 2018 a,b,c,d).

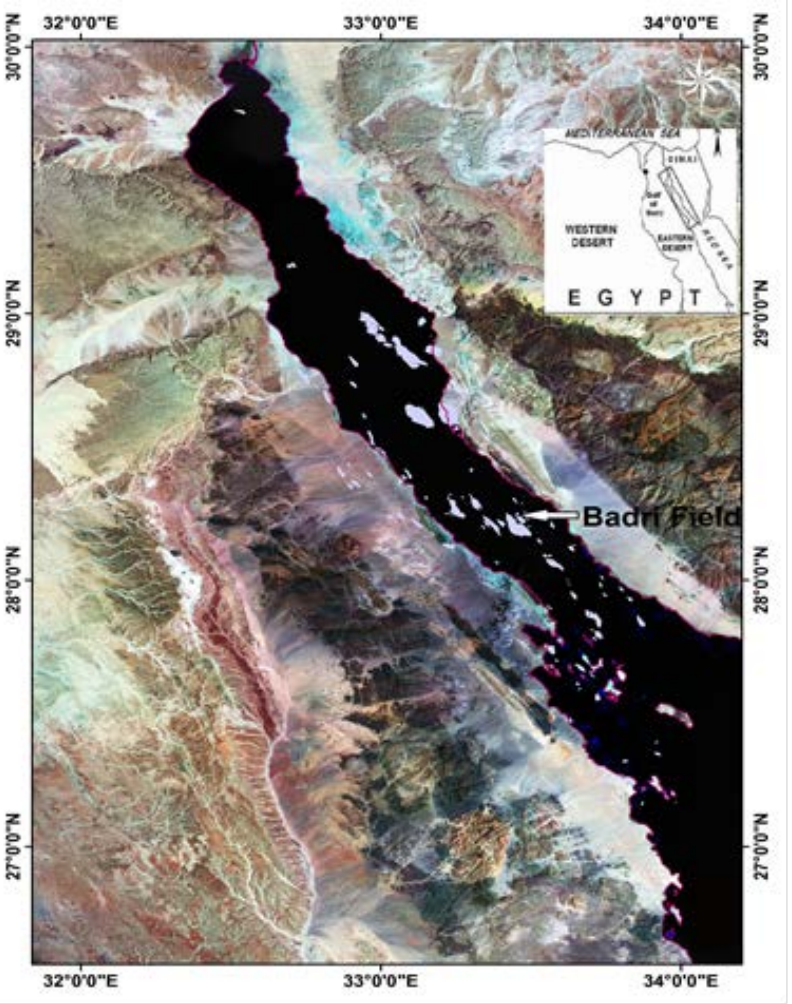


Fig.2; Tectonic element of the Gulf of Suez where the studied field location illustrated (Abudeif et al., 2016a,b; Abudeif et al., 2018; Radwan, 2019a,b,c).

2. Structural settings

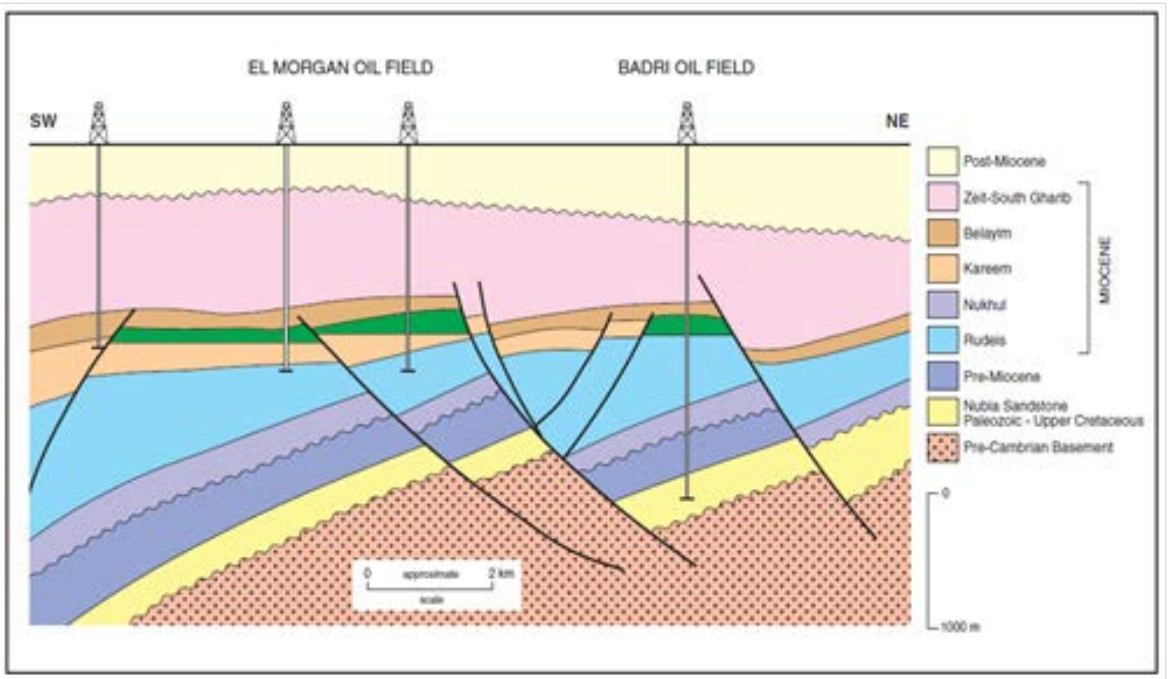


Fig.3; Generalized SW-NE cross-section showing the stratigraphy and structural relationship of the El Morgan Field and the nearby Badri Field (Radwan, 2018 a,b,c,d).

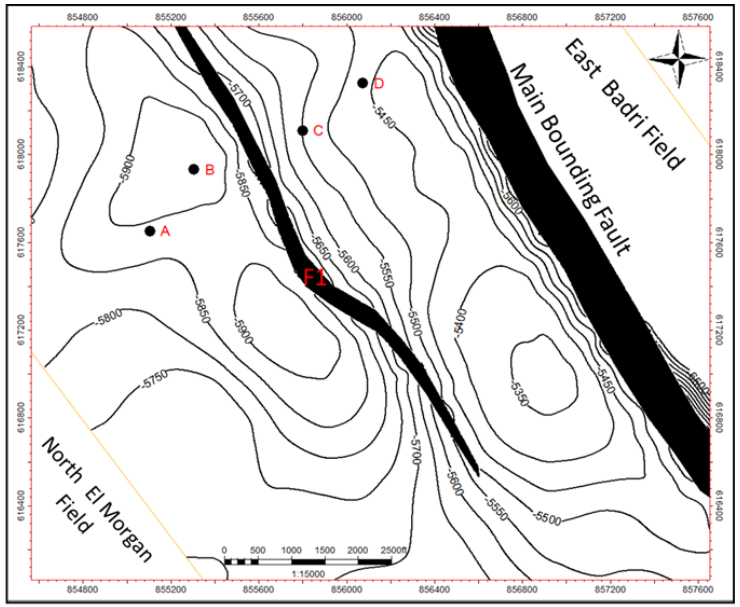


Fig.4; Structure contour map of Baba Member in Badri Field, where the Studied wells location illustrated, countouring represent elevation depth values. (Abudeif et al., 2016a,b; Abudeif et al., 2018; Radwan, 2019a,b,c; Radwan 2020a,b).

3. Lithostratigraphy

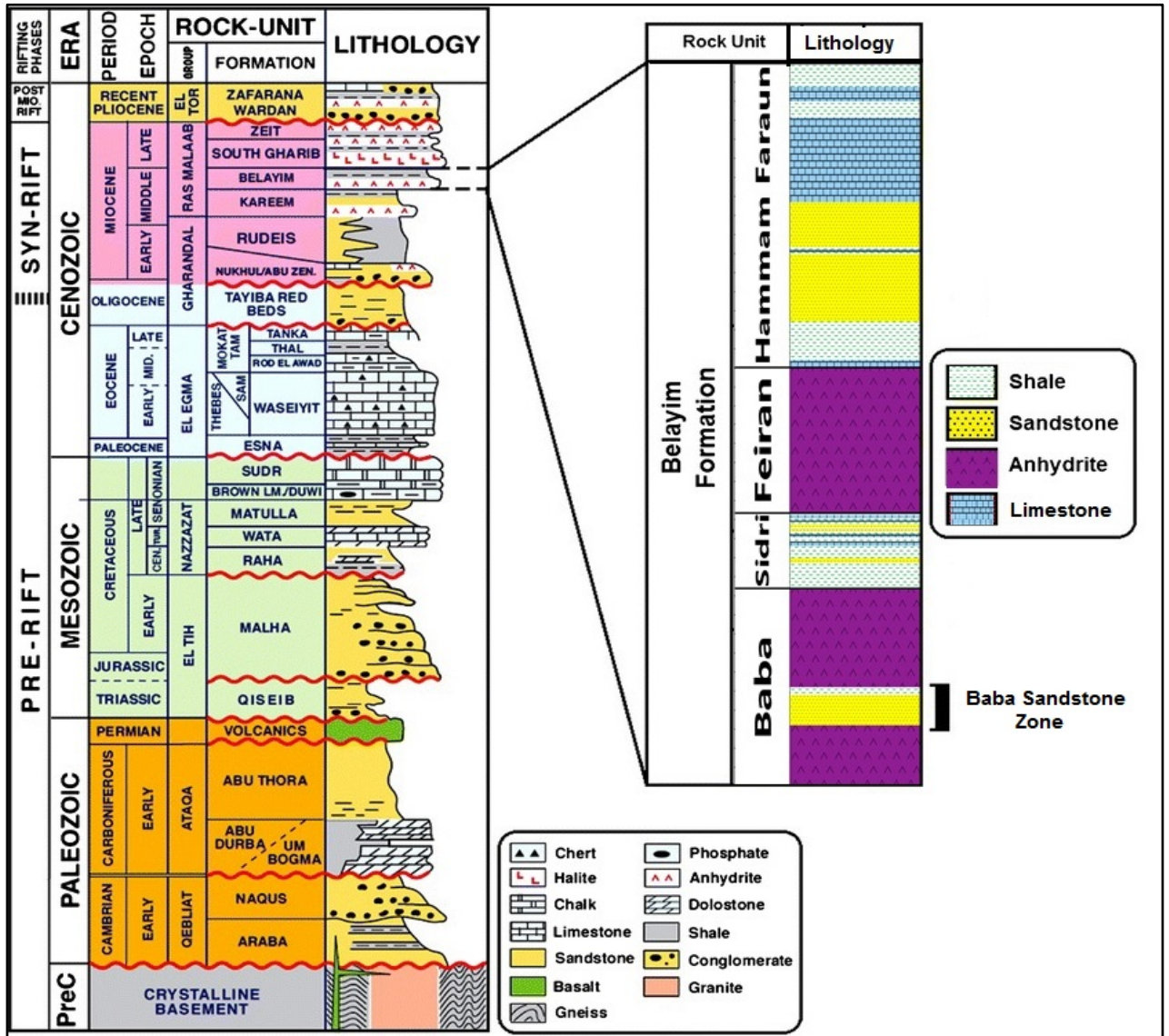


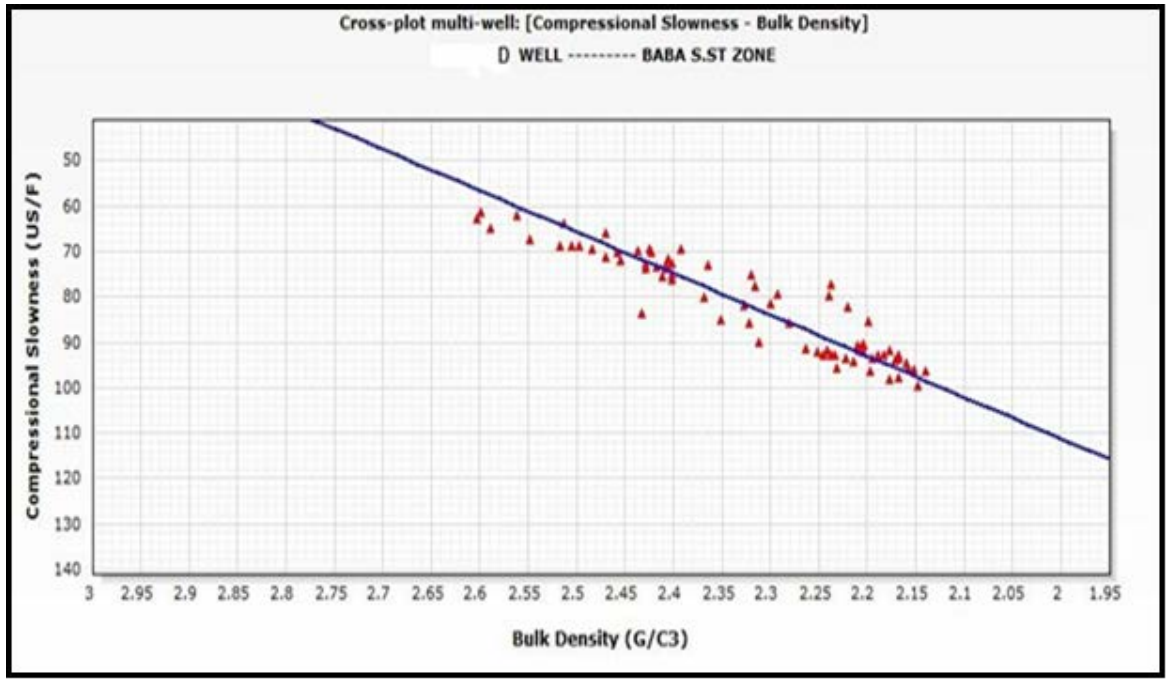
Fig.5; the stratigraphy and structural relationship of the El Morgan Field and the nearby Badri Field (Abudeif et al., 2018; Radwan, 2018 a,b,c,d).

4. Methodology

*All available data were used to estimate the hydrocarbon type in the studied wells at the level of Baba (S.S.) zone, firstly by using well logging relations between density and sonic in the wells which have sonic logs at the zone of interest, secondly by applying special petrophysical studies to help for estimation of hydrocarbon type.

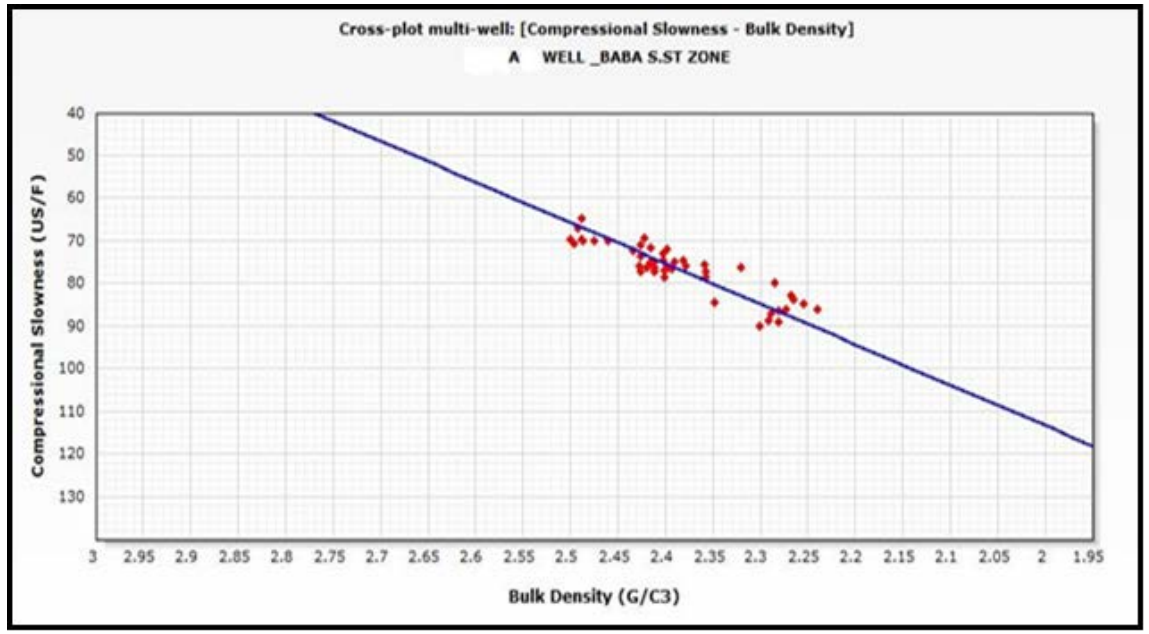
*Crossplot technique was used to estimate the hydrocarbon type in the zone of interest using the synthetic sonic curve, original density curve, original neutron curve plus their derived porosity and variables values such as (M, N, DTMAA and RHOMAA) in the used well logging Crossplots. These include (M-N and MID) Crossplots, which can help in this situation.

4.1. Creating Synthetic logs Zone 1



Plotting the Compressional Slowness (□s/f) as a function of density (G/C3) for the studied well D. .

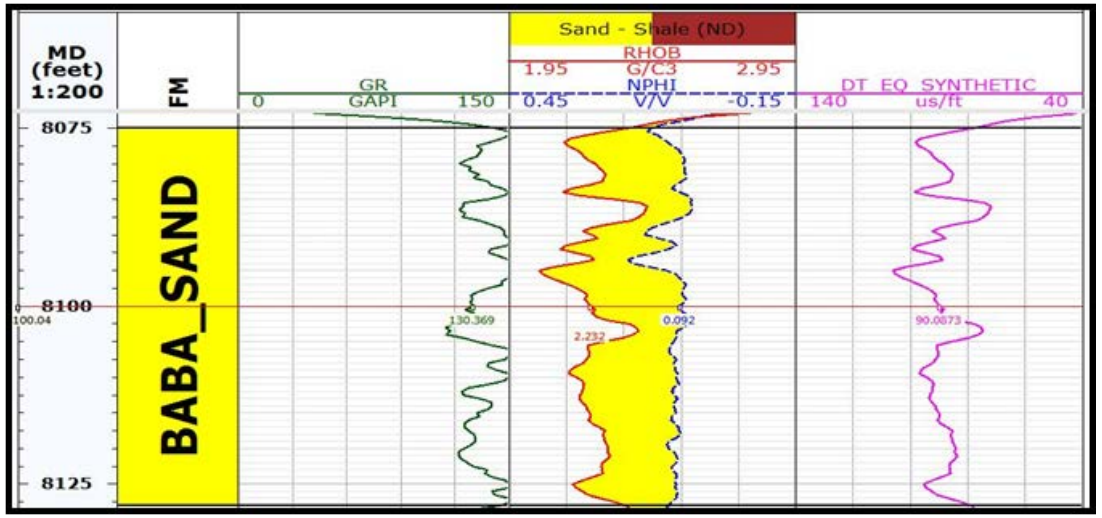
DT = -90.98*RHOB+293.1……(R2 = 0.876)

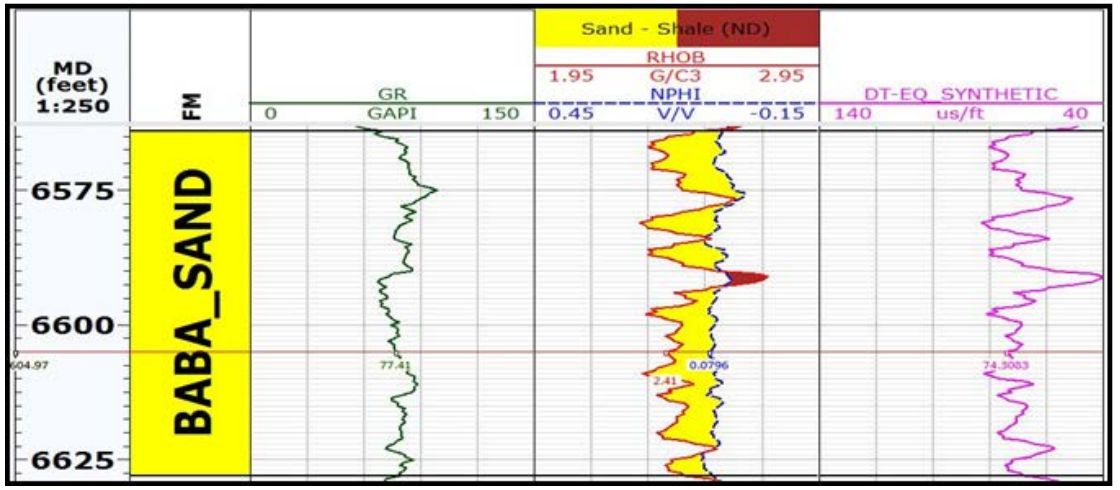


Plotting the Compressional Slowness (□s/f) as a function of density (G/C3) for the studied well A.

DT = -95.18*RHOB+303.7…… (R2 = 0.802)

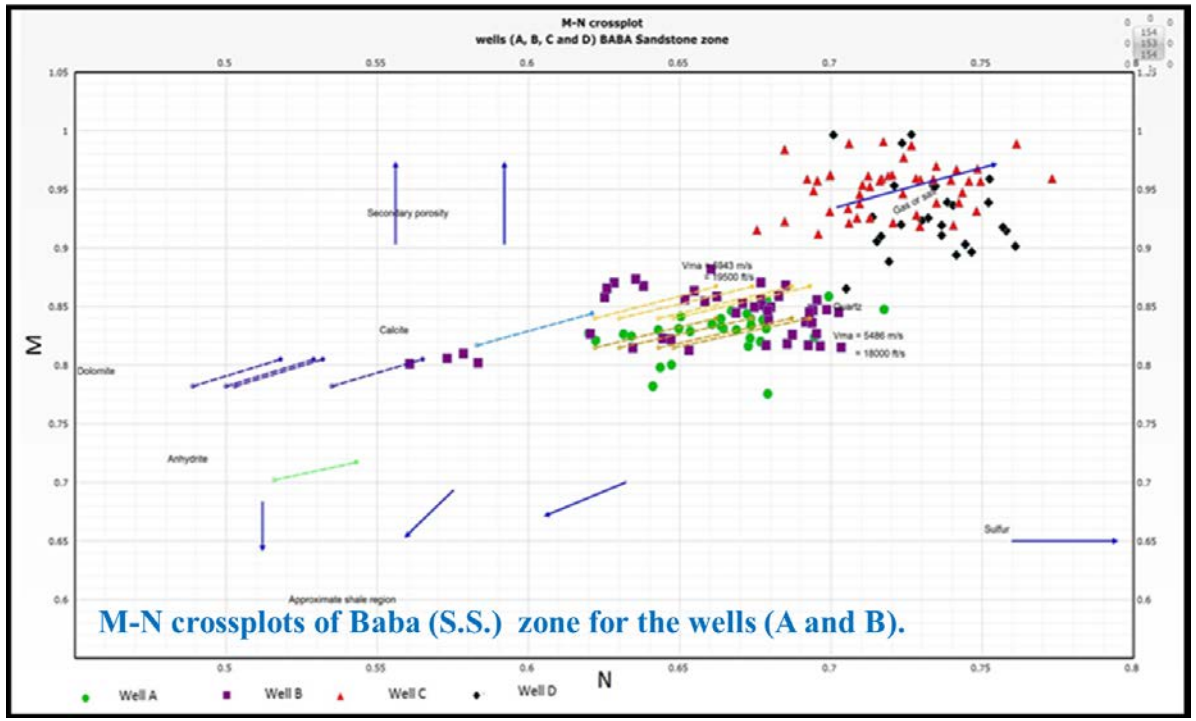
4.1 Creating Synthetic logs Zone 1



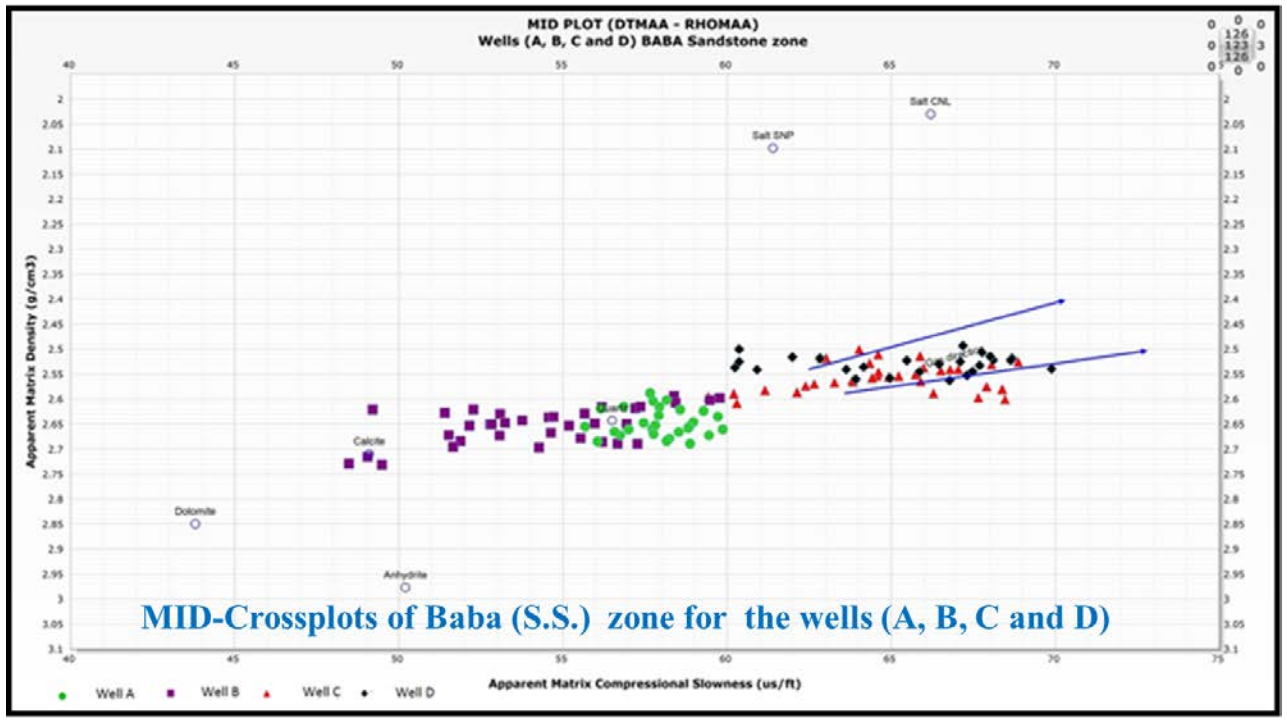


The calculated synthetic sonic log for the well (B) where, GR is Gamma ray curve, RHOB is the Bulk Density curve, NPHI is the neutron porosity and the DT-EQ SYNTHETIC is the synthetic sonic curve.

4.2 cross plotting zone 1

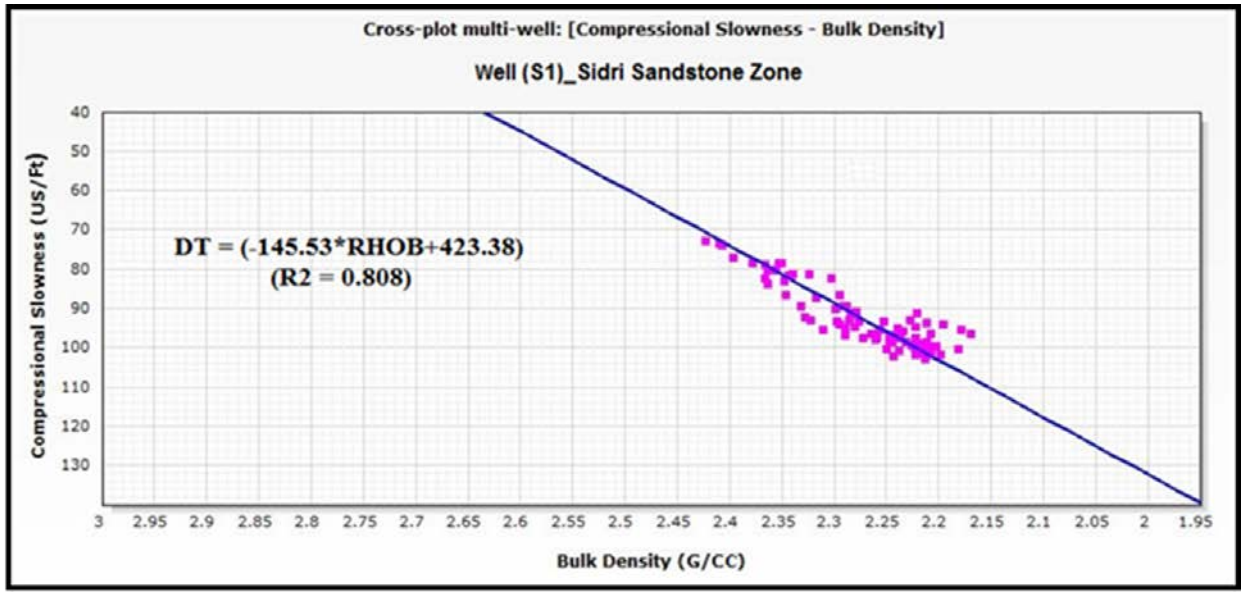


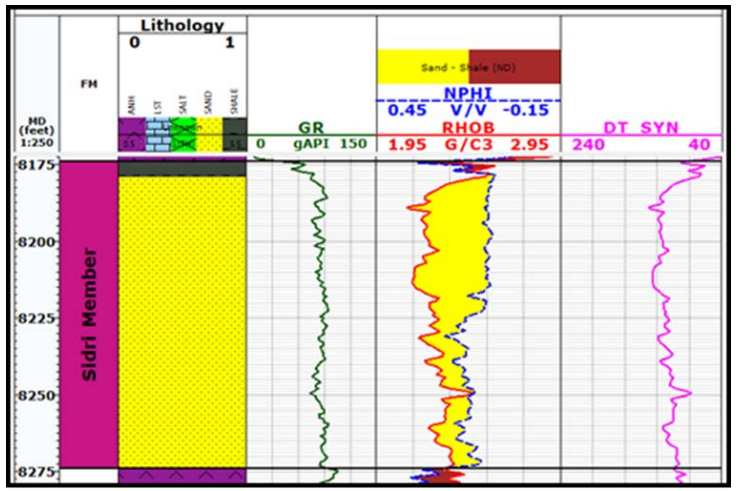
M-N crossplots of Baba (S.S.) zone for the wells (A and B).

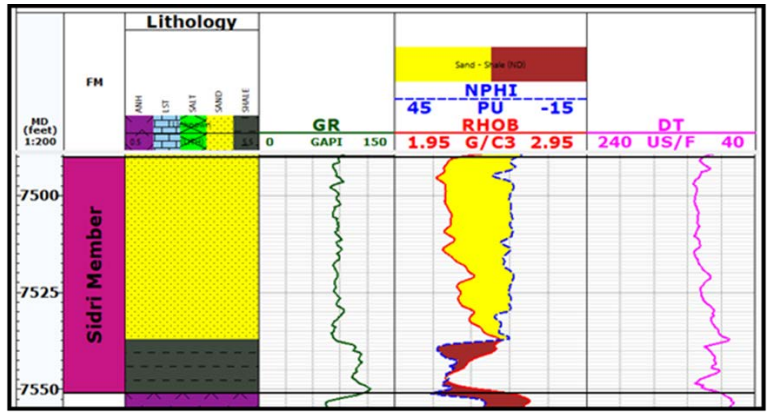


MID-Crossplots of Baba (S.S.) zone for the wells (A, B, C and D)

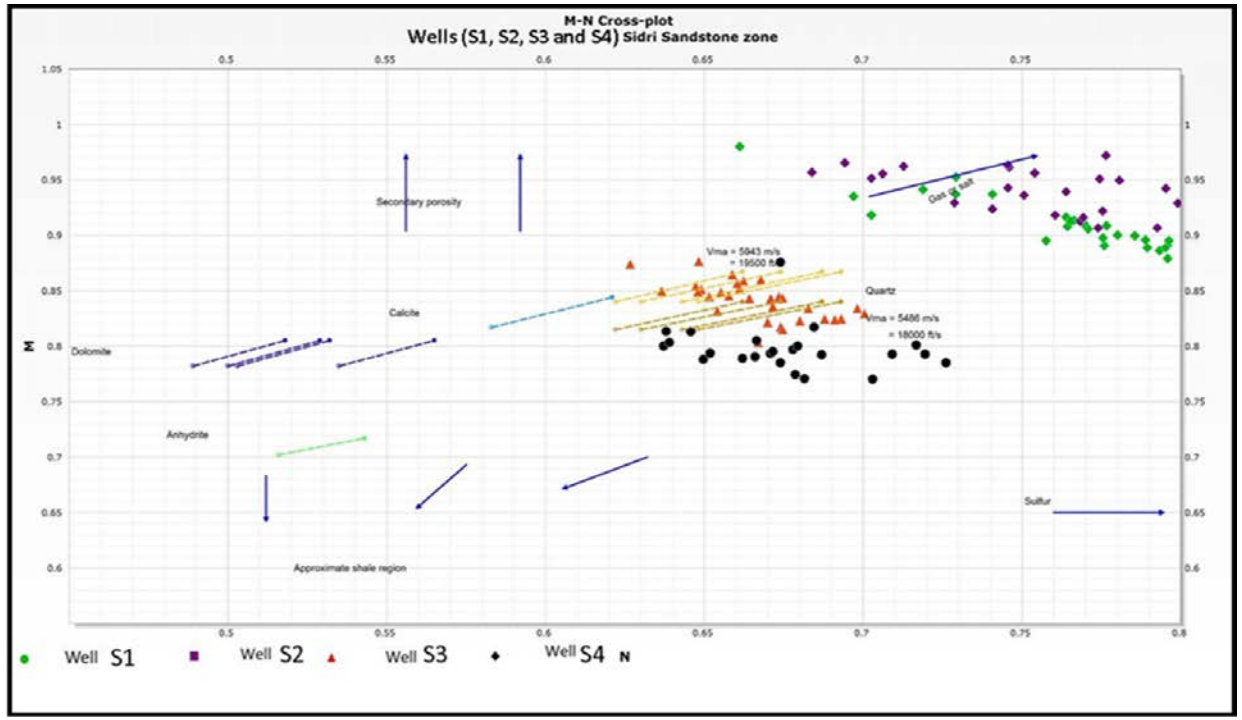
4.3. Creating Synthetic logs Zone 2

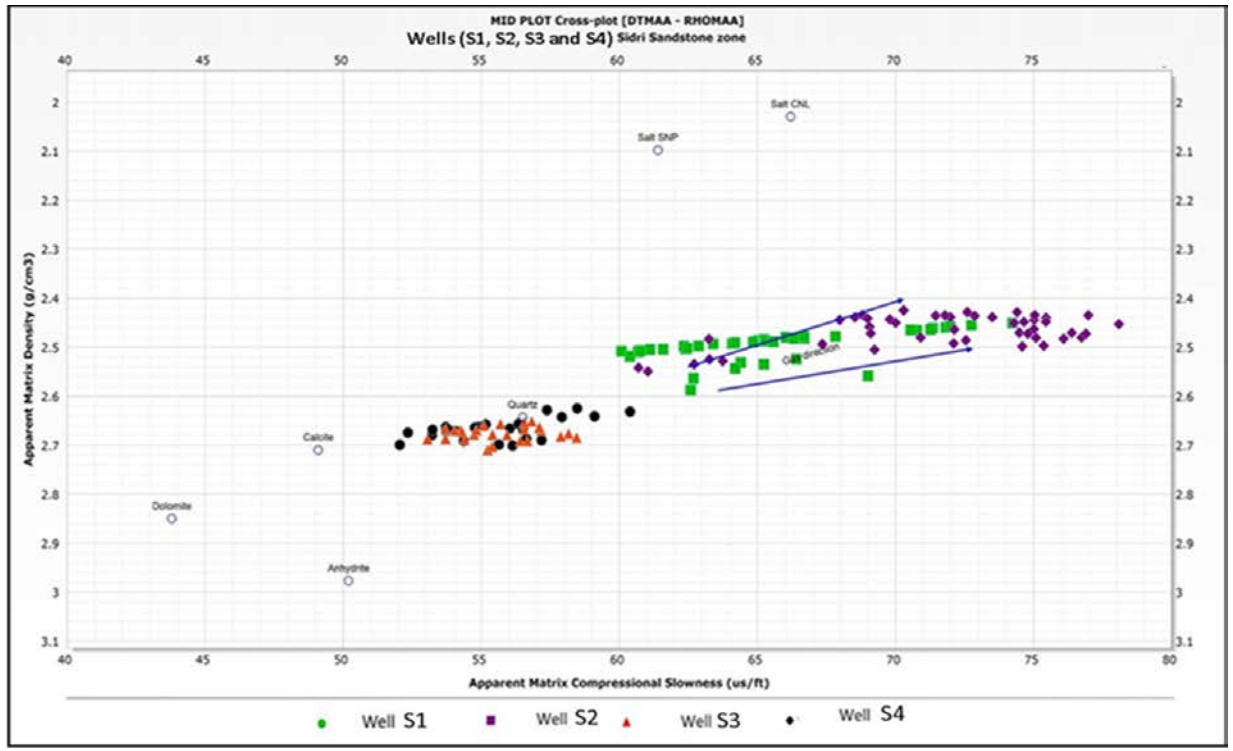




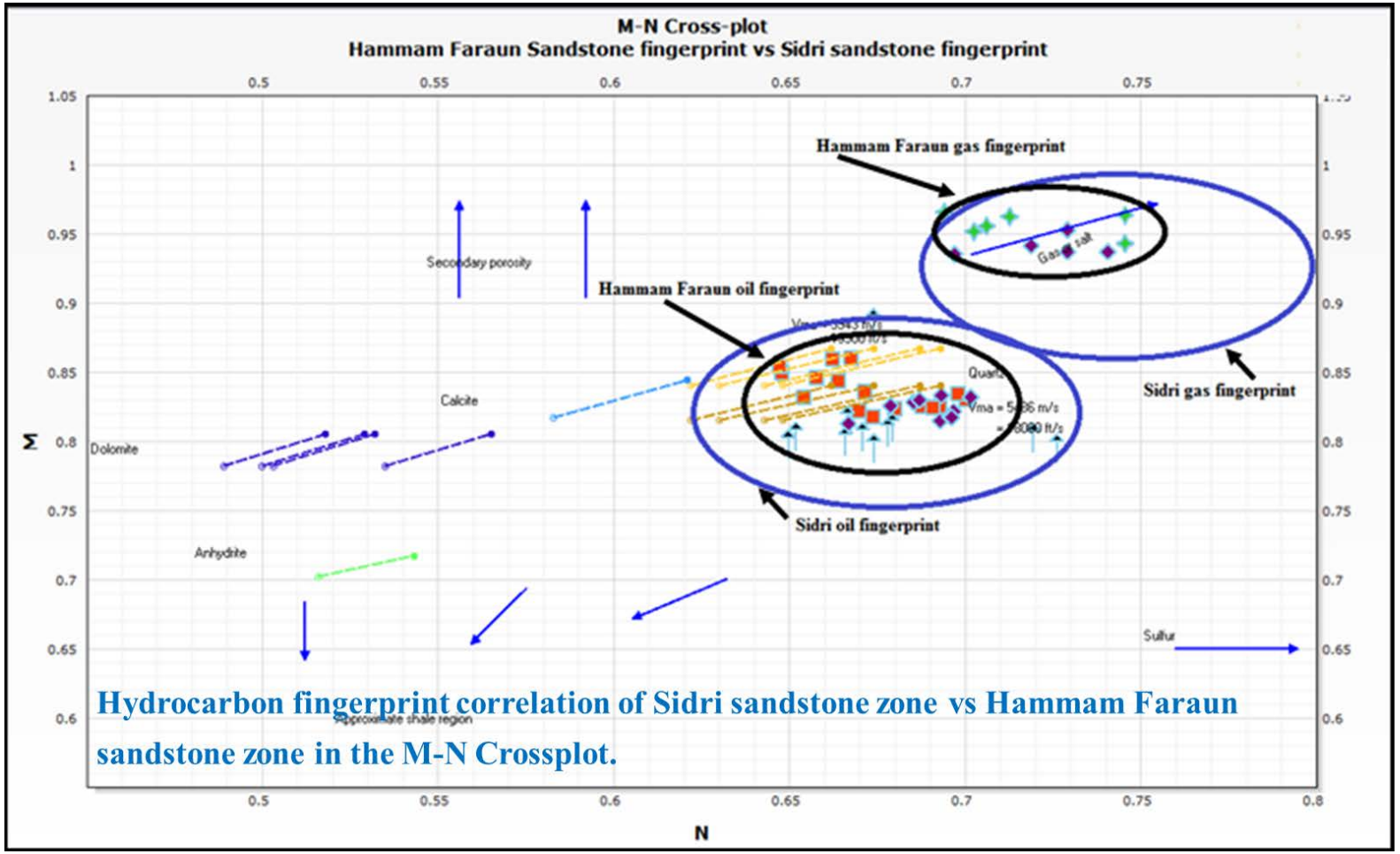


4.4 cross plotting zone 2



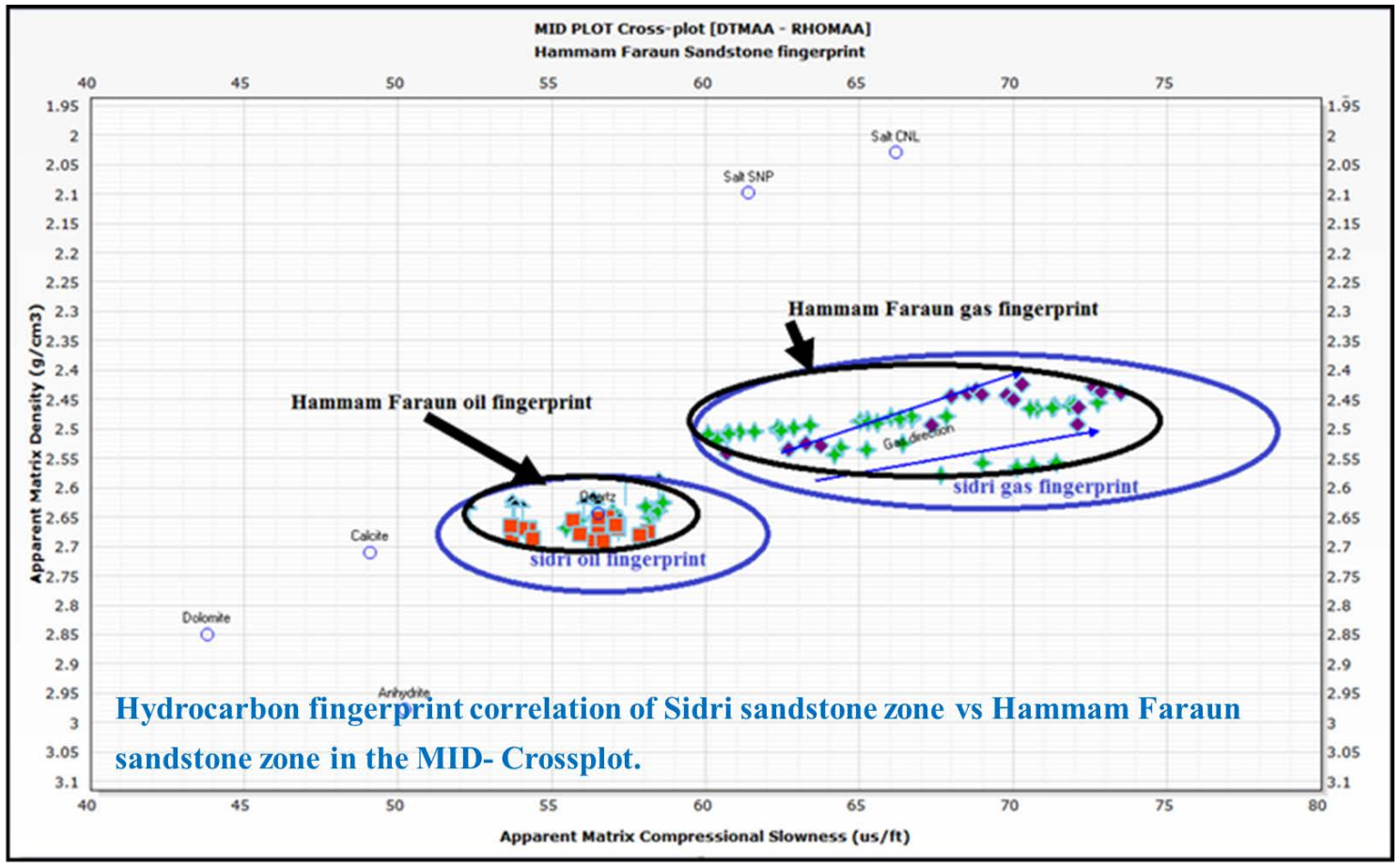


5. Results



Hydrocarbon fingerprint correlation of Sidri sandstone zone vs Hammam Faraun sandstone zone in the M-N Crossplot.

5. Results



Hydrocarbon fingerprint correlation of Sidri sandstone zone vs Hammam Faraun sandstone zone in the MID- Crossplot.

5. Results

Well Name	Member	Traditional method (quick look interpretation)	M-N Crossplot Interpreted Result	Mid Crossplot Interpreted Result	Sonic Log Type	Final Result
S1	SIDRI	Oil or gas ?	GAS	GAS	Recorded	GAS
S2	SIDRI	Oil or gas ?	GAS	GAS	Synthetic	GAS
S3	SIDRI	Oil	OIL	OIL	Synthetic	OIL
S4	SIDRI	Oil	OIL	OIL	Synthetic	OIL

5. Results

Well name	Member	M-N Crossplot interpreted results	MID Crossplot interpreted results	Sonic log type	Final results
A	Baba	Oil	OIL	Recorded	Oil
B	Baba	Oil	OIL	Synthetic	Oil
C	Baba	Gas	Gas	Synthetic	Gas
D	Baba	Gas	Gas	Recorded	Gas

Conclusions

The results of this study revealed that,

1) **the petrophysical fingerprint crossplot technique is very helpful in the petrophysical investigations,**
2) **there was a good relation between the density and the sonic logs in the analogue wells which can be applied in the others wells,**
3) **the obtained synthetic sonic log from the derived empirical equation makes a sense with lithology and other logs (neutron and gamma) and it is recommended to be used in Badri field for the zone of interest level,**
4) **the synthetic sonic log in corporation with the density and the neutron logs with the crossplots can help for estimation of fluid type of the studied wells,**
5) **synthetic logs play a great role in solving of Petrophysical and geological problems, the final result that the most likely hydrocarbon type in the studied zone shows a gas fingerprint in well S2, while shows an oil fingerprint in well S3 and S4. the most likely hydrocarbon type in well (B) is oil while it has gas signature in well (C).**