Geochemical Characteristics and Modeling of Conventional Petroleum System of Majnoon Oil Field, South Iraq.

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Abstract

Organic geochemical analysis and model set–up to simulate the genetic relationships among 18 crude oil samples recovered from different formations and various oil fields within Amara city South Iraq, with depths approximately begin from 2167 to 4430 m, ages of marine carbonates sourced from Middle Jurassic age (Sargelu Formation) according to geochemical similarities appointed previously for this period. The levels of maturation are relatively varied for each sample from low to moderate, MJ-1, MJ-18 (Hartha Formation), MJ-3, MJ-10 (Mishrif Formation), MJ-9 (Nahr Umr Formation), MJ-15 (ZubairFormation), MJ-2, MJ-19(Nahr Umr Formation MJ- 10,MJ-11(Zubair Formation) MJ-3 (Nahr Umr Formation), Mj-3 (Sulaiy Formation), MJ-12 (two samples) Sulaiy Formation MJ-11, MJ-2 (Nahr Umr Formation), MJ-2 (Zubair Formation), MJ-11 (Sulaiy Formation)of Amara city Oil fields.

These samples suggest the ages and paleoenvironments of their source rocks. The samples were collected from Upper Jurassic to Cretaceous reservoirs of 18 developed oil fields where about 15 billion barrels of recoverable oil have been reserved.

The oil density varies in rather wide range, between 12.2 and 39.2 API. Twelve oil samples are <25° API referring to heavy oil and only oil samples attained defiantly from 25 to 35°API are medium oil. Canonial Variables (CV) range attain to (- 1.89 to – 3.99) of waxy oil. According to the Tissot and Welte's classification (1984), most of the oils can be classified as ''high sulfur'' oils/indicate that these samples are of marine origin.

Stable Carbon Isotope Composition C15+ Saturate and Aromatic is relatively approximate values giving good supporting evidences for the same family which is Middle Jurassic Age (sourced from Sargelu Formation), generated within the sedimentation of the bituminous calcareous shale and Limestone in Mesopotamian basin. This basin consider as one of the most formative, potential and promising basin in the Middle East according to the typical petroleum system elements. This family was generated by marine carbonate - intrashelf sub basin source rocks, occurring in Jurassic – Cretaceous – Neogene reservoir rocks of Mesopotamian basin which are geochemically similar to the extracts from Middle –Upper Jurassic age (Sargelu Formations), yielding the majority of petroleum oil and gas fields in north and south Iraq. Petroleum system modeling in one dimension (1-D Petro Mod) was performed using Petro Mod basin modeling software which developed by Integrated Exploration System (IES) to demonstrate burial thermal history hydrocarbon generation and expulsion for Majnoon oil field so that 1-D Petro Mod was applied to Nine wells (Mj-2, Mj-3, Mj-4, Mj-8, Mj-9, Mj-11, Mj-12, Mj-15, and Mj-19) following the procedure of Pitman et al 2004.

Keywords: Biomarkers, Carbon Isotopes, Gas chromatography, Petro Mod.

Introduction

Organic–matter-rich sediments which act as source rocks in oil promising and generating basins are the result of the process of sedimentations during geological time. Conditions during sedimentation may vary, and hence quality and quantity of organic matter both in north and south Mesopotamian Basin, but this study consider as a complementary fashion for the previous studies north part of Iraq with the same reservoirs situated southern Iraq [1]. Jurassic marine shale and carbonates are the major sources of hydrocarbons produced in the Zagros basin and fold belt [2]. The undertaken study is an aid to resolve so many problems to determine the source of the oil in Majnoon oil field at nine oil wells Table (1), and may establish adequate, reliable data base for organic geochemical correlation between northern and southern part of Iraq, preparing and establishing, fundamental, basic and complementary geochemical fashion for the whole Iraqi regions Fig.(1).

It is of a great interest to declare that the approaches for setting up comprehensive scenario for more identification and descriptions to the Jurassic rocks in Iraq are currently obvious. Samples were virtually sent to American laboratories for various analyses.

The purpose of the current study is to evaluate the geochemical characteristics of the Jurassic and Cretaceous oils in Mesopotamian Basin.

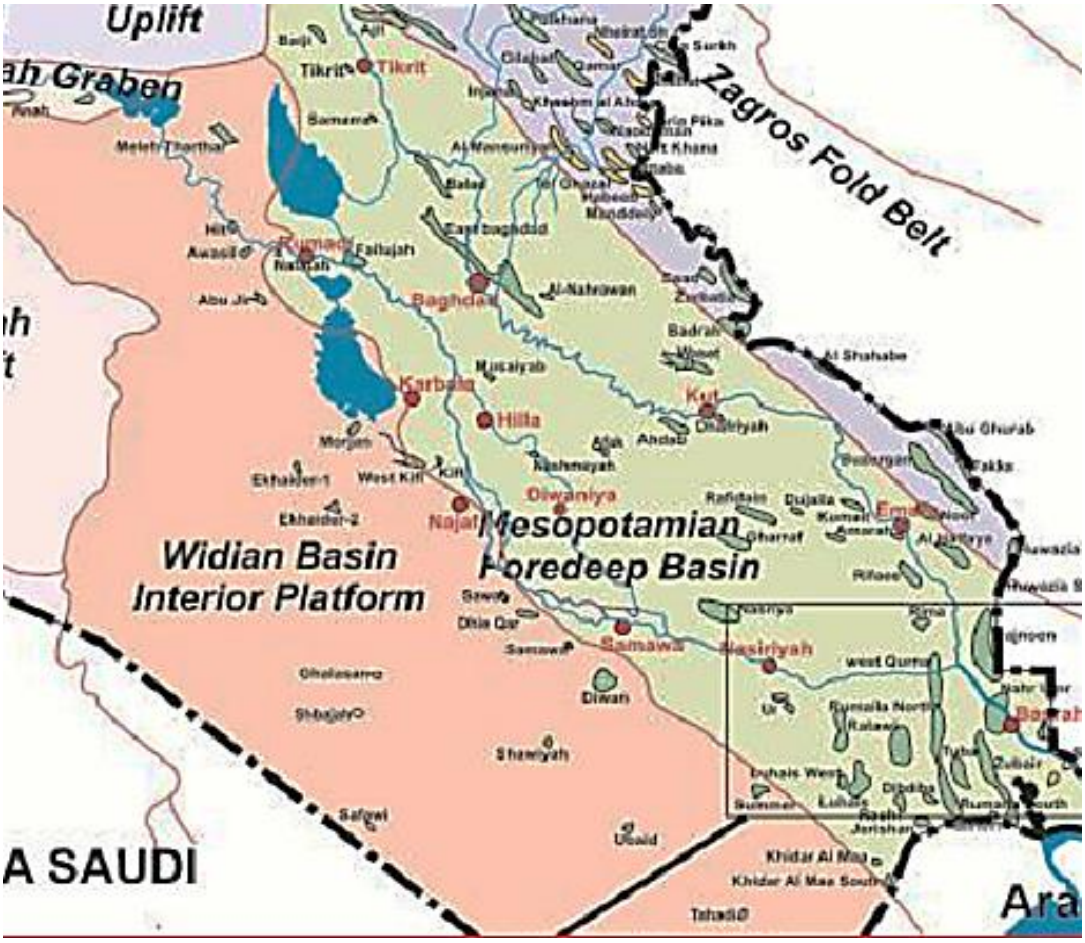


Fig.(1): Location of Majnoon oil field in Mesopotamian Fordeep Basin modified from (Pitman, 2004).

Geologic Setting

Structural and Tectonic Setting:

Majnoon oil field is a north–south anticlinal structure located in southern Iraq about 60 Km North West Basra. The length of structure is approximately 50Km, while its width is approximately 11Km. It covers a surface of approximately 400 Km^2. The area of Majnoon Oil Field lies within Zubair subzone of Mesopotamian zone as in Fig.(1) [3][4]. The Cretaceous sediments of the Mesopotamian Basin are one of the richest petroleum systems in the world. These are overlain by multiple, tight carbonate and shale seals. Potential source rocks charging these reservoirs are either associated within the same major sequence or group, particularly in the lower and middle Cretaceous, or are older, such as the Upper Jurassic Naoklekan and Sargelu formations Northern part of Iraq and Sargelu Formation southern part of Iraq. Either local factors effect on Mesopotamian basin is salt diapirism and movement of basement [5], [6], [7], [8], [9] and [10]. Regionally, Basra area lies on the stable shelf of the Mesopotamian basin. It is characterized by the occurrence of gently elongated anticlines and dome-like structure. The anticlines structure like

Ruamila, Zubair, Ratawi and Nahr Umr – Majnoon are north- south. The Majnoon structure is situated in the eastern edge of the Basra area, not far from the western limit of Zagros orogeny belt. Both structures Majnoon in the north and Nahr Umr in the south are individual culminations in a major north–south trend. The area of study illustrates tremendous intensive tectonic activity forming folded zone within Mesopotamian basin Fig.(1). In particular, Jurassic geologic conditions of the Arabian subcontinent resulted in deposition of the following ideal sequence of facies in Cretaceous and Neogene rock units and excellent seals which could ultimately accumulate oil primary petroleum system elements; thick oil – prone source rocks, 100-200m in north Iraq meanwhile in south part the thickness attain to more than 300m and extend from north to south Iraqi continent.

Extensive reservoir and gas in huge reservoirs that extended in all parts of Iraq Fig.(2) [2]. In latest Toarcian time renewed differential subsidence occurred in the Mesopotamian Basin in Iraq and South west Iran with the onset of deposition of euxinic marine carbonate source rocks. Passive margin condition along the Arabian plate during the Jurassic through late Cretaceous periods produced a broad stable shelf environment. Flooding of this platform in warm equatorial latitudes allowed for continued deposition of shallow-marine carbonates over the greater Arabian basin [10], [11]. Late Jurassic differential subsidence and sea level rise resulted in the formation of broad, intra shelf sub – basins, these intra shelf sub – basins were depocenters for the main Jurassic rocks (upper Jurassic) [8].

Reservoirs

Cretaceous reservoirs are abundant; especially in south Iraq are Nahr Umr and Mishrif, and others forming supergiant oil fields in south Iraq.

Nahr Umr Formation

The Nahr Umr is a significant oil reservoir in south Iraq [4]. The Nahr Umr Formation is a sand–dominated clastic unit in the West and SW and shale –dominated in the East; it passes laterally into the Upper Sarmord Formation in North Iraq. It is equivalent to the important Burgan Formation of Kuwait. The formation has a gradational contact with the overlying Mauddud Formation; in the Majnoon field 40% of the Nahr Umr Formation comprises carbonate beds. The maximum thickness of the formation is around 250 m in South Iraq.

The porosity of the formation ranges from 16 to 23.3% (averaging 21%); permeability ranges from 20 to 3000 md (averaging about 200md). The API oil gravity ranges from 20 to 35° (averaging about 28°) and sulphur ranges from 0.92 to 3.7 % (averaging about 2%) [4].

Mishrif Formation

The Mishrif Formation is best developed as a thick rudist builds ups over structure highs in South Iraq, specifically in the eastern Mesopotamian Zone.

The formation comprises repeated cycle of backreef/ lagoonal sediments and rudist banks [12] .Other banks also developed a long the West side of the Mesopotamian zone, especially near Kifl. Oil in the Mishrif Formation reservoir is confirmed in 32 structures in northern, central and South Iraq. High net reservoir thickness is best developed within the rudist banks of East Mesopotamia. Porosity is up to 22% and averages 15%.

Permeability ranges from 23 to 775 md and is generally good. The API gravity of the oil in the Mishrif average permeability of 13 md is recorded from the Sufaiyah field in NW Iraq, but is locally much higher .The API gravity of oil varies from 14° to 63° (average ~25). The API gravity is highest in the Cham Chamal field of NE Iraq .The Sulphur content varies from 0.14 and 4.3 % [4] Fig.(2).

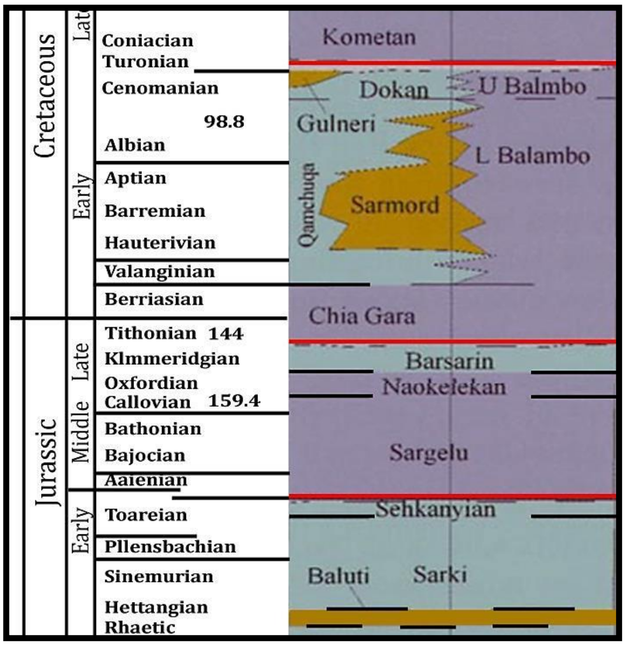


Fig.(2): Stratigraphic section of the studied area and formations (Jassim, 2010).

Samples and Methods

A total of 18 oil samples were collected from Majnoon Oil field within Mesopotamian Foredeep Basin. Crude oils were treated to remove asphaltenes by precipitation with n-pentane, and the maltenes fractioned by liquid column chromatography (silica gel), using n- Pentane, and methanol and methylene dichloride into aliphatic hydrocarbons, aromatic hydrocarbons and NSO components. Silicate column were used for rapid isolation of branched–cyclic alkanes from aliphatic hydrocarbons by elution with n-pentane.

Stable carbon isotopic compositions of saturate and aromatic hydrocarbon fractions were determined, and the branched/ cyclic fractions were analyzed by gas chromatography (GC) and gas chromatography–mass spectrometry (GC-MS).

Oil samples are analyzed in the laboratories of GeoMark Research Inc. Houston Texas. Fig.(3), and rock samples analyzed in Oklahoma.

Pyrolysis data (S1+S2, PI and Tmax) were obtained using a pyran Level 1-FID system. S1 was obtained from the volatilization of Liquid hydrocarbons at 300°C. The thermal cracking of residual organic matter was performed at 300-600°C with a 25°C/min temperature gradient and hydrocarbons released as peak S2. The production index (PI) is defined as the ratio S1/(S1+S2).The hydrocarbon index (HI) corresponds to the quantity of pyrolyzable organic compounds from S2 relative to the total organic carbon (TOC) in the sample (mg HC/g TOC; [14]. The temperature at which the maximum amount of S2 hydrocarbons is generated is known as Tmax .TOC values for the source rocks were determined using a Leco CR-12 carbon determinate.

Table (1)
Location of oil wells at Majnoon oil field.

Well No.	Geographic Coordinate – decimal	
	Longitude	Latitude
MJ-2	47°38′20″	31°1′22″
MJ-3	47°34′45″	31° 4′35″
MJ-4	47°37′14″	31°6′20″
MJ-8	47°37′0″	31°3′55″
MJ-9	47°36′38″	31°5′14″
MJ-11	47°36′7″	31°10′32″
MJ-12	47°35′51″	31°2′3″
MJ-15	47°38′43″	31°0′3″
MJ-19	47°35′52″	31°9′5″

Biomarker and non-biomarker geochemical parameters are best used together to provide the most reliable geologic interpretations to help solve exploration, development, production and environmental problems, so the (S1) values which represent the free hydrocarbons C-1 to about C-23 thermally librated at 300°C isotherm. As quantity represent the migrated hydrocarbons of immature sediments (oil and gas shows).

The (S2) represents hydrocarbons cracked from kerogen or from C24+ bitumen's hydrocarbons if buried deeper.

S1+S2 is the total genetic potential in mg Hc/ gm rock.

It is less than 2 for poor source rock, 2-5 for fair, 5-10 for good, and > 10 for very good (3).

The S1 values ranged from 0.41-2.16 mg Hc/ g rock is relatively high, this caused by no losses of extractable hydrocarbons through primary migration [13].

S1/ (S1+S2) values ranged from 0.03-0.12 indicating that substantial generation and expulsion taken place.

Table (1)
Geochemical Analysis for whole crude oils recovered from various geological formations.

Oil s.	Well no	Dept h m (m)	Formation	Pr/Ph	Pr/n -C17	Ph/n -C18	n- C27/ n- C17	CPI	δ13C (‰)			Fractions (wt%)			
									C15+ Saturate	C15+ Aromatic	C.V.	% Sat	% Aro	NSO	Sat/ Aro
1	MJ-18	2167	Hartha	0.88	0.26	0.38	0.17	1.107	-27.51	-27.53	- 3.17	22.5	52.7	12.3	0.43
2	MJ- 1	2263	Hartha	0.85	0.21	0.33	0.09	0.954	-27.68	-27.64	--2.98	21.3	41.2	14.9	0.52
3	MJ-3	2767	Mishrif	0.83	0.24	0.36	0.14	0.864	-27.52	-27.63	-3.36	24.4	51.6	13.5	0.47
4	MJ-10	2641	Mishrif	0.97	0.31	0.43	0.12	0.899	-27.46	-27.60	-3.45	20.6	53.3	15.6	0.39
5	MJ-9	3171	NahrUmr	0.94	0.27	0.36	0.15	0.945	-27.52	-27.62	-3.34	23.4	49.0	14.7	0.48
6	MJ-15	3671	Zubair	0.77	0.21	0.34	0.15	0.856	-27.62	-27.69	-3.24	3.9	48.2	15.2	0.50
7	MJ-11	3175	NahrUmr	0.79	0.21	0.33	0.14	0.932	-27.67	-27.72	-3.18	22.0	48.6	12.2	0.45
8	MJ-2	3291	Nahr Umr	0.84	0.25	0.36	0.18	0.871	-27.64	-27.62	-3.04	23.1	48.2	15.5	0.48
9	MJ-2	3563	Zubair	0.75	0.19	0.31	0.17	0.910	-27.81	-27.68	-2.74	26.2	42.1	14.2	0.62
10	MJ_11	4430	Sulaiy	0.88	0.22	0.33	0.08	0. 890	-27.59	-27.74	-3.43	22.3	45.7	16.7	0.49
11	Mj-2	3250	Nahr Umr	0.75	0.19	0.30	0.17	0.960	-28.12	-27.65	-1.89	35.5	39.9	13.0	0.89
12	MJ-19	3050	Nahr Umr	0.73	0.17	0.27	0.16	0.959	-28.07	-27.92	-2.62	34.4	40.4	14.7	0.85
13	MJ-10	3626	Zubair	0.84	0.21	0.32	0.16	0.920	-27.67	-27.87	-3.52	24.0	49.6	13.2	0.48
14	MJ-11	3498	Zubair	0.96	0.31	0.42	0.14	0.854	-27.36	-27.73	-3.99	19.6	49.2	18.2	0.40
15	MJ-3	3232	Nahr Umr	0.78	0.22	0.31	0.17	0.961	-27.10	-27.90	-1.90	35.0	40.0	13.5	0.87
16	MJ-3	4150	Sulaiy	0.85	0.21	0.32	0.07	0.895	-27.60	-27.75	-3.44	22.5	45.5	16.8	0.48
17	MJ-12	4250	Sulaiy	0.84	0.20	0.31	0.08	0.892	-27.60	-27.75	-3.42	22.4	45.6	16.6	
18	MJ-12	4270	Sulaiy	0.88	021	0.30	0.07	0.890	-27.62	-27.74	-3.40	22.1	45.6	16.5	

Gas Chromatography (GC)

Saturate, aromatic, and branched/ cyclic fractions were analyzed by GC using Hewlett-Packard 5890GC equipped with a 30x0.32 mm i.d.DB-1 fused silica capillary column. Rock extracts were fractionated and analyzed in a similar fashion to the oils. Representative gas chromatograms from the oils and rock extracts Fig.(4). The GC temperature conditions for whole oils were injector temperature 310℃; column temperature, initially 20˚C for 5 min and programmed at 4℃ /min to 310˚C where it was held isothermally for 43 minutes.

Temperature conditions for the saturate, aromatic and branched/ cyclic fractions were injector temperature, 310˚C; column temperature, 40˚C/min to 310˚C for 1.5min and programmed at 4˚C to 310˚C and held isothermally for 32 minutes.

Conclusion

The Pristine/Phytane (pr/ph) ratio for the oil samples of Amara Oilfield south eastern Iraq Typically pr/ph ratio<1 are taken to indicate an anoxic depositional environment, particularly when accompanied by high prophyrin and sulphur contents, typical of carbonate source rocks [14] shown in Fig.(4).

High Temperature (HT) Gas Chromatography

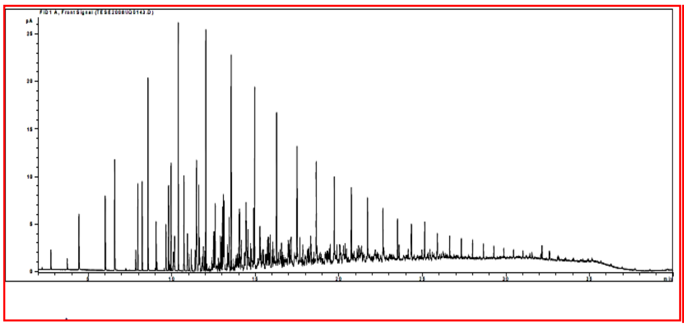
Whole oils were also analyzed by HTGC using a **Carlo Erba-GC 8000** with an on-column injector equipped with a SGE HT-5 fused silica capillary column (25m x 0.32-mm i.d.) The oven temperature was programmed from 40˚C to 370˚C at 4˚C /min, with flame ionization detector temperature set at 380˚C (total run time of 120 min).

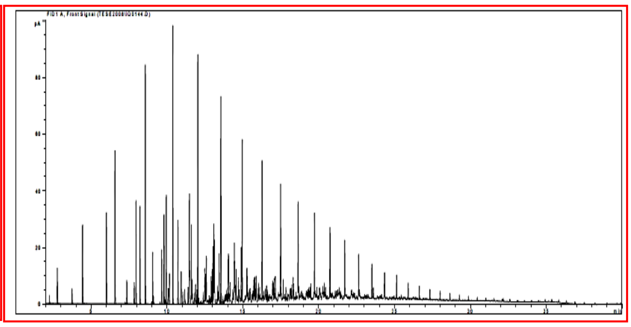
GAS CHROMATOGRAPHY

Field: Majnoon

Hartha Formation

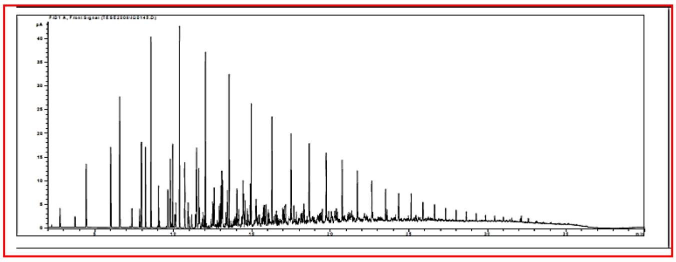
Majnoon-18 (MJ-18) Depth (2167) m Majnoon-1(MJ-1) Depth (2263) m
Pr/Ph= 0.88 Pr/Ph= 0.85
Pr/n-C17= 0.26 Pr/n-C17= 0.21
Ph/n-C18= 0.38 Ph/n-C18= 0.33
n –C27/n-C17= 0.17 n-C27/n-C17= 0.
CPI= 1.107 CPI= 0.954

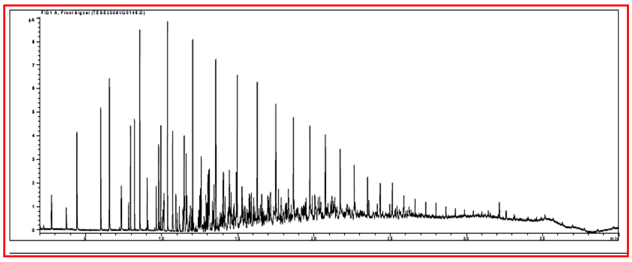




Mishrif Formation

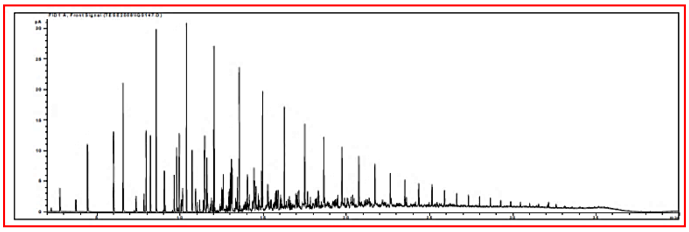
Majnoon-3(MJ-3) Depth (2767) m Majnoon -10 (MJ-10) Depth2641) m
Pr/Ph= 0.83 Pr/Ph= 0.97
Pr/n-C17= 0.24 Pr/n-C17= 0.31
Ph/n-C18= 0.36 Ph/n-C18= 0.43
n-C27/n-C17= 0.14 n-C27/n-C17= 0.12
CPI= 0.864 CPI= 0.899

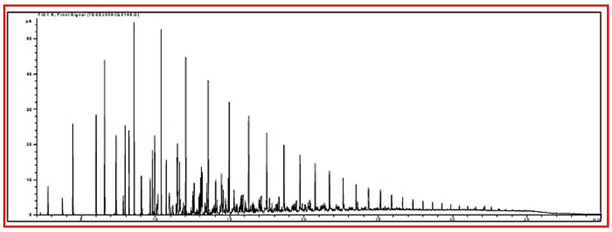




Nahr Umer Formation **Zubair Formation**

Majnoon-9 (MJ-9) Depth (3171) m Majnoon-15(MJ-9) Depth (3671) m
Pr/Ph= 0.94 Pr/Ph= 0.77
Pr/n-C17= 0.27 Pr/n-C17= 0.21
Ph/n-C18= 0.36 Ph/n-C18= 0.34
N-C27/n-C17= 0.15 n-C27/n-C17= 0.15
CPI= 0.945 CPI= 0.856





Nahr Umer Formation

Majnoon-11(MJ-11) Depth (3157)m Majnoon-2 (MJ-2) Depth (3291)m

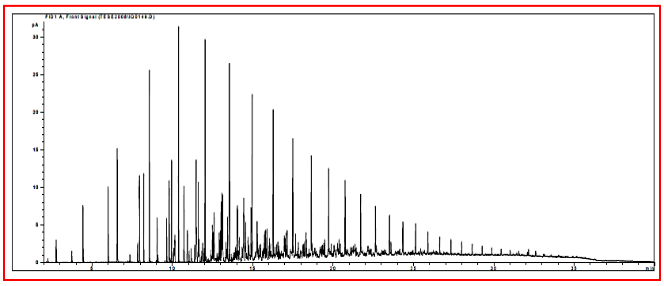
Pr/Ph= 0.79 Pr/Ph= 0.84

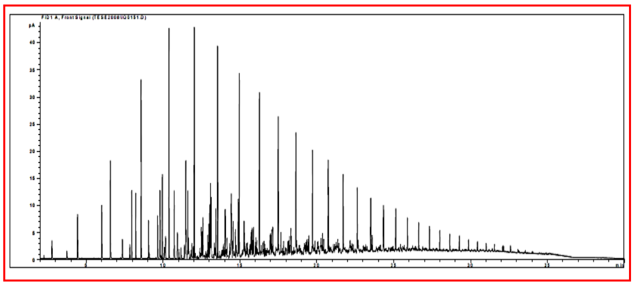
Pr/n-C17= 0.21 Pr/n-C17= 0.25

Ph/n-C18= 0.33 Ph/n-C18= 0.36

n-C27/n-C17= 0.14 n-C27/n-C17= 0.18

CPI= 0.932 CPI= 0.871





Zubair Formation Sulaiy Formation

Majnoon-2(MJ-2) Depth (3563) m Majnoon -11(MJ-11) Depth (4430)

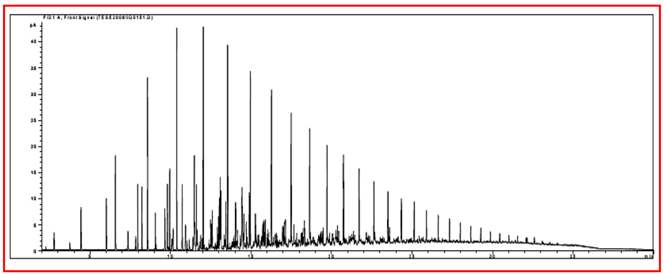
Pr/Ph= 0.75 Pr/Ph= 0.88

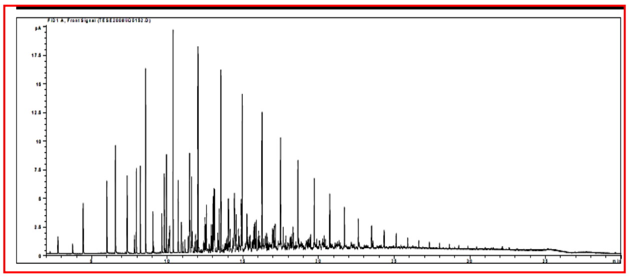
Pr/n-C17= 0.19 Pr/n-C17= 0.22

Ph/n-C18= 0.31 Ph/n-C18= 0.33

N-C27/n-C17= 0.17 n-C27/n-C17= 0.08

CPI= 0.910 CPI=





Nahr Umer Formation

Majnoon-2 MJ-2 Depth (3250) m Majnoon -19 MJ-19 Depth (3050) m

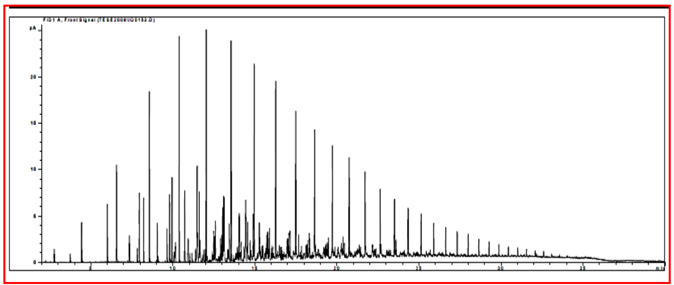
Pr/Ph= 0.75 Pr/Ph= 0.73

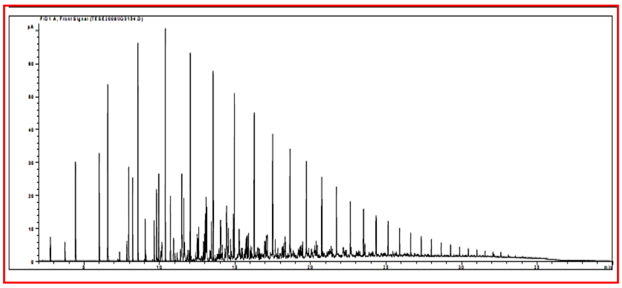
Pr/n-C17= 0.19 Pr/n-C17= 0.17

Ph/n-C18= 0.30 Ph/n-C18= 0.27

n-C27/n-C17= 0.17 n-C27/n-C17= 0.16

CPI= 0.960 CPI= 0.959





Zubair Formation

Majnoon -10 (MJ-10) Depth (3626)m Majnoon -11 (MJ-11) Depth (3498)m
Pr/Ph= 0.84 Pr/Ph= 0.96
Pr/n-C17= 0.21 Pr/n-C17= 0.31
Ph/n-C18= 0.32 Ph/n-C18= 0.42
n-C27/n-C17= 0.16 n-C27/n-C17= 0.14
CPI= 0.920 CPI= 0.854

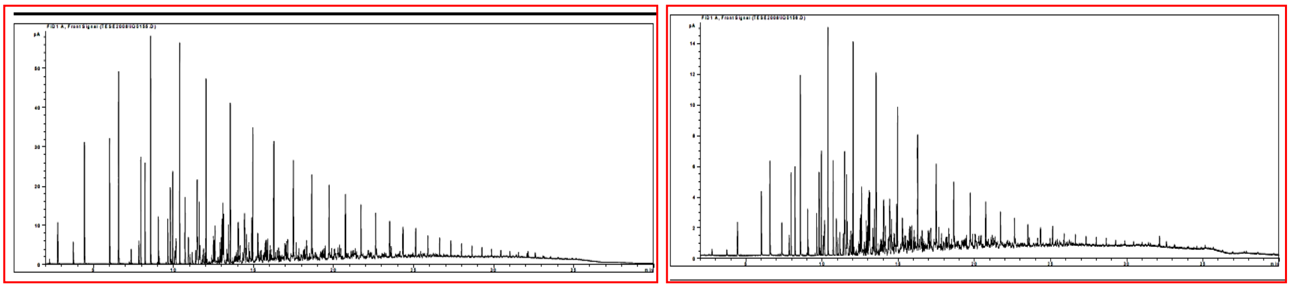


Fig.(3): Gas chromatograms for representative oils.

Gas Chromatography-Mass Spectrometry (GC-MS):

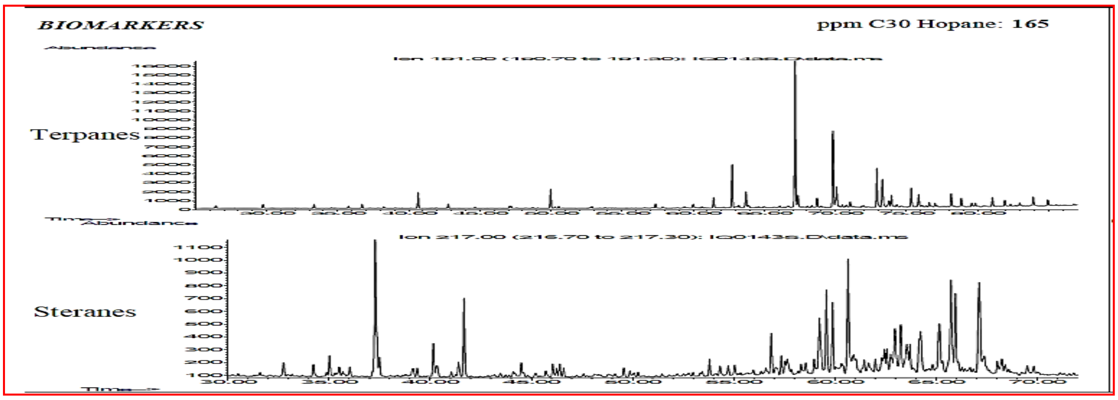
GC-MS analyses were investigated, to determine the distribution of Steranes and Terpanes, performed in both GeoMark Research Inc. and labs. of Oklahoma University, including Bulk Carbon Isotope determination.

GC-MS analyses were performed to determine the distribution of steranes and terpanes using a FinniganTSQ-70 interfaced to a Varian 3340 GC and equipped with a 30 x 0.32 mm i.d. fused silica DB-5MS capillary column. The GC conditions were injector temperature, 310˚C, column temperature, 40˚C for 1.5 min and programmed at 4˚C/min to 310˚C where it was held isothermally for 31 minutes. The ion source temperature was 200˚C; electron energy and emission current were -70 eV and 200 µA, respectively.

Conclusion

Fingerprints of whole crude determine highly corresponds to all previous studies that refer to Sargelu Formation as the most dominance of source rocks both in North and South part of Iraq.

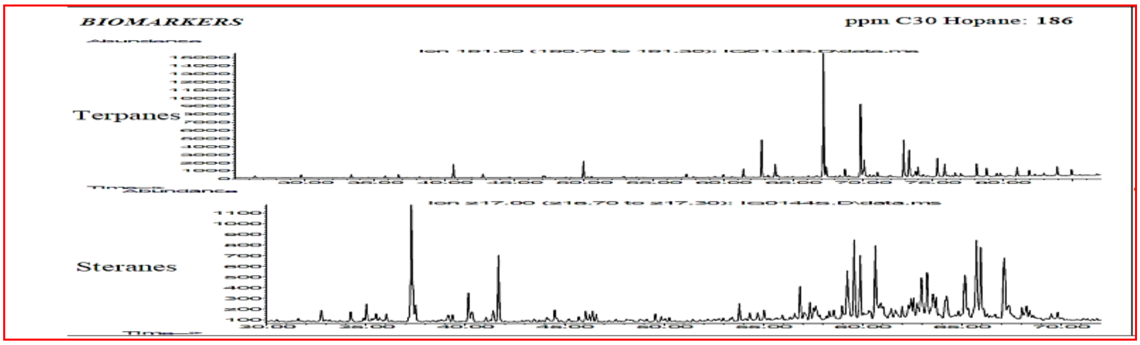
The Projected Source Rock Type is marine carbonate defiantly refer to Jurassic Age and the indication of Thermal Maturity Level is lower maturity with the Degree of Biodegradation referring to nondegraded.



LAT: 32.19 **LONG: 47.52**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic

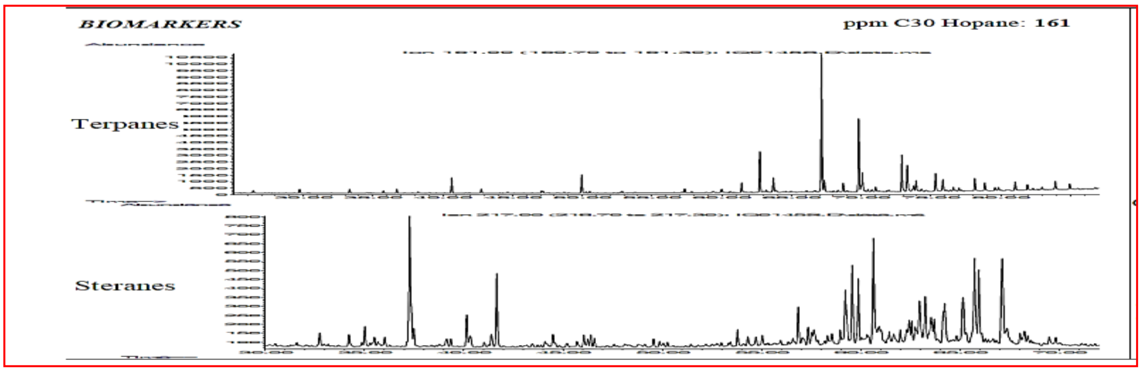
Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegraded



LAT: 32.058 **LONG: 47.445**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic

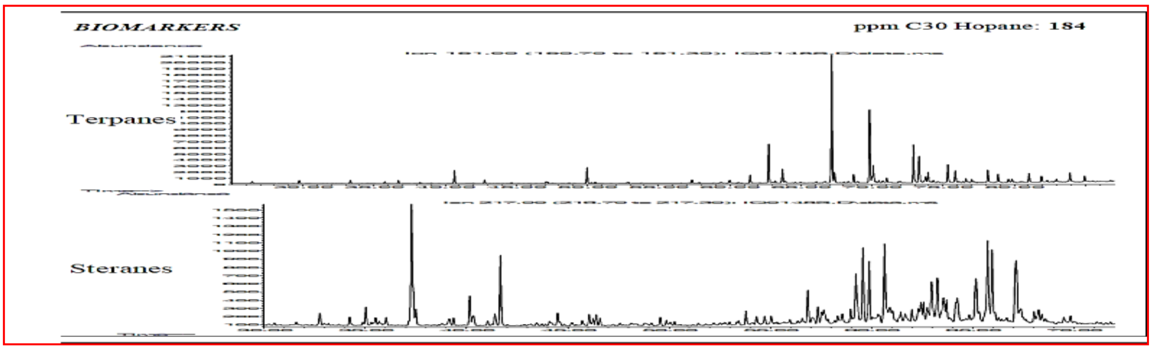
Thermal Maturity Level: moderate maturity ***Degree of Biodegradation:*** nondegraded



LAT: 32.104 **LONG: 47.569**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic

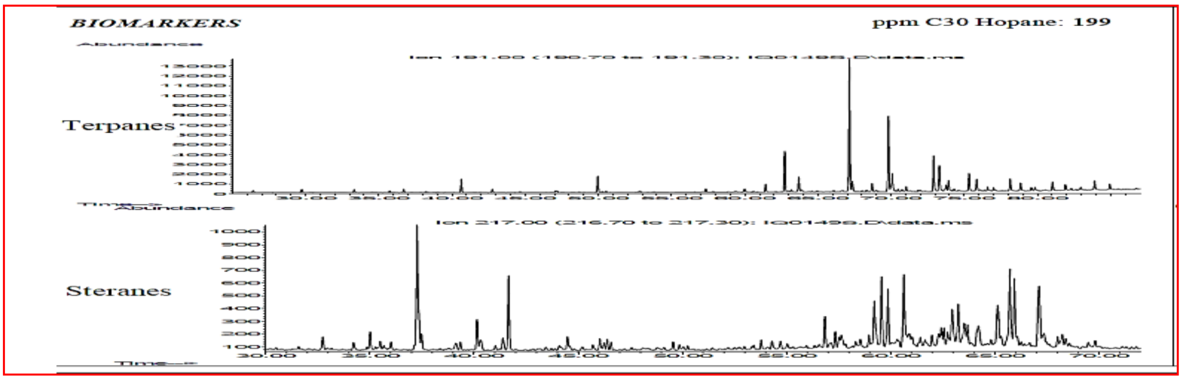
Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegrade



LAT: 32.104 **LONG: 47.569**

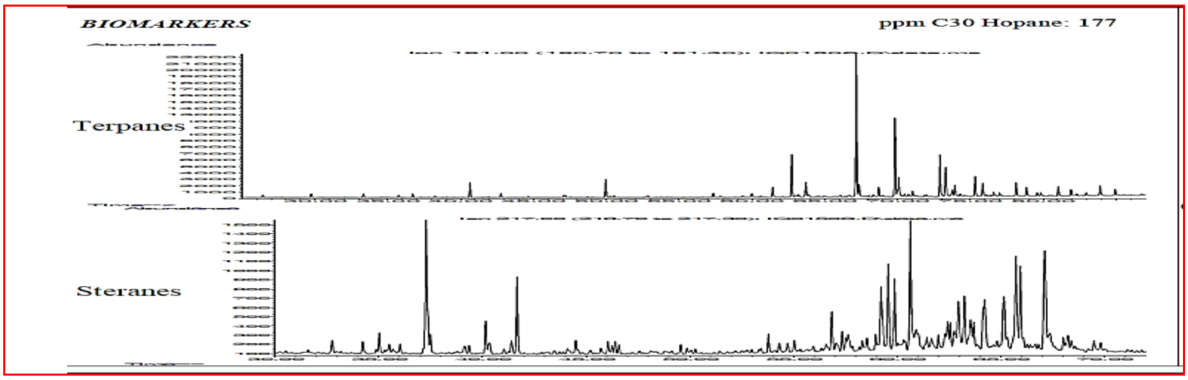
Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic

Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegraded



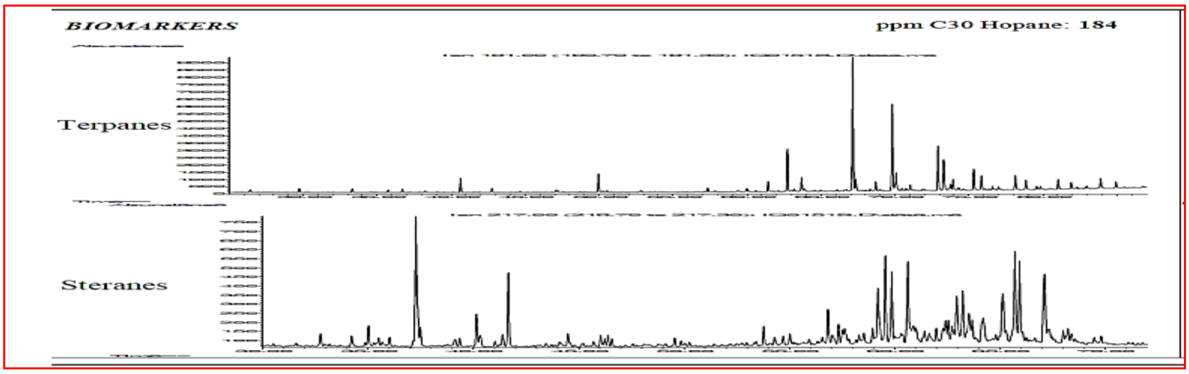
LAT: 32.45 **LONG 47.299**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic
Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegraded



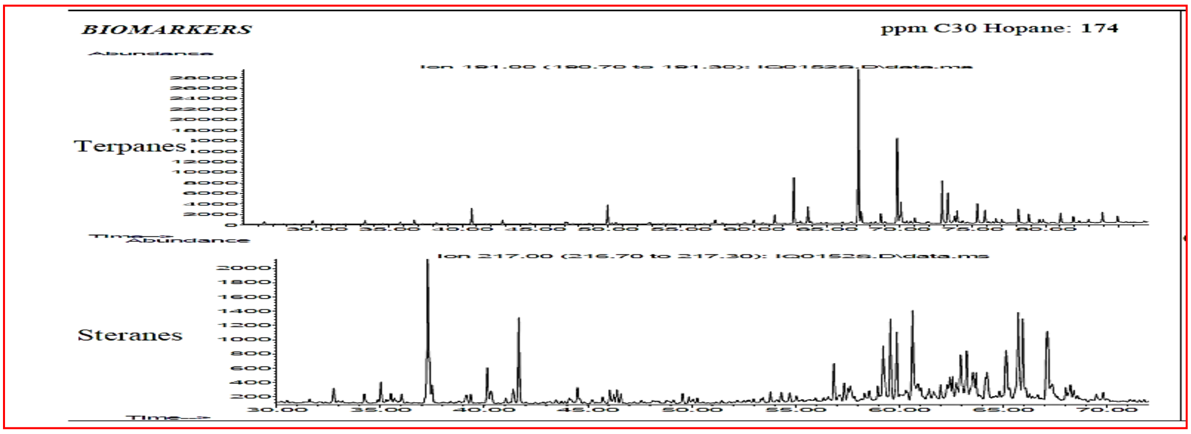
LAT: 32.103 **LONG: 47.571**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic
Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegraded



LAT: 31.665 **LONG: 47.439**

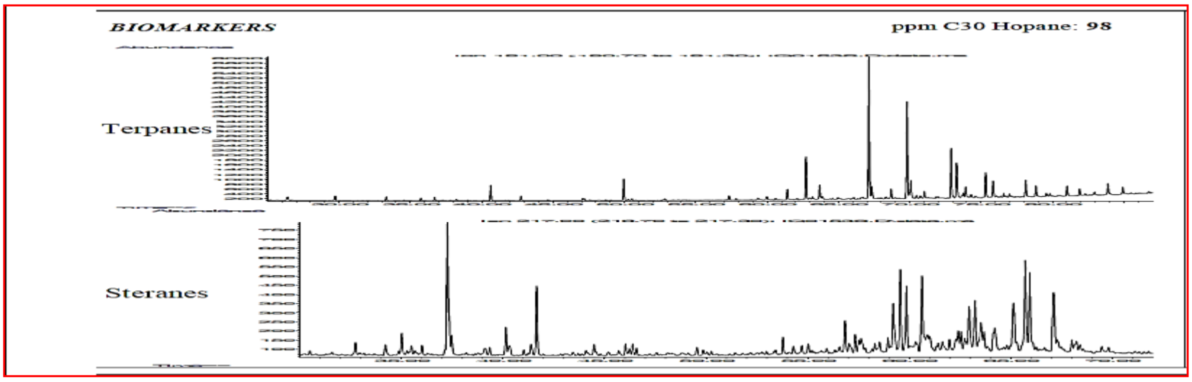
Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic
Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegrad



LAT: 32.466 **LONG: 47.278**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic

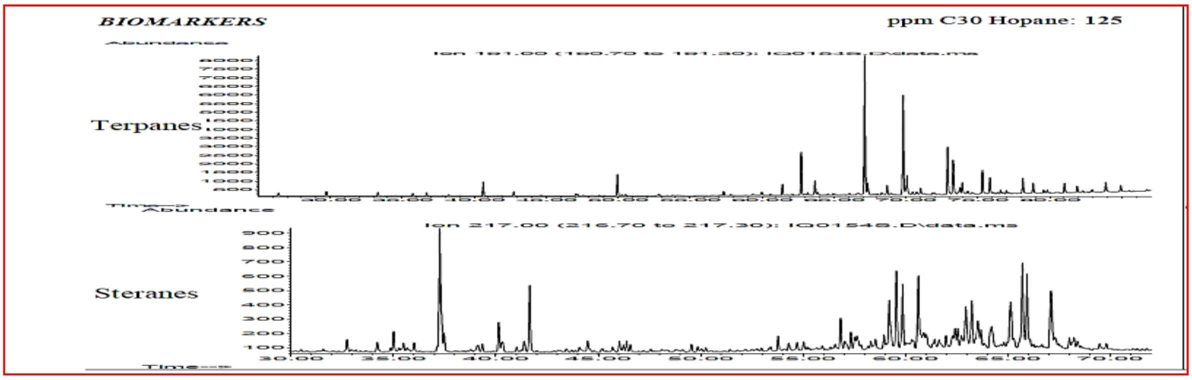
Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegrad



LAT: 32.162 **LONG: 47.522**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic

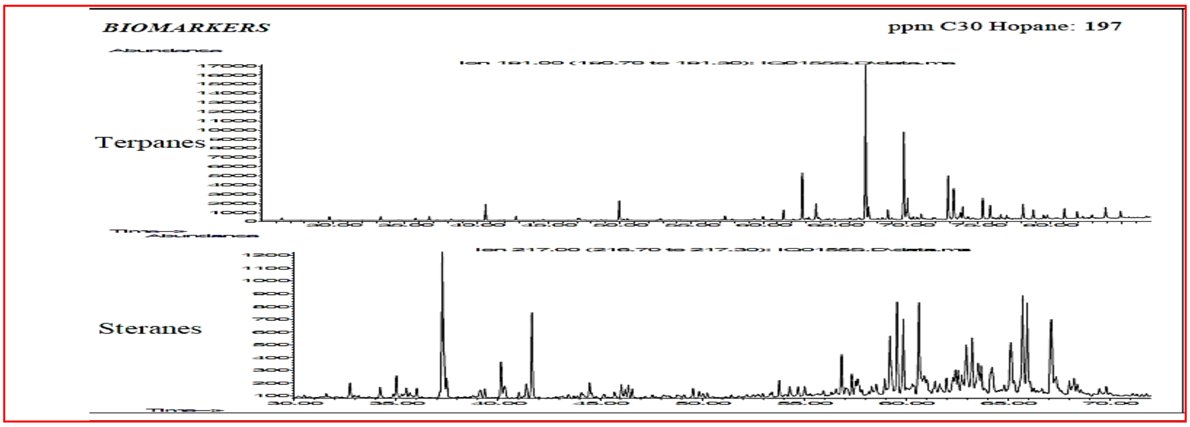
Thermal Maturity Level: moderate maturity ***Degree of Biodegradation:*** nondegraded



LAT: 31.665 **LONG: 47.439**

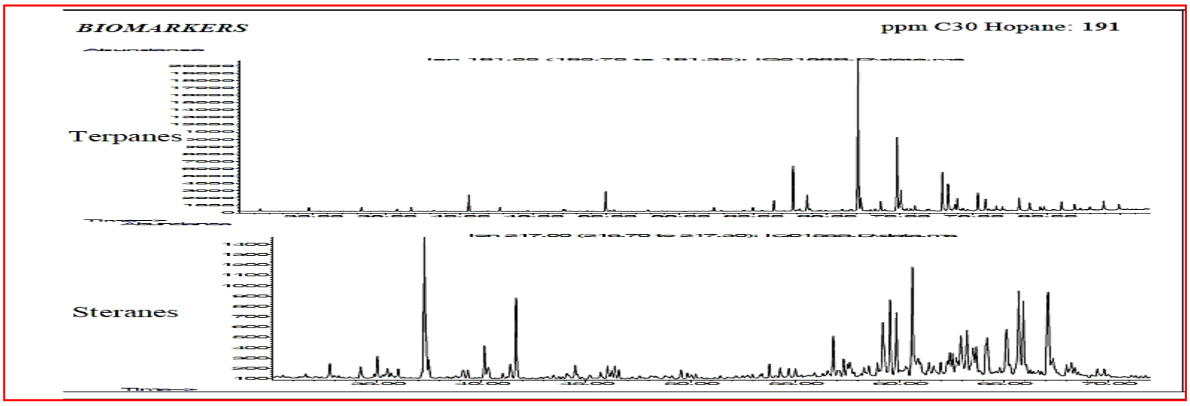
Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic

Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegraded



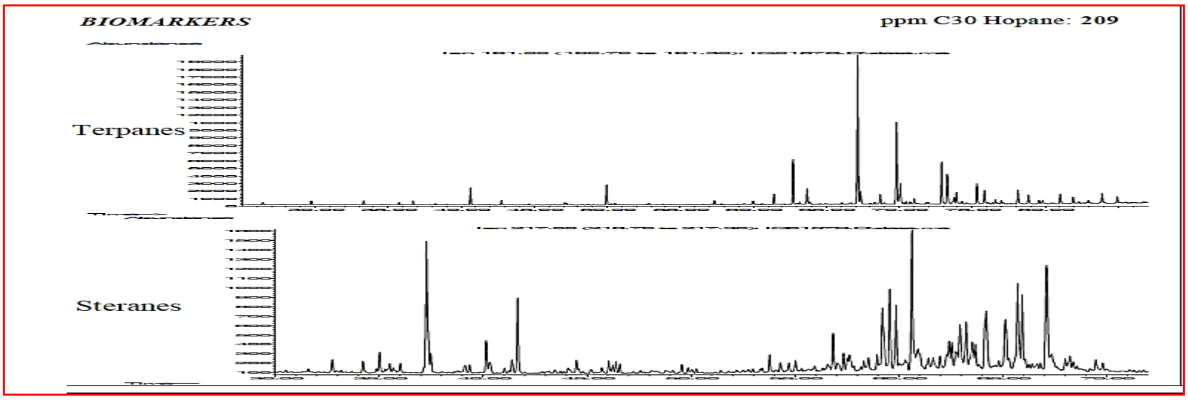
LAT: 31.664 **LONG: 47.465**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic
Thermal Maturity Level: moderate maturity ***Degree of Biodegradation:*** nondegraded



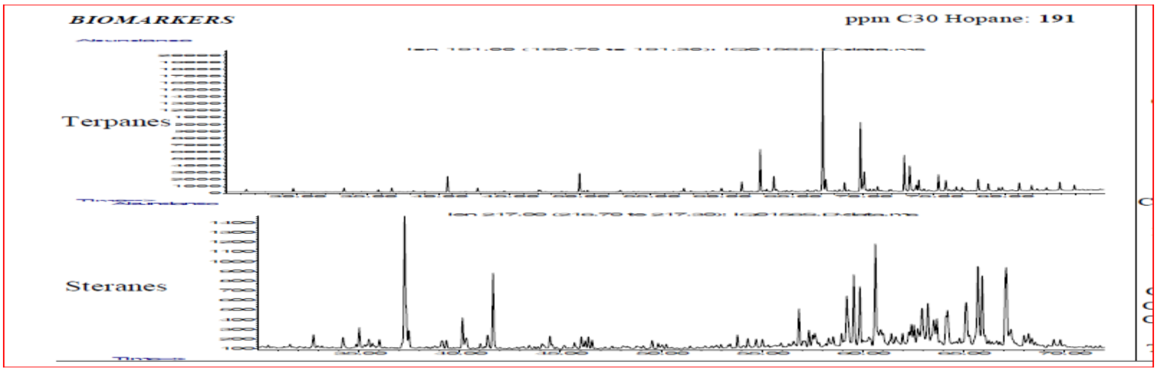
LAT: 31.76 **LONG: 47.06**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic
Thermal Maturity Level: moderate maturity ***Degree of Biodegradation:*** nondegraded



LAT: 32.07 **LONG: 47.42**

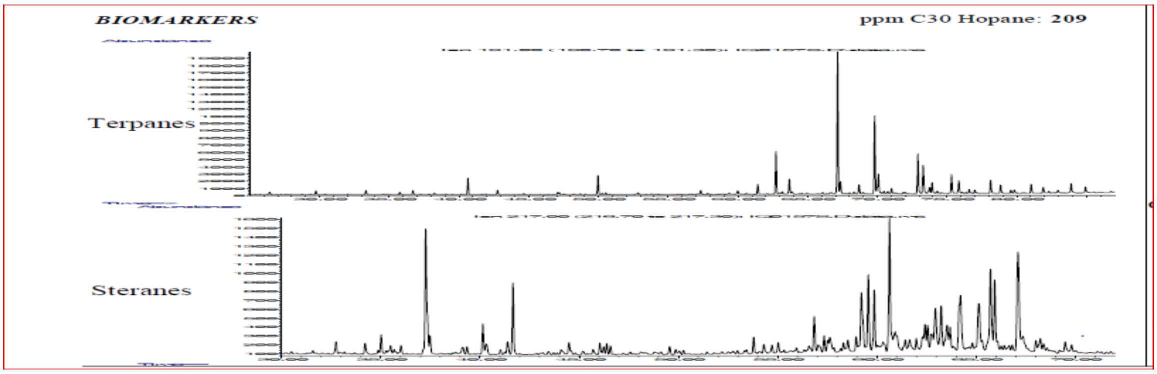
Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic
Thermal Maturity Level: moderate maturity ***Degree of Biodegradation:*** nondegraded



LAT: 32.1 **LONG: 47.57**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic

Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegraded



LAT: 32.441 **LONG: 47.329**

Projected Source Rock Type: Marine Carbonate ***Age:*** Jurassic

Thermal Maturity Level: lower maturity ***Degree of Biodegradation:*** nondegrad

Fig.(4): Gas chromatography –Mass spectrometry (GC-MS) for oil samples.

Results and Discussion

Correlations of various oil samples recovered from Majnoon oil field nearby Amara city southern Iraq. Generally become more reliable and give more accurate consequences, when more parameters are compared.

The multiparameter approach and independent measurements of biomarkers like carbon isotope data, and other genetic parameters support obvious correlation. The undertaken study is a type of advanced achievements among the kind of the studies performed previously, as the application of this type of comparisons and correlations, for the problems arise while the migrated oil exposed to so many variation while upward migration changes the main characteristics of the oil, this may lead to misleading in determination for accurate results and serious consequences took place.

Carbon isotope data

The stable carbon isotopic composition of organic matter is an important tool with which to differentiate algal and land plant source materials and marine from continental depositional environments.[15] concluded that the stable carbon isotope values of crude oils are dependent mainly on the depositional environment of the source rock and the degree of thermal maturity at which the oil was expelled. The carbon isotopic signature of bitumen is relatively heavy for predominantly higher plant sourced oil. Carbon isotope ratio of whole oils by themselves are generally not used for correlation because of the narrow range in δ13C values for all oils of about 15‰ (-18 to-33‰).

In fact, most oils are concentrated between -25 and -31‰, which causes considerable overlap. Consequently, oil–to–oil correlation are usually made using cross plots of carbon and hydrogen isotopes or by comparing oil fractions [16], found that the crude oils of Lower Congo coastal Basin of Angola overlapped in δ13C values .They separated them into two different genetic groups ,however, by using a cross plot of δ13C versus δ2H [13].The oils were nicely separated into two groups by plotting δ13C of the aromatic – versus–saturated hydrocarbons [15], compared the δ13C of the C15 + aromatic and saturate fractions of 339 oils and concluded that such plots could be used to distinguish oil families and to infer a marine (nonwaxy) versus a terrestrial (waxy) source [17].

The isotopic relationship developed by sofer (1984) is as follows:

For marine source: δ13C ARO =1.10 δ13C SAT + 3.75 (nonwaxy oils)

For terrestrial source: δ13C ARO =1.12 δ13C SAT + 5.45 waxy oils

Terrestrial waxy oils are considered to originate from land-derived OM deposited in a lacustrine paralic, or deltaic environment, whereas nonwaxy oils are from OM deposited in open marine environments with minor contribution of terrestrial OM.

Sofer carried out a stepwise discriminate analysis excluding biodegraded oils to determine the best straight line separating the two group's. It is

δ13C ARO = 1.14 δ13C SAT = 5.46 [13].

So the bulk isotopic compositions of the saturate and aromatic fractions of crude oils have long been used for correlation purposes. Fig.(2). The results in this study, Table (3), shows approximate values between C15+ Saturates and C15+ Aromatics providing good supporting Isotope profiles should be compared between oils that are at about the same maturity level based on biomarkers or other maturity indicators [18]. This is necessary because thermal maturation causes the Interpreting isotope profiles requires an understanding of not only thermal maturation but also other factors, such as biodegradation and water washing.

Isotopic Analysis of Sedimentary Organic Matter

Rock samples that had been powdered in a ball mill for liberation of residual gas were used for elemental analyses and stable isotope ratio determinations. Before analyses, rock powders were treated with 2N hydrochloric acid at room temperature to decompose carbonates, followed by thorough washing with deionized water and freeze drying. The TOC and total nitrogen contents and isotopic compositions of TOC and total nitrogen in terms of customary δ^{13}C and δ^{15}N values in parts per thousand (0%) were determined in continuous flow with an elemental analyzer attached to a Thermo Finnigan Delta Plus XP isotope ratio mass spectrometer (EA-IRMS, Indiana University). Normalizations of isotopic scales were accomplished with international measurement standards NBS 19, L-SVEC, IAEA-N-1, and IAEA-N-2.Table -3.

Model Set up

Chronostratigraphic Units and Lithologies

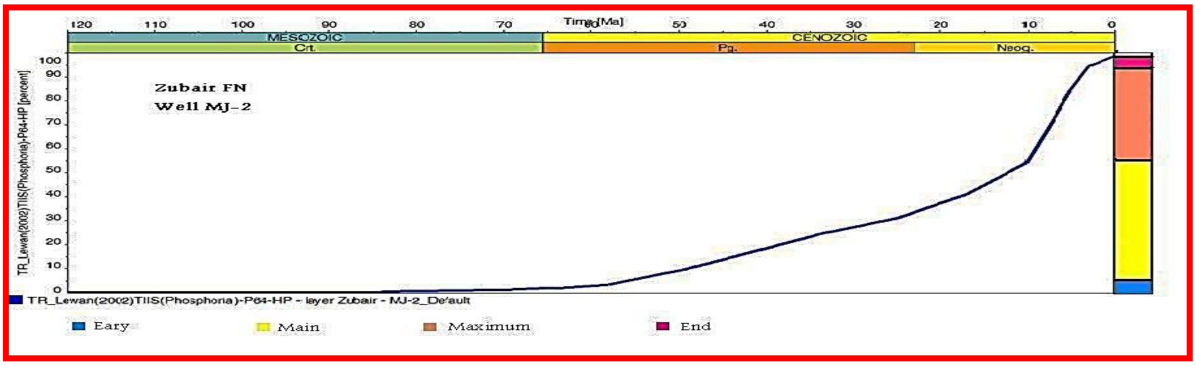
The chronostratigraphic units in the 1D model were assigned absolute ages of deposition and amounts and ages of erosion. The ages of depositional and erosional events were designated based on the geologic time scale of [19]. Lithologies represented as end-member rock types or as compositional mixtures of rock types were assigned to each unit using software default parameters.

Model Calibration

Determining the timing of petroleum generation and expulsion required calibration of the present and past thermal regime at each model location. Parameters used in the thermal calibration included heat flow, thermal conductivity of rock matrix, surface temperature and sediment thickness (present and past). Bottom-hole temperature data in combination with a geothermal gradient of 23C˚/Km [2] were used to estimate the present heat flow in the area of the wells. The resulting temperature profiles computed for the models are displayed in Fig.(3).

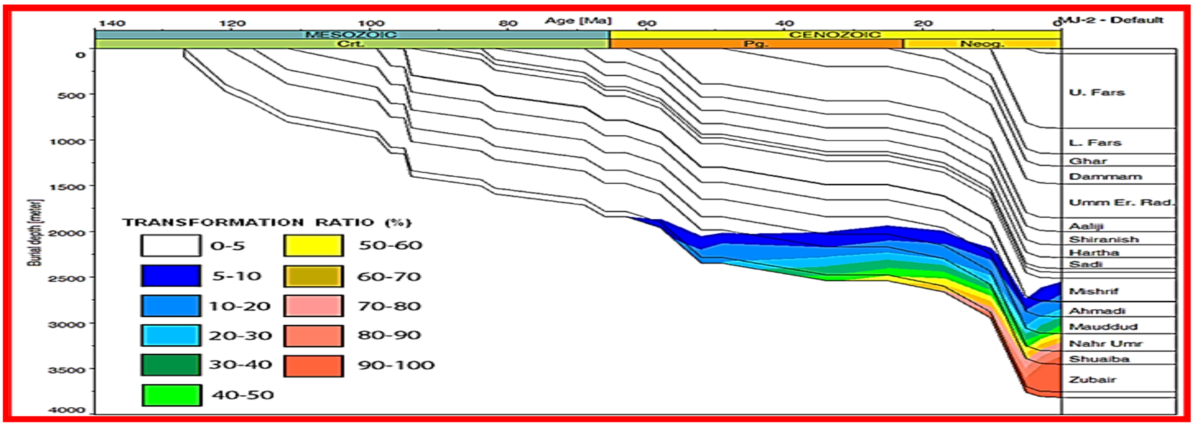
Vitrinite reflectance (% Ro) determined from Tmax values was used to evaluate the paleo thermal history at each well location. Although Ro values estimated using this method have a high degree of uncertainty, they do provide a first approximation of the effects of temperature through time. Calibration of the paleo thermal regime was based on matching

Ro values computed from Tmax with values calculated using the Easy Ro method of Sweeney and Burnham (1990) [20]. Fig.(5).

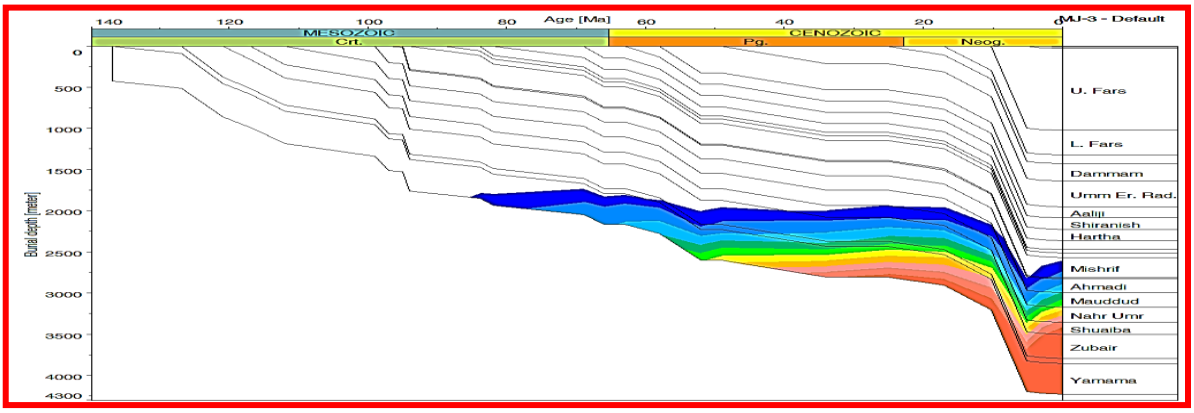


TR of Zubair Formation Well MJ-2.

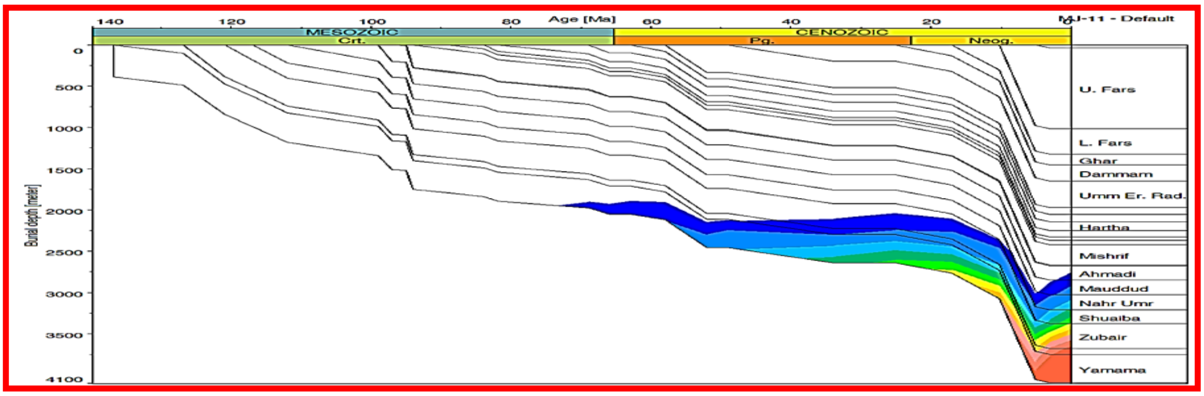
A good correlation between computed and calculated values was achieved by varying the estimated amount of erosion at each well locality and the paleoheat flow until a close match was achieved. The best calibration of the Ro data required between 1,700 and 1,900 m of erosion during the late Tertiary. It is noteworthy that pre-Tertiary erosion had little impact on source-rock maturity.



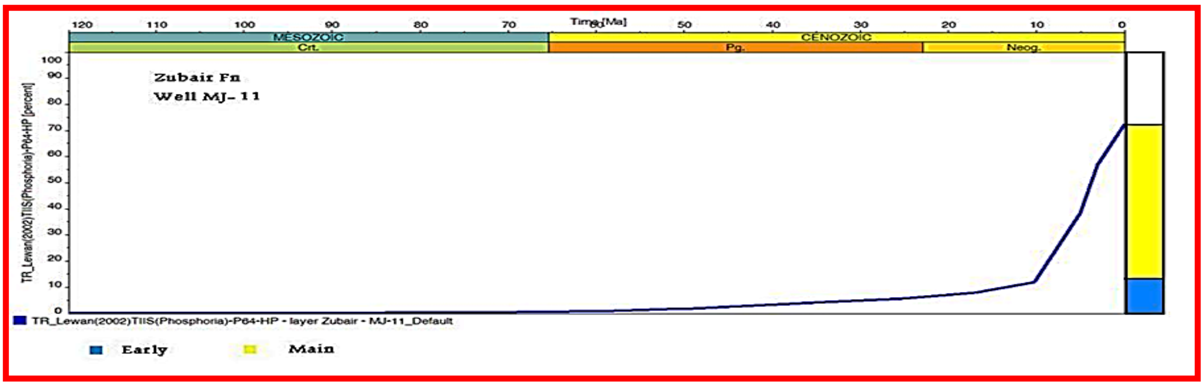
Timing and Extent of Oil Generation of Majnoon oil Field, Well MJ-2.



Timing and Extent of Oil Generation of Majnoon oil Field, Well MJ- 3.



Timing and Extent of Oil Generation of Majnoon oil Field, Well MJ-11.



TR of Zubair Formation Well MJ-11.

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الخلاصة

تحاليل الجيوكيماء العضوية وبناء موديلات تحاكي العلاقات الاحيائية بين ثمانية عشر من نماذج النفط الخام المستخلصة من تكاوين جبولوجية متعددة ومن حقول نفطية ضمن مدينة العمارة جنوب العراق وبأعماق تقريبية تبدأ من 2167- 4430 م، ومن اعمار لصخور كاربونية بحرية تعود للعصر الجوراسي المتوسط حسب التشابه الجيوكميائي مع صخور تلك الفترة والمحددة في دراسات سابقة. ان مستوى النضج يختلف بشكل نسبي لكل عينة من الواطئ الى المتوسط بئر مجنون -1 ومجنون-18 (تكوين الهارثة) وبئر مجنون-3 ومجنون-10(تكوين مشرف) ومجنون-9 (تكوين نهر عمر) ومجنون -15 ((تكوين الزبير) وبئريي مجنون- 2 و 19 (تكوين نهر عمر) ومجنون-10 و 11 (تكوين الزبير) ومجنون-3 تكوين نهر عمر ومجنون -3 (تكوين السلي) ومجنون-11 ومجنون-2 (تكوين نهر عمر) ومجنون -2 (تكوين الزبير) ومجنون-11 (تكوين السلي) من حقول النفط في مدينة العمارة. هذه النماذج توحي بالاعمار والبيئة الترسيبية القديمة للصخور المصدرية. تم جمع النماذج من مكامن الجوراسي الاعلى الى العصر الطباشيري لثمانية عشر بئرتم تطويرها حيث تحوي على احتياطي نفطي يقارب 15 بليون برميل قابل للاستخراج. كثافة النفط API لها مديات اختلاف واسعة تتراح ما بين 12,2، 39 API. اثنا عشر منها اقل من 25 درجة مما تشير الى نفط ثقيل وفقط هناك نموذج تتراوح فيه الاي بي اي ما بين 25 الى 35 درجة ويعتبر من النفوط الوسط اوالمعتدلة. Canonical Variable (C.V) بلغ (-1.89 الى 3.99). من النفط الشمعي. بالاستناد الى تصنيف تيسوت وفلته (1984) معظم النفوط يمكن ان تصنف عالية الكبريت مما يدل على انها من اصل بحري. مكون نظير الكاربون المستقر المشبع والاروماتي تكون ذات قيم متقاربة وتعطي قادت الى اعطاء دلائل جيدة على كونها من عائلة موحدة والمتمثلة بالعصر الجوراسي المتوسط (والي يمثله كصخور مصدرية جيدة هو تكوين ساركلو) المتولد من ترسبات حجر السجيل الجيري البتيوميني مع حجر الجيري حوض الرافدين. ان هذا الحوض يعتبر واحدا من اكثر الاحواض الرسوبية تميزا ومولدا وواعدا لتوليد النفط في الشرق الاوسط حسب توافر عناصر اجمالي

النظام النفطي النموذجي. ان هذه العائلة تولدت بفعل ترسب الكاربونيت البحري لصخور ساحلية متداخلة لأشباه احواض كونت مكامن من الفترات العصر الجوراسي– الطباشيري والى العصر الحديث الـ Neogene في حوض وادي الرافدين والذي يشابه من الناحية الجيوكيميائية للنفط المستخلص من عصر الجوراسي المتوسط والاعلى والمتمثل بتكوين ساركلو والناوكليكان والذي يولد معظم نفط العراق.

موديل النظام النفطي ذو الاتجاه الواحد تم انجازه باستخدام نظام Petro Mod والمطـور من نظـام الاستكشاف المتكامل (IES) والذي يظهر بوضوح تاريخ الدفن الحراري وتكوين الهيدروكاربونات لحقول مجنون Mj−2,3,4,8,9,11,12,15,19 بالاستناد الى ما اتبعته Pitman واخرون 2004.