Iraqi Journal of Science

ISSN: 0067-2904

Crude oil characterization and hydrocarbon affinity of Amarah Oil Field, South Iraq

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Abstract

Five oil sample of Mashrif and Nahr Umr Formation for Amarah oil field, southern Iraq, were taken and analyzed in Geo Mark laboratory in USA center in order to determine the bulk properties of crude oils and carbon isotopes for these samples in addition to determine biomarker parameters using Gas Chromatography(GC), and Gas Chromatography Mass Spectrometry (GCMS)analytical technique. According to these biomarker analyses of the two formation, it is indicated that they are **non-degraded**, **marine, non-waxy**, **derived from carbonate source and deposition in anoxic marine environmen**t. This study also showed that the bulk properties (terpanes and steranes) of Amarah oil field are **one family**, and the source rocks contain marine **kerogen type II**. All oil samples of Amarah oil field are from source rock refer to **Middle Jurassic age of sargelu Formation**.

Key Words: Crude, oil characterization, hydrocarbon affinity, Amarahn Oil Field.

خصائص النفط الخام وعائديه النفط في حقل نفط العمارة، جنوب العراق

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الخلاصة:

تم اخذ خمسة نماذج نفطية لتكوين المشرف ونهر عمر من حقل نفط العمارة، جنوب العراق وتم تحليلها في مختبر (Geo Mark) في مركز الولايات المتحدة الامريكية من اجل تحديد خصائص المواد النفطية السائبة ونظائر الكاربون لهذه النماذج بالإضافة الى تحديد معايير العلامات البيولوجية باستخدام تقنيه (كروماتوغرافيا الغاز)، وتقنيه (كروماتوغرافيا الغاز – طيف الكتله). ووفقا لتحاليل العلامات البيولوجية للتكوينين فقد تبين انها غير متكتلة وبحرية وغير شمعية متكونة من صخور مصدرية كاربونية ومترسبة في بيئة بحرية غير مؤكسدة. كما اشارت هذه الدراسة الى ان الخصائص السائبة في حقل نفط العمارة تعود الى عائلة واحدة، وان الصخور المصدرية تحوي نوع الكيروجين البحري الثاني. كما ان جميع العينات النفطية هي من الصخور المصدريه التي تعود الى العصر الجوراسي لتكوين الساركلو.

Introduction

Crude oil is defined as a mixture of hydrocarbons that existed in the liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities. In appearance, crude oil varies from straw yellow, green, and brown to dark brown or black in color [1]. Oil are naturally oily in texture and have widely varying viscosities. Oil on the surface tends to be more viscous than oils in warm subsurface reservoirs [2]. Crude oils are

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divided into fractions: n-alkanes, isoalkanes, cycloalkanes, mono-aromatics, di-aromatics, poly-aromatics, asphaltenes and resins.

Location and History

Amarah oil field was first discovered from seismic surveys conducted on Missan Province in late 1970's. It is about 10 Km to the south west of Amarah city, as show in Figure-1.

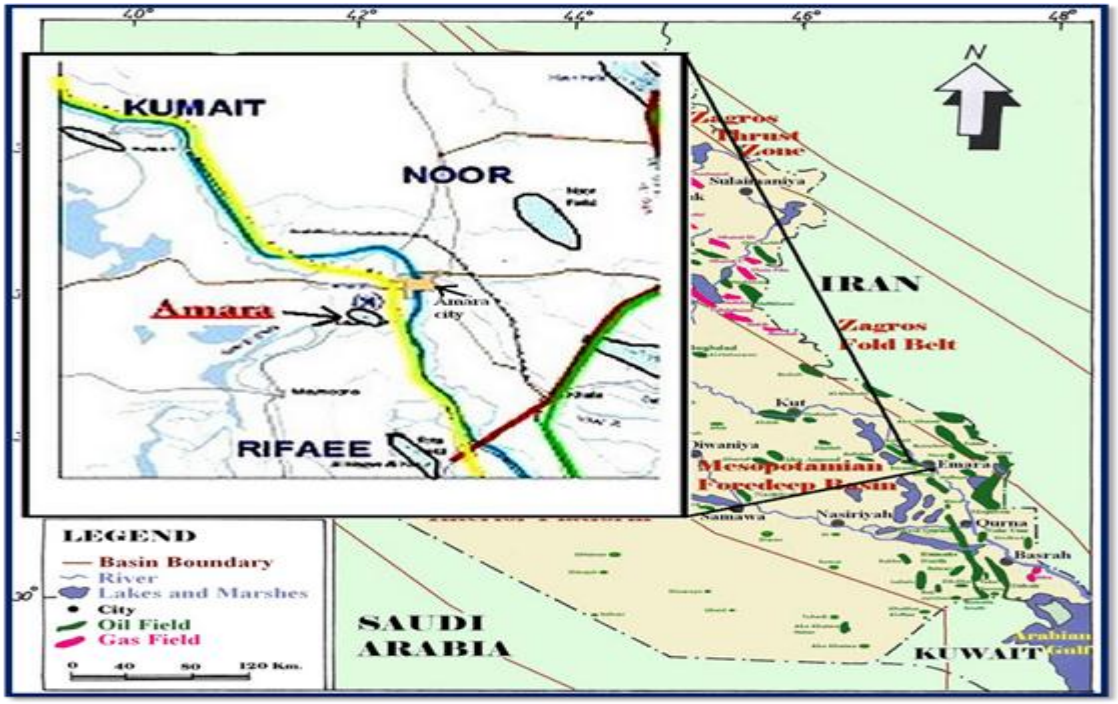

Figure 1- Location map of the study area [3].

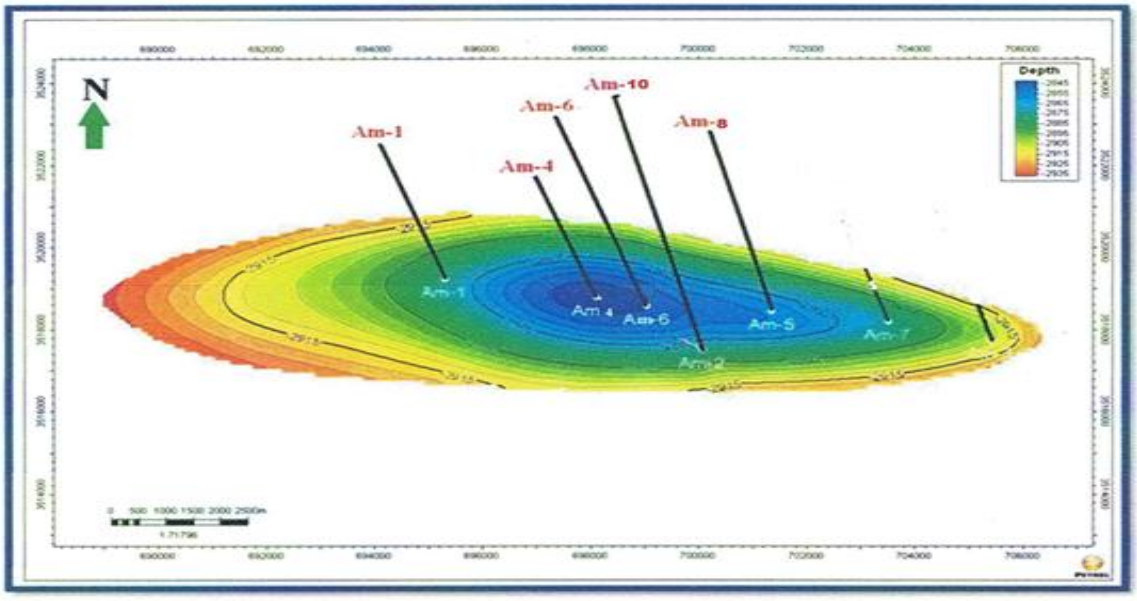

Figure 2- Structural contour map of Amara field with the locations of its wells [3].

Materials and methods

Crude oil analysis: Five oil samples of two reservoirs are analyzed in Geo Mark Laboratories Center - USA to determine the bulk properties and the carbon isotope parameters of whole crude oils in addition to biomarker parameters determination using Gas Chromatography (GC), Mass Spectrometry (MS), and GCMS analytical technique.

Classification of crude oil

The newly proposed classification is based on the content of the various structural types in crude oils (alkanes, cycloalkanes, aromatics) plus NSO compounds (resins and asphaltenes) and the distribution of the molecules within each type. It also takes into account the sulfur content [4]. The main classes of crude oils are:

- Paraffinic class: crude oils will be considered as paraffinic, if the total content of saturated hydrocarbons is over 50% of a particular crude oil, paraffins content is more than 40%, naphthenes is less than 50%. The amount of asphaltenes plus resins is below 10%, and sulfur content is less than 1%.
- Paraffinic – naphthenic class: the class paraffinic – naphthenic oils have a moderate resin plus asphaltenes content (usually 5 to 15%) and a low sulfur content (0 to 1%). Aromatics amount (25 to 40%) of the hydrocarbons.
- Naphthenic class: the naphthenic oil includes mainly degraded oils, they originate from biochemical alteration of paraffinic – naphthenic oils and usually have more than 40% naphthenes and they usually have a low sulfur content (below 1% although they are degraded).
- Aromatic – intermediate class: is comprised of crude oils which are often heavy. Resins and asphaltenes amount (10 – 30 %) and sometimes more, and the sulfur content is above 1%. This oil class the aromatics amount to (40 – 70 %).
- Aromatic – naphthenic and aromatic asphaltic class: are mostly represented by altered crude oils. Therefore, most aromatic– naphthenic and aromatic– asphaltic oils are heavy, viscous oil resulting originally from degradation of paraffinic – naphthenic, or aromatic intermediate oils.

Crude oil geochemistry

Adequate sampling of crude oils is essential for their characterization. The common methods for geochemical characterization of crude oils are the measurement:

- Bulk properties:

1- Specific gravity of crude oil (API°):

The API gravities variation may be caused by different thermal maturity, where low API means less in thermal maturity. Most normal oil has API gravities from 20˚ to 45˚, and is designated as medium (25-35˚ API) to light oil (35-45 ˚API). Heavy oil that has API gravities less than 20 are usually bio degraded, [5]. API gravity of Mishrif crude oil of studied area is ranging from (15.3-21.0) while in Nahr Umr is ranging from (16.6-30.4), as in Table -1. API gravities in Mishrif and Nahr Umr are medium crude oil in Amarah oil field that indicate marine environment.

Table 1- Bulk properties (API° gravity, sulphur content, and N/Vi Ratio) for crude oil samples from Amarah oil field (Geomark Laboratories).

Sample No.	Well No.	Formation	Depth(m)	API	%S	Ni (ppm)	V (ppm)	V/Ni
1	AM-1	Mishrif	2894	21.0	4.51	27	101	3.8
2	AM-4	Mishrif	2885	15.3	4.74	21	43	2.1
3	AM-6	Nahr Umr	3750	16.6	2.31	7	16	2.5
4	AM-8	Mishrif	2895	18.1	4.48	18	59	3.3
5	AM-10	Nahr Umr	3693	30.4	2.35	14	51	3.7

2- Sulphur content

Sulphur is the third most abundant aromatic constituent of crude oils, following carbon and hydrogen. It is present in medium as well as in heavy fractions of crude oils. In particular, there is inverse relationship between sulfur content and maturity, where the sulfur content decrease with increasing maturity [6]. The sulfur content can be used as a source indicator, as oil of marine origin has more than 0.5% sulfur content, the high sulfur content is derived from carbonate source rocks, on the other hand oil derived from clastic source rock are typically low in sulfur [5].

The analysis of crude oil samples from Amarah oil field show that they have sulphur content ranges from (2.31-2.35) for NahrUmr Formation while in Mishrif Formation is ranging from (4.48-4.74) as in Table -1 . High sulfur content in all samples refers to the marine source-rock organic matter.

GeoMark OIL™ used a cross plot between API gravity and sulfur content for a data base of 150 global petroleum system with known source environment as a tool for determining environment from this cross plot, as the API and sulfur % is easy to analyzed. This cross plot is used to determine Mishrif and Nahr Umr Formation Environment Figure- 3.

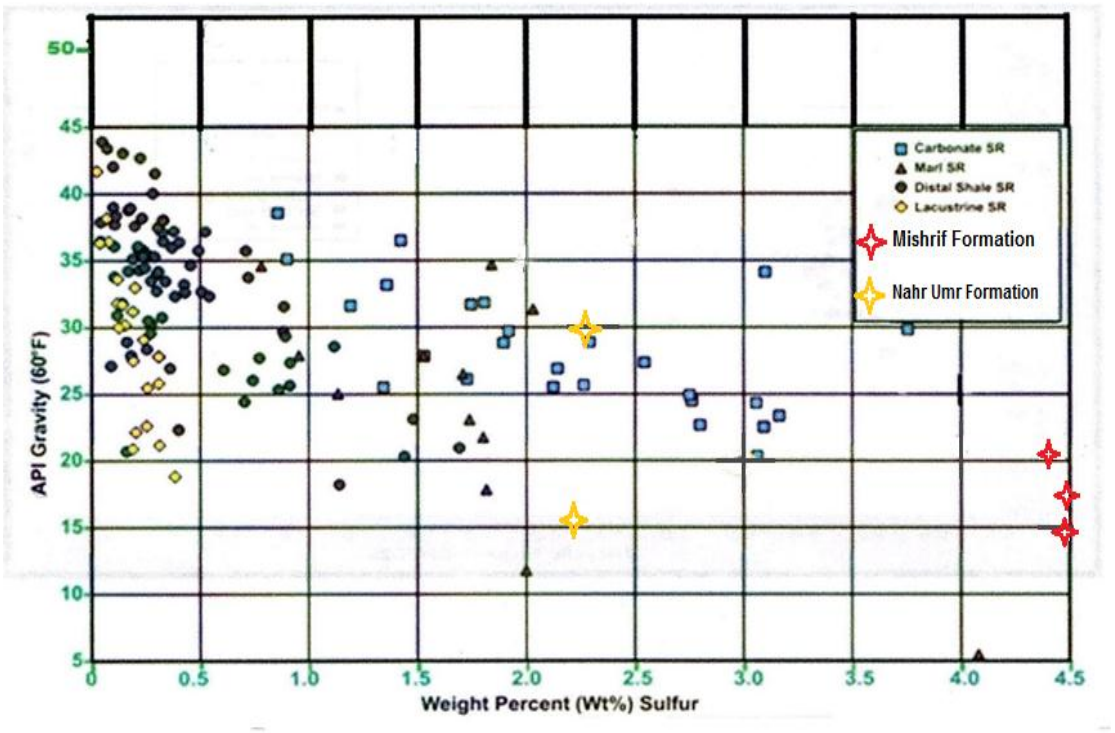

Figure 3-Shows the cross plot between API gravity and sulfur content of 150 global petroleum system source rocks modified after (1).

3-Organometallic compounds (Ni, V):

Crude oils contain metals, particularly nickel and vanadium, in variable amounts. These metals exist in petroleum largely as porphyrin complexes, and enter into the porphyrin structure by chelation during early digenesis; also, the depositional environment strongly influences their relative proportions [7]. Table -1 shows the nickel and vanadium content in these studied samples. High ratios reflect to anoxic sedimentation condition indicate marine environment.

4- Stable carbon isotopes:

Stable carbon isotopes are atoms whose nuclei contain the same numbers of protons but different numbers of neutrons are used to determine genetic relationships among oil and bitumen. stable isotope composition and ratio of carbon are used in characterization petroleum including gases, crude oil sediments and source rock extracts and kerogen it also uses with biomarkers to determine genetic relationships among oil and bitumen's. According to [8] the cross plot between δ13C‰ saturated and δ13C‰ aromatics Figure-3, is a way to know the provenance of organic matter. The values of δ13C‰ saturated and aromatic for Mishrif oil and Nahr Umr Formation. Table -2 is cross plotted shows that indicate that these oil source are marine organic matter input.

CV= -2.53δ13Csaturate + 2.22δ13Caromatic - 11.65

The calculated canonical variable (CV) values of the Tertiary and Cretaceous oil samples ranges from (-3.66 to -1.93) indicating non-waxy oil derived from marine sources, as described by [8]. The studied of oil samples studied canonical values (CV) show that their ranges are Mishrif oil (- 3.26 to -3.66) Nahr Umer oil (- 1.93 to -2.28) and hence indicate that all studied crude oil samples mainly non-waxy marine oil as show in Figure- 4.

Table 2- Bulk properties and stable carbon isotope composition for Mishrif and Nahr Umr crude oil samples from Amarah oil field (Geomark Laboratories).

Sample No.	Well No.	Formation	Depth(m)	< %C15	$^{13}C_{sat.}$	^{13}CA ro.	C.V.
1	AM-1	Mishrif	2894	31.3	-27.14	-27.16	-3.26
2	AM-4	Mishrif	2885	34.7	-27.00	-27.17	-3.66
3	AM-6	Nahr Umr	3750	51.9	-27.73	-27.23	-1.93
4	AM-8	Mishrif	2895	36.4	-27.15	-27.17	-3.28
5	AM-10	Nahr Umr	3693	40.2	-27.60	-27.23	-2.28

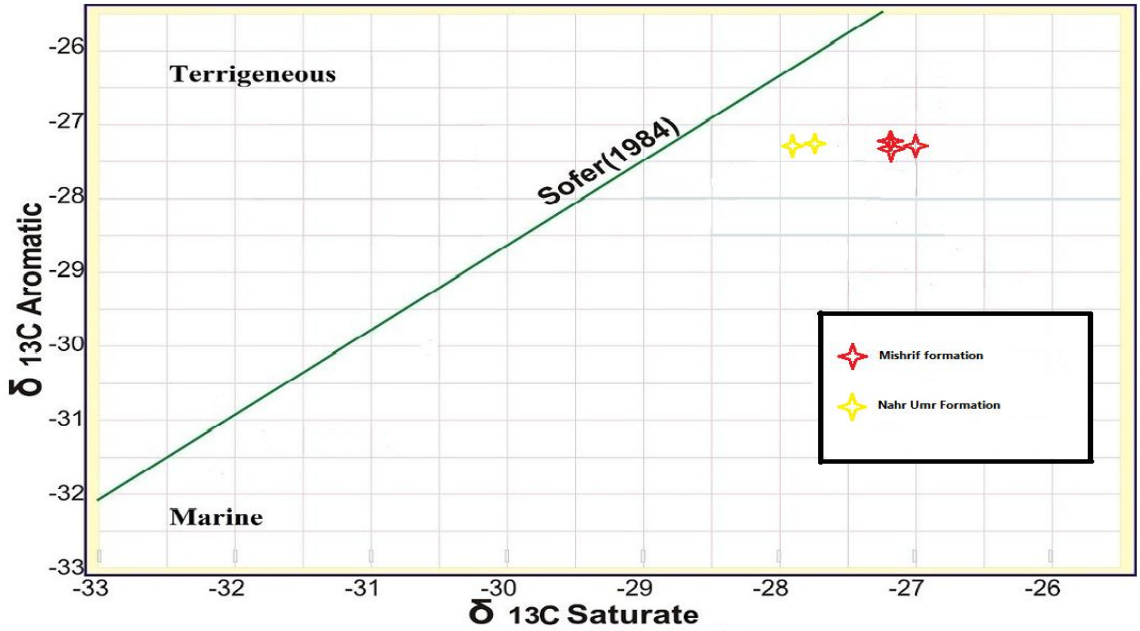

Figure 4- Cross plot of Carbone-13 isotope ratios of saturated versus aromatic hydrocarbon of Mishrif, Nahr Umr oil (8).

5- Light Hydrocarbons (< C15%):

Light hydrocarbons are gases that are volatile liquids at standard temperature and pressure and range from methane to octane, including normal, isocyclic alkanes, and aromatic compounds. Light hydrocarbons (C4–C9) are not biomarkers because their carbon skeletons are too small to preserve evidence of a unique biological origin. It may indicate to hydrocarbons ranging from C1 to approximately C15, depending on context. Low-maturity, early-expelled oil may have less than 15%, typical mid-oil window marine oil has approximately 25% to 40%, and high-maturity condensates may be nearly 100% light hydrocarbons [1]. The light hydrocarbon of the sample studied of Amarah oil field is; Mishrif oil sample is (31.3-36.4) and Nahr Umr oil sample is (40.2-51.9) as in Table -2. the study of Mishrif and Nahr Umr oil samples represent mid – oil window and marine.

-Composition of crude oil:

The gross composition of a crude oil can be defined by the content of:

1. Saturated hydrocarbons, comprising normal and branched alkanes (paraffin), and cycloalkanes (naphthenes).
2. Aromatic hydrocarbons, including pure aromatics, cycloalkanoaromatic (naphtheno aromatic) molecules, and usually cyclic sulfur compounds.

3. Resins and asphaltenes made of the high molecular weight polycyclic fraction of crude oils comprising N, S and O atoms. Asphaltenes are insoluble in light alkanes and thus precipitate with n-hexane [6].

These parameters are not independent, as all crude oils consist of these four groups of components, if one of these groups is missing. The other three groups of course, amount to 100%, as saturates plus aromatics plus resins and asphaltenes are unity. This fact automatically introduces a degree of correlation between these groups and their subdivisions, the concentrations of several hydrocarbon types or N, S, O, compounds show a high degree of covariance, as a result of a common origin, or common chemical affinities.

The compositions of the studied oil samples in percentage components in Amarah oil field are; as in Table- 3.

Table 3- Crude oil composition of Mishrif and Nahr Umr crude oil in Amarah oil field (Geomark Laboratories).

Sample No.	Well No.	Formation	Depth(m)	%Saturate	%Aromatic	%NSO	.Asph %
1	AM-1	Mishrif	2894	20.6	47.7	17.5	14.2
2	AM-4	Mishrif	2885	18.1	44.0	14.9	23.0
3	AM-6	Nahr Umr	3750	29.0	33.0	15.0	23.0
4	AM-8	Mishrif	2895	19.7	45.8	17.9	16.6
5	AM-10	Nahr Umr	3693	33.2	43.8	15.1	7.9

1- The Mishrif oil contain (18.1-20.6) saturate, (44.0-47.7) aromatic, (14.9-17.9) NSO and (14.2-23.0) aspheltenes.

2- The Nahr Umr oil contain (29.0-33.2) saturate, (33.0-43.8) aromatic, 15.0-15.1) NSO and (7.9-23.0) aspartames.

-Biomarkers:

Biological Markers (Biomarker) are complex molecular fossils derived from biochemical, particularly lipids, in once living organism. Because biological markers can be measured in both crude oils and extracts of petroleum source rocks [1] Biomarker is very important because.

1- They provide a method to relate the two (correlation) and can be used by geologist to interpret the characteristic of petroleum source rocks when only one sample are available.

2- They provide information on the organic matter in the source rock, environmental conditions during its deposition, burial (digenesis) and the thermal maturity experienced by rock or oil (catagensis).

3- They provide information on the degree of biodegradation, some aspects of source rock mineralogy (lithology), and age, because of their resistance to weathering, biodegradation, evaporation and other processes.

4- biomarkers are commonly retained as indicators of petroleum contamination in the environment. The most used and available biomarkers are:

1- Alkanes and acyclic isoprenoids:

Alkanes and acyclic isoprenoids are obtained from the gas chromatograms device. The whole crude chromatograms are dominated by n-alkanes C5 –C25, where C23+ n-alkanes are derived from higher plant lipids and cuticular waxes, C15 and C17 are derived from the lipids of algae [9].

CPI values significantly above 1.0 indicate low maturity land plant input, while values below 1.0 indicate low thermal maturity marine organic input, values of 1.0 or ~ 1.0 suggest that the oil is thermally mature [9]. The CPI of the crude oil analyzed as in Table -4 are (1.10-1.17) for Mishrif and (1.04-1.05) for Nahr Umr Formation which could indicate thermally mature oil and the slightly shifting from 1.0 may be due other parameters as this ratio is affected by source input. According to [10], Pr/Ph<1 indicate anoxic source rock deposition particularly when accompanied with high sulfur content, while pr/ph> 1 indicate oxic environment. the Pr / Ph in Mishrif oil sample is Ranging from (0.66 – 0.68), and Nahr Umr oil sample is (0.65) and all this indicate Pr/Ph < 1 indicate anoxic source

rock deposition particularly when accompanied high sulfur content in this case Mishrif and Nahr Umr oil samples derived from source carbonate and anoxic environment. Accompanied with high sulfur content as discussed in previous section, this indicates anoxic conditions of the source environment. [9] suggest that pr/ph< 1 indicate hyper saline environments. However, [10] suggests that high pr/ph values (> 3.0) indicate terrigenous organic matter input under oxic conditions, while low values (<0.8) indicate typify anoxic, commonly hyper saline or carbonate environment, the values between 0.8 to 3.0 is influenced by environment conditions and other factors. Accordingly, all Mishrif and Nahr Umr derived from carbonate anoxic environment. The isoprenoids / n-alkanes ratios also could be used in petroleum correlation studies such as Pristane/nC17 and Phytane/ nC18 ratios. Both Pr/nC17 and Ph/nC18 are decreased with thermal maturity of petroleum, while Biodegradation increases this ratio because the aerobic bacteria attack the *n*-alkanes before the isoprenoids [1]. The ratios of pr/ph in Mishrif crude oil is Ranging from pristane / nC17 (0.13 – 0.14) while pr/ph in Nahr Umr crude oil is (0.14), while the ratios pr/ph in Mishrif crude oil of phytane / nC18 is Ranging from (0.23 – 0.26) while in Nahr Umr crude oil is (0.25). this case indicates mature non-biodegradation marine Algal kerogen II according Figure- 5.

Table 4- Alkanes and acyclic isoprenoid ratio (Geomark Laboratories).

Sample No.	Well No.	Formation	Depth(m)	CPI	Pr/ph	Pristane/nC_{17}	Phytane/nC_{18}
1	AM-1	Mishrif	2894	1.17	0.66	0.14	0.26
2	AM-4	Mishrif	2885	1.12	0.67	0.13	0.23
3	AM-6	Nahr Umr	3750	1.04	0.65	0.14	0.25
4	AM-8	Mishrif	2895	1.10	0.68	0.14	0.26
5	AM-10	Nahr Umr	3693	1.05	0.65	0.14	0.25

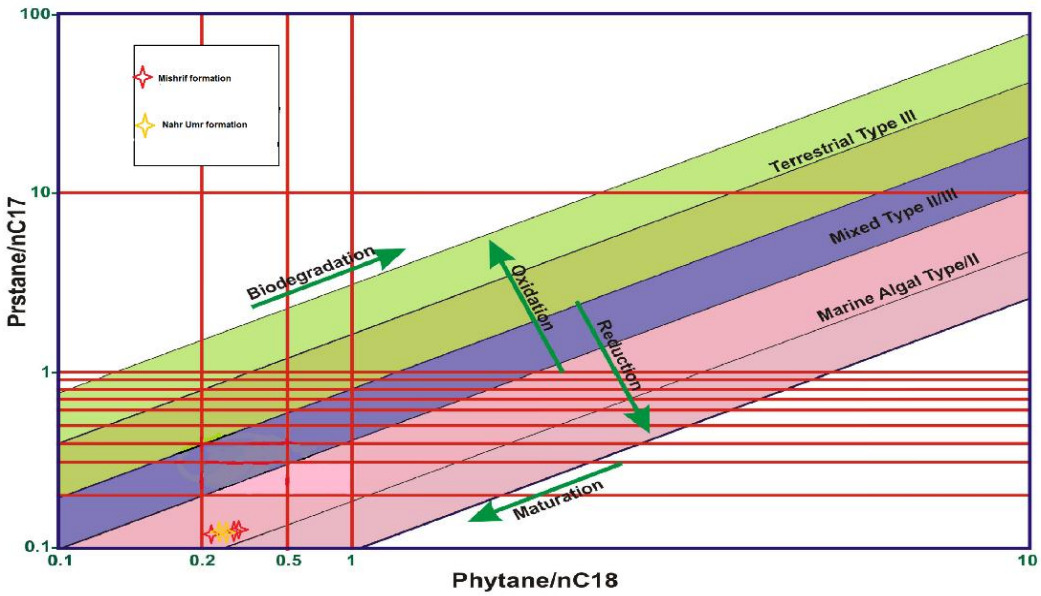

Figure 5-Shows cross plot between pristane/nC17 versus phytane/nC18 for Mishrif and Nahr Umr + crude oil after (1).

2- Terpenes and similar compounds:

-Tricyclic terpanes ratios:

The tricyclic trepanes are including C19/C23, C22/C21, C24/C23, C26/C25 and (C28+C29) / TS widely distributed in crude oil and source rocks of marine or lacustrine origin. The C22/C21 and

C24/C23 tricyclic terpane ratios help to identify extract and crude oil environment, by cross plot the C22/C21 with C24/C23 [9]. So, the Figure- 6 show that Mishrif, and Nahr Umr crude oil was derived from carbonate Marine environment.

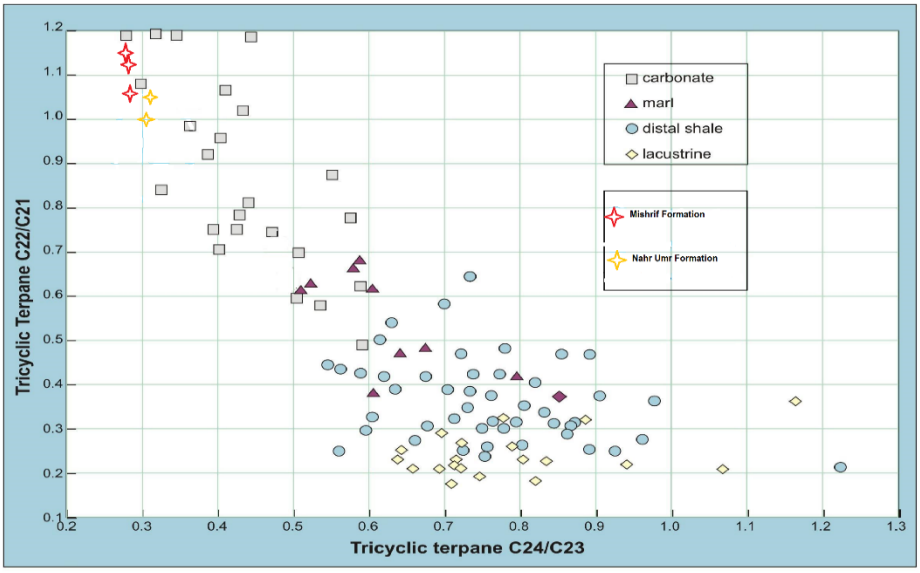

Figure 6- Relationship between tricyclic terpane C22/C21 and tricyclic terpane C24/C23after (15).

- C24 tetracyclic terpane ratio:

Tetracyclic terpane which occur in most oil and rock extracts range from 24 to 27 with extensive evidence for homologs up to C35 [11]. Abundance C24 tetracyclic terpane in (commonly expressed as C24Tet / hopane, C24Tet / C23, tricyclic and C24Tet / C26 tricyclic) petroleum appears to indicate carbonate and evaporate source –rock setting [7]. Table -5 shows Mishrif crude oil sample is ranging from (1.36-1.38), while Nahr Umr oil sample is ranging from (1.77-1.88). all oil samples indicate mature carbonate sources and the samples indicate marine environment.

Table 5- Mass Gas Chromatography of (m/z 191) Terpanes Parameters for Mishrif and Nahr Umr crude oil samples from Amarah oil field (Geomark Laboratories).

Sample No.	Well No.	Formation	Depth(m)	C_{19} / C_{23}	C_{22} / C_{21}	C_{24} / C_{23}	C_{26} / C_{25}	Tet / C_{23}	C_{35} / C_{34}	C_{31} R /H	C_{29} /H
1	AM-1	Mishrif	2894	0.10	1.13	0.27	0.75	1.38	1.19	0.35	1.54
2	AM-4	Mishrif	2885	0.08	1.07	0.28	0.77	1.36	1.17	0.37	1.42
3	AM-6	Nahr Umr	3750	0.09	1.07	0.32	0.76	1.88	1.11	0.36	1.22
4	AM-8	Mishrif	2895	0.09	1.15	0.27	0.76	1.37	1.16	0.38	1.49
5	AM-10	Nahr Umr	3693	0.13	1.0	0.31	0.75	1.77	1.14	0.37	1.30

- C35 homohopane index

It is an indicate of redox potential in marine sediments during diagenesis. High values indicate anoxia, but are also affected by thermal maturity. It is also expressed as C35/ C34 and C35 S/ C34 S hopanes. Most oil from marine carbonate source rocks show high C29/ C30 hopane (greater than 0.6) [7]. High C35 homohopanes are common associated with marine carbonates or evaporates.in Table -5, indicates that these oils are generated from high reducing condition marine carbonate source rocks.

C35 hopane index for Mishrif is ranging from (1.16-1.19) while in Nahr Umr is ranging from (1.11-1.14). all crude oil sample indicate high reduction marine and carbonate source rock.

- C31 / C30 hopane:

It is used to distinguish between marine versus lacustrine source rock depositional environments. Oil from marine shale, carbonate, and marl source rocks generally show high C31 homohopane/ 30 hopane greater than 0.25[7]. Mishrif oil sample is ranging from (0.35-0.38), while in Nahr Umr oil sample is ranging from (0.36-0.37). All crude oil sample indicate marine source rocks.

- 30-Norhopone / hopane:

It is expressed as C29 / C30 hopane (C29/H). The 30-norhopane is typical of anoxic carbonate or marl source rocks and oil. The crude oil samples reflect greater than 1.0 and higher norhopane / hopane C35S/C34S such as in Mishrif oil sample is ranging from (1.42-1.54), while Nahr Umr oil sample is ranging from (1.22-1.30), and these is indicating that the oil is anoxic and carbonate source rocks as show in Figure- 7.

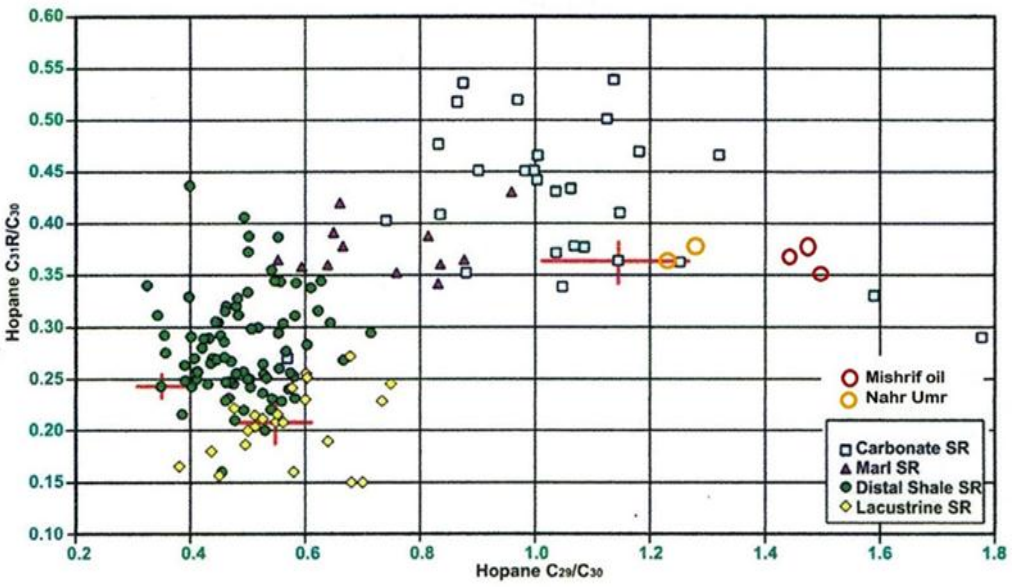

Figure 7-Relationshap between tricyclic terpane C29/C30 and tricyclic terpane C31R/C30 after(15).

3-Steranes:

Steranes are a class of tetracyclic, saturated biomarkers constructed from six isoprene subunits (approximately C30). Steranes originate from sterols, which are important membrane and hormone components in eukaryotic organisms.

-Regular Streanes (C27, C28, C29)

The relative abundances of C27, C28, and C29 are given in Table -6 as percentage, which show that C29 and C27 steranes are generally more than those of C28. Almost all higher plants have C29 as the dominant; also, C29 sterols are dominant in brown algae and same species of green algae. The C27 sterols tend to be dominant in most Plankton, particularly in red algae and zooplankton [11], while the C28 sterols may have derived from unicellular green algae such as parasynophytes or chlorophytes [12] Distribution of C27-C28-C29 Steranes could be used to differentiate depositional settings [13], and this study indicate that all formations oil samples marine carbonate source as show in Figure- 8.

Table 6- Mass Gas Chromatography of (m/z 217) Steranes parameters for crude oil samples for Mishrif and Nahr Umr from Amarah oil field (Geomark Laboratories).

Sample No.	Well No.	Formation	Depth(m)	$\%C_{27}$	$\%C_{28}$	$\%C_{29}$	C_{28}/C_{29}	$C_{29}\ 20S/R$
1	AM-1	Mishrif	2894	32.7	23.8	43.5	0.55	0.48
2	AM-4	Mishrif	2885	33.1	23.8	43.1	0.55	0.57
3	AM-6	Nahr Umr	3750	32.5	24.7	42.8	0.58	0.58
4	AM-8	Mishrif	2895	34.1	24.6	41.3	0.60	0.57
5	AM-10	Nahr Umr	3693	33.9	24.4	41.7	0.59	0.60

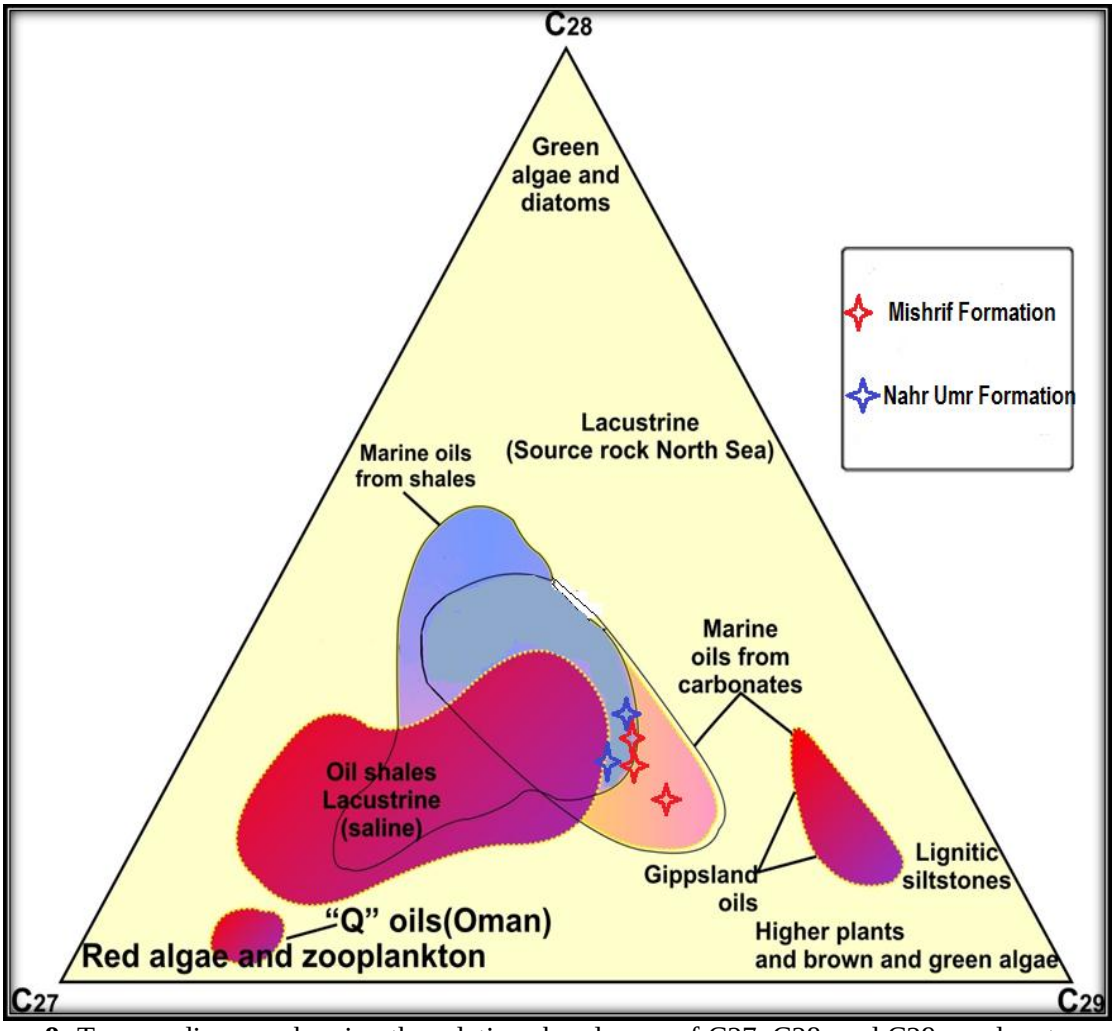

Figure 8- Ternary diagram showing the relative abundances of C27, C28, and C29 regular steranes of Mishrif, and Nhar Umr crude oil after (9).

-C28 / C29 Steranes ratio:

The relative content of C28 steranes increase and the C29 steranes decrease in marine petroleum through geologic time. The increase in C28 may be related to increase diversification of phytoplankton assemblage including diatoms coccolithophares, and dinoflagllates in the Jurassic and Cretaceous periods. [14] observed that C28/C29 steranes <0.5 for lower Paleozoic and older oils, (0.4-0.7) for Upper Paleozoic to lower Jurassic oils, and greater than 0.7 for Upper Jurassic to Miocene oils. The C28/C29 steranes ratio of Mishrif oil sample is ranging from (0.55-0.60) and Nahr Umr oil sample is ranging from (0.58-0.59) and all oil samples indicate the age Middle Jurassic as showing in Table- 6 and Figure- 9.

- 20 S/ (20 S+ 20 R) isomerization:

[15] indicate that petroleum generation begins at %20 S of approximately 40%, while the ratio range from 0.23 to 0.29 refers to low maturity oil [16] as shown in Table- 6 . According to biomarker analysis show that all Formations, oil samples indicate the high value of 20S/(20s+20R) and this is indicating mature oil.

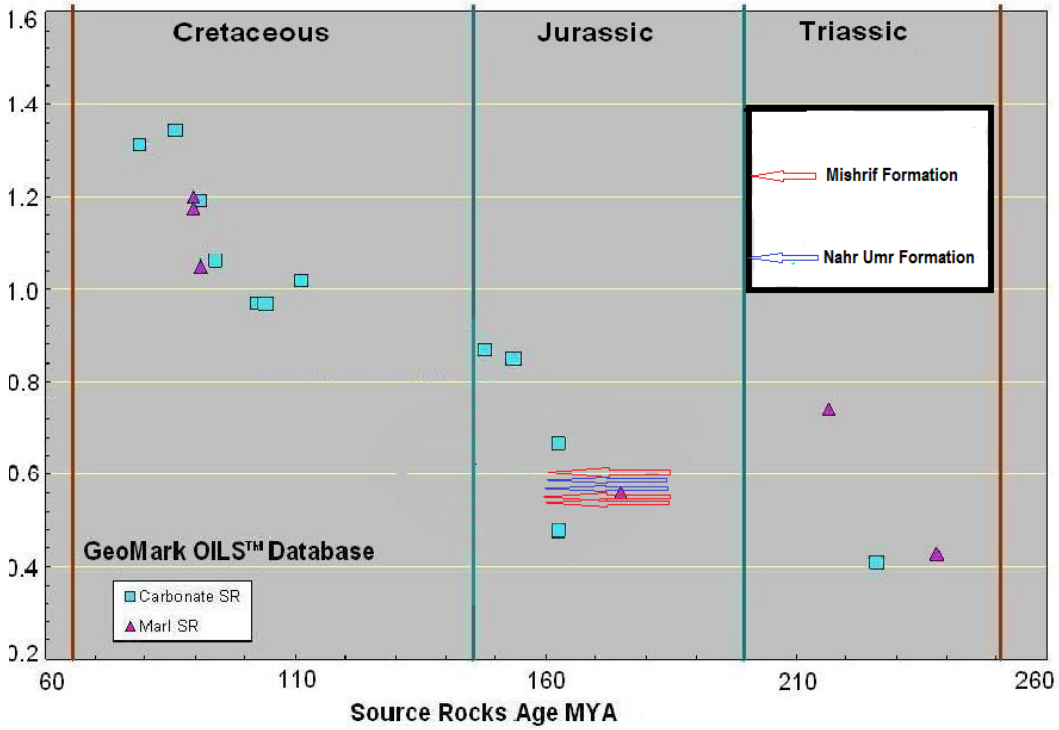

Figure 9- shows the C28/C29 steranes ratios for 150 global petroleum system source rocks for different environments after (12).

Results and Discussion:

1- Amarah oil field shows that this field contains of two oil reservoirs which are classified according to their crude oil value (API). Such as Mishrif, and Nahr Umr Formations are the main reservoirs.

2- Bulk properties is characterized by medium API gravity where Mishrif oil sample is ranging between 15.3% -21.0% ,and Nahr Umr oil sample is ranging between 16.6% – 30.4%, and high sulfur content of Mishrif oil sample is ranging between 4.48% - 4.74% ,and Nahr Umr oil sample is ranging between 2.31% – 2.35% while the ratio of vanadium over nickel of Mishrif and Nahr Umr oil samples that indicate that dominance of vanadium over nicle that reflect anoxic sedimentation condition, While the carbon isotope ratio of Mishrif oil sample is ranging between -27.09% to -27.16%, Nahr Umr oil sample -27.42% to -27.48%.

3- The composition of Mishrif and Nahr Umr crude oil characterized by abundant of aromatic compound, where the saturated hydrocarbon ratio of Mishrif oil sample is ranging between 18.1% - 20.9%, and Nahr Umr oil sample is ranging between 29.0% - 33.2% and aromatic hydrocarbons of Mishrif oil sample is ranging between 44.0% - 47.7% ,and Nahr Umr oil sample is ranging between 33.0% - 43.8%, and NSO and resine compounds of Mishrif oil sample is ranging between14.9% - 17.9%,and Nahr Umr oil sample is ranging between 15.0% - 15.1%.

4- The different relation between different biomarkers that is related to environments indicates that Mishrif and Nahr Umr crude oil is derived from anoxic marine carbonate kerogen type II where the pr/ph<1, pr/nC17 for Mishrif oil sample is ranging between0.13-0.14, andNahr Umr oil sample is about 0.14 while pr/nC18 for Mishrif oil sample is ranging between 0.23-0.26, and Nahr Umr oil sample is about 0.25.

5- The regular steranes ratio for Mishrif oil sample is ranging between 32.7% - 34.1% for C27% and 23.8% - 24.6% for C28% and 41.3% - 43.5% for C29%, and Nahr Umr oil sample is ranging between 32.5% - 33.9% for C27% and 24.4% -24.7% for C28% and 41.7% - 42.8% for C29%, All

value ranges of terpane and similar compounds includes tricyclic ratio, C24 tetracyclic ratio C35 homohopane, C31 C30 hopane ,30- Norhopane /hopane, Gammcerane index.

6- Biomarker related to age indicates that Mishrif and Nahr Umr source age is Middle Jurassic, that is obvious from the value of carbon isotope and the calculated C28/C29 regular sterane of Mishrif oil sample is ranging between 0.55-0.60, and Nahr Umr oil sample is ranging between 0.58 -0.59.

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