New Jurassic Play Concepts in the Mesopotamian Basin and the Western Desert of Iraq

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Abstract

Intensive tectonic activity during Zagros Orogeny (Late Cretaceous-Late Tertiary) and the final uplift in Holocene, reactivated folds and faults and eroded parts of the Lower Cretaceous, Jurassic and earlier sequences in western Iraq. Subsequently, within the Study area, the post Jurassic tectonics and the Upper Jurassic paleo-depositional environments left potential carbonate reservoirs at the basin margin (the Najmah Formation) and a potential evaporite cap rock (the Gotnia Formation) basin wards. Such relationship sealed the generated hydrocarbons from the source rocks formations (the Sargelu Formation) but it unlikely sealed the laterally migrated oil into the Najmah Formation. The major N-S fault planes of the Khleisia uplift that extended from northwestern part of Iraq to the southwestern Desert forming a barrier to laterally migrated oil and putting an end to the potential migration pathways from the Basinal Sargelu Formation in ENE Iraq. At the same time the prolonged thermal activity may have convert the organic matters within Paleozoic layers to Thermogenic gases.

Total petroleum system enabled us to better understand the provenance of oil accumulated in the Najmah Formation's layers another rock packages. According to 1-dimention model the migrated oil can pass through the Khleisia fault planes into the Middle Jurassic Muhaiwir Carbonate Formation (marginal equivalent to basinal Sargelu Formation) to form potential oil reservoir sealed by Gotnia evaporates and Kimmeridgian anhydrite .The equivalent formations located in western desert (Ubaid, Hussiniyat and Amij) Formations to the formations located in the central part (Mesopotamian Basin) which is (Butmah, Adaya, Mus and Alan Anhydrite) may consider as a new Jurassic reservoirs. So far no oil wells yet are available to cover the study of the whole area.

Keywords: Jurassic, Formation, Reservoir rocks, Migration, Mesopotamian Basin, Zagros fold belt

Introduction

Iraq considers as a promising area to generate theromgenic gas and reserves the migrated oil through the potential pathways from the eastern part of Iraq.

Najmah Formation of Malimain age represents calcareous neritic and lagoonal facies of the upper Jurassic period in Iraq overlaying major unconformity that could trap oil. The presence of Gotnia Formation which is consists of (200m) of anhydrite with subordinate shale and limestone appear to be a tight seal for local oil and gas accumulation in underlying Najmah limestone and oil in interbedded limestone, Al Sharhan (1997).

Muhaiwir Formation equivalent to Sargelu Formation (Middle Jurassic), a which is may also considered as a potential reservoir rocks, and generally.

Lower Jurassic formations (Ubaid, Hussainiyat and Amij) in western Desert seem to be typical formations to correlate with the central parts (Mesopotamian Basin).

Accordingly, Iraq may reserve supergiant reservoir as extension of thick oil prone of source rocks with excellent seals from Ordovician to Tertiary (Al Jobouri, 1979, USGS, 2004) in addition to the current announcement of the Iraqi Ministry of Oil that refers to have 505 Trillion cubic meter of reserved oil in Iraqi super giant fields.

Considered as a major control of the of clastic reservoir properties, which reserves the horizontally migrated oil from nearby Sargelu Formation (Pitman, et al, 2004).

Geophysical prospecting via seismic section already contributes in recognizing remarkable geological structure (folds and faults) that characterize the active tectonic history of the Mesopotamian Basin, located within the succession of the subsurface

formations of the western desert along Wadi Horan as shown in the map (Fig.(1)).

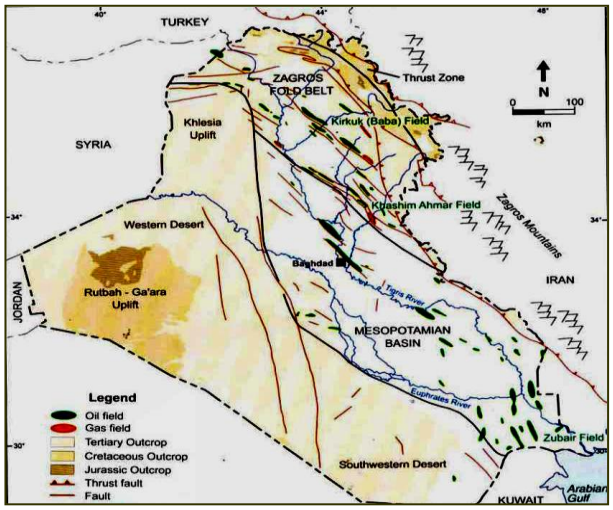


Fig.(1) Map shows location of the Mesopotamian basin and the Zagros Fold belt and major oil and gas fields modified from Aqrawi, 1998). (Pitman, 2004).

Geological Setting

The area of study include wide areas of promising to reserve hydrocarbons which surrounds western part of Zagros Fold Belt (Mesopotamian Foredeep) in central faulting zone (Ditmar,et al, 1972), and geosynclinals flank Fig.(2) ,and Mesozoic stable shelf (khlesia Uplift).

The structural evolution of the Zagros Fold Belt reflected in the orientation of present structures. The structurally complex Zagros Fold Belt is characterized by a liner NW-SE folds and fault pattern that was imposed during Palogene and Neogene tectonism.

The present seismcity indicates that Zagros fold belt is still tectonically active (Jackson et al 1984), (Hessami et al 2001). The development during the lower–Middle Jurassic sub stage of the upper Triassic–Middle Jurassic cycle started with a progressive transgression on the Stable Shelf where the Triassic and Jurassic were separated by a break after the Rhaetic emergence.

On the remaining, mobile areas the emergence and transgression are marked by terrigenous clastic supply or by increased subsidence only. Lagoonal evaportic facies throughout liassic decreasing toward north east, abrupt change in the sedimentary regime during Middle Jurassic took place. Transgressing of the sea includes stable shelf toward west and southwest with the late Liassic occurred in the geosynclines in Iran (stocklin, 1968). The former basin during Liassic which is partly or fully with evaportic sedimentation was replaced by a neritic euxinic one and the area of the former continent are of shallow water, littoral-lacustrine sedimentation was replaced by aneritic calcareous-pelitic or calcareous-arenaceous sedimentation.

At the end of the Doggerian a regressive phase marks the end of the cycle (Buday, 1980).

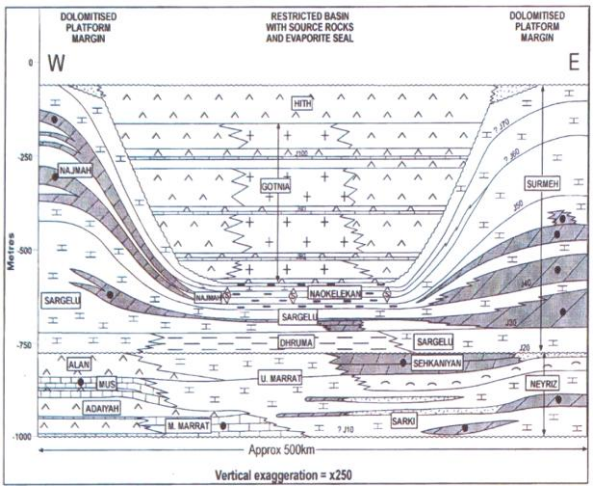


Fig.(2) Stratigrphic correlation section through the Jurassic sequences of the Gotnia Basin.

Geophysical Indication

Primary accumulation in Jurassic reservoirs could determined through recent secondary accumulation due to certain evidences like the exist of up dip migration from source beds toward the western part of Iraqi land, meantime Kimeridgian anhydrite forming seal rocks, in addition to other minor faults abundant around this area (Fig.(3)) also indicates secondary accumulation in upper Jurassic reservoir .These accumulations are mainly formed nearby the most important source rocks that generates oil and gas then trapped, close around the unstable zone which already forms due to the tectonic activity (orogenic movement) so a liner folds as shown in seismic sections is with out doubt traps the Still generates oil and gas.

Fault properties:

Depending on seismic section, already available in the reports of oil well, (Fig.(4)) and structural schematic section shows high amplitude normal faults were defined as Semi-sealing in the horizontal direction, and semi-open in the vertical direction. The property of this faults permitted cross-formation flow in the model, while allow for trapping petroleum in a vertical succession of reservoirs.

It should be noted that only major fault zones in Zagros Fold Belt were incorporated in the regional model. Thrusting in the Zagros Fold Belt is trending NW-SE crossing North eastern Iraq which uplifted the subsurface section to form outcrop for the Sargelu Formation as an effect of tectonic compression that may indicate intensive minor faults affect by one way or another to the migration of oil. So it isn't easy to determine all the faults meanwhile the area described as an imbricate zone.

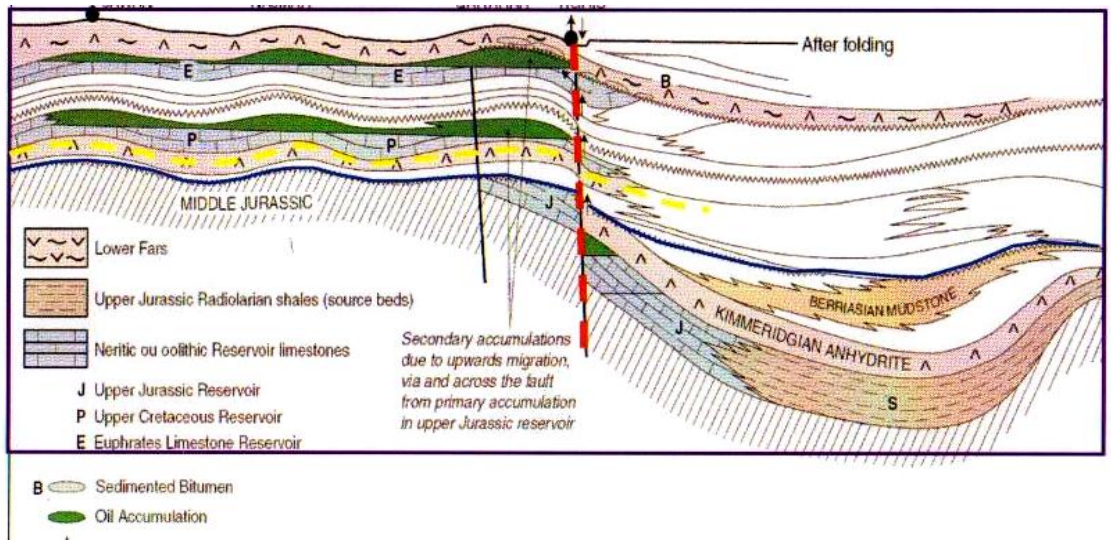


Fig.(3) Schematic sections across the studied area illustrating the probable mode of accumulation of oils in Jurassic, cretaceous and Tertiary rocks.

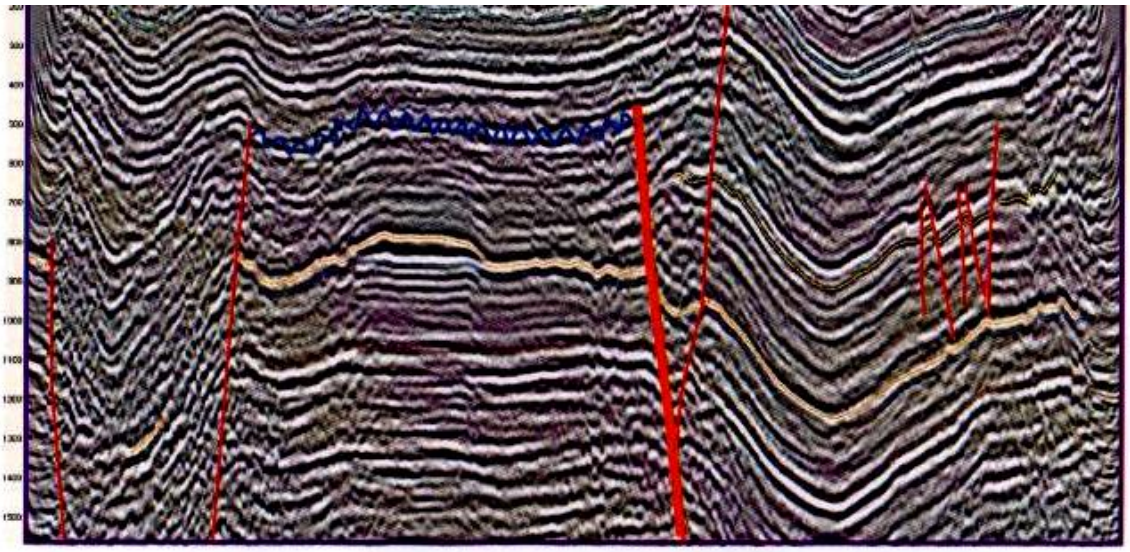


Fig.(4) Seismic section shows folding and faulting that trapping oil due to tectonic activity.

The predicted Clusters:

1- Najmah Formation;

Geochemical analysis referred to this formation as being formed from dolomite especially in borehole (KH12/7) situated about 50km away from Anah city in the west Iraq, but its outcrop is in Wadi Horan within Western Desert consists mainly from limestone (Jamil, et al,1994). The previous indications shown high effect of dolomitization and increasing in non–carbonate content in section downwards (Basssi et al, 1988). Plate-1 show bioclastic Oolitic Packstone–Wackstone facies and peloidal Packstone (Jamil, 1994). In general this type of lithology may consider as the typical reservoir rocks located in western part of Iraq.

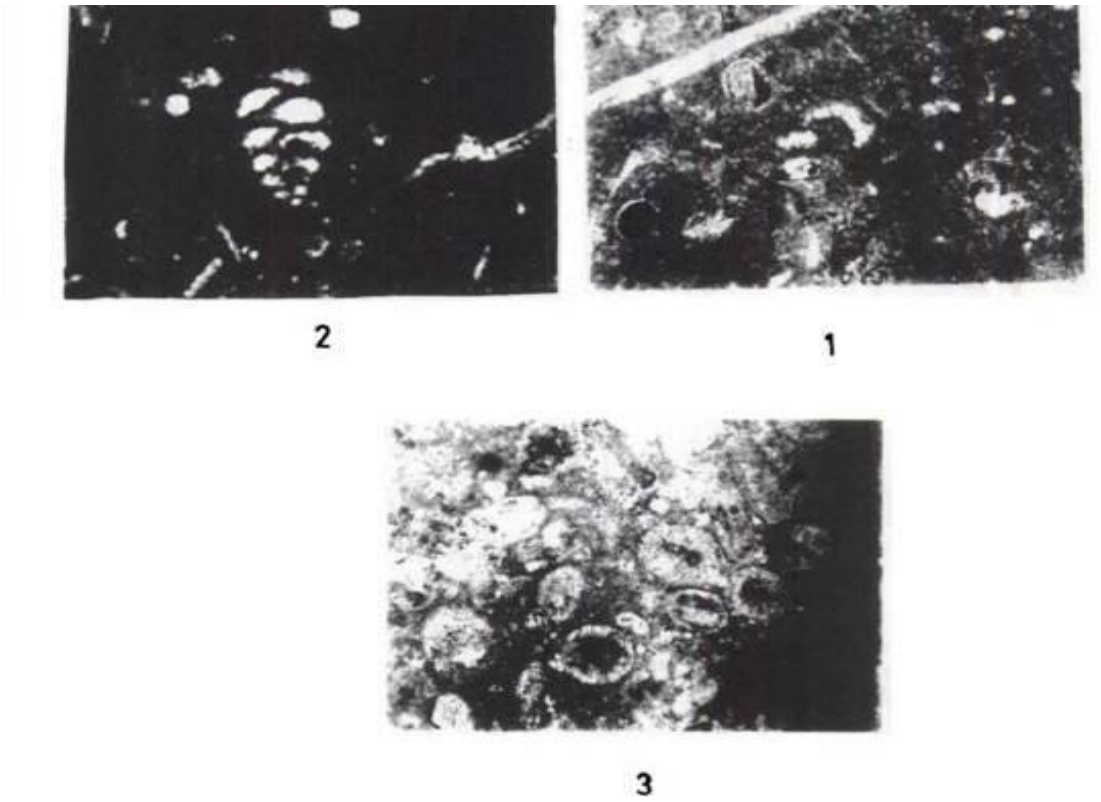
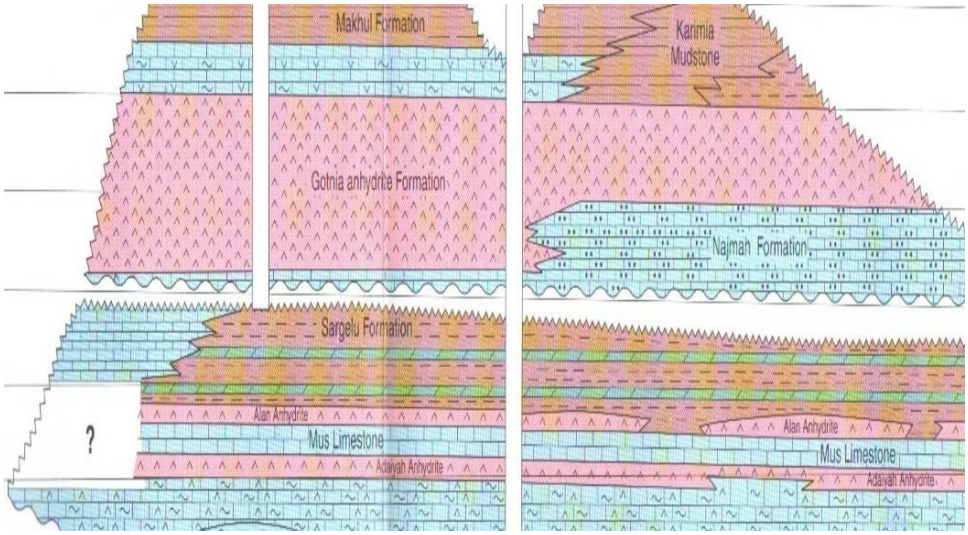


Plate -1 (1&2) is Bioclastic Oolitic Packstone –Wackstone Facies, and (3) is peloidal Packstone (Jamil et al, 1994).

2- Muhaiwir Formation

This formation consists mainly from, sandy, Oolitic, profusely spicular, neritic limestone with full open –sea fauna. (Bellen et al, 1958).

The expelled oil from Sargelu Formation might inject horizontally through this formation in spite of the abundances of the fault planes that faced the route of migrated oil with subordinate gas tonguing and isochronously bounded with Sargelu Formation may forms remarkable reservoir Fig.(5).



Muhaiwir Fn.

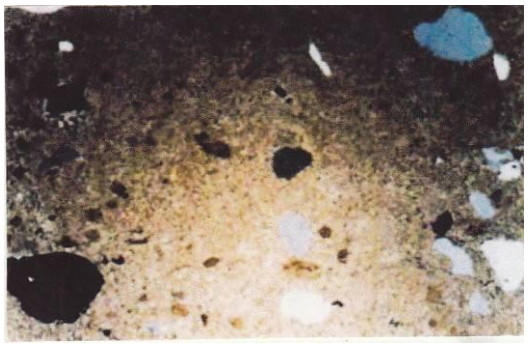
Fig.(5) Geologic section shows the promising formation to reserve oil in addition to gap and source rocks (Lexique).

The Equivalent clusters:

The Lower Jurassic (Liassic) formations located and exposed in Western desert are graded laterally to central part of Iraq (unstable shelf) into Butmah- Adaya-Mus-and Alan anhydrite Formations, so the equivalent formations as follows enabled to do comparison and correlate well with the lithofacies mainly consist of Dolomitic-peloidal packstone and Oolitic grainstones might consider as a typical and reliable reservoirs. These variations lead to conclude that the upward migrated oil from both Triassic and Paleozoic rocks could trapped in these equivalent clusters.

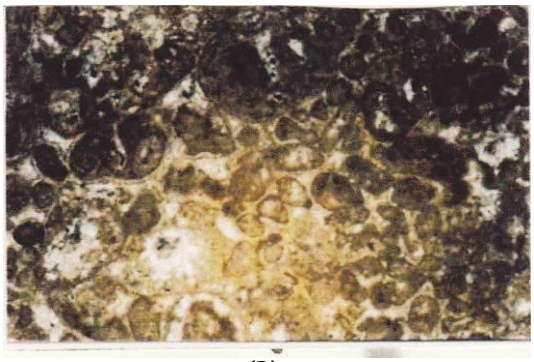
1- Ubaid Formation:

Is the oldest exposed formation .Jurassic (Liassic) in the stable shelf of western Iraq I desert (Stable Shelf), which deposited in various environments within the carbonate shelf .This formation consists of dolomitize mudstone with some sand grains (plate-2 no. 1), dolomitic bioclastic wackstone and dolomitic peloidal packstone (plate-2 no.2&3).



(1)

(2)



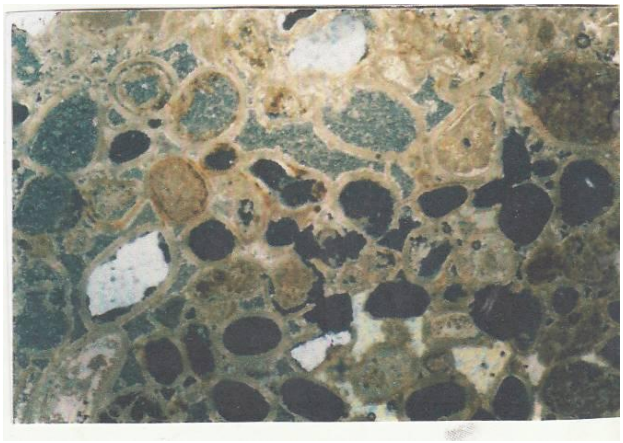
(3)

Plate- 2 lithofacies of Ubaid Formation (Mag.x10).

2- Hussiniyat Formation:

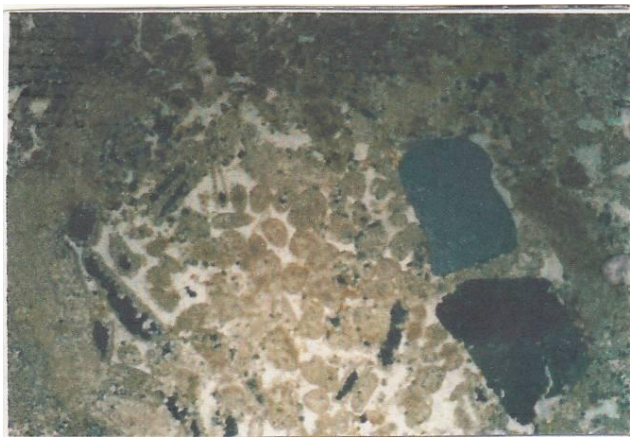
This formation is composed of two major units, Lower clastic unit and upper carbonate unit. Microfacies analysis of the carbonate unit represented by dolomitic peloidal packstone (plate-3 no.1&2) with sand grains and dolomitize Oolitic grainstone (plate-3 no.3&4).

(1) Mag.x 40



(2) Mag.x 10

(3) Mag.x 40



(4) Mag.x 10

Plate-3 Lithfacies of Hussiniyat Formation.

5- Amij Formation:

Consist of dolomitize Oolitic grainstone, dolomitic mudstone with thin layers of sand grains and dolomitic bioclastic wackstone (plate-9).

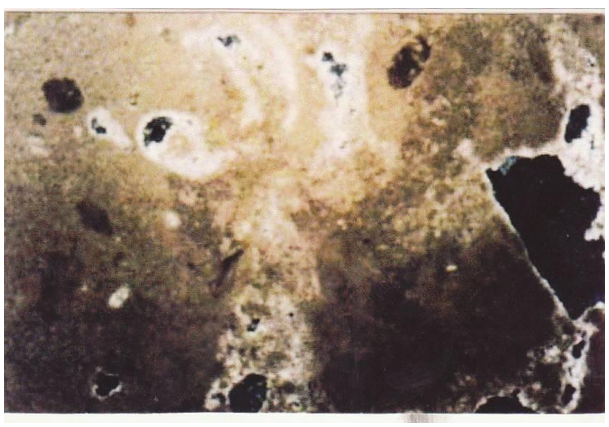


Plate-4 Lithofacies of Amij Formation Mag.x 10.

Migration pathways:

In the Mesopotamian basin migration from the late Miocene onward was directed to the west and southwest perpendicular to the depositional axis of the foredeep trend, whereas in the fold belt petroleum focused along northwest –trending compressional folds and faults systems .This west –northwest flow pattern reflects the shift in regional structural dip to the northeast that occurred in response to compressional tectonics and the developments of the Zagros orogen. Petroleum continued to migrate farther west through time as deposition expanded westward across eastern and central Iraq. The late Miocene flow-path model Fig.(6) shows that the majority of fields in the Mesopotamian basin and Zagros fold belt were located over the area

of active source rock and on the modeled petroleum pathways by late Miocene time, thus those fields not charged before the late Miocene received a petroleum charge during and after the late Miocene, whereas the fields that were charged earlier (from the Late Cretaceous through the middle Miocene) acquired additional charge in the late Miocene and Pliocene .In the fields that were charged earliest, the flow–path model indicates that initial petroleum generation and migration predated final entrapment by more than 60 my.

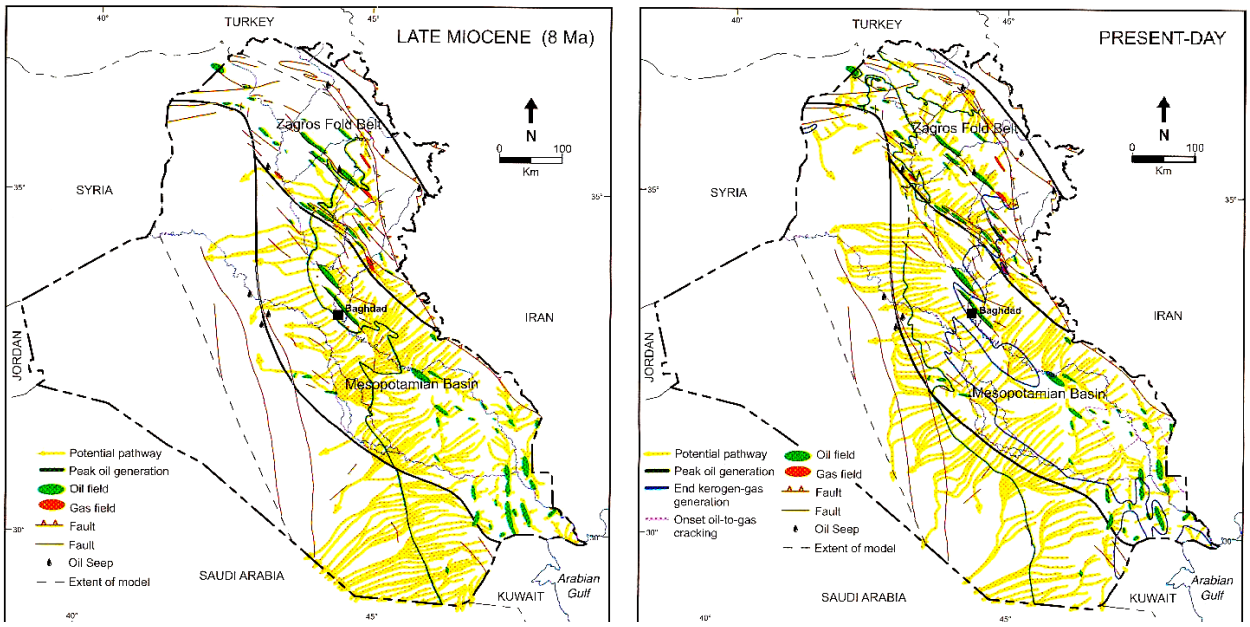


Fig.(6) Migration model (Pitman, 2004).

Summary and Conclusions

For a long time the former geologists and geochemist believes that the potentiality of generating oil and gas is focused on Cretaceous and Tertiary rocks, but reservoirs in the recent studies will going to open horizon on further correlations with the nearby region and with the surrounding countries that produce oil from Jurassic rocks, determined Jurassic rocks as the main generating of oils with subordinate gas, also it is a good reservoir. The injected oil through fault planes will permit to vertical upward migration isochronously oil pathways could permit to horizontal migration toward the typical litho and biofacies under high pressure impressed from eastern part of Iraq although the surfaces of faults could prevent it, but due to the wide extension of evaporitic and sealed layers attained to tens-hundred miles that lead to traps hydrocarbons within imbricate area .All the predications assured that the seepages of gas concentrated in the middle part of the northern regions of Iraqi lands (Qaiyarah, Makhul, Hamrin and Wadi Abu Jeer) and so many asphalt seepages situated around the area of investigation giving indication of widely and so many pathways from north and south regions of Iraq accumulated to form tremendous amounts and super giant oil and gas fields, that refers clearly to the new economic horizons, and might put Iraq in advanced ranking among the oil producing and reserving countries.

The whole prediction is relatively still sophisticated unless the efficient materials is arranged forward for more rigorous exploration processes.

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بناء الطيات وأحداث فوالق وأدى ايضا الى تعرية اجزاء تعود للعصر الطباشيري الاسفل، وكذلك العصر الجوراسي وتتابعات لأعمار جيولوجية أحدث عمرا في غرب العراق. وضمن المنطقة المدروسة،فأن حركات الجوراسي المتقدمة مع بيئات الترسيب القديمة اوفي فترة الجوراسي الاعلى المبكرة ادت الى تكوين مكامن كاربونية في حافة الحوض (تكوين النجمة) وصخور غطاء فعالة (تكوين القطنية) بأتجاه الحوض. أدت هذه العلاقات الى احداث غلق على الهيروكاربونات المتولدة من تكاوين الصخور المصدرية (تكوين ساركلو) ولكن وبصورة مغايرة ادى هذا الى احتباس النفط المهاجر بشكل جانبي في تكوين النجمة.

ان سطوح الفوالق العظيمة بأتجاه شمال–جنوب من منطقة نهوض الخليصية والمتد من الشمال الغربي من العراق الى جنوب غرب الصحراء ادى الى تكوين حواجز للنفوط المهاجرة جانبيا ووضع نهاية للمسالك الفعالة للهجرة من الحوض التكويني لتكوين ساركلو في شرق وشمال شرق العراق. وفي نفس الوقت فأن النشاط الحراري المتنامي ربما ادى الى تحويل المواد العضوية والواقعة في طبقات الباليوزوي (دهر الحياة القديمة) الى غازات ذات أصل حراري.

أن أجمالي النظام النفطي مكننا من الفهم الجيد لأصل النفط المتجمع في طبقات تكوين النجمة وصخرية من نوع اخر، وبالاستناد الى المقاطع الزلزالية فانه بالامكان للنفوط المهاجرة التوغل من خلال مستويات فالق الخليصية الى تكوين محيوير الكاربوني وهو مكافيء لحوض تكوين ساركلو (الجوراسي المتوسط) ليكون مكمنا نفطيا فعالا تغطيه متبخرات القطنية وانهايدرايت العصر الكامبريجي وكذلك فأن دراسة السحنات الصخرية لتكاوين تعود للعصر الجوراسي الاسفل والمتمثل بتكاوين (عبيد، حسينيات وتكوين عامج) هي المكافئة للتكاوين (بطمة، عداية، موس وعلان) والتي يعتقد بكونها واستنادا الى صخاريتها من تشكيلها لمكامن نفطية جوراسية واعدة. هذا هو الاستنتاج الرئيسي من هذا البحث.

ان التصور لهذا النوع من المكمن لم يتم اختباره لعدم توافر ابار استكشافية في المنطقة.

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الخلاصة

حدث نشاط تكتوني شديد خلال حركة زاكروس (الطباشيري المتأخر–الثلاثي المتأخر) وكذلك النهوض الاخير الذي حصل في عصر الهولوسين، ادى الى تنشيط