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Chia Ziri formation "U. Permian" in Iraq Reservoir characteristic, depositional facies and diaigentic control on reservoir and future oil producing

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Abstract

The Permian –Triassic Chia Ziri formation holds oil and gas reserves in exploration blocks in Iraq .Paleozoic is the most under explored succession in Iraq including important Permo-Triassic sequences.

Several wells was penetrated the Chia Ziri fm. in Iraq, three wells in NW Al-Jazira area (Kd-1,Mt-1 and As-1) and south west desert blocks in the two wells (Dn-1 and Wk-1). The Chia Ziri fm. represents a Permian transgression over varied topography in Iraq.

Lithologicaly, the formation is comprised of both carbonate & siliciclastic. The depositional setting was in subtidal to supratidal “shelf platform" with multiple digenetic events which control the reservoir characteristic. However,

The main source rock for entire Paleozoic plays in Iraq is Lower Silurian Akkas formation and lower Chia Ziri shaley parts.

Paleozoic is the most under explored succession in Iraq including important permo-Triassic sequences. The Permian –Triassic Chia Zairi formation holds oil and gas reserves in Iraq.

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Keywords: Iraq, permain, Gas Reservoir, Paleozoic.

Introduction:

In the Iraq Chia Zairi fm. and Arabian Gulf zone, the Permian gas reservoir is known as the Khuff Formation. This sequence is

Composed mainly of carbonate rocks and exists in Bahrain Qatar, Abu Dhabi, Saudi Arabia, and Iran.

The Upper Permian Chia Zairi and Lower Triassic Mirga Mir Formations contain extensive gas reservoirs in the North West, South west Iraq. Which not produced but it promised future a good potential. Arabian gulf is major reservoir and producing (Al-Laboun, A.A. 1986 and Aljallel,l. ,1995)

Chia Zairi Formation of Iraq together with the overlying Early Triassic Mirga Mir Formation form a chronostratigraphic equivalent for the Khuff Formation of eastern Arabia, and Dalan and Kangan formations of Iran

The Paleozoic succession represents a prospective target for exploration and future production of Gas and condensate oil in Iraq permain reservoir is on the south west exploration blocks and North West Al-jazira region and the most under-explored succession in Iraq, including the Permo-Triassic sequence.

Iraq Petroleum exploration focusing on Paleozoic sections has been limited to date and not produced. In all of Iraq only the Mosul Petroleum Company (MPC) well Atshan well No.1 had been drilled on 1950s, penetrated Permian section. , and little has been done to investigate the possible Paleozoic petroleum system(s) of the Permian Basin. This study aims to link between lithofacies and reservoir within the cyclic Chia Zairi deposition system and also made to give a generalized picture and source-rock. Reservoir and cap rocks.

Paleozoic is the most under explored succession in Iraq, including the carbonate Permo-Triassic sequence," Chia Zairi and Mirga Mir" formations., North western Iraq and equivalents in Arabian plate are one of major hydrocarbon reservoirs in the Middle East.

The Chia Zairi in Iraq extends from Ora outcrops in Kurdistan near Turkish border fig-2 to southern Iraq(e.g. West Kifil-1 and Diwan-1), thus covering most parts of the country. It is absent in the far western deserts at Jordanian border and some areas near Syrian border (i.e. Khelsia High region) due either to non-deposition or erosion.

The Chia zairi Formation" Upper Permian" contain extensive gas reservoirs In north west blocks, the fields as Atshan, Mityaha and Jabel Khand in North West Al Jezra rejion and the south west blocks the wells West kifl and Diwan in Southern west blocks .

Diagnostic allochems such as ooids, pelloids and shells. Rock fabric was separated into grain- and mud-dominated fabrics (Lucia, 1999), which are minor modifications of the Dunham (1962) classification.

Area of Study:

Areas which are considered to have the most favorable Permian section from the Study Area Fig-1,2,3 five deep wells penetrated the Chia Zairi Fm; in the north west Al-Jezara and south west blocks (Uqaili,T, 2012,IEI).

The Upper Permian is Absent In far Western Iraq. At Akkas and Khleisa fields as fig-1, 2, 3 and below:

North West Al-Jezara region including the exploration wells:

Atshan-1, As-1: Atshan-1 well is located about 20 km southwest of Mosul City, slightly south of the crest of Jabal Atshan anticline. The total depth of the well is 3448 m and it bottomed on the Permian Chia Zairi Formation.

Mityaha-1 MT-1: is located in Mityaha structure, about 70 km southwest of Mosul City. The well reaches a total depth of 2870 m and bottomed on the Permian Chia Zairi Formation.

Jabal Kand-1 Jk-1: is located at the middle dome of Jabal Kand structure; about 30 km north of Mosul City. The well penetrated all Chiazairi formation reaches to total depth of 5848 m Harur Formation Lower Carboniferous.

South West desert blocks:

West Kifil-1 WK-1: The West Kifil Field is located about 40 km southwestern Karbala City between Kifil Field to the east and Merjan Field to the west. West Kifil-1 ,which reaches a total depth of 5872 m and bottomed on Ga'ara Formation (Permo-carboniferous).

Diwan-1 ,Dn-1: is located about 35 km to the southwest of Samawa City. It was drilled the Diwan structure. The total depth of 5483.5 m and bottomed on Permian Chia Zairi Formation.

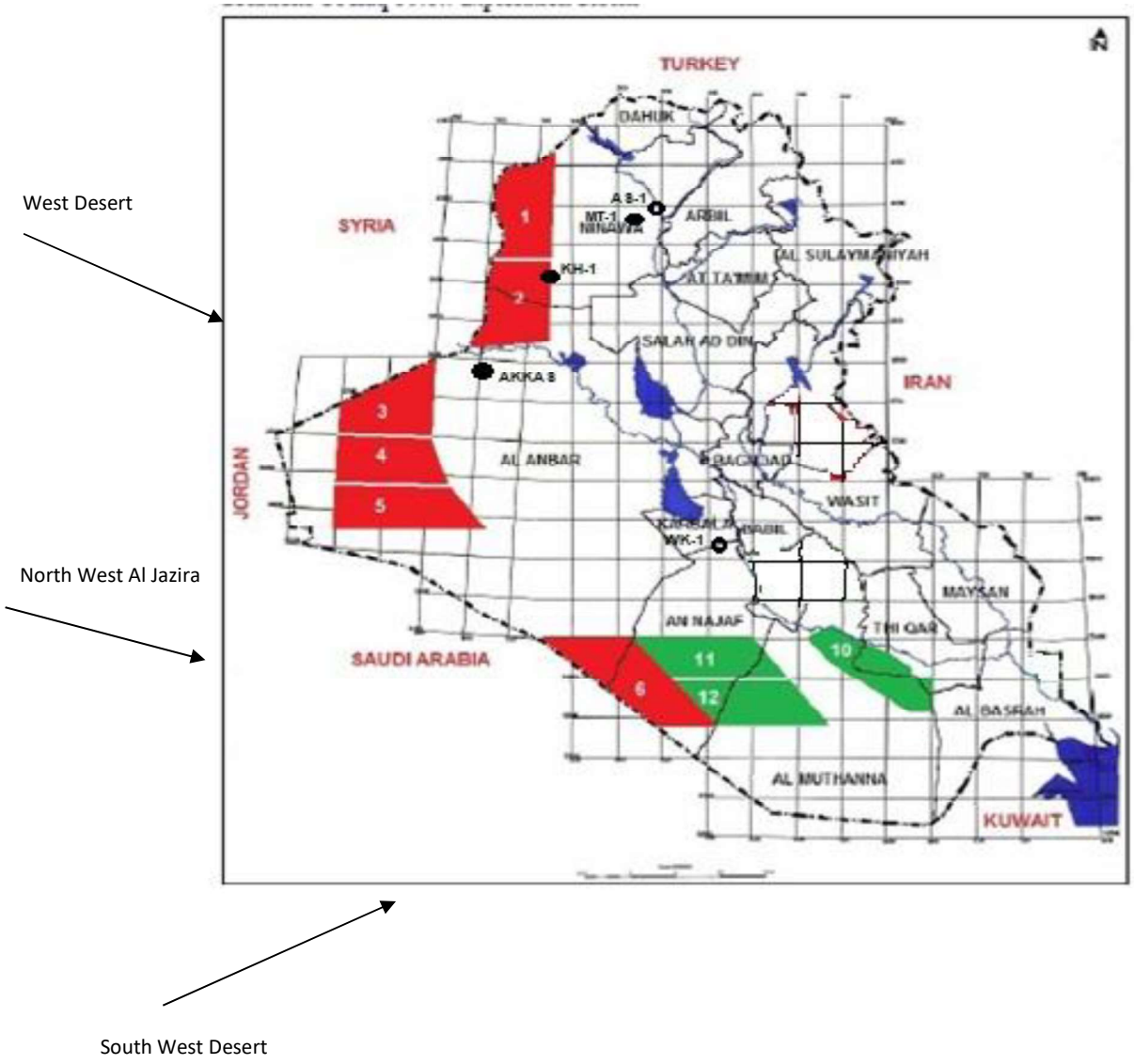

Fig.(1) Blocks of study area at north west ,west and south west desert in Iraq which promising future oil producing containing blocks(modified from(Uqaili,T. 2012,IEI).

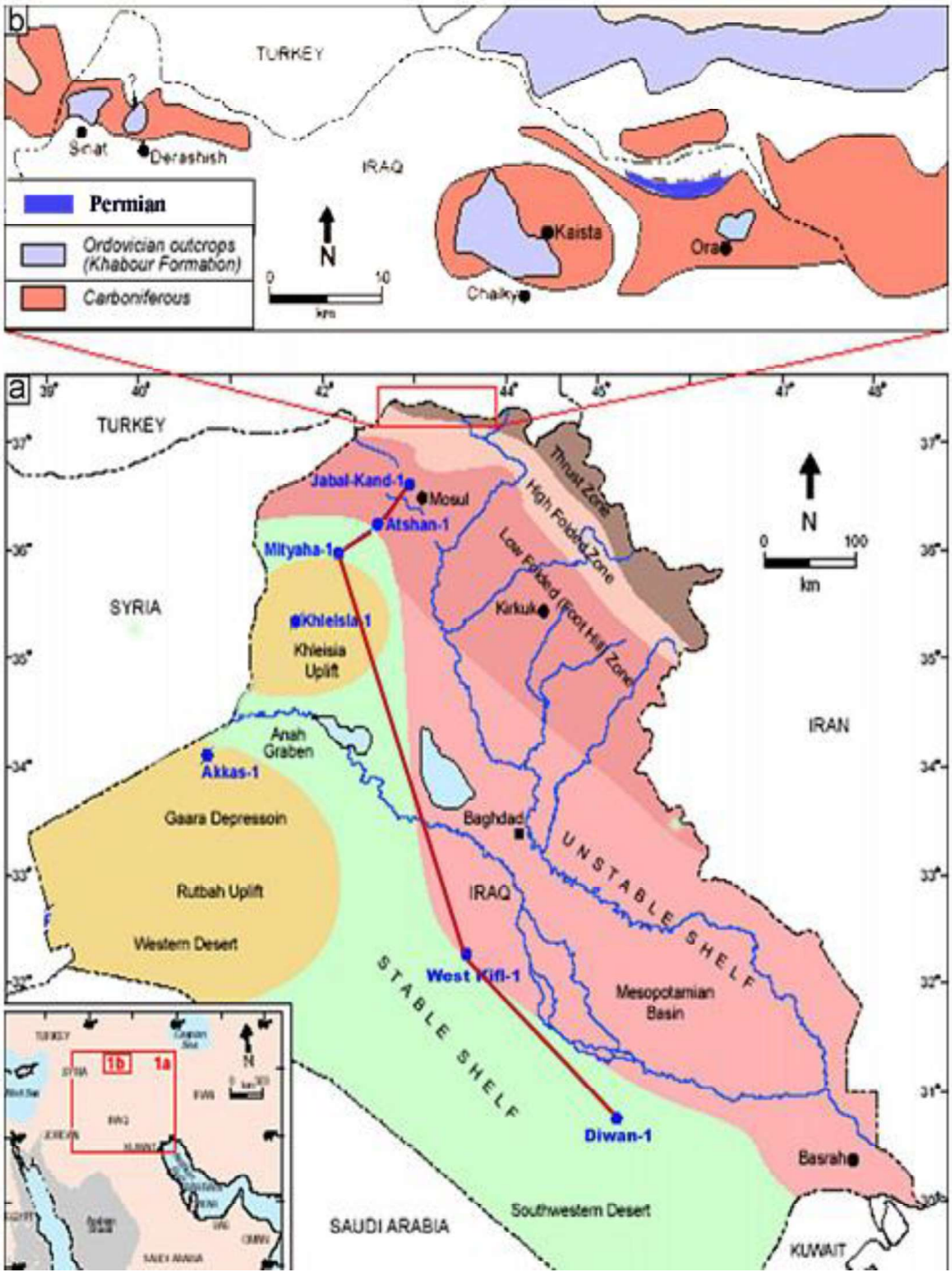

Fig.(2) location map of the wells penetrated Chia Zairi formation & outcrops of Permian rocks in Iraq.

Most of the penetrated wells of Paleozoic successions in Iraq are located in the(west desert blocks) Stable Shelf Fig-3 , i.e. Akkas Field, Khleisia-1, Mityaha-1 and Diwan-1. The other two wells (Atshan-1 and Jabal Kand-1) are located in the Unstable Shelf, whereas West Kifil-1 lies at the contact between the Stable and Unstable Shelves.

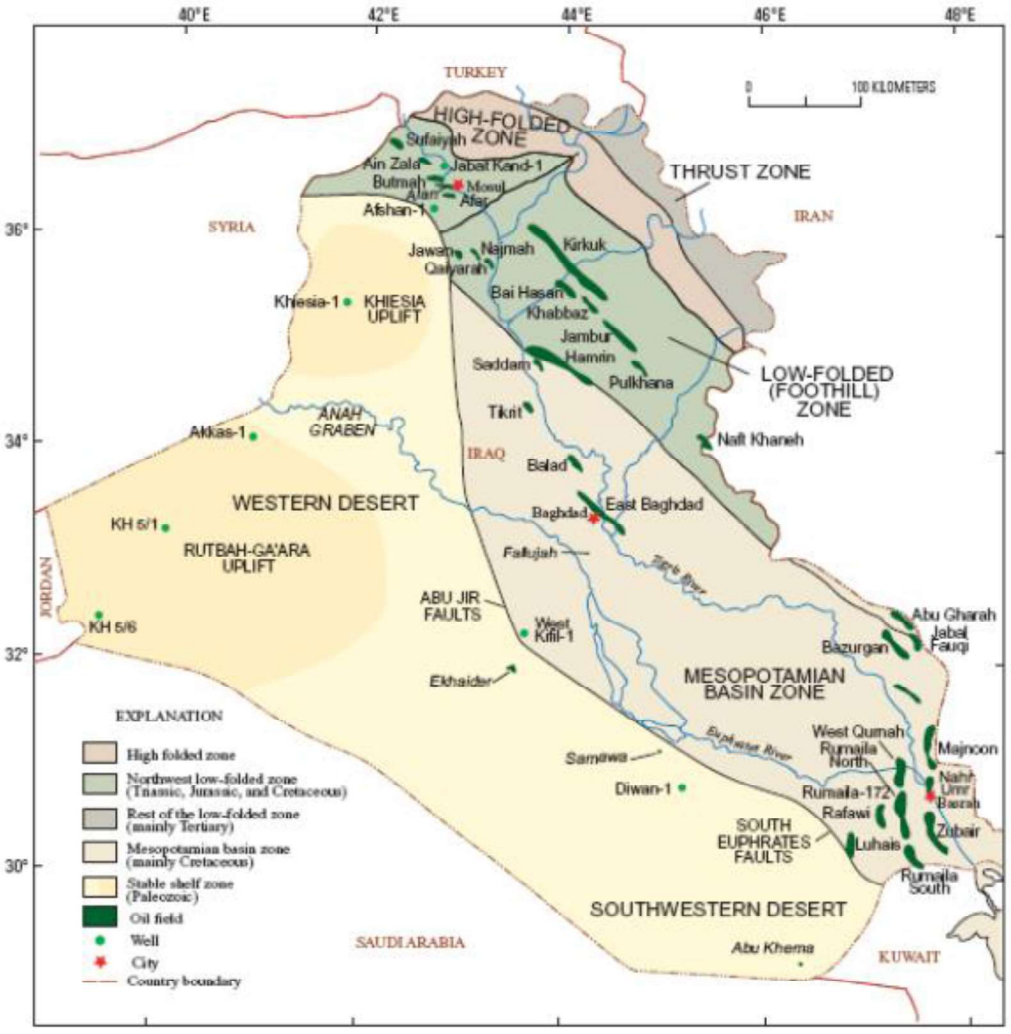

Fig. (3) Tectonic map of Iraq explain Permian wells in different location. Modified from (Fox and Ahlbrandt 2002).

Regional Geoloigical Framework of the Study Area:

The Iraq permian sequences is strongly affected by the structural elements position of the country within the main geo structural units of the Middle East region as well as by the structure in the end of Paleozoic Permian system within Iraq. Permo-Triassic carbonates ("Khuff and Chia Zairi equivalent") Fig-3, form the most important producing reservoir in the Arabian Gulf and surrounding area (Bordenave, 2008).

The Paleozoic tectonic super cycle ended with the onset of break up tectonics in the Permian, and the deposition of Khuff" and equivalent Chia Zairi" .This sequence is composed mainly of carbonates over the eastern passive margin Figures (4, 5).

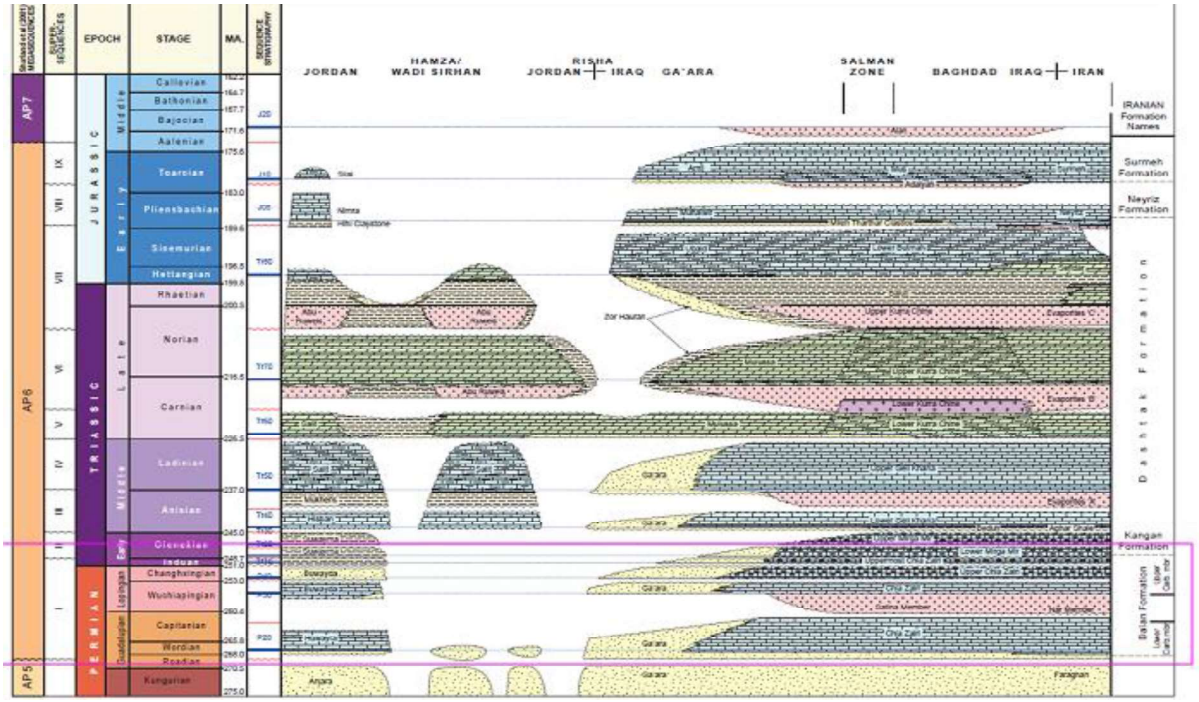

Fig. (4) Chia Zairi formation correlation in Iraq and equivalent in Jordan and Iran (Aqrawi et al. 2010).

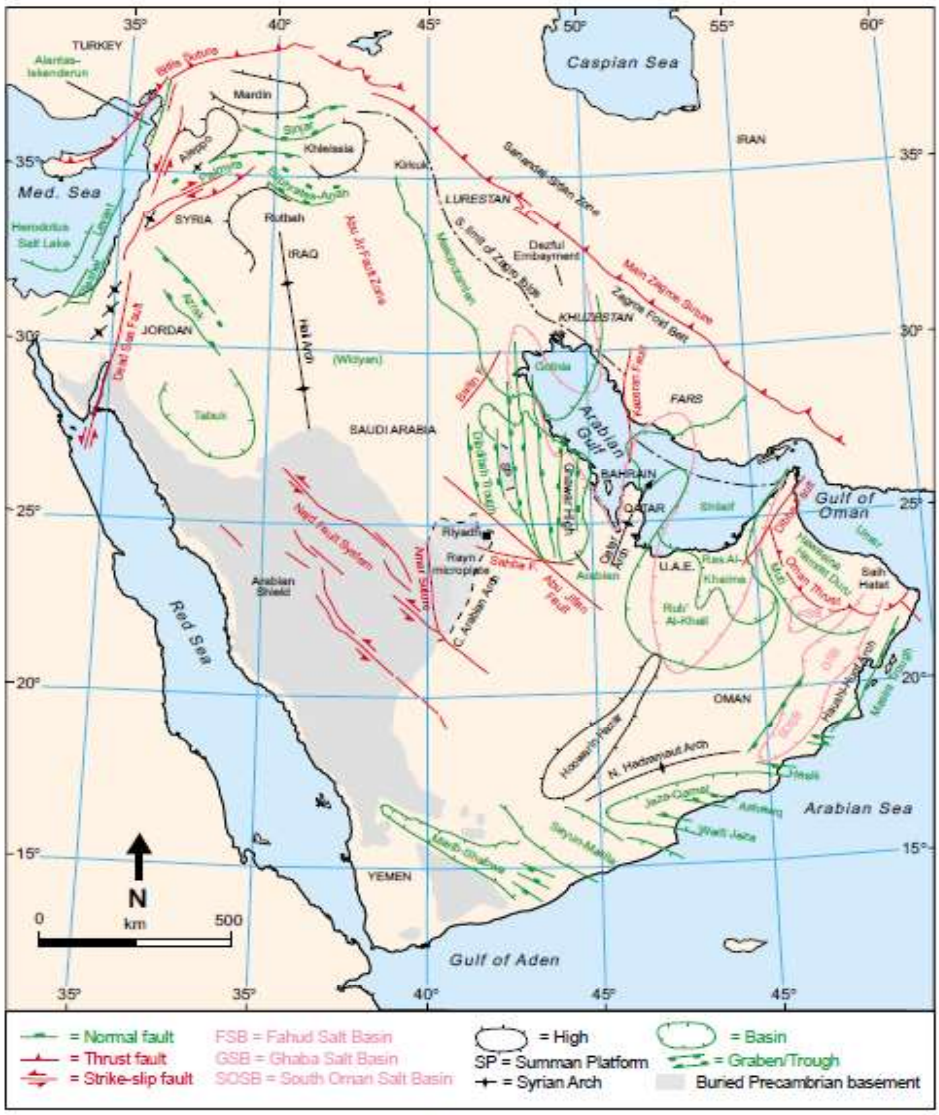

Fig. (5) Structural interpretation of the Arabian plate as it relates to the distribution of the late Permian sequences.

Review of Type section (Facies) of Chia Zairi Formation and distribution

Chia Zairi Formation (mid-Late Permian). Originally described by Wetzel (1950, cited by Bellen et al., 1959) in the Northern Thrust Belt area of Iraq, the formation has a thickness of 750-810 m (2. 460-2,657 ft).

The Chia Zairi Type section was divided by Hudson (1958) into three members and described by Bellen et al. (1959) and Buday (1980) from: Figures (6, 7) and Permian-Traissic boundary P-T boundary of the Chi Zairi type section at the Ora outcrops (Gayara, 1992) the three units Chia Zairi Fm.:

The lower unit ('Darari Formation"): The lower Dariri Member consists of alternating thin bedded detrital limestone, dark blue limestone and massive, cliff-forming silicified limestone with black shale beds near the base.

The middle unit (Satina Evaporite Member): The Satina Evaporites Member consists of dolomite with recrystallized breccias, and recrystallized marls. is made up of 60-80 m (197-262 ft) of dolomites, with solution and recrystallized breccias and marl. Tamar Agha " personal communication 2013" field study the type section no evaporate but dolomite and breccia The evaporate rocks is dolomite and breccias at out crops not as descriptive by type section as satina evaporate middle member

The upper unit ("Zinnar Formation"): The upper Zinnar Member which is 300-320 m (984-1,050 ft) thick consists of thin bedded organic detrital, occasionally cherty, limestone with some harder, scarp-forming silicified limestone; in the uppermost part oolitic limestone with clastic beds.

The upper contact of Chia Zairi Formation is gradational and conformable with Mirga Mir Formation; it is taken above massive dolomitic limestone of Chia Zairi and at the base of thick succession of thin-bedded, soft limestones and silty marls of Mirga Mir Formation.

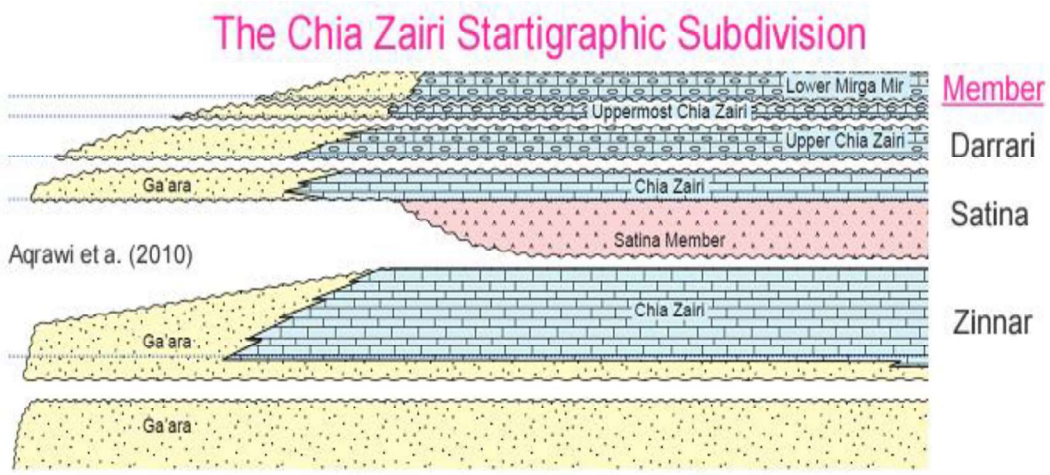

Fig. (6) Chia Zairi formation "Three unit" Member (Bellen *et al*., 1959).

The Chia Zairi (Cz) carbonates are overlying the Harur (Ha), Ora (Or), Kaista (Ka) and Prispiki (Pi) formations at this outcrop in the Ora region of Iraqi Kurdistan
(Photo by Eric Blanc)

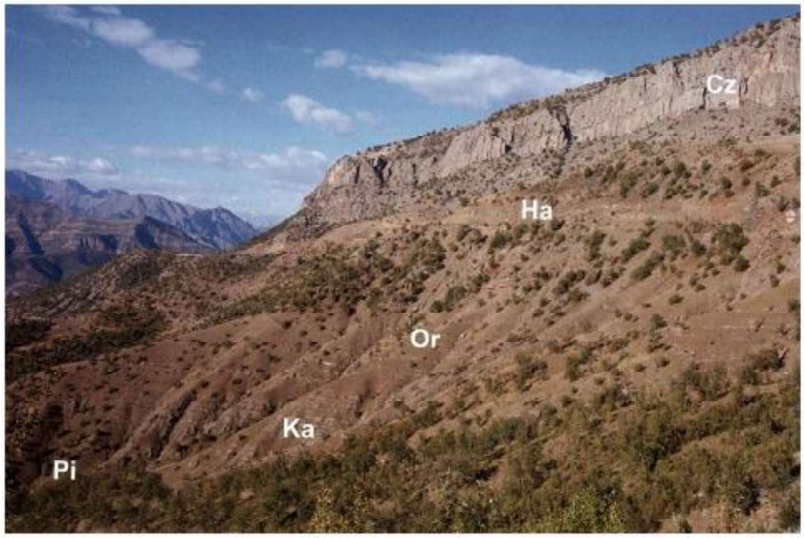

Fig. (7) The chia Zairi outcrops,) Ora region, North Iraq, After Aqrwai 2010,

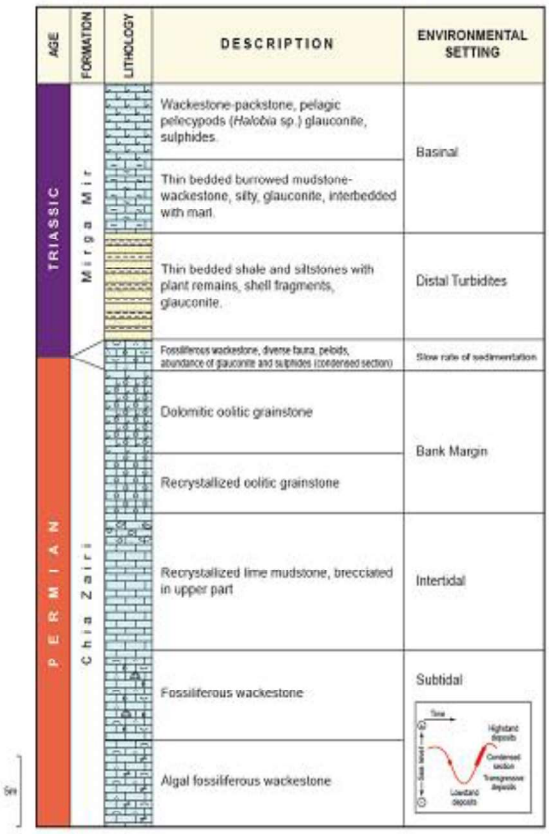

Fig. (8) Permain-Traissic boundary P-T boundary of the Chi Zairi type section at the Ora outcrops (Gayara, 1992).

Lithfacies and Distribution of Chia Zairi formation:

The distribution and lithofacies changes of Chia Zairi Formation in studied area are of major importance in the evaluation of Permian strata as prospective reservoir rocks for oil and gas in iraq and adjacent areas.

In general, the Late Permian Chia Zairi and Early Triassic Mirga mir Formations consist of a series of cyclic units beginning with non-dolomitized to partially dolomitized subtidal grainstones to packstones (offshoal and shoal facies), passing up into lagoonal / intertidal dolomites (anhydrite-cemented facies) and capped by supratidal dolomitic or anhydrite.

A general subdivision of sediments has been made on the basis of dominant lithological type, as shown on the accompanying regional facies Figure (9): are, firstly, marine sediments including:

a. Shelf carbonates (North West) Iraq MT-1 and As-1 wells

B. Shelf Rim and slope carbonates (North) Iraq Kd-1 well and out crops type section Ora region.

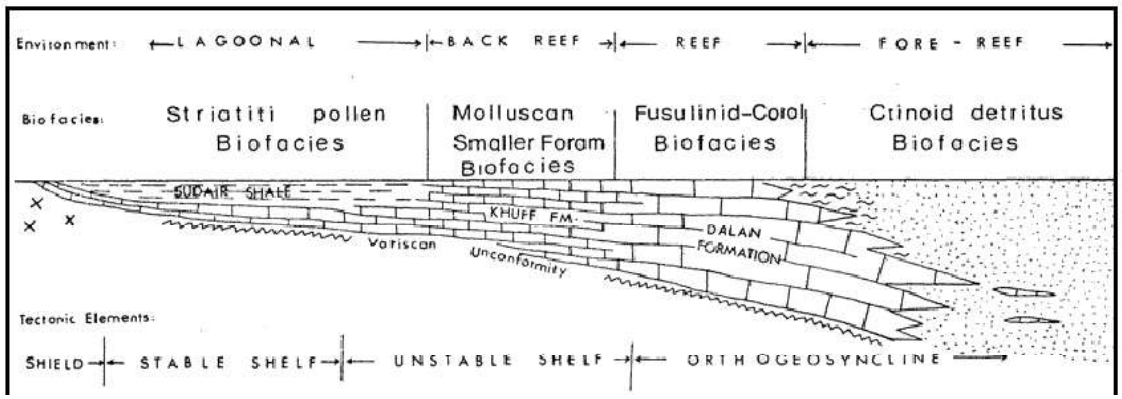

Fig. (9) Diagrammatic Lithofacies cross section of the "upper Permian-lower Traissic" from North to West of Iraq.

Chia Zairi fm. At Jabel Khand-1 well subdivision

These three units are here considered as informal members of the Chia Zairi Formation which is suggested five lithologic units in well Jabal-Kand -1 and correlated with the wells ,As-1, Mt-1 and Type section .Fig- (from younger to older) are:

-Upper limestone unit;

-Mixed carbonate–siliciclastic unit;

-Middle limestone unit;

-Lower dolomite unit

-Lower limestone

Fig-10 in The well Jabal-Kand-1 Permian" Chia Zairi Formation" Unit CH the formation is divided into three units with the upper CH1 and lower CH3 are predominantly limestone, while the middleCH2 unit consists of alternating dolomite sand clastics. The clastic unit below the Chia Zairi Formation is here shown as the Ga'ara Formation although it may be coeval with the Chia Zairi carbonates.four subsurface units CH1,CH2,CH3 and CH4 downwards;

CH1 unit The upper Darriri Member carbonates contain regional MFS P30 and MFS P40, which can be correlated with the Khuff C (Khuff B ?) of Saudi Arabia.

CH2 unit "The middle Satina evaporite Member" (i.e of subsurface) may be correlated with the Khuff D anhydrites of Saudi.

CH3unit the lower Zinnar Member () contains carbonates deposited during the middle Permian transgression and consists of the regional MFS P20 that can be correlated with the Khuff c Member of Saudi.

The Chia Zairi Formation extends from upper-north Ora outcrops near the Turkish border fig-2, 12. To southern Iraq (wells West Kifil-1 and Diwan-1), thus covering central and eastern parts of the country fig-10, 11 and 12. It is absent in the far western deserts at the Jordanian border and some areas near the Syrian border (i.e. Khelsia High region and south of Jabal Sinjar) due either to non-deposition or erosion..

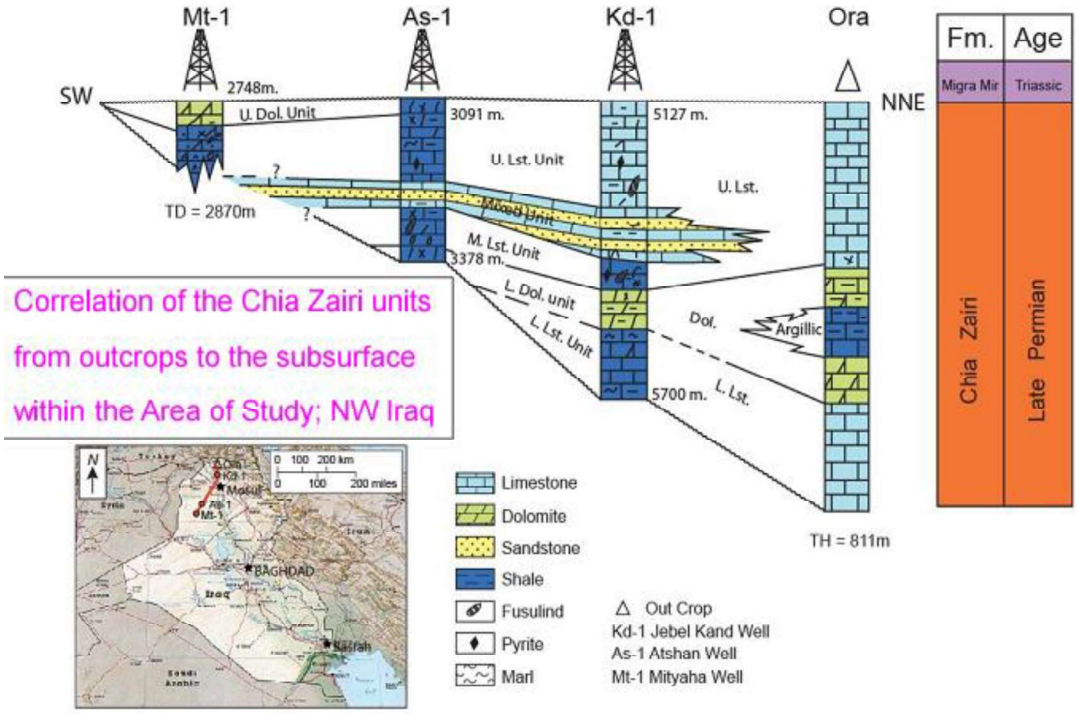

Fig. (10) Correlation the Chia Zairi Five Units of well Kd-1 and wells AS-1 and Mt-1 to Outcrops" Ora" region North Iraq.

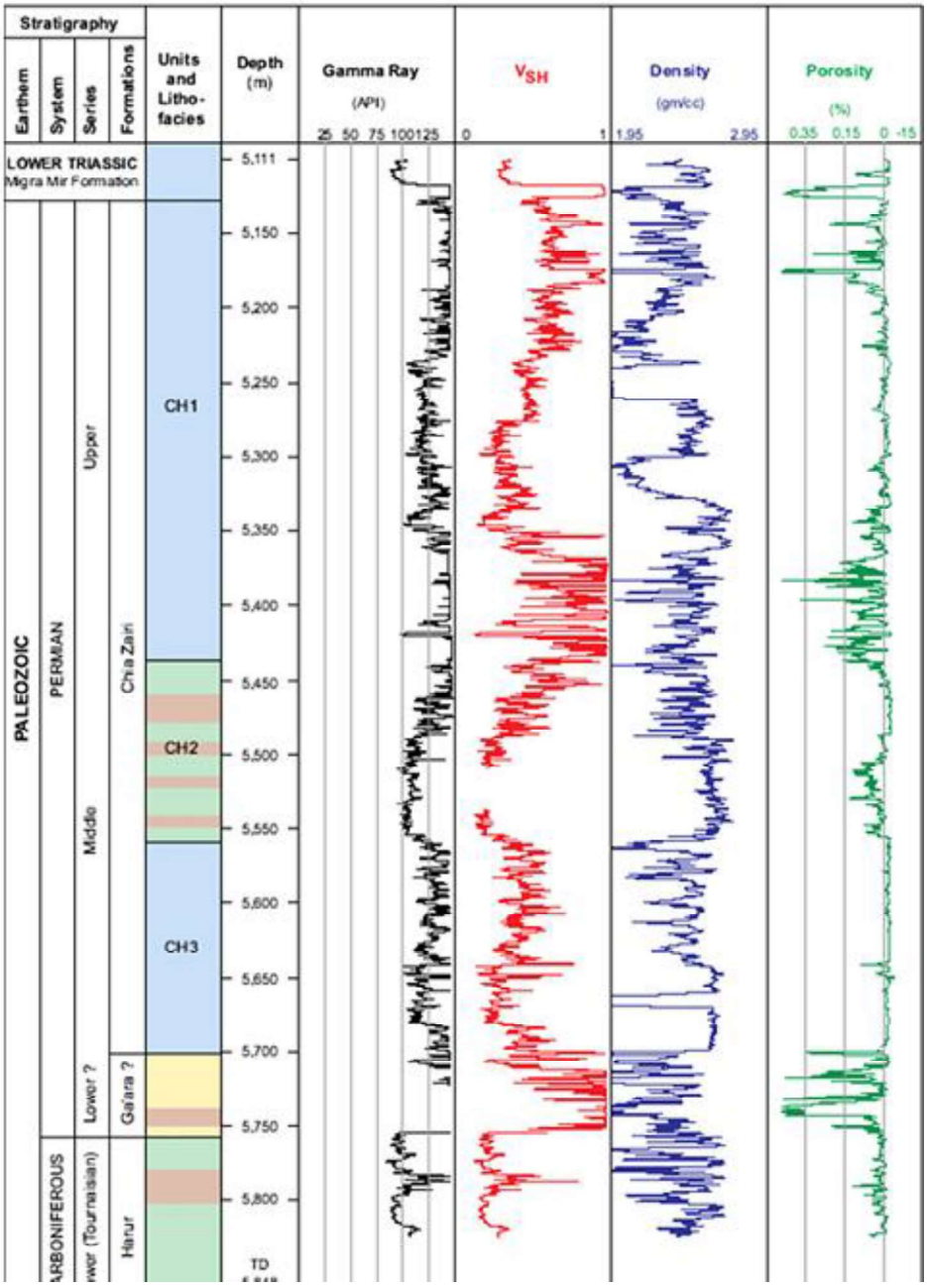

Fig. (11) Well Kd-1, General, Chia Zairi fm. lithofacies unit,CH1,CH2 and CH3.

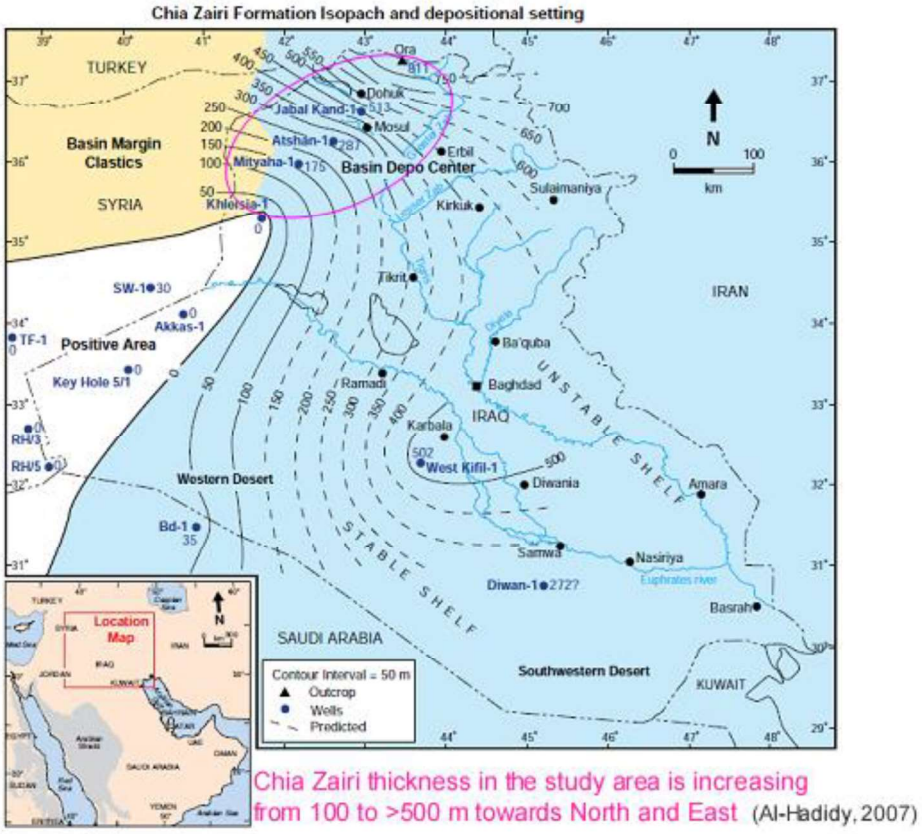

Fig.(12) isopach map of Chia Zairi fm increasing from 100 to >500m and missing west desert.

Diagenetic Sequences and porosity control on reservoir efficiency

The interpreted sequence of diagenetic events, from petrographic relationships and is summarized in Figure (13) These processes have also been distinguished and Core examinations together with detailed thin section analyses indicate that many of the diagenetic processes overlapped in time. Three major diagenetic environments were recognized in Chia Zairi Formation as Figure (13)

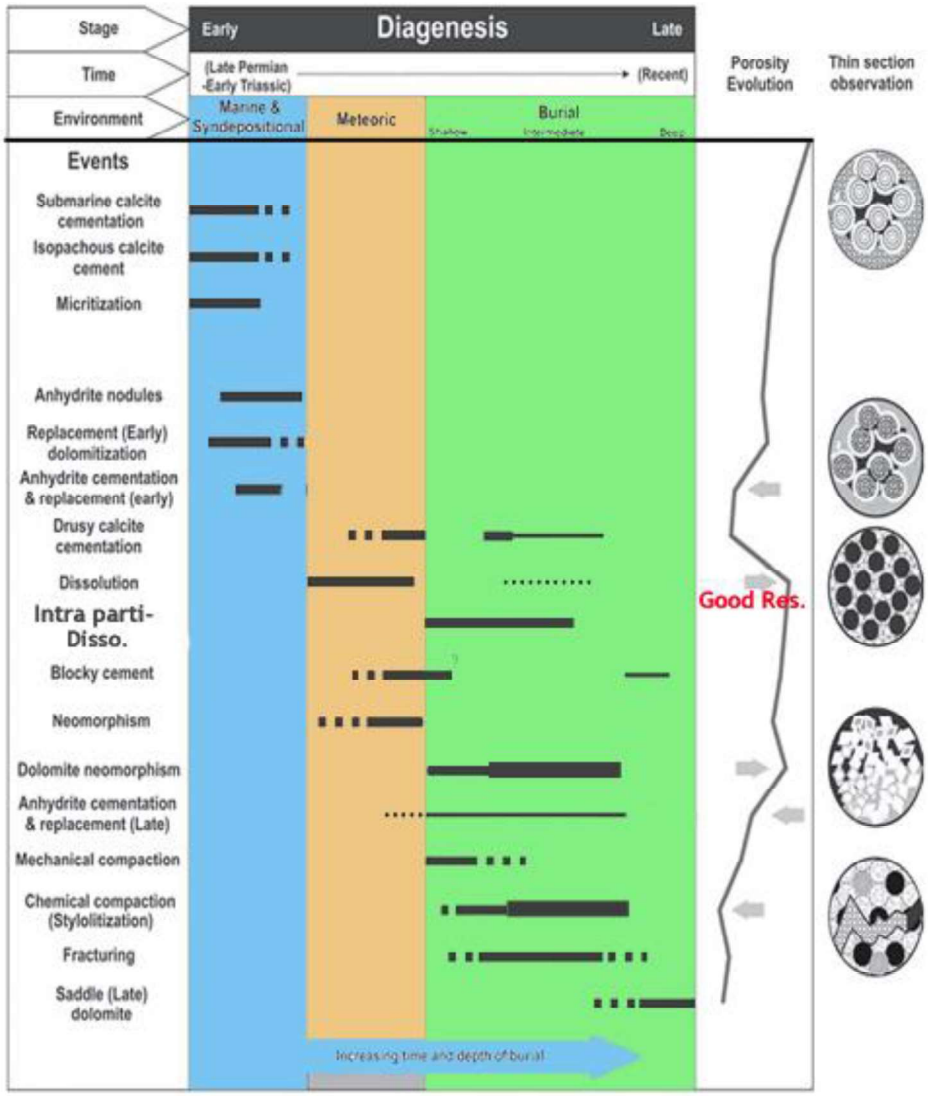

Fig.(13) Daigenetic sequnces of affecting reservoir properties of chia zairi fm.

(1) Marine and syndepositional diagenesis:

Hypersaline conditions occurred in landward locations on the carbonate platform (e.g. in restricted lagoons).Calcite cementation occurs in lagoon and shoal facies

(2) Meteoric diagenesis: subaerial exposure during sea-level lowstands caused extension of a meteoriclens into the near-shore and shallow-marine realms. The effect of this diagenetic

mechanism on non-dolomitized deposits (mainly open-lagoon, shoal and offshoal facies) was more important than on dolomitized intervals.

(3) Burial diagenesis: Alteration and re crystallization of replacive dolomites led to the formation of fabric-destructive (coarse and idiotopic) dolomite bodies Late stage anhydrite and calcite cement occluded early porosity and late diagentic.

Fractures, which are locally important. Fracturing and saddle dolomite cementation occurred during late phases of burial diagenesis.

In general, diagenetic processes were facies-selective and limited by stratigraphic boundaries at afield scale.

The main diagenetic features affect Porosity that dolomitization and anhydrite cementation, along with original facies type, are major factors controlling the reservoir quality of the Chia Zairi fm in NW and ,SW Iraq

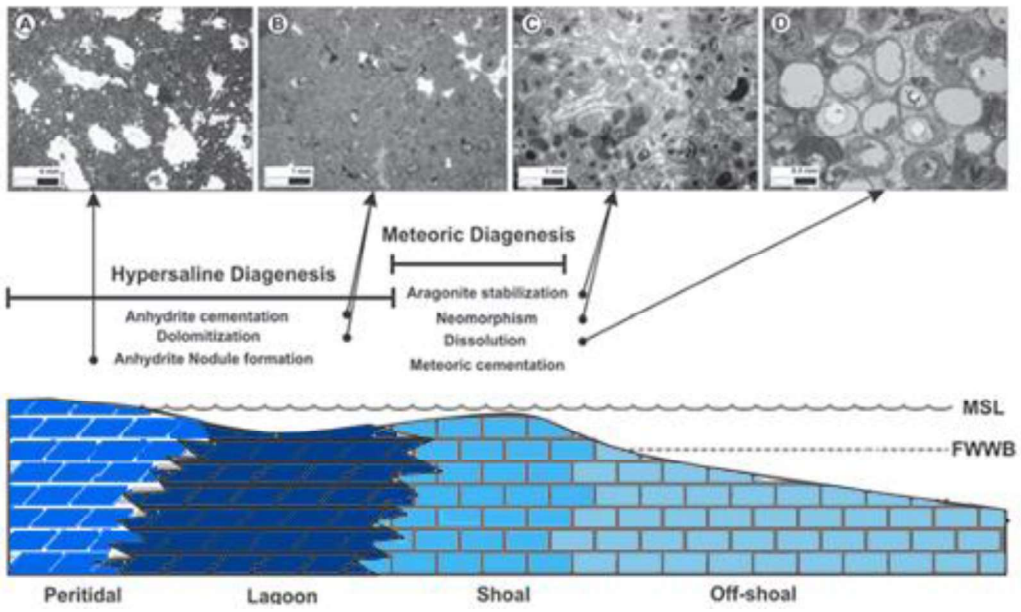

Fig.(14) Hypersaline and meteoric diagenetic zones distinguished from core and thin-section analyses of Chia Zairi Fm.

In the hypersaline zone, which coincides with the peritidal and closed lagoon facies, dolomitization, anhydrite cementation and nodule formation occur.

In general, stylolites show cross-cutting relationships with dolomite and anhydrite crystals (and anhydrite nodules). Also afeect the porosity and permability.

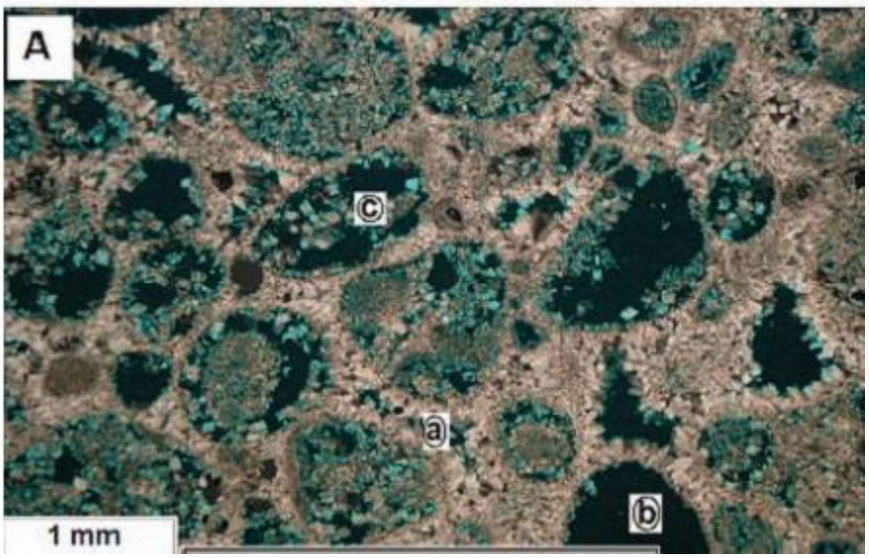

Plate (A) Dolomitize of oolite moldic porosity of chia Zairi fm. In Wk-1

Plate (B) sucroidal dolomite in Chia Zairi Fm. well Dn-1.

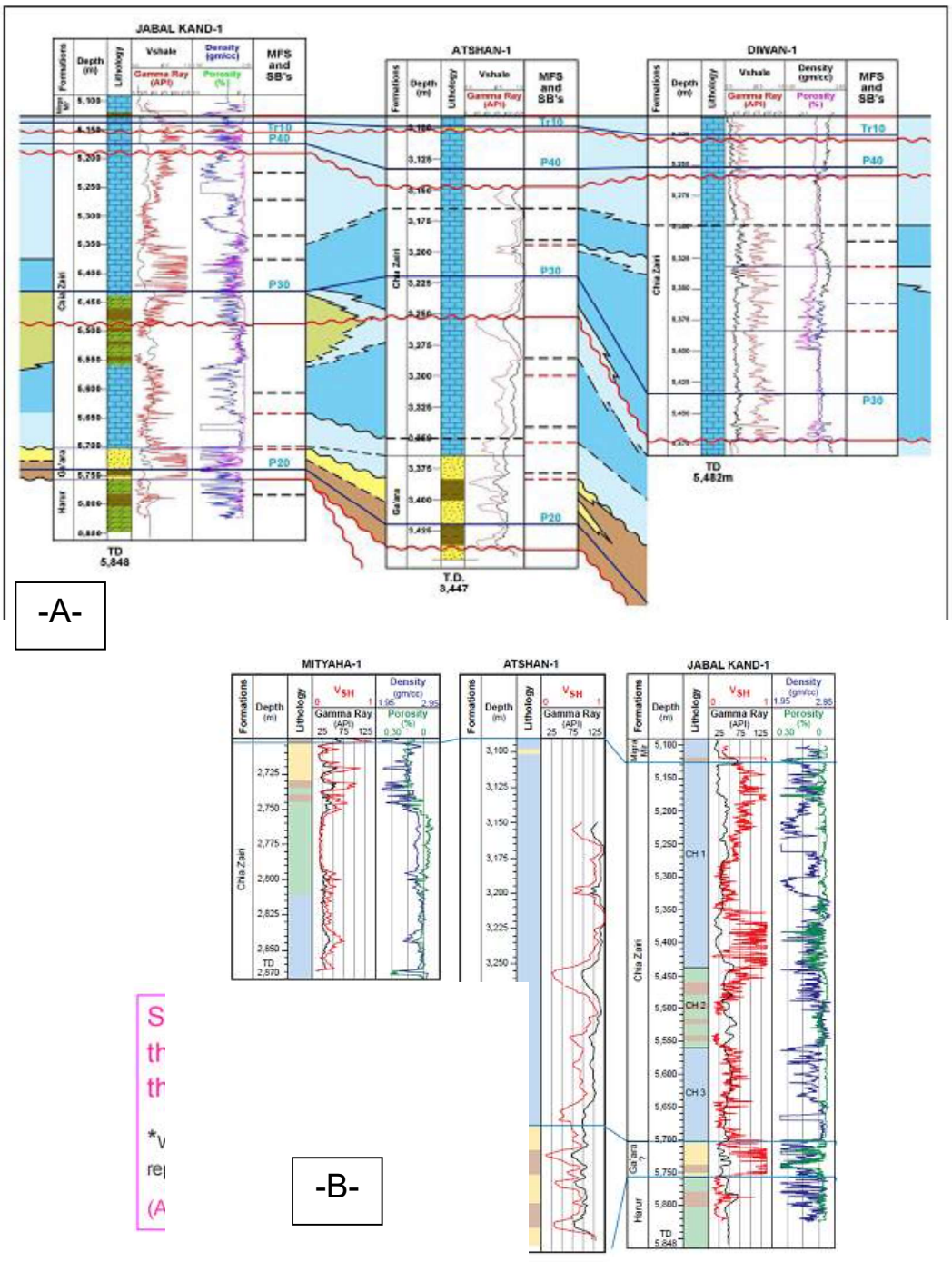

Fig.(15) A,B Strtigraphic Chia Zairi fm. Correlation along the wells Kd-1,As-1,Mt-1,WK-1,And Dn-1

Chia Zairi Fm ".Depositional Model:

"The North West Al-Jazira region wells(Kd-1, Mt-1 ,As-1) and south west blocks wells (Dn-1 and Ws-1) and positive in west desert Iraq wells (Akk-1, Kh-1) Chia Zairi fm. Distribution as in Figure(12) due to sea level " Trangressive-Regressive" depositional sequences and tectonic elements effect and The evolution of depositional Model as Figure(12) which is represents of facies distribution of chia zairi and positive area in west Iraq.

These facies were deposited in a shallow-marine ramp or epeiric platform as the growth and evolution to the. Carbonate platform" homoclinal ramp" uplifted due to thermal doming within the submerged craton caused by thermal (Numan, 1997). .

The peri-platform of Chia zairi formation trends North West to ward the wells Mityaha-1andAtshan-, where the thickness increases in the basin center at the type section of the formation in the Ora area Figure (12).

The Chia Zairi formation (permain) in the area of study influenced by two main tectonic elements which deduce to non deposition or erosition in west Iraq Figure(12).

1-Hail-Rutba-KhleisiaArch, which was active and considered as appositive area and source of clastics during middle Devonian and Permian in the Akkas and Khleisia field area (Al-Mashadani, 1984).

2- Anah Graben,which forms a subsidence setting in the Paleozoic and Mesozoic ,and affected the depositional regimes in the area.

A homoclinic-ramp model is proposed for the deposition of the Chia Zairi Formation as indicated from its facies distribution. The ramp model forms the foundation stage for the succeeding ramp deposition in the lower Triassic as ramp stacks (Burchett and Wright (1992). This coincides with the ideas for the ramp deposition in the lower Triassic MirgaMir Formation(Al-Adool,1998) sediments for the maximum transgressive phase of the late Permian and may also include the younger lower Triassic sediments and as below:

Outer-ramp setting: shale and mudstone facies may represent the, whereas,

Mid Ramp: the carbonate (dolomitic) facies, with its skeletal components of fusilinds, bryozoans and some algae, were deposited in high energy mid ramp.

Inner-ramp the mudstone–wackestone with some intercalation sof sandstones may reflect the *deposition.*

Chia Zairi Formation as fig-16 forms apart of wide shallow-epeiric seas that extended toward the south western part of Iraq in the wells West Kifl-1 and Diwan-1 to widyian basin(Al-Labion 1986).

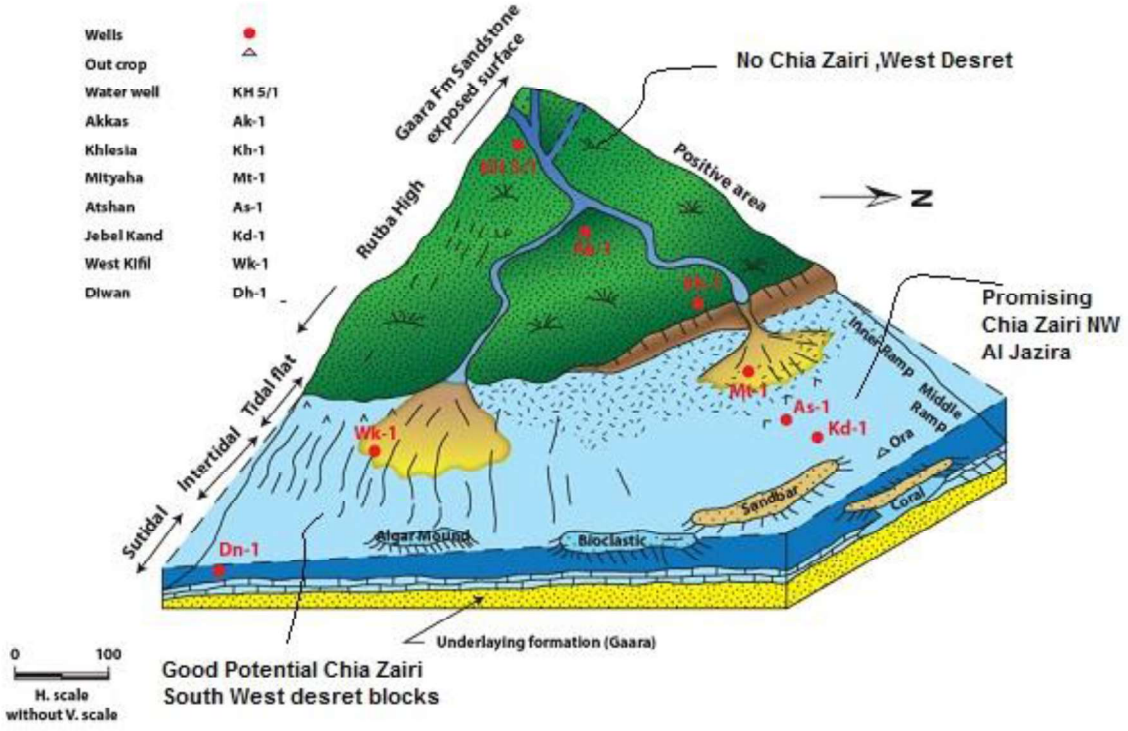

Fig.(16) Depositional model for the Chia Zairi Fm. In NW Al-jazira region and South West Blocks of Iraq.

Hydrocarbon potential of North West and South East "Exploration blocks " and future Gas Production from Permain reservoir in Iraq

The importance of the Permian sequence in Iraq and first production in Arabian Gulf (Saudi Arabia, Kuwait, and the United Arab Emirates,) and no Gas accumulations fig-, the high potential Sw Blocks the wells ,Dn-1, WK-1 and medium potential is NW al-Jazira region the wells AS-1 and Mt-1.

Chia Zairi and Lower Triassic Mirga Mir Formations contain extensive condensate oil and gas reservoirs in the North west ,south west blocks in Iraq In such exploration gas fields as Atshan,Miteha,Khand in North west and Diwan and West Kifl, in Southern Iraq. As:

1-Conformably involved in major oilfield as structures and many large unproved, anticlines in North west and south east Iraq.

2. Mostly capped by Triassic marls and upper beds of Chia Zairi fm. With some evaporites. Impervious cap rocks, or roof rocks, for actual and potential Permian hydrocarbon reservoirs exist in several stratigraphic positions.. thinner bedded limestones and dolomites of the Lower Triassic.

3. Significantly fractured and dolomitized with secondary porosity. The main types of porosity are inter oolitic, intergranular, and fissure. Permeability varies widely from less than onto a few tens of millidarcy

4. Mostly organic limestones and thus potential source the lower unit of Chia Zairi Shale

5-The Chia Zairi Formation in Atshan-1,Jabal-Kand-1, West Kifil-1and Diwan-1 show source rock potential, particularly in the lower shale part which is about 20m thick (Al-Haba etal.,1994). The Permian carbonates could be self-sourced or sourced from older formations such as the Akkas Formation, from further to the south and north west Iraq.

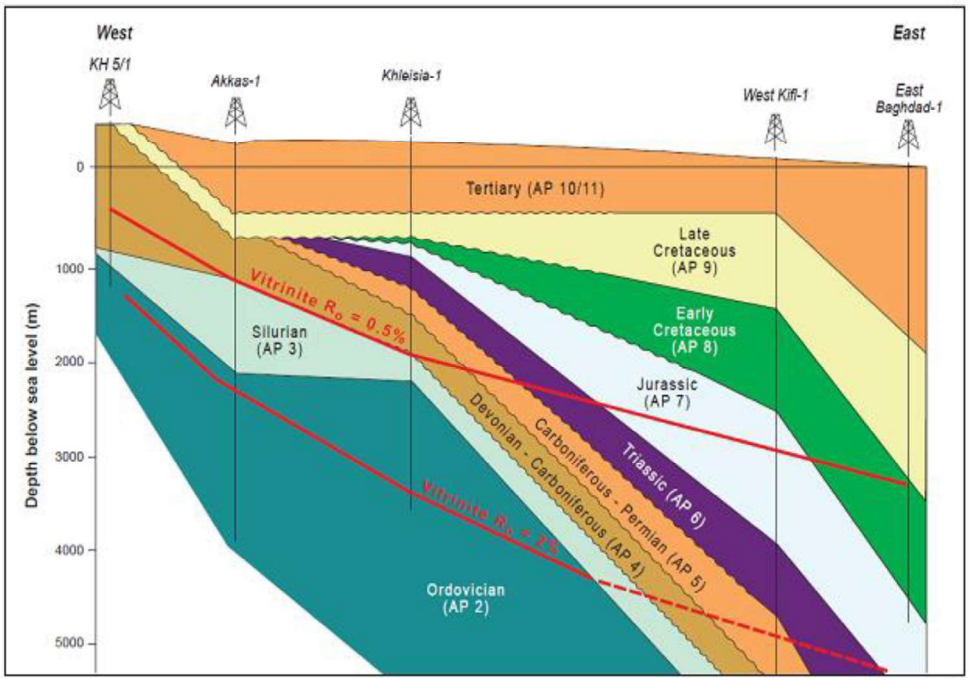

Fig.(17) Chia Zairi Gas Reservoir south and central Iraq(after Aqrawi et al. 2006 modified from Al Haba et al .1994)

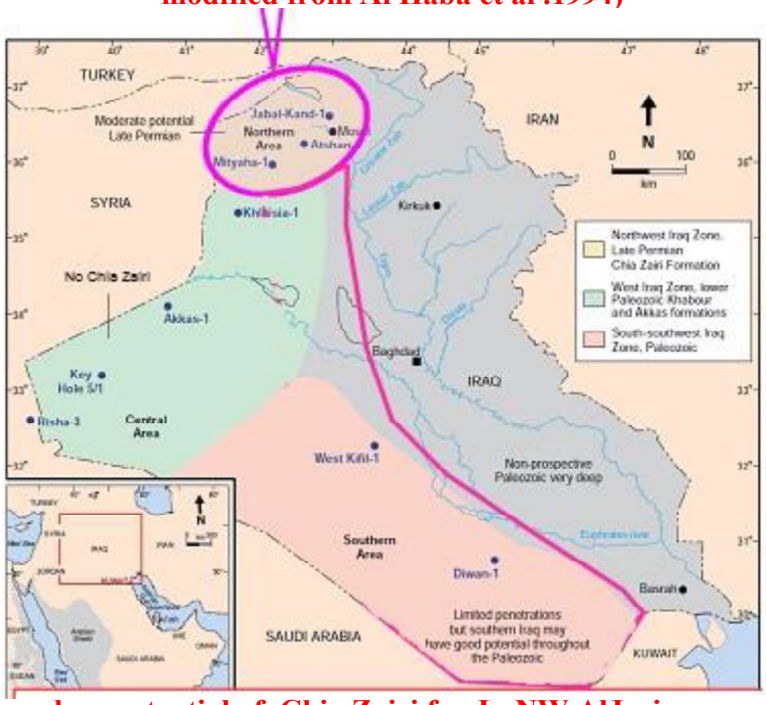

Fig.(18) hydrocarbon potential of Chia Zairi fm. In NW AlJazira area,and south west blocks .

Conclusions:

1-The Permian "ChiaZairi fm equivalent Khuff in the south west blocks of Iraqi desert. considerd as a potential gas reservoir although deeply buried More than 4000mt. and have extended north Saudi Arabia And Kuwait in facies and reservoirs.

2- Important for Non- associated gas reservoir in North West al-Jezera region in field Atshan , And Mityha exploration structure. And the facies of dolomite and oolitic limestone

3--The top of upper unit of Chia Zairi fm. Is a good reservoir oolitic-grainstone with oomoldic porosity and hydrocarbon shows in some intervals act as reservoir.As-1, Mt-1, Dn-1 and WK-1.

3-The Upper Permian "Chia Zairi " equivalent to "Khuff formation" reservoirs are mainly shelf carbonate grainstones and reef carbonates .

5-The main source rocks the dark shale of Ga,ara fm.Ora shale 3 % TOC and shale beds in the lower unit of Chia Zairi fm (20 mt. and 1% TOC) and cap the lower part of the younger Mirga Mir Fm.

6- The Chia Zairi fm. Is missed in the west desert in Akkas field is either no deposited or eroded.

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