Geology of Iraq

Lecture-5

(The Jezira- Mesopotamian & Salman Zones)

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2020-2021

B-The Jezira Subzone

The *Jezira subzone* was part of the greater W Arabian Palaeozoic basin until the Late Silurian.

*It was uplifted in Late Silurian-Mid Devonian time forming a NE-SW trending arch.

*It formed part of the Rutba-E Palmyride Permocarboniferous N-S trending basin.

*It was part of the Rutba Uplift from *Late Permian to Early Eocene time though it was intermittently submerged.*

*It subsided during Eocene to Middle Miocene time.

*It was uplifted in Late Miocene-Recent time.

*It is dominated by the ***Khlesia Basement Uplift*** which is part of the **N-S** trending Rutba Uplift.

****It is segmented by two E- W trending grabens and a trough; these are:-***

*A- the Anah Trough and

*B- the Tayarat and Khlesia Grabens.

*The sedimentary column of the Jezira Subzone consists of Palaeozoic (3300-5000 m)

Triassic (mainly Upper Triassic, 200-700 m thick),

Lower Cretaceous (100-250 m thick),

Upper Cretaceous (generally 50 m but over 1500 m thick in the Anah and Tayarat grabens), Palaeogene (300 m thick), and Neogene sediments (200-1000 m thick).

Geological and geomorphological characteristics

*The oldest rocks outcropping in the Jezira Subzone are the Upper Oligocene Kirkuk Group, which outcrops at the S boundary of the subzone along the E- W section of the Euphrates River between the Syrian border and Anah.

*The Middle Miocene *Fatha* and the Upper Miocene *Injana* formations outcrop over most of the subzone.

*One major surface anticline is observed north of the Euphrates river (the ENE-WSW trending Tayarat anticline); the N flanks of this anticline are visible on satellite images (Fig. 5-9, inset B).

*The Tayarat anticline forms a topographic high.

*It drains towards the Euphrates River in the S, the Khlesia Graben in the N, the Tuwaila playa in the W and the Tharthar valley in the E.

*The short drainage systems end in small playas which *suggest active karstification in the evaporites of the Fatha Formation is occurring.*

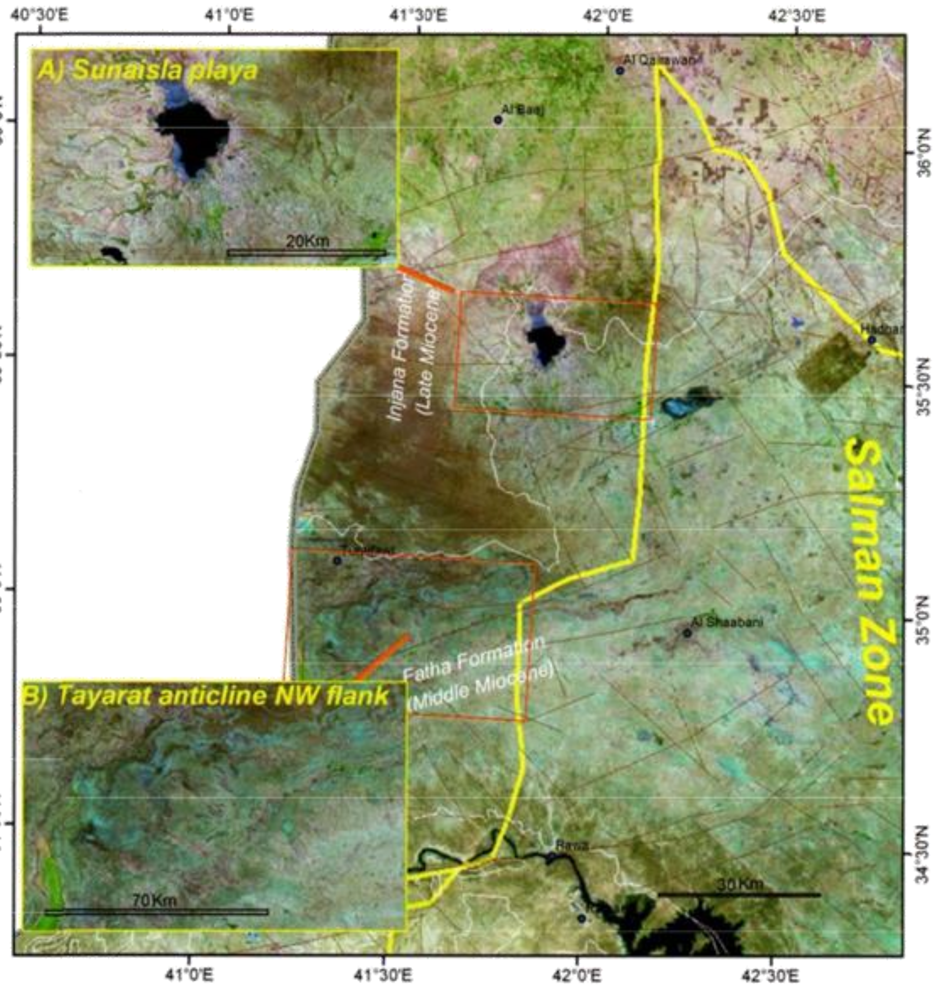


Fig. 5-9: Satellite image of the Jezira Subzone with insets showing the Sunaisla playa (A) and the NW flank of the ENE Tayarat anticline (B)

Structures

*The Jezira Subzone is part of the ancient wider Rutba Uplift.

It is segmented into two highs by the Tayarat Graben:

*-the Tayarat High in the S and

*-the Khlesia (Abu Rassain) High in the N (Fig. 5-10).

The Khlesia Graben overlies the Khlesia High.

The Tayarat anticline overlies the Tayarat Graben indicating *inversion occurred during Plio-Pleistocene compression*.

*The Tayarat High is separated from the Rutba High by the ***Anah Trough of the Jezira Subzone***.

*The structural highs and grabens of the Jezira Subzone are shown in the profile of Fig. 5-11 which starts from the Jordanian border and ends near the Turkish border in the N.

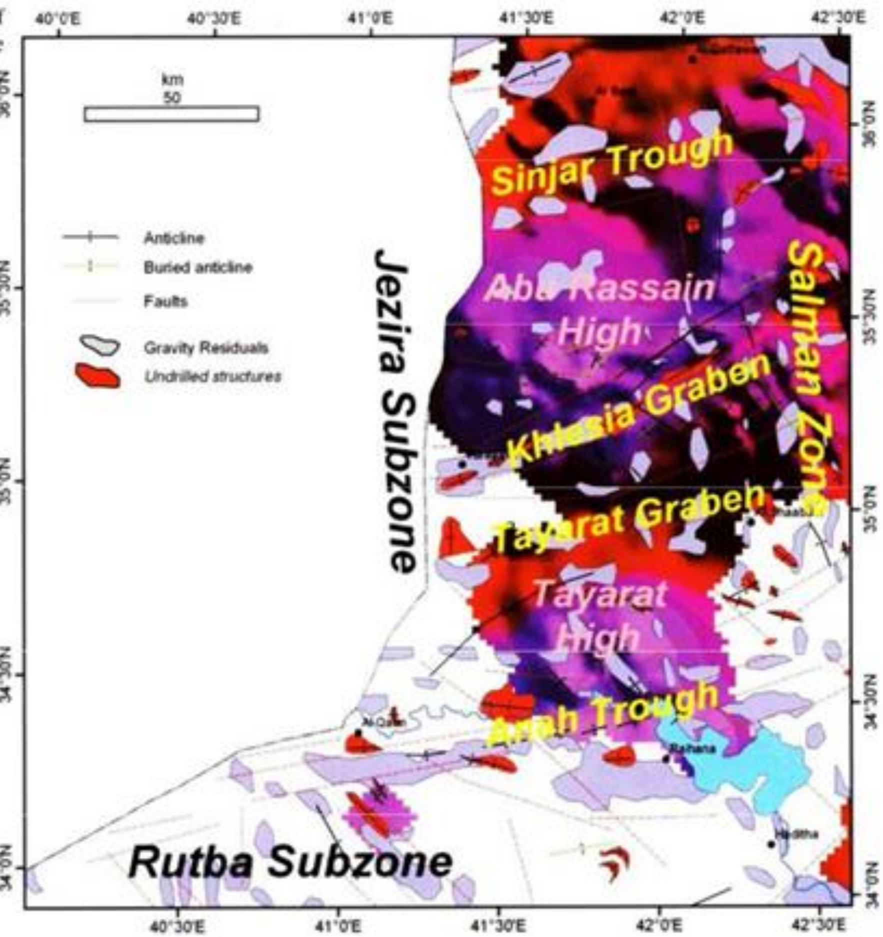
The Anah Trough lies between the Rutba and Jezira Subzones.

*The trough appears narrow at the surface.

At depth it is bounded by a series of E- W trending step faults.

* *The Anah Graben formed by transtension in Late Cretaceous time; it contains up to 2000 m of Upper Cretaceous sediments.*

Fig. 5-10: Structural map on the top of the Upper Triassic Kurra Chine Formation



-The *Tayarat Graben* strikes E- W and probably formed synchronously with the Anah Graben.

-Its bounding faults have 1700 m of displacement on the top of the Triassic Kurra Chine Formation(Fig. 5-9&5-10).

-The ***Khlesia Graben*** (Fig. 5-9) shows very little displacement at The top of Kurra Chine Formation (-150 m).

-*Drainage patterns suggest it was active in the Quaternary; salt playas developed along it.*

-The northern boundary of the sub zone is located along the Sinjar-Herki Transversal Fault which defines the southern boundary of the Foothill Zone and the Late Cretaceous Sinjar-Abdul Aziz basin which extends into N Syria.

-Small anticlines occur throughout the zone.

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2-Salman Zone

-The *Salman Zone* is part of the Salman-Summan Zone of Getech and Jassim (2002) which extends into W Kuwait and central E Saudi Arabia.

-It is generally associated with gravity and magnetic highs indicating a shallow basement at a depth of 5-7 km.

-It was formed during the Late Precambrian Nabitah orogeny, and reactivated during Late Carboniferous and Early Permian time.

-The western boundary is poorly defined in the north; in the south the western boundary is associated with a line of faults and residual gravity anomalies and strong karstification of the Eocene strata.

-The eastern boundary is associated with a strong gravity gradient along the Euphrates Boundary Fault in the S and along the western shores of the Razzaza and Habbaniya lakes, and with the Tharthar faults in the N.

-The eastern boundary has been slightly modified from the original definition of Buday and Jassi m (1984, 1987), especially near the lakes. Some small changes to the boundary were also made near the Sinjar-Herki Fault.

-The ***Salman Zone*** has a shallower basement than the Rutba-Jezira zone to the W and the Mesopotamian Zone to the E.

- It is part of the Upper Precambrian ArRayanTerrane that was uplifted during the Late Carboniferous (Hercynian) time and partly during the Early Permian; the Lower Palaeozoic section was deeply eroded prior to Late Permian transgression .

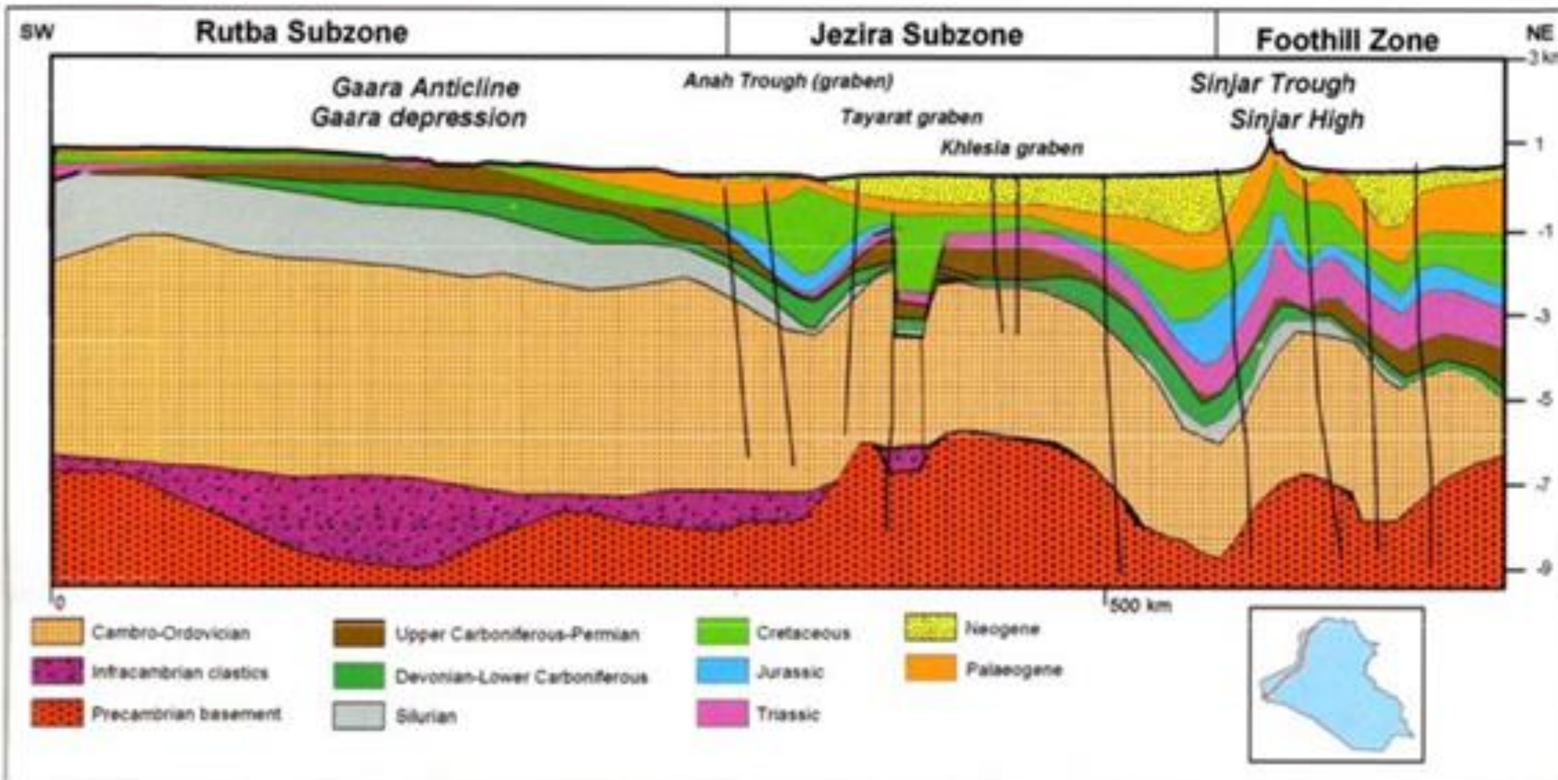
-Basement depth in the Salman Zone is 5-8 km, mostly 6-7 km; along the boundary with the Mesopotamian Zone the basement depth increases to 8 -9 km.

-The Infracambrian megasequence is thought to be absent.

The Lowe r Palaeozoic section is 1500-300 0 m thick; Permocarboniferous sediments may be preserved locally in Hercynian grabens.

The thicknesses of the Mesozoic and Tertiary units are as follows: Triassic: 700 -2000 m, Jurassic: 100 0-1400 m, Lower Cretaceous: 300 -1000 m, Upper Cretaceous: 800-1000 m, Palaeogene: 400-90 0 m and Neogene:
0-200 m.

Fig. 5-11: Profile from the Risha area in NE Jordan to the Mushorah area in N Iraq passing through the Rutba Subzone, Jezira Subzone and the Foothill Zone. Cretaceous troughs and grabens are clearly visible in this profile



Geological and geomorphological characteristics

-The *Salman Zone* is a monocline dipping towards the Euphrates River; Middle-Upper Eocene strata outcrop in the W and Lower and Middle Miocene beds outcrop in the E.

-The S part o f the zone is a sandy plain formed by Miocene clastics.

-Eocene carbonates are pock-marked(patches); *depressions are filled by Pliocene fresh water limestones and clastics* (Fig. 5 -13 B).

-There are also numerous buried (or abandoned) river courses that have been strongly influenced by karst.

They are usually aligned with the NE-SW trending faults (Fig. 5-13 A and 5-14).

-These features are associated with present day wadi courses.

Structures

*The Salman Zone subsided from Late Permian time onwards.

It comprises NE–S W and prominent NW–SE trending uplifts and depressions, bounded by faults.

*The most conspicuous structures in the Salman Zone strike NWSE.

They are relatively narrow, long anticlines, often accompanied by faults.

Broader N–S trending structures, indicated by gravity data are buried Hercynian horsts which are mostly restricted to the S and SW part of the zone.

*Other parts of the zone contain relatively short anticlines and structural noses, many of which are located along transversal faults.

In the north, these structures trend N–S to NW –SE.

Transversal faults control the sinuous course of the zone's borders.

Other faults mostly trend NW–SE in the centre of the Zone and along the NE margin of the zone.

* N–S trending faults are frequent in the S and SW.

The northern part of the zone has fewer faults.

- Folds of unknown origin occur in the S part of the zone.

*Gravity residuals (Fig. 5–15, grey colour) show a series of N–S trending anomalies possi- bly indicating buried Hercynian antiforms.

However such features have not been identified from seismic surveys.

* NW–SE trending faults are dominant in the southern part of the zone.

*Transversal faults occur throughout the zone.

*NW–SE trending faults are common in the NE part of the zone.

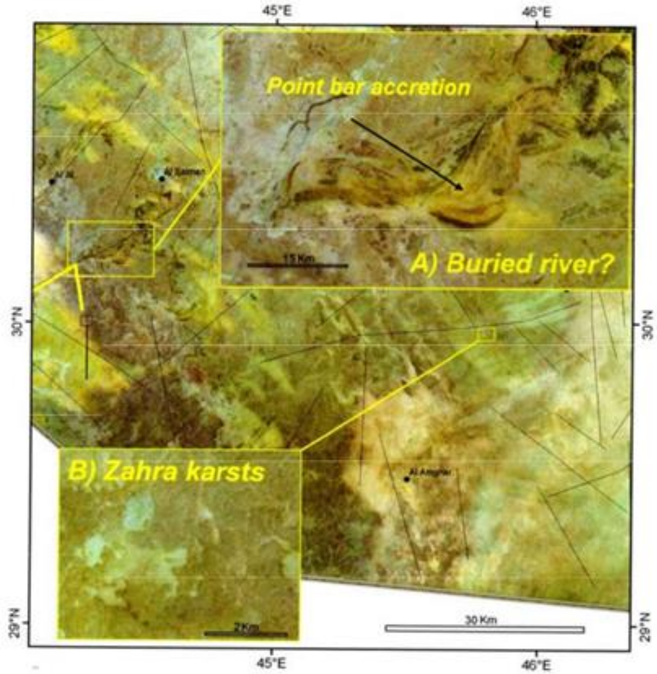


Fig. 5-13: Satellite image of the southern part of Salman Zone with insets showing buried river beds W of Salman depression (A) and the typical karsts scattered throughout the zone (B)

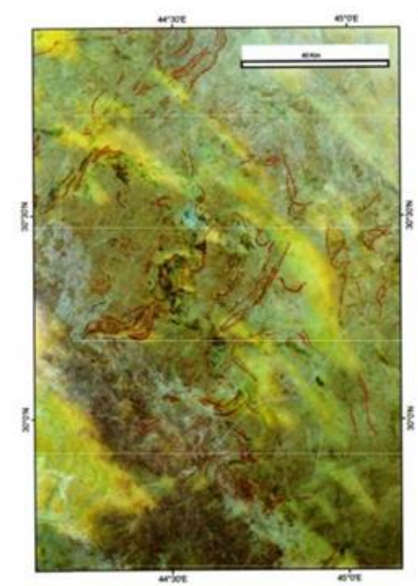


Fig. 5-14: Satellite image of the Salman Zone with tracing of some of the arcuate features that may be related to buried or abandoned river systems

3-Mesopotamian Zone

*The *Mesopotamian Zone* is the easternmost unit of the Stable Shelf.

*I t is bounded in the NE by the folded ranges of Pesh -i-Kuh in the E, and Hemrin and Makhul in the N.

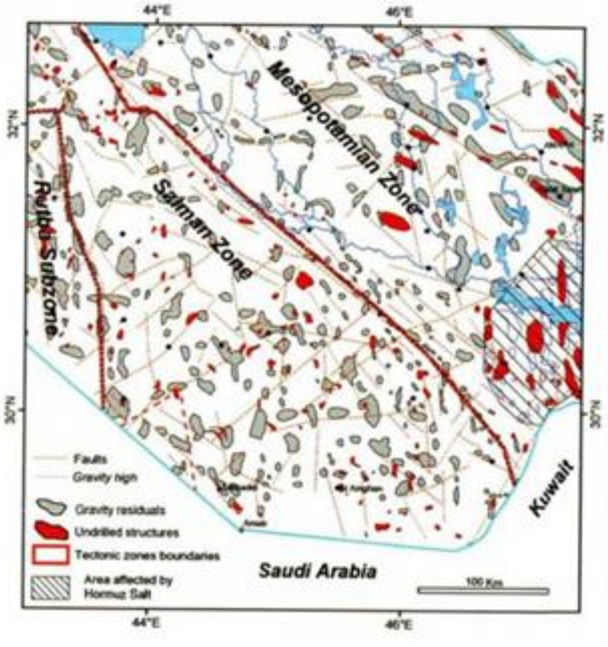
*The SW boundary is controlled by faults (Fig. 5-15).

-*The zone was probably uplifted during the Hercynian deformation but it subsided from Late Permian time onwards*.

*The sedimentary column of the Mesopotamian Zone thickens to the east.

It comprises up to 1500 m of Infracambrian , 2500-5000 m of Palaeozoic,1500-2200m of Triassic,1100m of Jurassic, 500-700m of lower cretaceous, 700-1400m of upper cretaceous,200-900m 0f Palaeogene,and 150-1500m of Neogene and Quaternary sections. Quaternary sediments alone are up to 300 m thick.

Fig. 5-15: Residual gravity anomalies (grey polygons) and undrilled structures (red polygons) of the southern part of the Salman Zone



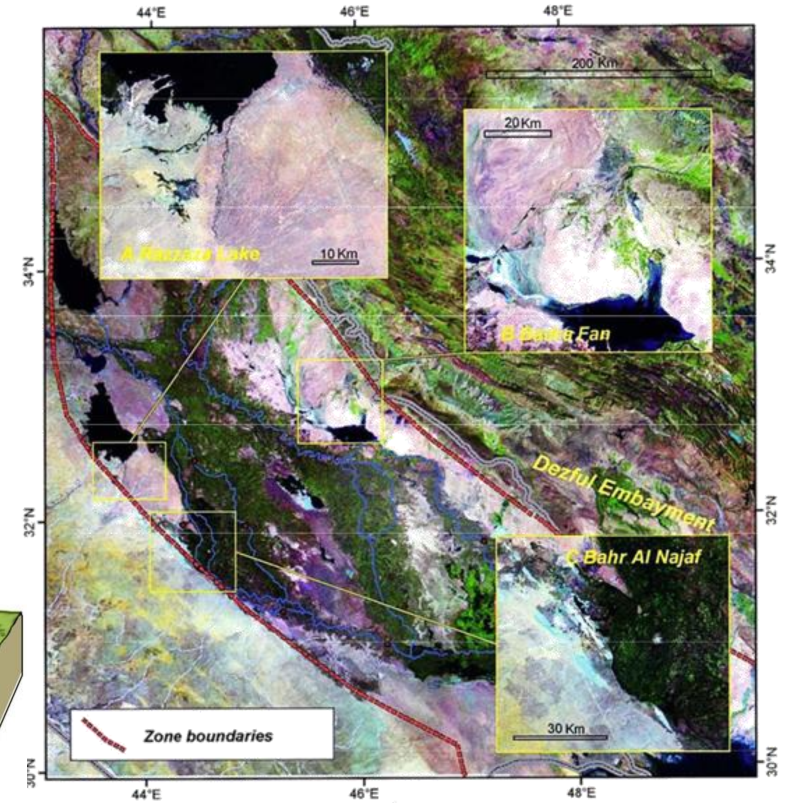
<u>*Geological and geomorphological characteristics*</u>

*Quaternary sediments of the Mesopotamian Zone were deposited by the interacting Tigris, Euphrates, Diyala and Adhaim Rivers, on the alluvial fans emanating from the surrounding elevated areas, and following marine incursions from the Arabian Gulf.

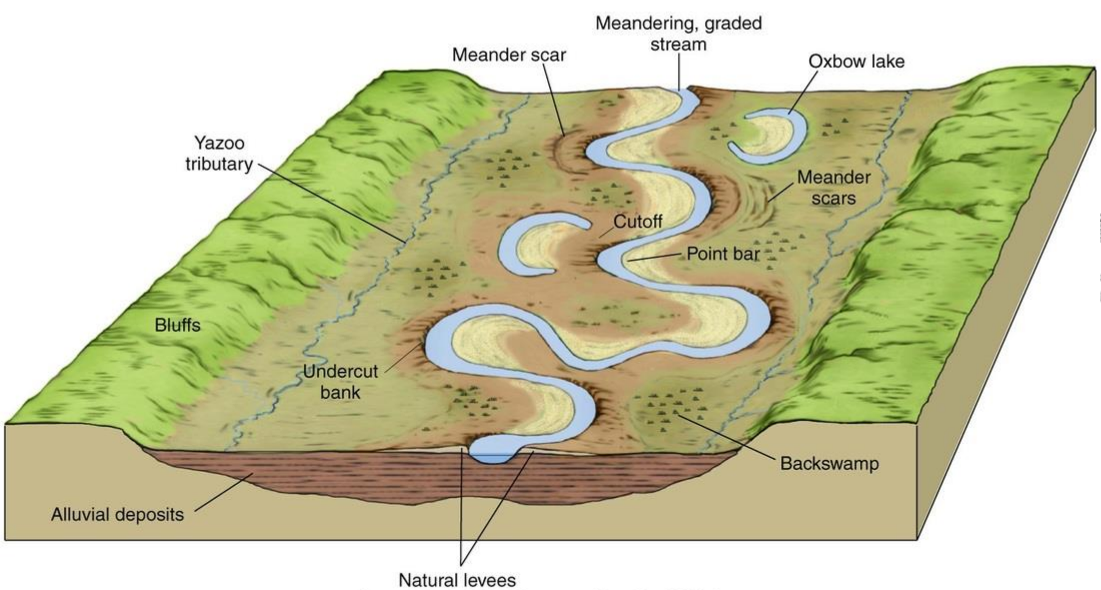
-*<u>Flood plain deposits include</u> channel deposits, levees and crevasses plays, flood plain depression, marsh, sabkha and deltaic deposits.*

<u>-The alluvial fans are derived from rivers passing through the Foothill Zone (Fig. 5-16 B) in the NE or from desert wadis flowing from the desert plain in the W.</u>
(Fig. 5-16 A).

*Fluvial-marine sediments are represented by the Shat Al Arab delta.



ig. 5-16: Satellite image of the Mesopotamian Zone bound by the Foothill Zone in the NE and the Salman Zone in the SW Inset maps how alluvial fans on both side of the zone (see text)



Structures

-The *Mesopotamian Zone* contains buried faulted structures below the Quaternary cover, separated by broad synclines.

-The fold structures mainly trend NW -SE in the eastern part of the zone and N-S in the southern part; some NE-SW trending structures occur (Fig. 5-15).

-A major N-S trending gravity and magnetic high is located along the Gharraf River, between the Tigris and Euphrates which may indicate a buried *Hercynian structure.*

-However the well-defined structures of Zubair, Rumaila, and Nahr Umr in the Zubair Subzone in the **S** are associated with negative residual gravity anomalies and suggest salt is present below some of the structures in **S** Iraq (Section 5.4.3)

The Mesopotamian Zone is divided into three subzones:

*1- ***the Zubair Subzone*** in the S with N-S trending structures in the S,

* ***2-the Euphrates Subzone*** in the **W**

* ***3-the Tigris Subzone*** in the **NE** with NW- SE trending structures.

1-Zubair Subzone

-The *Zubair Subzone* is bounded in the north by the Takhadid- Qurna Transversal Fault.

-The southern boundary of the subzone is either located at the Al Batin Fault or along a transversal fault in Kuwait.

-The northern dome of the Zubair anticline is associated with a negative gravity anomaly.

-However the southern dome of this anticline and the structures to the south in Kuwait are not.

These structures and the southern Zubair dome could be included in another subzone (Fig. 5-17).

-This subzone forms the southern most unit of the Mesopotamian Zone and has a uniform structural style controlled by the underlying basement .

-It contains prominent N-S trending structures which continue hundreds of kilometres south wards into Kuwait and E Saudi Arabia .

-These structures originated during the Late Nabitah orogeny and were reactivated during Permocarboniferous, Mesozoic and Tertiary time.

-The association of negative gravity residuals with the main structures of S Iraq Fig. 5-18) strongly suggests they are underlain by Infracambrian salt.

-The ***Sanam salt plug*** (Fig. 5-19) indicates *Infracambrian salt* is present i n the south of the subzone.

-The amplitudes of the N-S trending structures of the subzone increase with depth and reach 300 m at Lower Cretaceous level.

-*The structures are long and relatively narrow anticlines separate d by broader synclines especially in east*.

Shorter and oblique trending structures also occure.

-**Themost prominent narrow elongated antiforms are** *the (Zubair and Rumaila structures).*

-**Shorter, often broader structures include** ***Nahr Umr, Majnoon, Rachi, Ratawi, Subba and Luhais.***

*****The Zubair Subzone is the most prolific petroleum region in Iraq*.

Fig. 5-17: Residual gravity anomalies (grey polygons) and undrilled structures (red polygons) of the Mesopotamian

Fig. 5-18: Structural map to the top of the Ahmadi Formation showing the position of residual gravity anomalies (open polygons) in relation to the anticlines. Most of the residual gravity highs are associated with structural lows

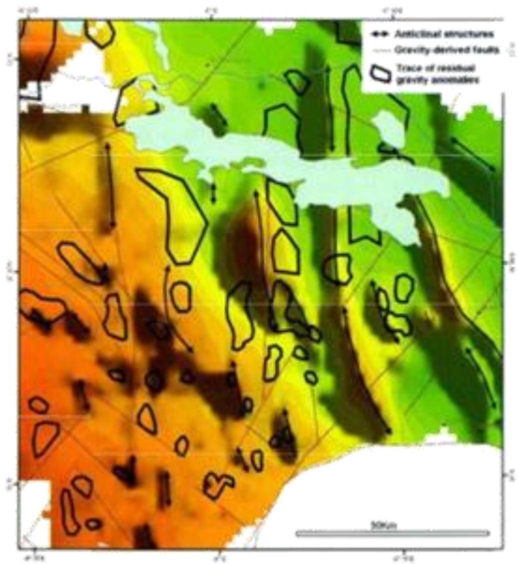
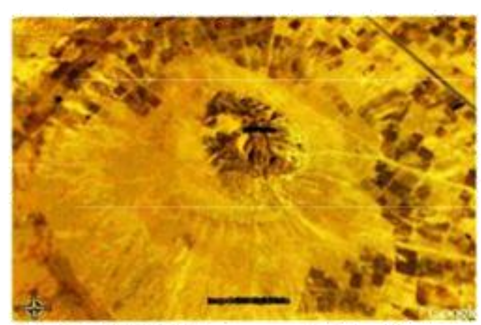


Fig. 5-19: Oblique view of Sanam Plug in S Iraq, 5 km W of Safwan Town on the Basra-Kuwait High way. Steeply dipping, locally vertical Upper Miocene grit beds of the Dibdibba Formation form visible circles around the central salt extrusion (Courtesy of Google Earth)



2-Tigris Subzone

-The *Tigris Subzone* is the most extensive and mobile unit of the Mesopotamian Zone.

It contains broad synclines and narrow anticlines trending predominantly NW -SE, accompanied by long normal faults..

-The Tigris subzone contains *two NW-SE trending groups of buried anticlines* of relatively low amplitude associated with longitudinal faults (confirmed by seismic surveys) and an *EW transversal trend*.

These anticlines lie on the:-

1- Ramadi Musaiyib

2- Tikrit-Amara Fault Zones of the Najd Fault System

3- and on the Kut-Dezful Fault.

They also influence the course of the Tigris River today.

**The first line of anticlines* runs from Tikrit to Amara. Where the basement deepens in the N the anticlines are cut by normal faults. The total length of anticlinal line from Tikrit to Amara is over 500 km; it is segmented into shorter domes about 20 to 70 km in length.

The line straddles the Samarra Amara palaeoridge.

**The second, less pronounced*, line of anticlines is the Ramadi-Musaiyib anticlinal trend corresponding to the West Baghdad basement structure of Ditmar et al. (1971 and 1972) and the western 'boundary of the subzone.

This structural trend (at Mesozoic level) consists of a series of SE plunging structural noses. It is roughly 150 km long, and extends from Ramadi to Musaiyib. Its amplitude in the Mesozoic cover does not exceed a few hundred meters. The amplitude at basement level is < 1 km.

**The third anticlinal structural trend of Najaf-Kut* is an oblique structure trending approximately E-W. It comprises a series of faulted anticlines.

3-Euphrates Subzone

-The *Euphrates Subzone* lies in the W of the Mesopotamian Zone.

-It is a monocline dipping to the NE with short anticlines (10 km) and structural noses.

-Some longer NWSE oriented anticlines (20-30 km long) lie near to and parallel with the Euphrates Boundary Fault especially between Samawa and Nasiriya.

-*They are related to horsts and grabens developed along the fault zone*.

-The Euphrates Subzone is the ***shallowest*** unit of the Mesopotamian Zone.

-The basement is generally 7-9 km deep but has thicker Quaternary sediments compared with the Tigris Subzone

A *monocline* (or, rarely, a monoform) is a step-like fold in rock strata consisting of a zone of steeper dip within an otherwise horizontal or gently-dipping sequence.

Reference:-

Jassim,S.Z.& Goff,J.C. (ed.). Geology of Iraq,2006.DOLIN, Prague.