المحاضرة الثامنة

THE MESOZOIC EVOLUTION (245 – 65) MA

The Mesozoic witnessed the birth and development of the Atlantic-type Arabian passive margin that bordered the western shore of the Neo-Tethys Ocean.

- An extraordinarily wide, shallow marine epeiric shelf developed on this ENE-dipping platform .

-The first order impact of the Mesozoic era is reflected by a major change in sedimentation from a primarily silici-clastic Paleozoic regime to a major carbonate with interspersed clastic episodes.

- In **the Western Desert region***, however, this is reflected by the deposition of the Late Triassic carbonates over the eroded Permian clastics.*

-The predominance of carbonate during most of the Mesozoic **reflects** *the Paleo-latitudinal position of Arabia within tropical to equatorial climatic belt*

-Sea floor spreading continues through the Triassic leading to a progressive expansion of the Neo-Tethys Ocean*.*

- In the mean time the passive margin went through steady subsidence due to the influence of the accumulated sediments.

The first tectonic event of the Jurassic was the closure of the Paleo-Tethys Ocean by the collision of central Iran with the mass of Laurasia.

- *At that time the Neo-Tethys reached its maximum width which was (2000 – 4000) Km, this event was too far to be felt on the platform.*

- Nevertheless, on the Western Desert region of the stable platform it was also evident that upwarpping along Hail – Rutbah Arch became clearly effective.

-The western part of the Western Desert was exposed, forming a source area for the clastics throughout the entire Jurassic .

- *However, the Late Jurassic (also Early Cretaceous) was the time of a significant regional unconformity throughout the northern Arabian platform associated with a globally low sea level.*
- *Thus the sedimentary pattern on the platform including the Western Desert during the Jurassic (208– 145) Ma is a* ***reflection of a fluctuating sea level and minor epeirogenic movements along Hail – Rutbah Arch.***

*The **Cretaceous period** (145 – 60) Ma display three distinct phases of evolution:-*

*1-The **first phase** persisted throughout the Early Cretaceous to Turonion/ Coniacian, where the oceanic part of the Arabian Plate was continuously consumed by subduction beneath Iranian plate.*

The subduction had very weak effect on the Arabian platform.

-Accordingly during that period of time, the depositional environment conditions of a shallow carbonate shelf with clastic influxes persisted over the region, following the pattern established during the Jurassic.

Therefore, sedimentations pattern and facies variations reflect global sea level fluctuation and minor upwarpping along Hail – Rutbah Arch which left the western part of the Western Desert as an exposed area.

*2- The **second phase** of the Cretaceous evolution was remarkable and sharp. During the Campanian – Maastrichtian, the Arabian Plate underwent regional stretching.*

- The stretching was enough to generate systems of intracontinental elongated rift basins in the northern Arabian platform.

*The **extensional phase** produced numerous E – W and NW – SE trending fault bounded troughs as grabens and half-grabens that dominated the northern Arabian platform including north and eastern Syria and north western Iraq (Fig.9).*

-Most of these rifts developed along pre-exiting lines of weakness that were related to the Neo-Tethys rifting and development.

- Anah and Abu Jir Fault Zones, which formed during this extensional period of time, started receiving significant Campanian – Maastrichtian syn-rift sedimentary infill.

- *The syn-rift sequence, which is represented by the Shiranish Formation display a huge thickness increase in passing from the shoulders towards the center of the basin particularly in Anah Graben.*
- *Simultaneous sedimentation and basin subsidence conditions continued between (20 – 15) Ma.*
- *This time span was associated with a major global sea level rise.*
- ***The marine transgression was extensive, covering almost the entire Western Desert including Hail – Rutbah Arch except the Ga`ara region which was the highest part of the arch at that time.***

Al-Bassam et al. (2004) pointed out that though mostly submerged, Hail – Rutbah Arch acted as basin divide at that time separating different marine facies on its flanks.

- Owning to its orientation with respect to the N – S stretching, the NW – SE trending Abu Jir Fault Zone underwent a transtensional movement rather than pure extensional movement (Fig.9), and that may explain the reduced thickness of the associated syn-rift sequence in comparison with that of Anah Graben.

3-**The third and the final phase** of the Cretaceous evolution occurred in the Latest Maastrichtian when the Arabian passive margin was under compression for the first time as a consequence of the first phase of the **Alpine Orogeny**.

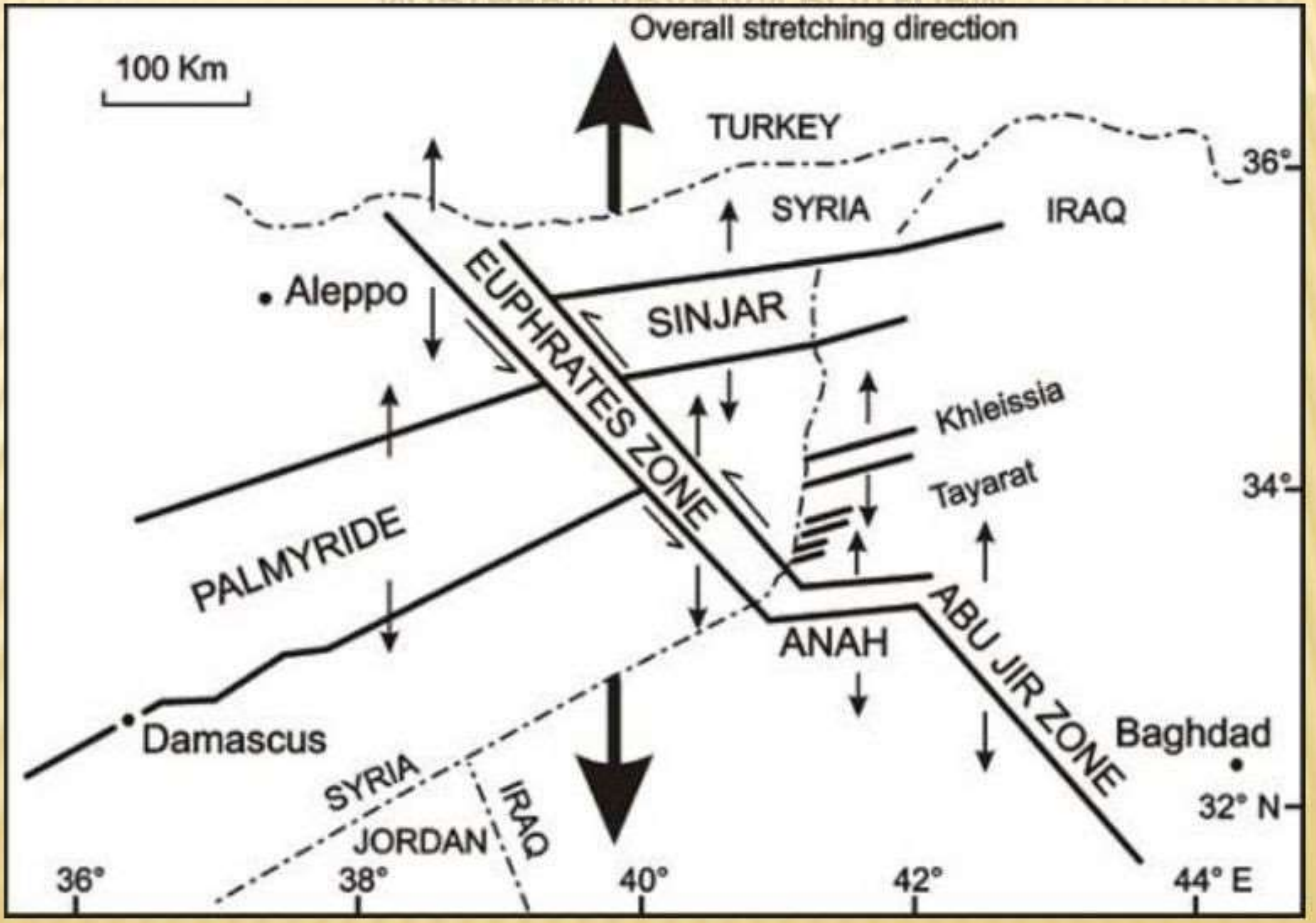
-**The compressive phase is related to the ophiolites obduction and emplacement along the Arabian Plate margin** .

-Away from the compressed and destroyed margin, however, within the interior of the Arabian Plate body, the compression caused the cessation and termination of the active Late Cretaceous grabens subsidence followed by a regional emergence of the entire stable part of the platform.

- **The Cretaceous period therefore, is terminated by an extensive region wide unconformity**.

- It is noteworthy to mention that, though the left lateral displacement on Hauran Fault System is a Late Cretaceous event, earlier history of fault formation might be expected since there are signs of multiple deformations on the faults.

9: SIMPLIFIED SKETCH MAP ILLUSTRATING THE LATE CRETACEOUS EXTENSION AND THE FORMATION OF THE INTRACONTINENTAL RIFT BASINS IN THE NORTHERN ARABIAN PLATFORM



THE CENOZOIC EVOLUTION (65 MA – PRESENT)

After a relatively short but extensive break, the Cenozoic era started with a large scale transgression, covering the entire platform.

-***The Paleocene – Eocene*** *(65 – 35) Ma was largely a time of* ***quiescence*** *in the northern Arabian platform and* ***deposition*** *of significant open marine sediments. Hail – Rutbah Arch though mostly submerged except its highest part around Ga`ara region, remained active in separating local basins east and west of the arch.*

- *The* ***Eocene sea*** *was the last to cover almost all of the Western Desert.*
- *After the Eocene period of time, the western part of the Western Desert including Hail – Rutbah Arch, remained as positive land all the way through.*
- *Later marine transgression covered only limited portions of the eastern part of the Western Desert.*
- ***Middle Eocene*** *was the time for early collision of the Arabian Plate with Bitlis fragments of the Turkish Plate.*
- *This event was too remote to leave any effect on the interior of the Arabian plate.*

*The **Oligocene** (35 – 25) Ma started with sharp global sea level fall exposing large areas of the Western Desert to erosion.*

The sea, later on returned back to the eastern part of the Western Desert only.

The Oligocene ended by another wide areal exposure.

It is not clear if this exposure was related to the regional upwarpping associated with the early initiation of the Red Sea rift.

*The **Early Miocene** (25 – 17) Ma witnessed the final marine transgression on the eastern and northern parts of the Western Desert.*

*Different **Middle Miocene** sedimentary facies were deposited on both sides of Anah – Abu Jir Fault Zone.*

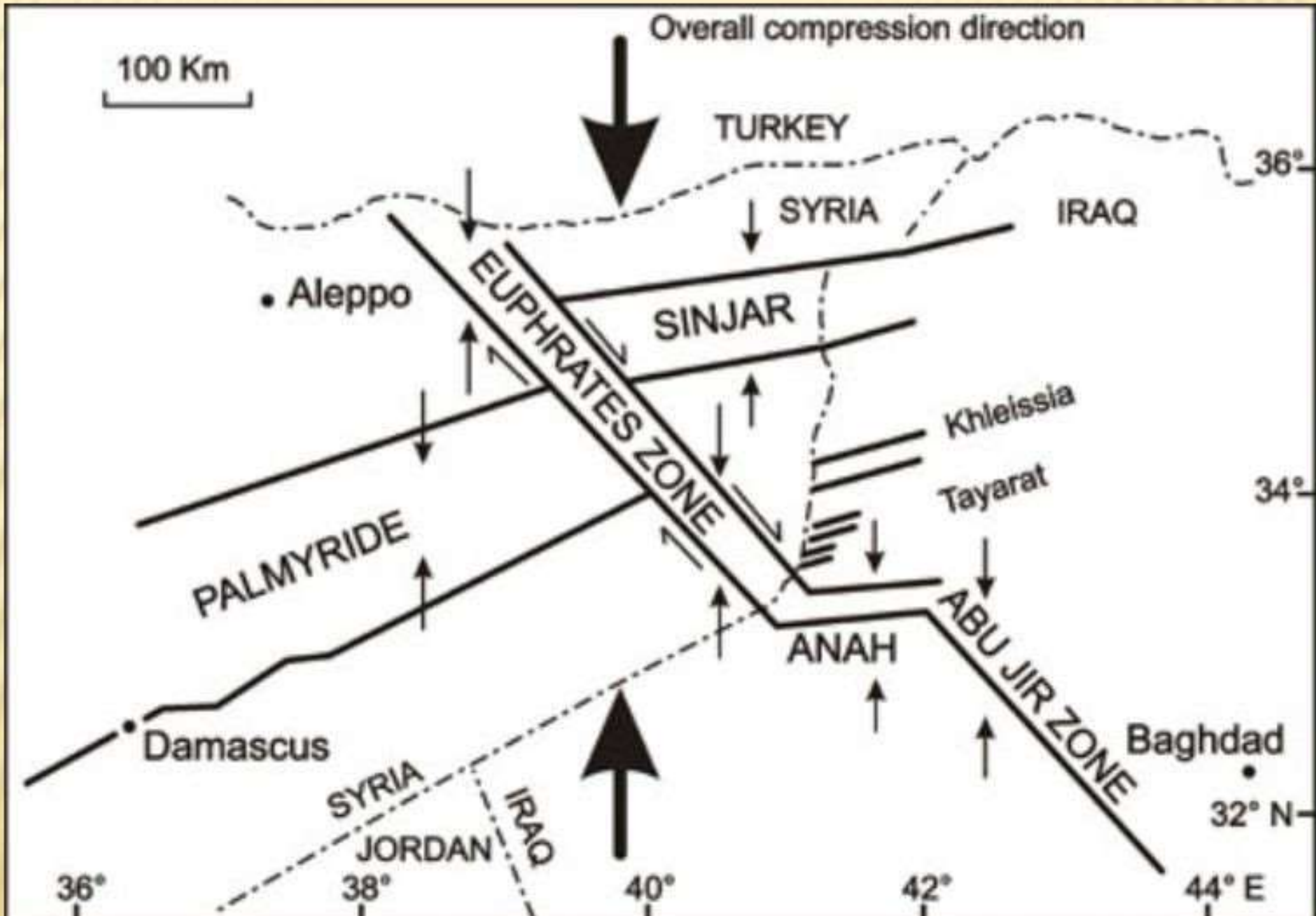
The sediments contain extensive syndepositional (soft-sediments) deformational features along most of the zone, indicating the seismic activity of Anah – Abu Jir Fault System at that time .

*The **Late Miocene** (~11 Ma) was the time of the final transition to continental condition.*

Late Miocene *onwards is marked as a time of increasing* ***compression*** *as collision along the northern and eastern boundaries of the Arabian Plate with Iran/ Anatolia portions of Eurasia proceeded, then culminated through the Pliocene (5.3 Ma).*

- *The* ***compression*** *produced regional folding and thrusting of the north Arabian Plate margin.*
- ***In the interior of the plate body, however the far field compression caused structural*** *inversion* ***of the Late Cretaceous rift basins, not only to the proximal basins such as Abdel Aziz and Sinjar, but also to the distal ones such as the Palmyra and Anah*** *(Fig.10).*

10: SIMPLIFIED SKETCH MAP ILLUSTRATING THE LATE TERTIARY COMPRESSION, WHICH PRODUCED STRUCTURAL BASIN INVERSION AND TRANSPRESSIVE MOVEMENTS ON SOME OF THE NORTH ARABIAN RIFT BASINS,



*The **inversion of Anah Graben** as the northern boundary of the stable platform and the Western Desert occurred by the **compressional reverse reactivation** of the pre-existing basin boundary normal faults.*

- The partial extrusion of the Campanian – Maastrichtian syn-rift fill as a result of the basin inversion forced the upper most part of the syn-rift and the entire post-rift units to drape over the tip of the boundary faults generating pronounced fold known in the region as Anah Monocline (Fig.5).

***Late Tertiary** collision exerted compressive stresses perpendicular to the E – W trending troughs of the northern Arabian platform such as the Palmyra, Sinjar and Anah, but imposed transpressive movement along the NW – SE trending fault zones such as the Euphrates of eastern Syria and Abu Jir (Fig.10).*

*The associated **flower structures**, **pressure ridges** pull-apart and **sag ponds** provide additional evidences to the occurrence of right lateral movement on these fault zones -Moreover, because of their orientation with respect to the regional N – S compression, the NW – SE trending fault zones escaped significant structural inversion.*

It is very important to note that Anah – Abu Jir Fault Zones acted as a mobile zone by accommodating the Late Cretaceous extension by subsidence and the Late Tertiary compression either by lateral movement or structural inversion.

This behavior hindered the far field stresses to propagate further within the stable part of the platform.

***Recent activity** is evident along Anah – Abu Jir Fault Zone.*

1-The continuous subsidence of Al-Jabha sag pond within Abu Jir Fault Zone is an example to the current activity of the zone.

2-The successive terraces like lithified bitumen flows around the periphery of the depression pointing out to the continues widening and deepening of the depression (Fig.11).

-Each active period of extension was accompanied with eruption of bitumen flow and formation of a new step like terrace.

At least five stages of bitumen terraces are preserved around the depression.

-These terraces, which are younging upwards, are separated from each other by a horizons of aeolian sand mixed with reworked bituminous materials pointing to the quite periods between the successive eruptions.

3-The sudden gas explosion at the remote village of Abu Jir in the Western Desert in 1982 provides another interesting example.

-The gas seeped out through newly formed cracks in the ground and went into flame as witnessed by the local villagers (Fig.12).

-This fire is called "Sea`aria" by the local villagers which mean "Little Hell", but the author give it the name "Abu Jir Eternal Fire" in tribute to the famous "Kirkuk Eternal Fire".
Other geomorphological evidences were recorded by Brew (2001) and Sissakian along the Euphrates and Anah.
However, this evidences collectively indicating the active nature of the Euphrates – Anah – Abu Jir mega lineament of the northern Arabian Plate.
4 -The continuous changing in trends of valleys and accumulation of terraces around them is another evidence for the activity of the Abu Jir Fault Zone.