*Geology of Iraq* Lecture-6 (Units of Unstable Zone) *Prof.Abed Fayyadh* 

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Units of the Unstable Shelf and the Zagros Suture

The *Unstable Shelf* in Iraq is divided into four zones:

- 1– The *Foothill Zone*,
- 2-The High Folded Zone
- 3- The *imbricated Northern (Ora)*.
- 4- Balambo- Tanjero Zones.

- The Mesopotamian Zone of Buday and Jassim (1984 and 1987) is now included in the Stable Shelf.

- The Zagros Suture Zone comprises 3 tectonic units :-
- 1-The Qulqula Khwakurk,
- 2- The Penjween- Walash
- 3– The *Shalair zones* (Fig. 6–1).



Fig. 6-1: Tectonic zones and structura elements of the Unstable Shelf unit (modified form Buday and Jassim 1984)

# **Units of the Unstable Shelf**

-The Unstable Shelf had been the most strongly subsiding part of the Arabian Plate since the opening of the Southern Neo-Tethys in the Late Jurassic.

Maximum subsidence occurred :-

\*during the Late Cretaceous ophiolite obduction onto the NE margin of the Arabian Plate .

\*and during Mio-Pliocene continental collision.

### The Unstable Shelf is thus characterized :-

\* by structural trends and facies changes that are parallel to the Zagros-Taurus suture belts).

\* Surface folds are a characteristic feature of the unit.

A cross section through the Foothill and High Folded zones is shown in Fig. 6-2.

Obduction was originally defined by Coleman [1] to mean the overthrusting of oceanic lithosphere onto continental lithosphere at a convergent plate boundary where continental lithosphere is being subducted beneath oceanic lithosphere.

Subsequently, this definition has been broadened to mean the emplacement of continental lithosphere by oceanic lithosphere at a convergent plate boundary, such as closing of an ocean or a mountain building episode.

An ophiolite is a section of the Earth's oceanic crust and the underlying upper mantle that has been uplifted and exposed above sea level and often emplaced onto continental crustal rocks





## 1-The Foothill Zone

\*The SW boundary of the Foothill Zone lies along the SW flank of the impressive anticlinal line of <u>Makhul, Hemrin and Pesht-i-Kuh</u>.

North of Hatra the boundary of the Zone runs along the <u>Tharthar valley</u> then westwards in to Syria along the southern flank of the Sinjar anticline (Fig. 6–1).

To the SE the boundary passes through the <u>Dezful Embayment in SE Iran</u> and along the eastern coast of the Arabian Gulf.

Its eastern boundary <u>lies along high anticlines</u> with Palaeogene or Cretaceous formations exposed in their cores.

\* The Foothill zone has the deepest Precambrian basement in Iraq (-13 km) and very thick Miocene-Pliocene molasse sediments (-3000 m thick0).

The zone comprises two longitudinal units:-

A-the *Makhul-Hemrin* Subzone in the SW and

B- the *Butmah- Chemchemal* Subzone in the NE.

The Foothill Zone contains four transversal basement blocks with different structural histories.:-

**1-The NW transversal block of the Foothill Zone (here termed the Sinjar Block)** lies to the N of the Sinjar-Herki Fault and covers the Sinjar area (Fig. 6-1).

-Top basement is usually at 8-10 k m but ranges from 5-11 km.

-This block is dominated by mostly E- W or WNW-ESE trending basement elements.

-The block has a more complete sedimentary sequence than the neighbouring Mosul Block; I

-It subsided strongly in Mesozoic and Tertiary time and its Mesozoic-Tertiary cover is 6-7.5 km thick.

-However Rutba Uplift influenced this area during Late Jurassic-Early Cretaceous time .

2-The transversal block that lies between the Sinjar-Herki Fault in the NW and the Hadhar-Bakhme Fault in the SE is referred to as the *Mosul High*.

-It forms an important palaeogeographic and structural divide across the foredeep of Iraq, including the Foothill Zone. It overlies shallow Precambrian basement at 6-9 k m.

-The basement structural features trend in WNW and NE directions. The Mesozoic- Tertiary cover contains several stratigraphic gaps (mainly in the Mid Jurassic, Late Jurassic and Early Cretaceous).

-Anticipies within the block are generally short (10–30 km long), and enechelon with NW-SE, and rare E-W trends.

3-The third transversal block lies between the Hadhar-Bakhme Fault in the NW and Anah-Qalat Dizeh Faults in the SE.

-Top basement in this block is at 8-11 km rising to 7 km in the NW and dropping to 12 km in the SE. NW-SE and subordinate E-W striking structural elements occur in the basement in addition to anticlines trending NW-SE.

**4-The largest transversal block is the Kirkuk Embayment** which lies between the Anah-Qalat Dizeh Fault in the NW and the Sirwan Fault in the SE.

- It has the deepest Precambrian basement within the Foothill Zone at 10-14 km but locally rising to 8 km.

-Major basement structures and surface folds trend almost uniformly in a NW-SE direction.

This deep block contains relatively narrow anticlines often associated with reverse and normal faults.

-They are 100 km to 200 km long. However on the structurally higher parts of the block in the NW, the anticlines are generally shorter.

-The anticlines are separated by broad synclines filled by thick Pliocene and Quaternary sediments.

The term 'en echelon' refers to closely-spaced, parallel or subparallel, overlapping or step-like minor structural features in rock (faults, tension fractures), which lie oblique to the overall structural trend. Conjugate deformation structures are related in deformational origin.

### Faulted "En-échellon" Folds



# A-Hemrin-Makhul Subzone

-The *Hemrin-Makhul Subzone* (Fig. 6-1) is the structurally deepest part of the Foothill Zone.

-The subzone was the depocentre of the Neogene molasse but has been a subsiding unit throughout the Mesozoic and Tertiary.

-The SW boundary of the subzone coincides with the SW boundary of the Foothill Zone (Fig. 6-1).

-Its NE boundary lies along the N limb of the Sinjar anticline, passing along the anticlines of Ishkaft and Atshan (NW of Mosul), Mishraqs . Qara Chauq and Makhmur (SE of Mosul), and along Jambur and the SE part of the Kirkuk anticline. -The Makhul-Hemrin Subzone comprises long prominent NW-SE (or E-W) trending anticlines.

-The anticlines are also segmented into doubly plunging domes; the segmentation usually occurs at intersections with transversal faults where the axes of the anticlines are bent.

-Anticlines in this subzone often have relatively broad crests and steep S or SW flanks. (Except Sinjar).



## Sinjar double plunging Anticline



### B-Butmah-Chemchemal Subzone

# \* *The Butmah–Chemchemal Subzone* is the NE unit of the Foothill Zone.

It is the structurally highest part of the Zone.

\*The SW boundary of the subzone is located along a line connecting the Sinjar, Qara Chauq, Kor Mor and Chia Surkh anticlines.

\*The NE boundary lies along the SW flank of the anticlines of the High Folded Zone (Fig. 6–1) that includes the anticlines of Chia–i–Spi, Dohuk, Aqra, Pirmam Dagh, Haybat Sultan and Qara Dagh (Fig. 6–3). \*The Mesozoic–Tertiary sequence is up to 1.5 km thick.

\*The subzone was intermittently uplifted during the Jurassic and Cretaceous, usually forming either a submerged or exposed ridge often associated with a carbonate platform (the Chemchemal– Taq Taq palaeoridge of the Iraqi–Soviet Team, 1979). \* In the Palaeogene, the subzone became a foredeep. \* In the latest Miocene–Pliocene the subzone became part of the Foothill Trough and was filled in by coarse molasse sediments. \*The transversal Mosul Uplift affected the subzone, but to a lesser extent than in the Makhul-Hemrin Subzone.

\*The anticlines are medium-sized, NW-SE trending in the SE and E-W trending in the NW.

\*The Butmah-Chemchemal Subzone, however, has very conspicuous long and deep synclines with thick Pliocene molasse dominated by conglomerate.

\*The prominent features of the subzone are long anticlines often not associated with longitudinal faults with the exception of the Kirkuk structure.

\*Broad and deep synclines are a feature of the subzone.

\*The three transversal blocks of Sinjar, Mosul and Kirkuk have also influenced the structure of the subzone but to a lesser degree than in the Makhul-Hemrin Subzone.



Fig. 6-3: Satellite image of the SE part of the Foothill Zone with insets showing close-up of three anticlines



Fig. 6-4: Satellite image of the NW part of the Foothill Zone with insets showing close-up of three anticlines

#### Reference:-

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

