



Comparison between Taurus and Zagros Thrust zone in Iraq from basic geological data

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Abstract

Comparison between the Northern Thrust zone and the Zagros Thrust zone of Iraq reveals some basic differences between them. The differences are related to the timing of the opening and closure of the Neo-Tethys ocean. This implies that the two processes were diachronous. The Arabian indenter represents a protrusion and irregularity in the shape of Arabian plate margin. The indenter resulted in earlier collision in the Northern Thrust zone in comparison with the Zagros Thrust zone.

The basic differences between the two Thrust zones include the presence of Paleozoic rocks in the Northern Thrust zone, lesser thicknesses of the Mesozoic and Cenozoic rocks and the near complete absence of igneous bodies or exotic terranes. On the contrary the Zagros Thrust zone is characterized by the thick Mesozoic and Cenozoic sediments, plenty of igneous bodies and volcanic extrusion as well as thick flysch sedimentation exemplified by the Tanjero Formation. These differences were deciphered by the style and timing of the opening and closure of the neo -Tethys ocean during a complete Wilsonian cycle

Introduction

The Alpine Orogeny in the Northern Iraq characterized by geological structures which represent upper parts of the earth crust, this isostatic uplifting and the erosion cannot be able to expose the middle and lower parts of the continental crust as in the case of Himalaya Mountains and Western Alps in Europe [1]. The Alpine Orogeny belt in Northern Iraq consists both Thrust zone and foreland -fold belts. The nature of the structures of the Thrust sectors in Northern Iraq look likes structure found in the other Thrust sectors of the orogenic belts [25]. It includes Thrust faults and other structures such ramp and flat, imbrications faults, duplex as well as the strikes of the Thrust Faults may be parallel to the strike of the strata or cross cutting strike of the strata .The collision between the plates in the different areas does not occur on the same time also the speed of spreading oceanic basin and the irregularity of the ocean makes the collision diachronous process and that's appeared clearly in the studies of the Alpine Orogeny in different areas. The Iraqi case of the Alpine Orogeny results from the collision of the Arabian plate (which is part of the African plate) with the Eurasian plate in Turkey and Iran [12] which occurred before (49 m.y) (Eocene) [25]. The style of opening and closure of the ocean was similar to the opening and closure of a scissor [1] and [2] and that is the reason behind the fact that the collision was not chronous in both Thrust zone in Taurus and Zagros in Iraq.

THE BASIC GEOLOGICAL DIFFERENCES BETWEEN TAURUS AND ZAGROS THRUST ZONE IN IRAQ

1. STRATIGRAPHY

There are some differences in stratigraphy between the two Thrust zones:

A. BASEMENT ROCKS

The basement rocks are conceptually continental crust belonging to the North Eastern margin of the Afro- Arabian plate which was cratonized during the Late Proterozoic and Early infra-Cambrian Hejaz ,Najd and orogenesis[30]). While (Numan ,1997)[25]believe that basement belonging to remnant quasi –oceanic and oceanic crust of the Neo-Tethys Basement rocks does not expose in any area in Iraq also it was not reached by any of the drilled wells .The depth to the basement rocks were stipulated by the geophysical methods[11]and[13].

Geophysical maps shows that the depth to the basement rocks in Taurus Thrust zone is between (7-10 km) while in Zagros Thrust zone is (10-13 km) .(Al-Ali,2004)[2] stipulate the theoretical thickness of the sedimentary cover in Taurus basin (7.795 km) and in Zagros basin (9.620 km) . It appeared from 3 drilled wells in Taurus sector (figs 1-3) that the thickness of the sediments cover till depth (800 m) below Khabour – Quartzite- Shale Formation exceed (7 km)[4].

B. PALEOZOIC ROCKS

There is huge exposure of the oldest rocks in Iraq appeared on the surface belonging to the Paleozoic Era begin with Khabour –Quartzite -Shale Formation (Ordovician) followed by other Formations (Perispiki –red beds ,Volcanic Chalky ,Kaista ,Ora-shale ,Harur –limestone and Chia Zairi limestone) (Figs 4) these Formations appear clearly with a thickness more than (2000 m) without reaching the base of Khabour- Quartzite –Shale Formation .

These Formations appear in two basic situation within Ora and Nizdur anticlines[4] and in Harur village and Shish village near Iraqi -Turkey border .They appears also South of Turkey ,North of Nizdur village with a thickness reach (2000 m) .[15]and [28].While the exposure of Paleozoic rocks on the surface not recorded on Zagros Thrust zone in Iraq .

C. MESOZOIC ROCKS

From the field notes in Taurus Thrust zone[4] many Formations belonging to Mesozoic Era were appeared (MergaMir,Beduh-Shale,GeliKhana)(Triassic) and (Chia Gara,Qamchuqa,Hedina and Bechme) (Jurassic –Cretaceous) .These Formations represents carbonate shelf in the foreland basin of the foreland fold belts.

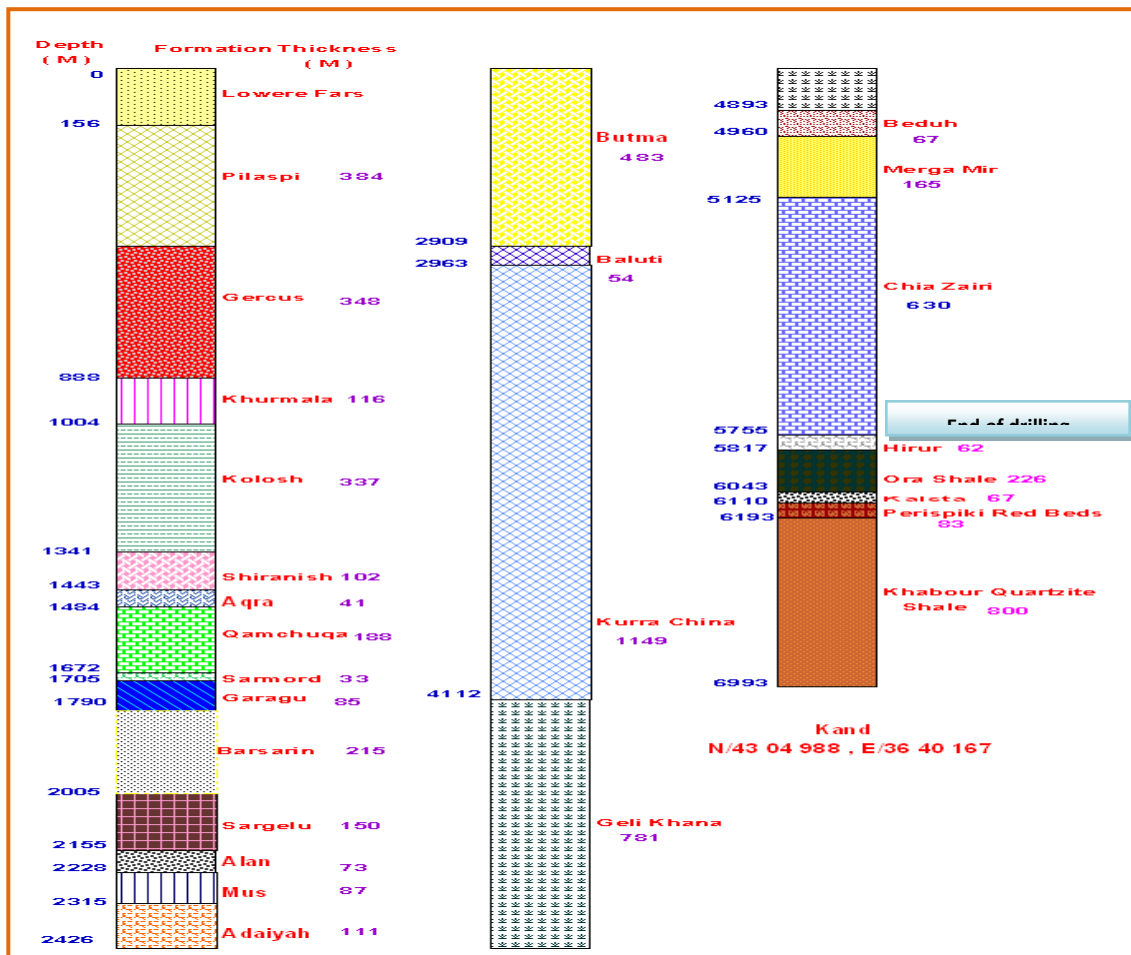
The total thickness of these Formations were calculated from the drilled wells in the area (figs 1-3) ,it was between (2980-3780 m) with the absence of Tanjero Formation (Campanian-Mastrichtian) in all wells ,beside that it had not exposed on the surface ,while Zagros Thrust zone characterized by the thick Mesozoic sediments .(Sharland et al, 2001) [30]found that Mesozoic sediments thickness in Zagros(5750 m) is much more than in Taurus (3400 m).Tanjero Formation exposed in Zagros Thrust zone as a belt extending (NW-SE) parallel to the Iraqi –Iranian border [6] and[21].The thickness of Tanjero in the type section in Sirwan valley (2018 m)[14] and (1210 m) in Rawandoze,(1442 m) inDokan,(1410 m) in Azmar[6], (1300-1350 m) in Zozak[9] , (more than 1000 m) in Chwarta and (179.4 m) in Chamchamal well[5]

D. MOLLASE SEDIMENTS

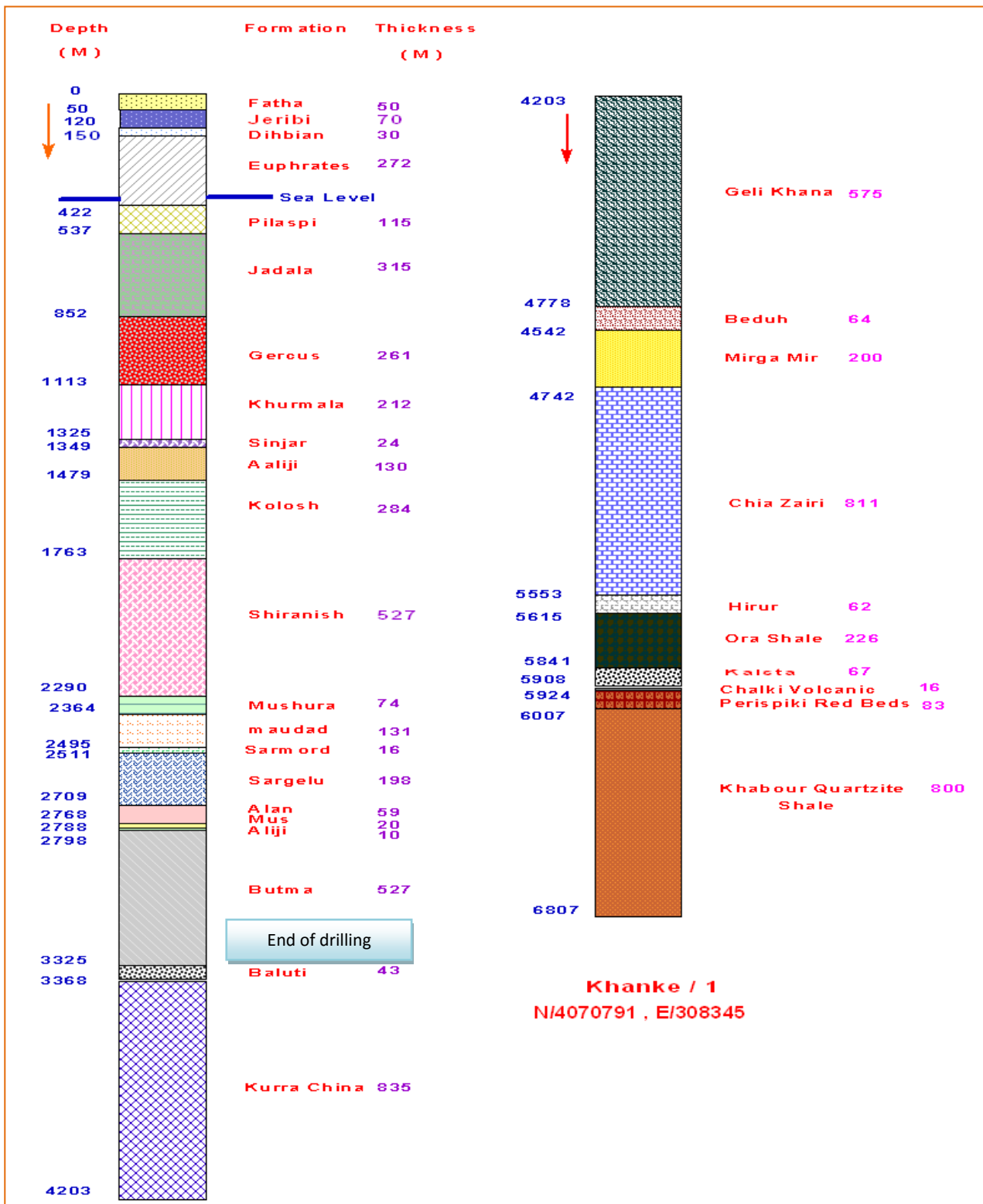
Mollase Sediments represents Injana Formation (Transitional Mollase) and Mukdadya & Bai Hassan Formation (Active Mollase) and it represent the huge area of the front basin area in front of Alpine Orogey belt[1] .

Mollase Sediments appears in Taurus Thrust zone on the surface ,where Bai Hassan Formation makes the core of Khanki syncline [4]while Mukdadya & Injana appears on its limbs with a limited thickness as a general in the area ,also Mollase Sediments appears in the core of syncline between Matin & Chia Gara anticlines within the high folded zone adjacent to Taurus Thrust zone .

Adeeb(2007)[1] cleared that there is an increasing in the maximum supposing thickness of the Mollase sediments from North-West (2250 m.) towards South-East(4000 m) , Numan(1997)[25] found that Mollase sediments in Kirkuk block is relatively higher than in Mosul block, Al-Ali(2004)[2] clear that Zagros basin received huge sediments most of them are Mollase over transitional sediments in (Middle Miocene-Now) while Taurus basin received less sediments.



Figure(1) Stratigraphic section in Kand well . Source : National Iraqi oil company,1982 in Al-Brifkani 2008[4]



Figure(2) Well (Khanke / 1) . Source :Norway (DNO) Company, 2006 in Al-Brifkani-2008 [4]

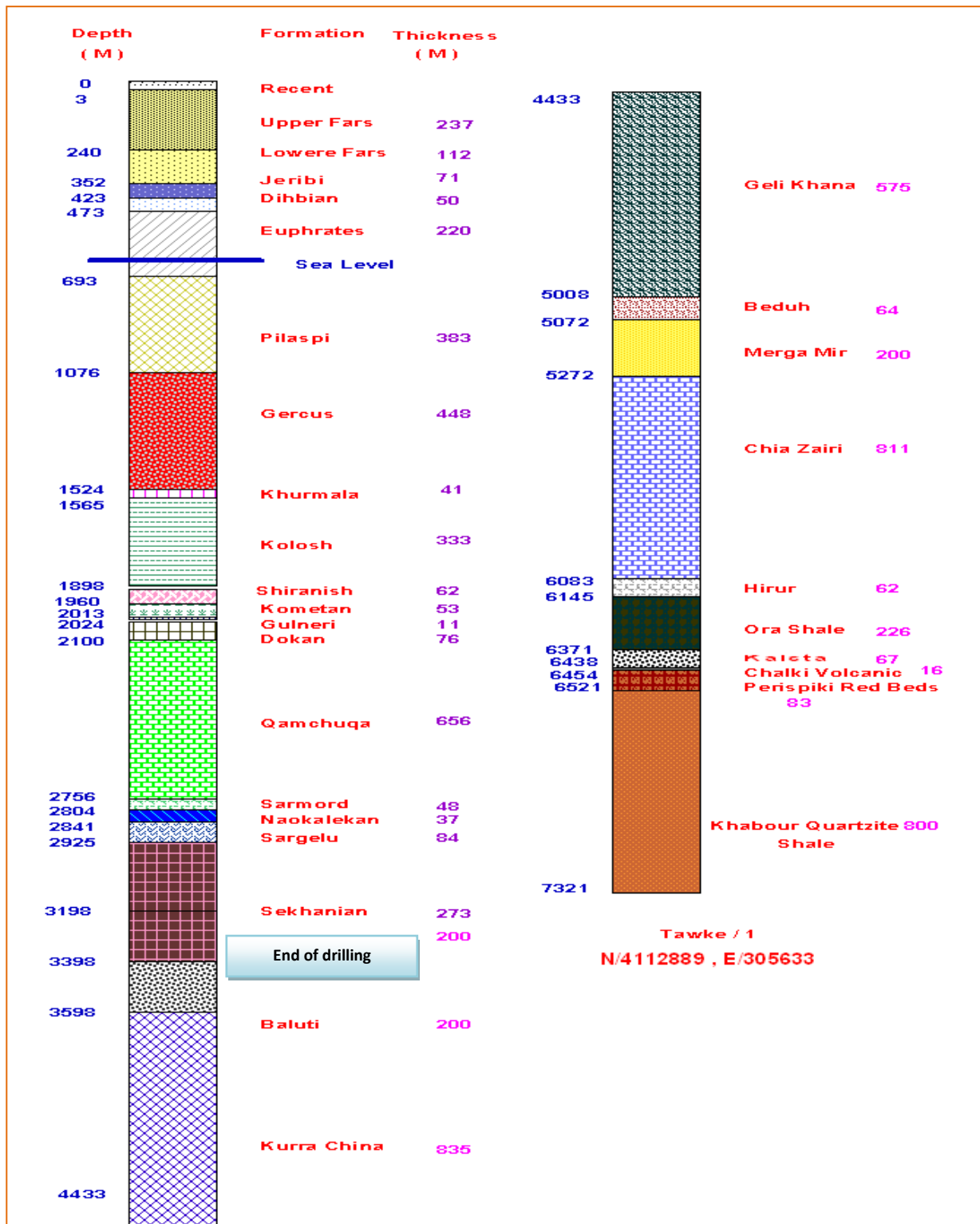


Figure (3) Well (Tawke / 1) . Source :Norway (DNO) Company, 2006 in Al-Brifkani -2008[4]

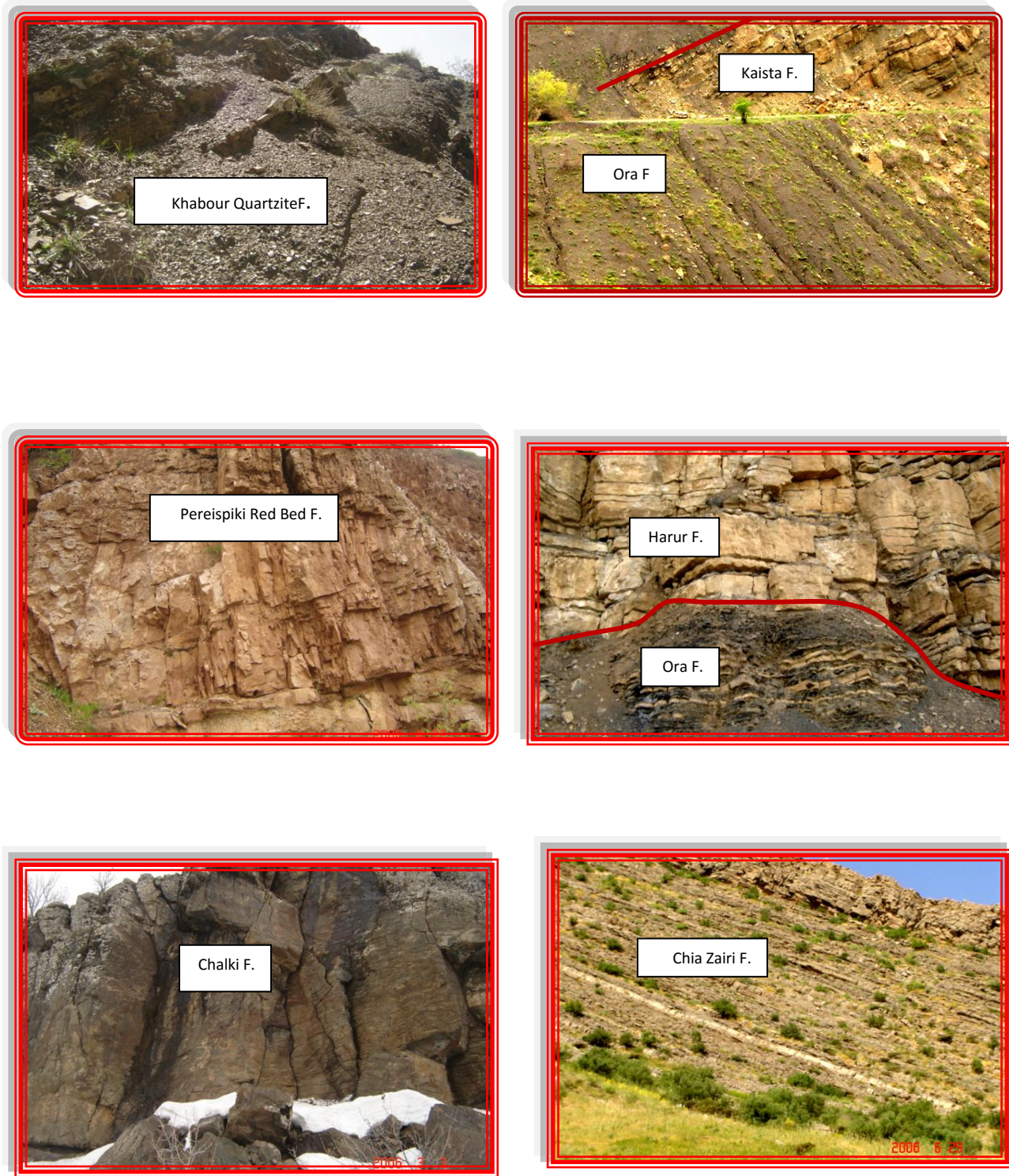


Figure (4) Paleozoic Rocks (Nizdur anticline, Northern thrust zone)

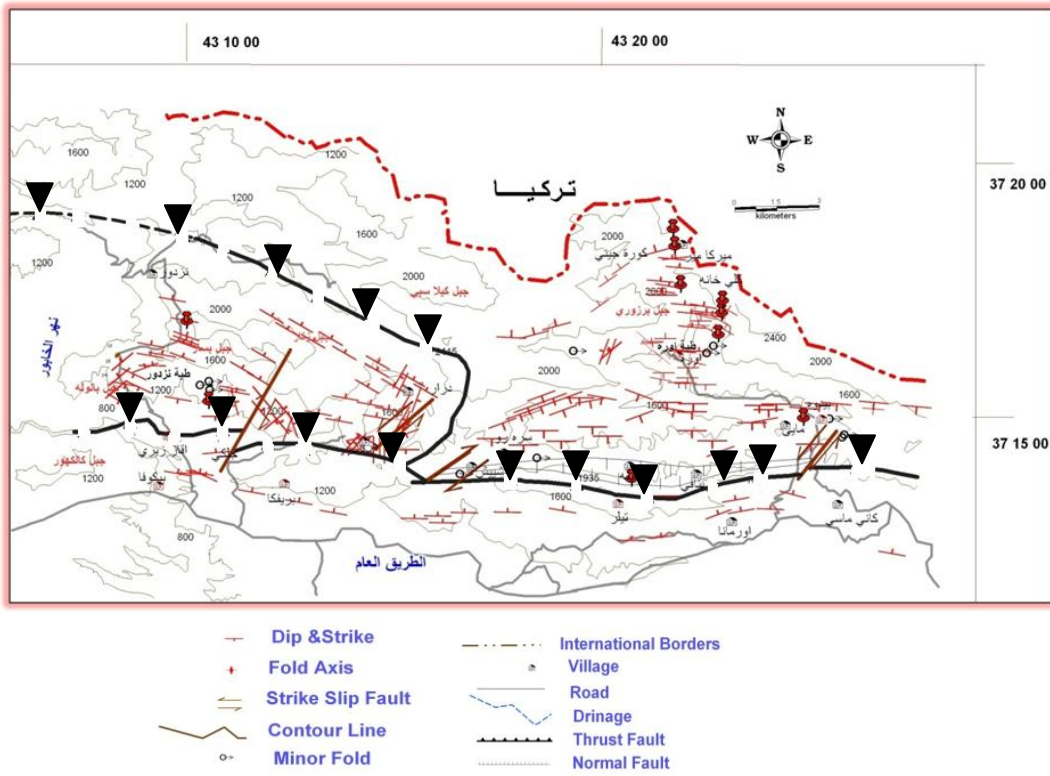
2. STRUCTURE

A. THE STRUCTURE OF THE NORTHERN (TAURUS) THRUST ZONE

Taurus Thrust zone located along Iraqi –Turkey border which is a narrow belt (10-15 km) in width and extend to(80 km) between Hezil river in the West and Great Zab river in the East .The characteristic features of the zone is the presence of thrust faults. Two thrust faults were recognized namely Northern thrust fault and Southern thrust fault [4]beside other smaller thrust faults in the Western part of the zone[23] (Fig-5) .The bulk of the displacement of these two faults is towards the South ,both faults have general East –West trends. These displacement make a major nape structure called Barware nape which also trends in East – West direction[4] .This nape consists two major anticlines (Nizdur, and Ora) and another smaller anticline between them (Harur anticline). Most of the folds are asymmetrical folds with their Northern limbs dipping gently to the North and their Southern limits dipping steeply to the South .so their vergence is towards the South. The displacement on the Southern thrust has brought Paleozoic Formation from depths to the surface on the form of “Ramp and Flat” structure (Fig-6).The displacement of the Northern thrust has again brought up Paleozoic and Mesozoic Formation to the surface. Many imbricate faults of small size and Duplex structure appeared in the zone. The zone characterized by the presence of some dextral and sinistral strike-slip faults trending (N-S, NE- SW). There is a complete absence of igneous bodies or exotic terrains but characterized by successional connected stratigraphy with common tectonic history[7].

B. THE STRUCTURE OF ZAGROS THRUST ZONE

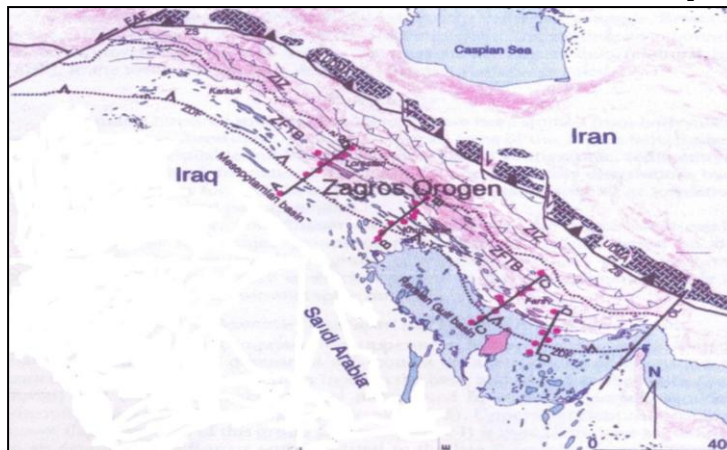
Zagros Thrust zone extend along the Iraqi – Iranian border (Fig-7). Two basic plates the upper plate representing by Qulqula group khuwakurk series (Cretaceous) and the lower plate comprising the main Zagros thrust which consist of Naoperdan , Wallash Chimo-Qandil (Tertiary) and there is series of red beds between them . Jassim and Goff(2006) [20]found three tectonic area from East to West . None of the Paleozoic rocks appears on the surface but the oldest stratigraphical units is Qulqula group (Albine-Noranin) . Heron and less (1943)[18] clears that the zone is an allochthonous while Smirnov and Nelidov(1960)[31], Al –Saidi (1992)[7] says that it is representing accretionary prism. Bolton (1958)[10] found that there is an imbrications faults zone present between the thrust zone and the foreland basin area. The lineament structures (folds) characterized by the great differences in their trends. The Zagros thrust zone consist of continuous stratigraphical succession separated by tectonical borders which are faults. The most of the rock groups in the zone are exotic or suspect terrains [7].Plenty of igneous bodies, volcanic extrusions and metamorphic rocks present in the zone. Numan(1997,2001)[25]and [27] clears that the first appearance of the subduction prism and the sedimentary –volcanic products were in (Aptian) which comprises Andean type subduction and continued till (Late Cenomanian). The thickness of kuwakurk is(3000 m) in Penjwen valley complex- Shiller (4500 m) ,Katarash volcanic (1900 m) and Mawat ophiolite (3600 m) ,Naoperdan group (300 m), volcanic Wallash (3000 m) and metamorphic Chimo – Qandil (4100 m).



Figure(5) Structural Map of Northern Thrust Zone .Source: Al-Brifkani, 2008[4]



Figure(6) Ramp and Flat Structure –Northern thrust zone . Source: Al-Brifkani, 2008[4]



Figure(7) Zagros thrust zone in Iraq , [3]

DISCUSSION AND RESULTS

The Phanerozoic succession in Iraq comprising strata belonging to the Caledonian, Hercynian, Kimmerian and Alpine orogeny's according to the classical geosynclinal concept, These Phanerozoic succession deposited in deeply subsiding, elongate and geographically fixed basins in orogenic belts but according to the mobilistic concept these sedimentary basins related to the earth's plate tectonism. The tectonical history of North and North Eastern Iraq begin with the Iranian and Turkish plates split off from the Arabian plate with the opening of the Neo-Tethys ocean at the expense of the Paleo-Tethys further North. Dewey et al (1973)[12] proposed that Iranian plate split off from Arabian plate in (Early Triassic), while Gamreliaze (1981)[15] propose that Turkish plate split off from Arabian plate in (Liassic). Numan(1997)[25] says that the deposition of Beduh -Shale Formation in Early Triassic represent the beginning of split off Iranian plate from Arabian plate and the deposition of Baluti -Shale Formation in (Late Triassic) representing split off of Turkish plate from Arabian plate, it means that Arabian plate split off from Iranian and Turkish plates were not diachronous and Iranian plate separated firstly from Arabian plate than Turkish plate. The diachronous in the time of opening of the Neo-Tethys was behind many basic geological differences between the two thrust zone like the huge thickness of the Mesozoic sediments in Zagros zone that in Taurus zone, which was shown clearly from the drilled wells (Figs 1-3) that the thickness of Mesozoic sediments in Taurus zone (3000-3800 m) and Sharland et al(2001)[30] found the thickness of Mesozoic sediments in Zagros is(5750 m) this caused the depth to the basement rocks more in Zagros zone (10-13 km) while in Taurus (7-10 km) [13]and[11], Al-Ali(2004)[2] found that the value of the pulled factor (b) of the lithosphere were increased in the direction of South East (b=2.19) and decrease in the North West direction (b=1.74) in Bitlis zone. This strength the proposal that the passive continental margins on its South Eastern parts were exposed to more pulling because of the tensional stresses and the pulling decreases toward the North Western till Taurus. This means that the Neo-Tethys were began opening from South East toward North West.

The high amount of pulling in the South Eastern part means more thinning of the continental crust and more departure of the continental margin from the mid oceanic ridge of the Neo-Tethys oceans and this causes more thermal decreasing of the continental margin. The less thickness product of the continental crust with the high subsidence leads to the availability of huge space for deposition and producing of thick stratigraphic columns. The Neo-Tethys ocean attained maximum width during (Liassic-Bajocian and Bathonian) [25]. In (Late Tithonian) the horizontal extension of the ocean were finished and the subduction of the oceanic crust started below the Turkish and Iranian plates. Altunli(1966) [8]gave an age of (Late Jurassic) for the blocks of ophiolite -flysch complex in SE-Turkey. Rigo de Righi and Cortesini(1964)[29] suggested an age of (Late Jurassic to Late Cretaceous) for the igneous activity that took place in the mobil belt of Turkey. Alave (1980)[3] gave an Early Cretaceous age for the beginning of subduction underneath the Iranian plate. The process of subduction of the oceanic crust below the Turkish and Iranian plates continued which lead to the process of narrowing of new-tethys. Stonley(1983) [32] cleared that increase of subduction of the oceanic crust over generation of new oceanic crust lead to narrowing of the neo-Tethyan ocean. In (Aptian, Albian, Cenomanian) the obduction of ophiolite on the passive Arabian plate margin began.(Numan, 1997)[25] marks (M-Eocene) as the continental plate collision between the under riding Arabian plate and the overriding Turkish and Iranian and that marking the completion of the Wilsonian cycle that spanned over (200 m .years). Hessami(2002)[19] says that the convergence between the Arabian and Iranian plate began in (Late Cretaceous -Early Miocene) and as a result of the collision between the plates. The active margin of each of Iranian and Turkish plate override the passive Arabian margin. Most of studies shows that the convergence between plates and the closure of the ocean was diachronous as in the opening of the ocean where firstly collision happened below the North Western parts (Taurus) and the collision continued toward the South Eastern parts (Zagros), it means that the closure of the ocean was ended in Taurus before Zagros and the style of the opening and closure of the ocean was similar to the opening and closure of a scissor [25].

To certificate that, there are some differences between the two thrust zones :

The exposure of the oldest Formation belonging to the Paleozoic Era on the surface in Taurus zone which means that the first big collision occurs between Turkish plate and Arabian plate , The collision lead the older Formation (Khabour- Quartzite –Shale) which was found at a depth of (6000 m) to displace to the surface by the Southern thrust fault . At the same time this causes the Formation of ramp and flat structure in Nizdur area in Taurus zone and with the continuity of collision ,another displacement of the Paleozoic rocks occur by the Northern thrust zone leads to the over thrusting of Formation belonging to Paleozoic and Mesozoic . While in Zagros thrust zone, one cannot see any of these Paleozoic rocks in the surface because the neo_oceanic Tethys was widen at that area and the collision did not occur yet ,but there is subduction process and subduction ophiolite on the massive Arabian margin and the overriding of the Iranian plate ,this leads to the deposition of red beds and presence of igneous volcanic and metamorphic bodies (Cretaceous – Tertiary) like tectonic facies of Walash-Naoperdan group and Chimo –Qandil group, these represent fore arc –arc –back arc (Numan, 1997) while there are absence of these igneous bodies in Taurus. At the end stages of subduction processes and the continuous overriding of Iranian plate Zagros zone had receiving continuously flush sediments especially sediments of Tanjero and kolosh Formations ,as it was seen before the huge presence of Tanjero sediment in (Cretaceous) along the Iraqi –Iranian border with a thickness exceeding (2000 m) sometimes. In contrary ,no record about these sediments in Taurus Numan(1997)[25] certify that Kirkuk block is the product of higher subduction of oceanic crust relation to Mosul block and that the base of Kirkuk block is more active and contain oil field because of the presence of huge sediments of Mesozoic . The collision of the Arabian indentor firstly with Turkish plate leads to the presence of mollase deposits to the North and North Western part of front of mountain in Taurus series which locate on Mosul block while in Kirkuk block mollase sediments formed a shape of pulling basin[1] and that the thickness of mollase sediments in Mosul block (2250 m) which is less than mollase sediments in Kirkuk block (>4000 m) . The presence of irregularity in the shape of collision plate margins in subduction zones beside the anti-clock wise rotation of Afro –Arabian plate leads to the occurring of strike slip movement on the basement block on Northern Iraq generally [17] , [19] ,[22] and [25] .

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