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Tectonic and Depositional History of Upper Cretaceous Tanjero Formation in Sulaimaniya Area, NE-Iraq

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Abstract

The basin of (Upper Cretaceous) Tanjero Formation is combined (tectonically) with that of the underlying Shiranish Formation and named Upper Cretaceous Zagros Early Foreland Basin instead of previous miogeosyncline and trench. In this basin Tanjero Formation is deposited in the near shore area in front of southwest advancing positive land of Iranian plate. This near shore area is called Upper Cretaceous Depocenter, whereas, the underlying Shiranish Formation a summed to be deposited in the deeper central part of the basin, which is called Upper Cretaceous Basin Center. The advancing of the hinterland (Iranian plate front) is very clear from southwest position changing of the shelf for about 20km. The shelf of lower sequence was near the Iranian border during Upper Campanian while it migrated to the area around Chuarta and Mawat Towns during middle Maastrichtian. It was inferred that most part of the formation is deposited by forced regression during collision of Iranian and Arabian plate. During this regression both flysch and molasses facies are deposited.

Keywords: - Tanjero Formation, Geologic history, Cretaceous tectonic, foreland basin, Zagros, Kurdistan geology, Sulaimaniya area, Shiranish Formation.

Introduction

Tanjero Formation is an Upper Cretaceous (Campanian-Maastrichtian) unit, which crops out within the Imbricated and High Folded Zones in Northeastern Iraq Buday (1980) [1] and Buday and Jassim (1987)[2]. It stretches as narrow northwest-southeast belt near and parallel to the Iranian border (Fig. 1). The formation mainly consists of alternation of sandstone, marl and calcareous shale with occurrence of very thick conglomerate and biogenic limestones (Bellen *et al.* 1959)[3].

On the basis of main lithological distribution, it is divided the formation into three parts (lower, middle and upper parts Karim (2004)[4]). These parts are correlated across eight different sections (Fig. 2). The correlation is based on lithology and stratigraphic position of distinctive conglomerate and its derivative sandstones, which are discussed in detail n different geographical localities. The lower part (lower regressive part) is mainly composed, on the lower slope and basin, of thick succession of sandstone (100-400m), whereas on the shelf it is dominated by 500m thick succession of conglomerate (in this study, called Kato conglomerate). The middle part is composed of 100-300m of bluish white marl and marly limestone on the slope and basin whereas it changes to calcareous shale on the shelf and to 20-50m thick of red claystone inside incised valleys.

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The upper regressive part consists chiefly of 50-200m thick mixed carbonate-siliciclastic successions (in this study, named Kato Mixed Carbonate-Siliciclastic Successions).The constituents of this succession are alternation of biogenic limestone and calcareous shale with miner amount of sandstone and conglomerate. He also found both flysch and molasse facies in the lower part of the formation in the distal and proximal area of the basin respectively.

Tectonic history

It can be inferred from the facies distribution maps given by Buday, (1980) [1] that the basins paleoslope direction (depositional dip) was toward northeast during Lower Cretaceous till Middle Turonian. During later ages (Coniacian and Santonian) the general basin paleoslope direction was reversed 180 degree toward southwest during Upper Cretaceous. This reversal case is associated with colliding of continental parts of Arabian and Iranian Plate after deposition of Qamchuqa and Balambo Formation in the studied area. This colliding occurred after the oceanic crust is exhausted and then the two related continents are collided. Before this, the studied area was passive continental margin (carbonate platform) and bordered from the north by subduction trench (active continental margin). The collision finally changed the area of subduction to positive land and studied area to foreland basin (Fig 5B and 7). According to Karim (2003a)[5] , during this process, the previously deposited Qulqula Formation compressed, as accretionary prism, between two plates and uplifted forming positive land and source area.

According to Buday (1980, p.402) [1] the miogeosyncline was separated from unstable shelf by a ridge. He mentioned that the continuation of this ridge is not clear enough in the area southeast of Ranyia Town (part of the studied area).

In the present study, the absence of this ridge is proved in the Sulaimaniya Governorate. It is observed that the present position of Azmir, Goizha, Piramagroon, Sara, Qarasard and Kosrat anticlines (Fig. 1 and 3) was part of the slope of the Tanjero basin, while the present position of Haibat Sultan, Tasluja and Baranan homocline most possibly comprised part of the basin plain of the formation. The deposition, bypassing and erosion of sediment occurred extensively during deposition of Tanjero Formation on the position of former anticlines (Azmir, Goizha, Sara and Kosrat). So there were not any major irregularities (submerged paleohigh or geoflexture) in the basin of Tanjero Formation, in the studied area, during deposition.

The possible tectonic activities are observed as following:

At the beginning of the deposition of the lower sequence (proved to include Kometan, Shiranish and part of Tanjero Formation, the studied area suffered from clear deepening. This is proved from field work which is demonstrated by deposition of deep pelagic Kometan Formation over shallow marine reefal Qamchuqa Formation. This transgression may be reflection of prominent subsidence due to tectonic loading of the existed platform. The over loading is happened by colliding of Iranian and Arabian plate by which the former plate thrusted over the latter and advanced toward position of Tanjero basin.

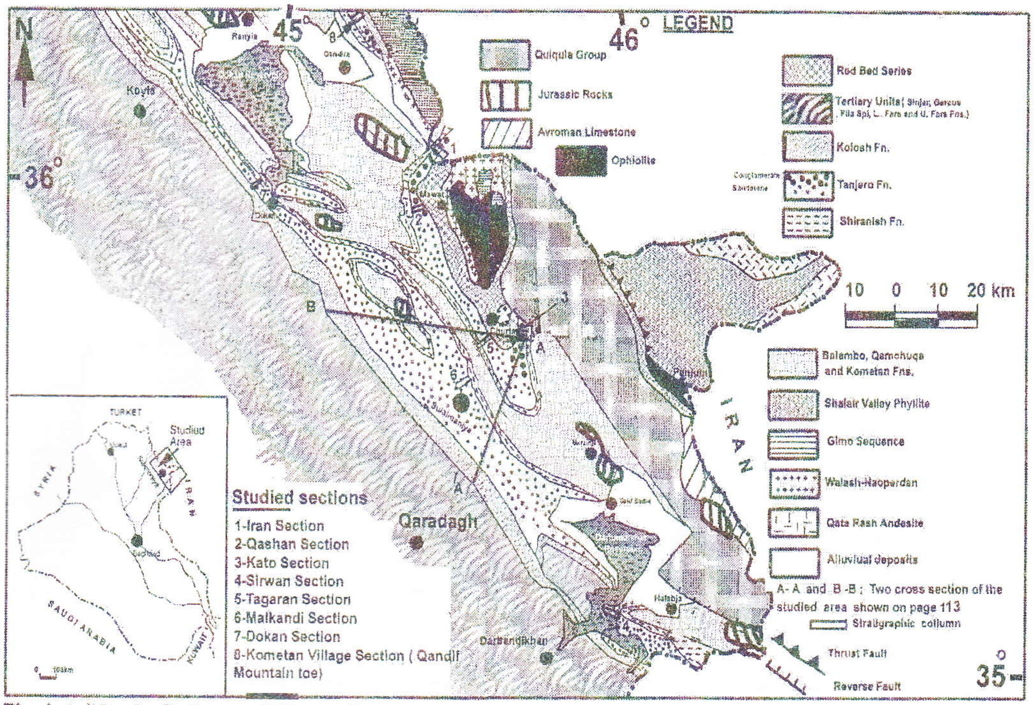

Fig. (1) Geological map of the studied area (modified from Jassim and Al-Hassan, 1977)

The thrust has uplifted the area that located to the north and northeast of the studied area. This is probably started from Campanian and continues till the beginning of Tertiary and forming active continental margin. Uplifting created a southwest advancing positive tectonic front (frontal part of Iranian plate). The continuous erosion of this front shed large quantity of clastic sediment into the Tanjero basin. It is possible that later in the early Tertiary, the position of the slope was acted as geoflexture for the existing present anticlines. The sequence stratigraphy proved that the facies of the Tanjero Formation have migrated to south and southwest in such way that the position of the shelf, slope and basin plain changed during lower and upper sequences, mostly by forced regression. This regression is due to eustatic sea level change with the aid of tectonic uplift of source area and possibly part of the basin.

The high thickness and coarseness of the Kato conglomerate is evidence for above-mentioned facts. The high tectonic and elevated source area is opposed in the basin by slight subsidence and general gradual shallowing, which is in some time, demonstrated by incised valleys (see Karim 2004) [4]. In some cases, they have scoured the shelf down into the Shiranish Formation such as the Iran and Qandil sections (Fig.2) At Iranian sectionfig(1jassim and Hussain ,1977) [6] the thickness of formation consists only of Kato conglomerate and typical lithology of Tanjero Formation is absent.

Previous ideas about tectonics of the basin

Previous workers have published the following ideas on tectonic and depositional history of Tanjero Formation:

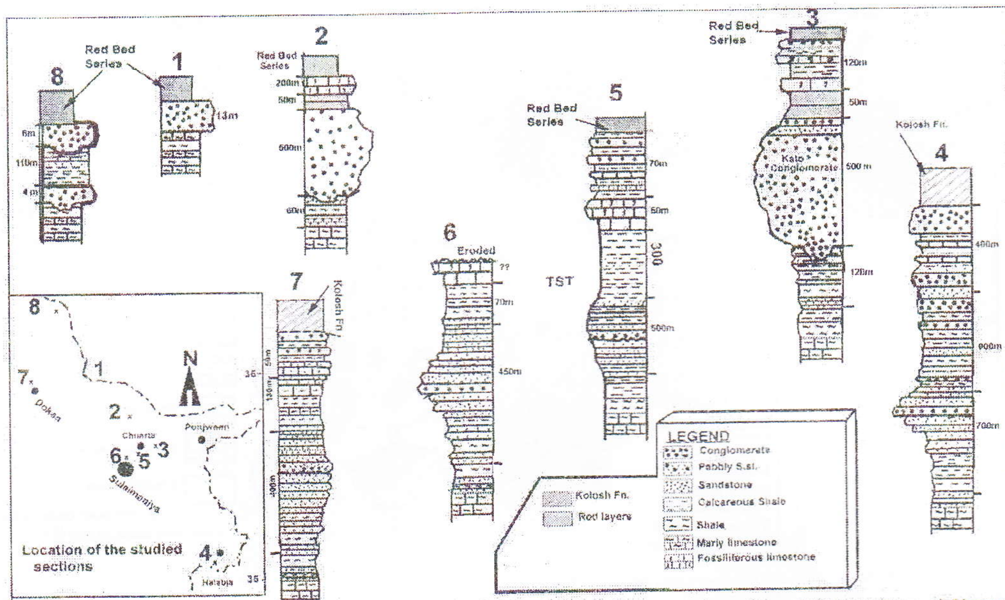

Fig. (2)Location and collumn of the studied section, 1) Iran section, 2) Qashan section, 3) Kato section, 4) Sirwan section, 5) Tagaran section, 6) Malkandi section, 7) Dokan section, 8) Kometan village section(Qandil Mountain toe)

Miogeosyncline idea

According to these ideas, the formation is deposited in miogeosyncline realms (deep marine trough) in which flysch sediments are deposited by turbidity currents (Buday, 1980[1]; Buday and Jassim 1987[2], Kettaneh and Sadik, 1989[7] and Lawa *et al*., 1998) [8]. But in the present study, both Tanjero and Shiranish Formations are considered as lateral and vertical facies change of each other and the differences between the two formations are only attributed to nearness to the shore and source rocks not to tectonism. Now these types of facies can be clearly explained by relative sea level change in sequence stratigraphy. In the present study both Shiranish (and Shiranish-like lithology) and Tanjero Formation are combined in single depostional sequence and even in single system tract (when distal and proximal lithologies of HST and TST is considered). In all ancient and recent basins, it is normal to see the near shore (proximal area) affected by more uplifting and sedimentological activities than the central part of the basin. This fact is interpreted previously, as regarded to Tanjero Formation, as abnormal tectonic activity.

Tanjero Formation: Transgressive sediment

Previously Tanjero Formation was considered as transgressive sediments Buday (1980, p.402) [1] and Minas (1997) [9]. Other authors mentioned intense subsidence of the Upper Cretaceous basin (Marouf, 1999) [10].

But in the present study it is proved that nearly all the typical lithology of the formation is deposited during major forced regression (LST), which is discussed in detail below.

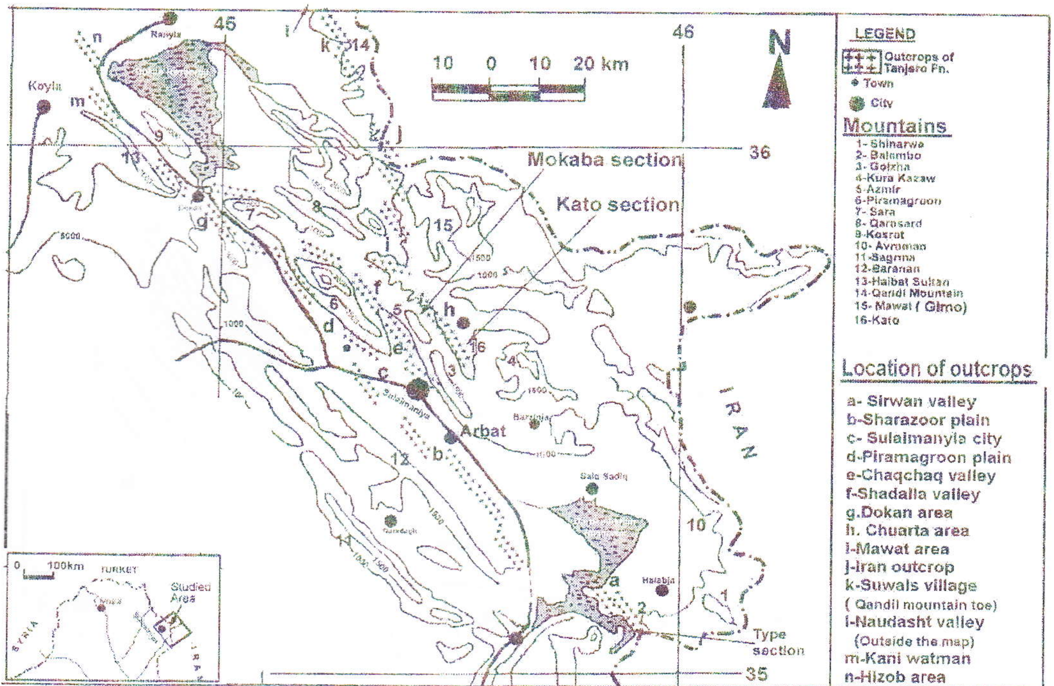

Fig. (3) Topographic map of the studied area showing location of main outcrops and mountains in the studied area.

Present ideas

The following ideas of the present study are based on fieldwork, recent new sedimentological and stratigraphic principles which are applied on the studied area.

Same tectonic setting of Shiranish and Tanjero Formations:

While the tectonic of Tanjero Formation is exaggerated in the above-published ideas, nothing is mentioned about tectonic of Shiranish Formation. In the present study, Tanjero Formation is neither sedimentologically nor tectonically separated from basin of Shiranish Formation. Also the unstable shelf and previous miogeosyncline is united in single basin named **Upper Cretaceous Early Foreland Basin**, all these are deduced from the following:

The contact between the two formations is gradational and they laterally interfingering Bellen et al. (1959) [3] and Buday, 1980) [1].

This was also observed in the field by the present author. The same above authors mentioned that Shiranish basin extends to unstable shelf (to near central Iraq) (Fig.6 and 7).

Therefore, according to traditional and sequence stratigraphy, both formations one makeup sequence, one depositional basin, and affected by one cycle of sea level changes. So both formations must be put in one single basin of same tectonic setting.

Fied study showed that, in all areas of distribution of both formations, the extent of Shiranish Formation is more than Tanjero Formation. Therefore the former formation acts as a carpet for the latter one. We called this relation between the two formations "a **sleeping man on a carpet**" which means that Tanjero is the man and Shiranish Formation is the" carpet".

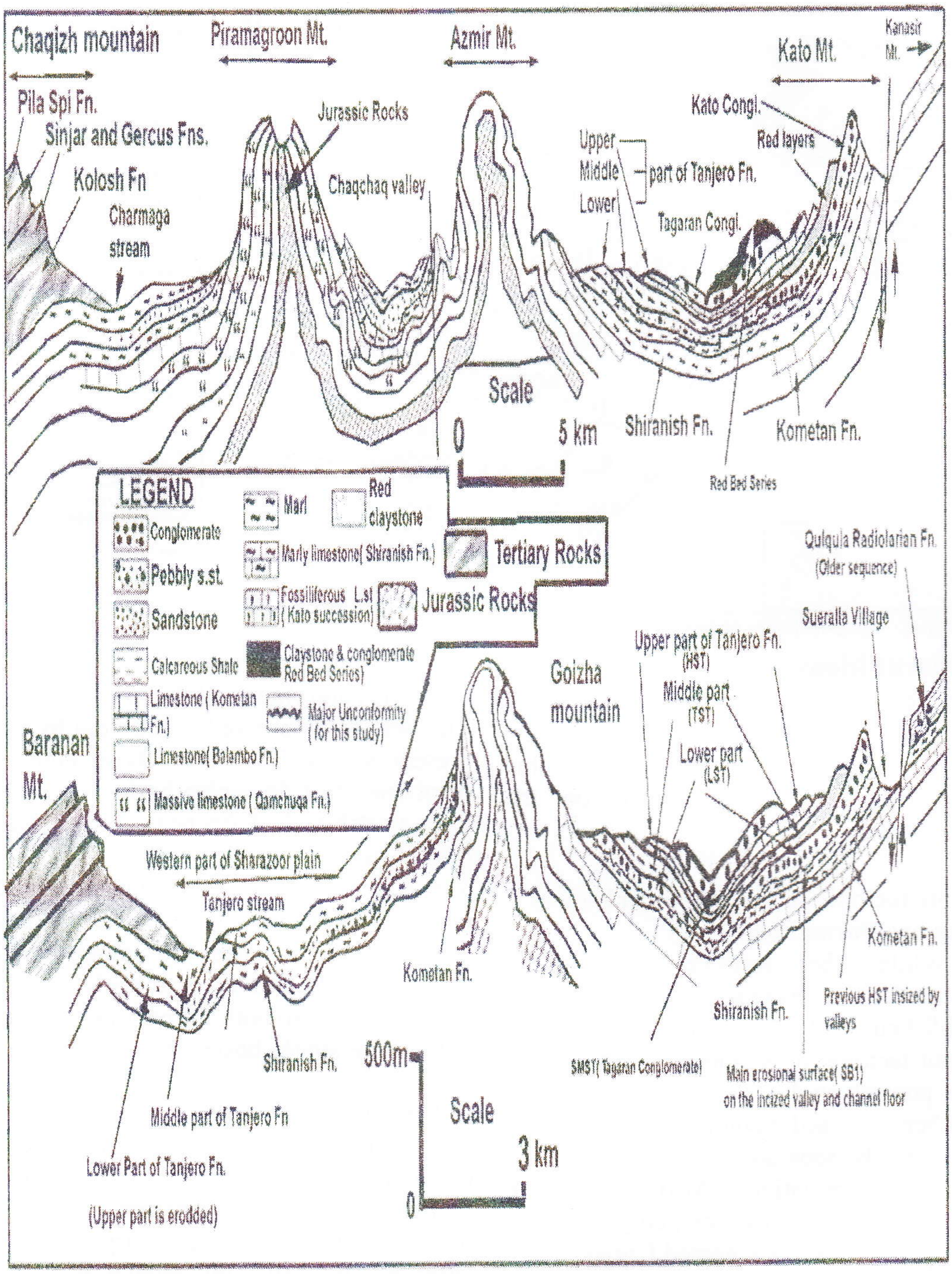

Fig.(4) Two cross sections connecting Kato mountain to the Chaqizh mountain (upper one) and Baranan Mountain. The first one passing through the axis of main fans while the scond one passing through one of the interfan lobes of Upper Cretaceous. The figure shows the new divisson, sequence stratigraphy of this study and ultimate deformation.

The paleocurrent direction (see Karim 2004)[4]and Karim and Surdashy (2005a) [10a] indicates the general direction of south and southwest, which shows no any separation of the region called "miogeosyncline" and "unstable shelf" from each other during Upper Cretaceous. Previously these two zones were assigned for sedimentation of Tanjero and Shiranish Formations respectively. In the present study the miogeosyncline basin (previously assigned as basin for Tanjero Formation) is changed to ***upper Cretaceous depocenter*** and unstable shelf to ***Upper Cretaceous basin center*** (Fig.7). Both basin center and depo-centers combined to form a broad southwest sloping *Zagros initial foreland basin*. This basin was bordered, from northeast, by recently uplifted (or over-thrusted) positive land, which was migrating continually. Karim (2004)[4] found both land plant and 500m of boulder conglomerate which are direct evidence for positive land (mountain belt). This terrestrial land drained by initial drainage pattern which most possibly of parallel type. This pattern is formed at the front of the thrust sheet (or reverse fault) formed a scarp. This pattern included many deep valleys through which water and sediments of many small watersheds (possibly less than 400km^2 for each drainage basin) were delivered (drained) to the basin (Fig. 7). During relative sea level fall (LST) these valleys, more and more advanced towards the basin by scoring of the delta plain and shelf sediments of previous HST. During this sea level fall, the coarse sediments are deposited as alluvial fans in the coastal area of the basin and part of these fans were built in to the main body of the sea forming fan delta (Fig.7). The valleys mentioned above are called incised valleys; three of these valleys are ascertained and mapped in the field. These valleys are filled with Kato conglomerate on the shelf and with both alternation of sandstone and conglomerate on the Upper slope and sandstone and shale at lower slope and basin plain. In North America Bhattacharya and Willis (2001) [11] described, in detail, a lowstand system tract in foreland basin during Cenomanian. The content of the lowstand is much similar to that of lower part of Tanjero Formation in the view of lithology, trace fossil (cruziana and skolithos) and sedimentary structures (HCS, Cross bedding)(see Karim 2004) [4]. Although Kolosh Formation has nearly same lithology as the Tanjero Formation, it is tectonically separated from miogeosyncline and regarded as a unit of unstable shelf by above authors. In the present study, the three formations (Shiranish, Tanjero and Kolosh) have given same rank of tectonics (early foreland basin or syn -collision active margin). The only difference is the possible depocenter migration toward southwest for about 25 km (estimated only) as regarded to position Tanjero Formation. Even Aqra-Bekhme Formation is included in the basin as reefal facies on local submerged paleohighs. Recording of abundant plant debris is good evidence for existing of lands that surround the basin. For this and other evidence cited above the basin is called foreland basin.

Initial (early) foreland basin

Bate and Jackson (1980) [12] defined foreland basin as:

A stable area marginal to an orogenic belt, toward which the rocks of the orogenic belt were thrust or over folded. Generally, the foreland is a continental part of the crust and is the edge of craton or platform area. In this study the Tanjero basin is considered to be initial foreland basin so the above definition can be applied to this basin when considerable amount of activity is given to the basin because of its early development. The applicability of the definition is attributed to the following:

The basin of Tanjero formation was relatively stable as compared to thrust sheets and over-folded source area of the formation which located in the Iran Territory. Another reason for relative stability of the basin is the basin shows no igneous activities. In other side, more active area is the source area of the Formation which includes Qulqula Formation, Ophiolite Complex and Qandil Group. All these represent the orogenic belt of the above definition.

As seen in sequence stratigraphy sea level fall and rise of the formation is nearly coinciding with the 3rd order eustatic sea level change. This is meaning that the tectonic was not so intense to obscure the effect of eustatic sea level change. The final reason for relative stability of the basin is the fact that the basin of Tanjero Formation is characterized by growth of the thickest and best reefal limestone. These limestones include both Aqra-Bekhme Formation and Kato Mixed Carbonate-Siliciclastic Succession. The formation and the succession are consisting of thick rudist and large foram bearing limestone which proves the relative stability of the basin with constant subsidence as all other basins. All these prove that the Tanjero basin was not tectonically so active such as estimated previously. This is true also for depth which was shallower than that assigned before. Einsele (2000, p.606) [13] called

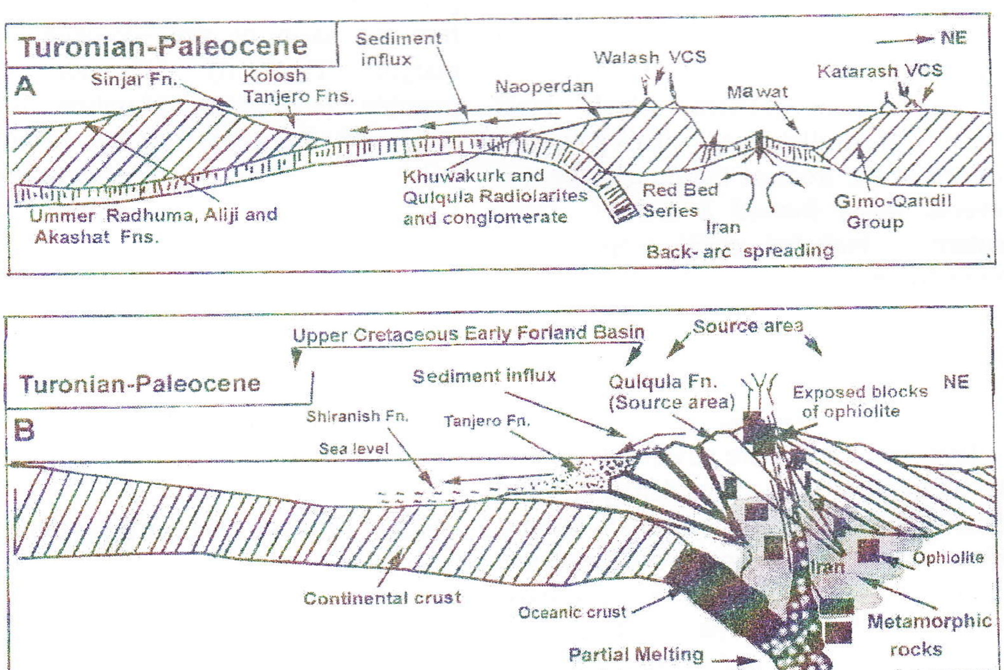

Fig.(5)Tectonic Model for Tanjero Formation, A) Pre-collision model of Numan(1997)
B) Post collision of the present study, which shows changing of paleo-slope direction from NE to SW.

this type of initial foreland basin "remnant basin" which is more active and deeper than the foreland basin. According to him it is largely filled with deep-water flysch sediments and confined with, on one side, by pre-existing passive continental margin (platform) (western desert in case of Iraq) with wedge of older clastics and carbonate sediments. On the other side, an approaching thrust belt confines the formation.

Qulqula Radiolarian Formation (accretionary prism) represented the thrust belt (in case of Tanjero basin) (Fig.5B). Due to erosion, this prism is shedding relatively large volume of various clastics in the form of turbidites and mass flow deposits into the basin. The actual position of Tanjero Formation may be located in transition zone between foreland and remnant basin.

Balambo and Qamchuqa Formations were forming the platform during Lower Cretaceous and Tanjero Formation started deposition on top of these formations after rapid subsidence. This rapid subsidence led to the deposition of Kometan Formation in the studied area. Later, when the source area was uplifted and sea level was lowered (during most times) Tanjero formation was deposited.

In foreland basins, sediment shallows up from deep water to shallow marine and then continental sedimentation (Mail, 1995) [14]. This type of shallowing is exactly applicable for Tanjero Formation and Red Bed Series, which have gradation contact (in some place) in the area of the study. In this connection Doyle *et al.* (2001, p.111) [15] mentioned that the sediments of foreland basin deposited in mostly river and deltaic environment and consist of heterogeneous gravel, sands and muds derived from orogenic belt.

Syn -collision idea

In contrary to pre-collision model, the present study assigned to the setting (tectonic model) of the Tanjero basin to syn-collision of the Arabian and Iranian plates (collision of their continental parts). The birth of Tanjero Formation started when Qulqula Formation (as an accretionary prism) was uplifted after the collision of the two plates. The relatively sudden start of the clastic influx and gradual increase of grain size to coarse conglomerate indicated uplift of the Qulqula Formation by thrusting or block faulting.

When an oceanic basin completely closed with the total elimination of oceanic crust by subduction, the two continental margins had been converged. Where two continental plates converge, subduction does not occur because the thick, low-density continental lithosphere is too light to be subducted. In between these plates Qulqula Radiolarian Formation, as the softest rocks in the collision zone, is deformed and uplifted forming orogenic belt. This belt might be developed by collision of the plates, which involved a thickening of the lithosphere. As the crust thickens it undergoes deformation with occurrence of metamorphism in the lower part of the crust (e.g. Shalair Phyllite) and faulting with folding at shallower levels in the mountain belt. Finally the uplifted land may thrust and form thrust belt. The material of belt is moved outwards, away the center of the orogenic belt. This caused the Tanjero and Kolosh Formation to be deposited by dislocation of depocenter toward southwest as the gradual moving or uplifting of source area (Fig.6 and 7).

Migration of depocenter

During fieldwork at the studied area, two depocenter of Tanjero deposits were found. These depocenters belong to two different successive depostional sequences. The distance of migration is about 25km, which measures the distance between two identical lithologies in the two sequences. These two sequences are as follows:

Campanian-Lower Maastrichtian Sequence

This sequence can be identified easily in the Chuarta area. This sequence is partially eroded by overlying (SB1). These situations are very clear at Kato Mountain where this sequence is located at the base of Kato conglomerate and the coarsest existed lithology consists of package of 30 m thick medium grain sandstone. This package represents sediment of LST. Similar package of the upper sequence is outcropped at south of Sulaimaniya City. The distance to the Kato Mountain and this latter locality is a bout 25km when the folding shortening is considered. The identification of this sequence is very difficult in the distal area. This is because it either changes to Shiranish Formation or it is interfingering, as fine sand, with marl of Shiranish Formation forming transitional zone between the two formations. The age of the two sequences

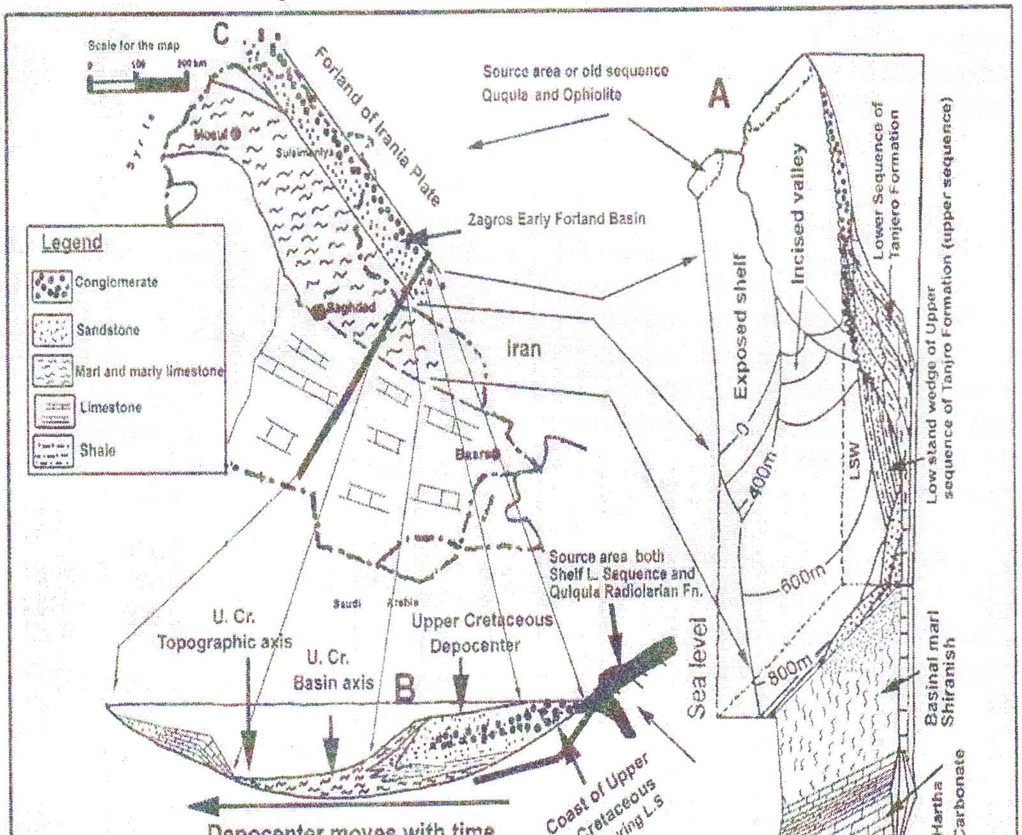

Fig.(6) Sequence depostional model (A) and general depositional model (B) as correlated with the Upprer Cretaceous lithofacies distribution map (C) The location of Tanjero Formation is valid only for upper sequence.

is based on age of the formation at Dokan area, which is indicated by Abdul-Kareem (1986b)[16].

Middle –Upper Maastrichtian Sequence

This is the main sequence comprising more than 90% of previously known lithology of the formation. This sequence is discussed in detail in the paragraph on sequence stratigraphy.in Karim(2004)[4]

The 25 km migration of the depocenter is attributed to sea level change and basin fill which are both well enhanced by progressive southeast advancement of thrust sheet of Iranian plate.

Sediments: As an apparent indication of high tectonic

As mentioned before both Tanjero and Shiranish Formations were sharing same basin and exchanging position laterally and vertically (Fig.6 and 7) The Tanjero Formation basin was active and relatively high tectonic but when compared to Shiranish Formation, its tectonic is highly exaggerated this is due to the high thickness and alternation of coarse and fine sediments. This gives, apparent(not real, high tectonics during deposition. But when one studies the nature and lithology of the source area, one realizes why the formation has high thickness and compositionally different lithologies.

In this study, the above two characteristics are attributed, partly, to the following:

The source area (Qulqula Formation) is composed of 30% variegated marl, calcareous shale; 40% thin bedded chert and 20% of limestones. These sediments are easily weathered and eroded during Upper Cretaceous stormy climate.

The source area, hinterland and foreland, was steep sloping and highly deformed during the collision of the Arabian and Iranian plates (continental – continental colliding phase). It is likely that at that time the brittle bedded chert and soft marls are so intensely jointed and fractured that helped rapid weathering, the erosion and creation of deep valleys.

The bedded cherts, although brittle, they shaped into hard and sharp edged boulder and gravel (with some blocks) by jointing. During transport in streams, these act as millstone for grinding and breaking up the clasts and the underlying rock too. All these helped enormous amount of material to be available for transporting and deposition in the basin of Tanjero Formation. It is worthy to mention that villagers, in the northeastern Iraq villages, use Kato conglomerate as a millstone after shaping into large circular disk then used for grinding the wheat into flour by water-powered mills.

The uplift of the source area is partly due to presence of the soft rocks mentioned above. These rocks sandwiched between the two plates as accretionary prism and uplifted by imbrications or forcefully emplaced upward by flowage, like salt domes or tooth past (see Costa and Venderville, 2001 for principle of diapirism in convergent setting, p.123-151) [17] . The softness of these rocks also led the ophiolite to rest in the core or boundary of the prism and later outcropped during erosion of the source area. This is can be ascertained by the fact that the lower part (e.g., Kato conglomerate) of the Tanjero Formation does not contain any type of igneous boulders and gravels while the upper part contains these rocks.

The high thickness may be partly returned to climate of Upper Cretaceous, which was stormy and wet. In this connection Haq (1991 p. 34) [18] mentioned that increased albedo during lowstand favors extreme climate, and this, in turn lead to enhanced thermal contrast of land and sea, between surface and bottom of seawater. He also added that the extreme climate increase weathering and erosion on land.

Types of regressions

The main succession of the Tanjero Formation is sandwiched between a forced regression and normal regression from the base and the top respectively as follows:

Forced regression in Tanjero Formation

Posamentier *et al.* (1992) [19], has defined forced regression as basinward movement of the shoreline, caused by relative sea-level fall and independent on sediment supply. While Ainworth and Crowley (1994) [20] defined it as progradation of the shoreline in response to relative sea-level fall in which the rate of sediment supply exceeds the rate accommodation space added.

The most important evidence of the forced regression is rapid coarsening upward, i.e. the resting of coarse sediments on fine ones with erosional contact between the two (Einsele, 2000) [13]. In Tanjero this arrangement of sediment is very clear in Kato Mountain (Plate 5.1.2 and 5.2) where coarse conglomerate (coastal sediments) rests on shale of shelf of the lower sequence. Moreover in Iranian section and Kometan section (Fig.2), Kato conglomerate rest on the pelagic marl of Shiranish Formation.

As a result of the forced regression, the thick pile of lowstand system tract is deposited. This forced regression is affected

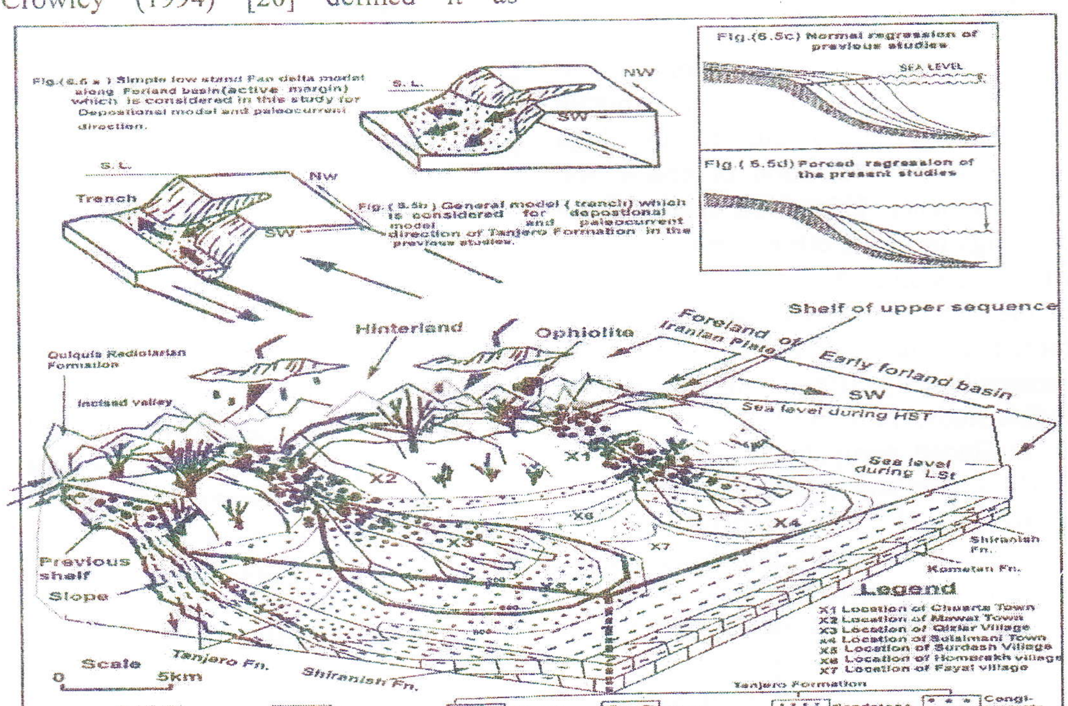

Fig.(7) Fan- Delta Model for Tanjero Formation, which shows gradation contacts and facies dislocation (migration) between conglomerate, sandstone, marl and marly limestone. The postion of the lithologies are valid only for the upper Sequence during Deposition of Low stand system (during forced regression).

by eustatic sea level change and most possibly enhanced by tectonic uplift of the source area. The uplift is also accompanied by progressive horizontal advancing (closing) of the source area.

The lithology of the Tanjero Formation revealed that the source area (hinterland) was mainly comprised of accretionary prism of Qulqula Formation and minor amount of ophiolite (exposed only during deposition of upper part), which was pushed southwestward toward early foreland basin (Shiranish and Tanjero basins). The grain size and roundness (fine grain size and rounded clasts) of the igneous pebbles showing that the outcrops of the ophiolite are located more remote distance than the chert ones.

Normal Regression

In contrast to forced regression at lower part of the formation, the upper part suffered from normal regression, which happened during the end of highstand system tract. According to Einsele (2000) [13] this type of regression also occurs during stable sea level and occurs as a result of sediment fill of the basin and not as a result of relative sea level fall. The arrangement of sediments is coarsening upward which shows no omission of any member of gradation facies succession.

In Tanjero Formation, this type of regression is occurred during deposition of the upper part in which the sediment supply exceeded the available accommodation space so that shallow bioclast and biogenic limestone, as a part of upper part, is deposited. These limestones contain abundant large forams and pepecypod bioclast. In some places, the high stand Kato mixed carbonate-siliciclastic succession is overlain by Tagaran conglomerate, which may be the deposit of shelf margin system tract (SB2).

Low subsidence and high sea level fall

All authors previously studied Tanjero Formation, agreed that it is characterized by rapidly subsiding basin. But the present study proved the opposite (in the studied area), as follows:

As previously mentioned in this study, the typical lithology of the formation is deposited above an unconformity (SB1) during sea level fall (LST). This sea level fall occurred by forced regression. This means that the sea level falls were more than subsidence. It is most probable that the eustatic sea level fall is enhanced by tectonic uplift. This tectonic uplift is associated with source area and probably part of the basin (the shelf of lower sequence). The evidence of the tectonic enhanced eustatic sea level fall is the high thickness of incised valleys sediment fills. In discussion of the foreland basin, Einsele (2000, p.8) [13] mentioned that clastic material influx from the rising mountain belt often keeps pace with or exceeds subsidence and cause basin filling. But during deposition of middle part the basin suffered from rapid clear subsidence demonstrated by deposition of Shiranish- like lithology (Pelagite and Hemipelagite facies).

Atlantic type continental margin

Atlantic and Pacific type continental margin (Dickinson 1971) [21], as two different depostional basins between continental and oceanic floor, can be used for comparing with that of Tanjero Formation. When the comparison is made in all aspects, Tanjero basin is more similar to Atlantic type continental margin than Pacific one, while the previous studies such as Jaza (1991) [22] and Numan (1977) [23] put the formation in a basin more similar to Pacific type continental margin. This is because the latter margin has subduction trench and an under-thrusting oceanic plate while Atlantic type margin has no such features. According to Hyndman (1970, p.7) [24] continental margin of the pacific type may revert to Atlantic type with dying out of under-thrusting of the oceanic plate under the continent, cessation of seismic activity, filling and uplift of the trench sediments, and welding of the continental to the oceanic plate. This was what happens to the basin where Tanjero formation is deposited. This is because the basin (or northern part (coastal area) of the basin) was most probably Pacific type during Lower Cretaceous (Qulqula and Balambo Formations) but changed to pacific type during collision of Iranian continent with Arabian one after dying out of oceanic plate and uplift of Qulqula formation, which according to Karim (2003a) [5] was forming sediments of trench before colliding.

Conclusions

1-The previously the basin of Tanjero Formation is considered as trench or miogeosyncline but in this study changed to early foreland basin.

2-In contrary to previous studies, all parts of the formation have given same degree of tectonics. Moreover, the basin of formation combined tectonically with that of underlying Shiranish Formation in a single basin, which is called initial Zagros Foreland Basin.

3-In this basin Tanjero Formation is deposited in near shore area, while Shiranish Formation is deposited in the central part of the basin.

4. Most parts of the formation is deposited by forced regression (sea level fall enhanced by tectonic uplift.

5. The whole basin was deposited in front southwest advancing of Iranian plate causing continuous migration of depocenter.

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