HISTORY AND GEOLOGICAL SETTING OF INTERMONTANE BASIN IN THE ZAGROS FOLD-THRUST BELT, KURDISTAN REGION, NE-IRAQ

KAMAL H. KARIM* , SHERZAD TOFIQ AL-BARZINJY* * AND BAKHTIAR, M. AMEEN*

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ABSTRACT

It is mentioned previously that the intermontane basins, in northeastern Iraq, are developed in the Early Paleocene. In present study, the timing, geographic location and geological setting of these intermontane basins are studied from Iraqi Zagros Fold-Thrust Belt during Tertiary. The study achieved in view of literature and recent sedimentological studies. The terrigenous clastic cutoff and facies comparison with their distribution is used as evidence for spatial and temporal development of intermontane basin. The study concluded that the first intermontane basin is developed during the Middle Eocene.

It is observed that the present position of Thrust and Imbricated Zones of Iraq was area of subsidence and generation of the intermontane basin during Middle Eocene. Concurrently with this subsidence and directly to the southwest of the latter zone a narrow paleohigh is developed which separated subsidence from the main basin. The present position of the paleohigh coincides with of the boundary High and Imbricated Zones. In these intermountain basin the flysch facies (sandstone and shale of Walash Nauperdan Group) are deposited at the beginning while later molasses facies (conglomerate of upper part of the Red Bed Series) are dominated. Concurrently, in the area of present Low Folded and Mesopotamian Zones (main water body of the main foreland basin) thick succession of pure carbonate (Pila Spi Formation) was deposited signalize the total cutoff of clastic sediments from the latter zones In contrary, during the Early Paleocene till Middle Eocene clastic (conglomerate and sandstone) influx was continued from source area into Early Zagros foreland basin and mixed (occasionally) with carbonate of Sinjar Formation in many places. During these latter ages, intermontane basin is not generated as cited in previous studies to trap transferred sediments from source area except some basin irregularities on which reefal limestones of Sinjar Formation are deposited. The separation of Early Zagros Foreland basin into two smaller basins (Main foreland basin and intermontane basin) decreased the current circulation and wave activity therefore lagoonal dolomitic limestone of Pila Spi Formation was deposited.

التأريخ و الوضع الجيولوجي للاحواض بين الجبلية في نطاق زاجروس المطوي –الزاحف في اقليم الكردستان ، شمال شرق العراق

كمال حاجي كريم، شيرزاد توفيق البرزنجي، بختيار محمد امين

الملخص

ذكر في السابق ان التطور الجيولوجي للاحواض بين الجبلية في شمال العراق بدأت في الباليوسين المبكر ولكن في الدراسة الحالية درس التوقيت و الموقع الجغرافي و الوضع الجيولوجي للاحواض بين الجبلية في نطاق زاجروس المطوي –الزاحف في العراق. اجريت الدراسة في ضوء الدراسات السابقة و التطور الحديث في علم

*Assistant professor, University of Sulaimani, Kurdistan Region, Iraq,
**Lecturer, University of Sulaimani, Kurdistan Region, Iraq

الرسوبيات حيث استخدمت توقف تدفق الرسوبيات القارية و توزيعها و مقارنة السحنات و كدليل للتطور الزمني و الجيوغرافي للاحواض بين الجبلية , حيث وأستنتجت على ان هذه الاحواض بدأت بالتكون في الايوسين الاوسط . لوحظ على ان الوقع الحالي لنطاقي الزحف و التراكب كان موقع هبوط و تكون الاحواض بين الجبلية في الايوسين الاوسط. مع هذا الهبوط و مباشرة الى جنوب غربي من النطاق الاخير تكون الرتفع حيث ادى الى فصل موقع الهبوط من الحوض الرئيسي وتكون الاحواض بين الجبلية. موقع الحالي للمرتفع يتطابق مع حدود بين النطاق الطيات العالية و التراكب. في البداية ترسبت في الحوض سحنات الفليش التابعة لسلسلة والاش ناوبردان(المتكون من الحجرالرملي , الصخور النارية و الطفل) و بعد ذالك ترسبت سحنات المولاس(المتمثلة بمدملكات الجزء العلوي لسلسلة الطبقات الحمراء). في نفس الوقت ترسبت سمك كبير من التتابعات الرسوبيات الكاربوناتية (تكوين بلاسبي) في النطاق الطيات الواطئة حيث يعكس انقطاع تام للرسوبيات الفتاتية عن هذا النطاق .

على العكس من هذا استمر تدفق الرسوبيات القارية الى الحوض البدائي (حوض قدمة القارة تابع لنطاق لزاجروس) من صخور المصدر اثناء فترة الباليوسين المبكر الى الايوسين الاوسط و امتزاجها، في بعض الاحيان، مع اللرسوبيات الكاربوناتبة لتكوين سنجار في انطقة كثيرة. في هذه الاعمار لم يتكون الاحواض بين الجبلية لكي تحجز الرسوبيات المنقولة من صخور المصدر كما ذكر سابقا ما عدا وجوود بعض عدم الانتظام (الارتفاعات) داخل الحوض الترسيبي حيث ترسبت عليها تكوين سنجار . ان تجزئة الحوض الرئيسي (الحوض المقدمة القارة البدائي) الى الحوضين الثانوين (الحوض الرئيسي لمقدمة القارة و الاحواض بين الجبلية) ادت الى تقليل حركة دوران التيارات و فعالية الامواج و من ثم ادى هذا الى ترسب الحجرالكلسي الدولوميتي التابع لتكوبن بلاسبي .

INTRODUCTION

The studied area is located in the Kurdistan Region, Northeast Iraq near the with Irani−Iranian border (Fig.1). This area forms the three main (present days) tectonic zones of Iraq (High, Imbricated and Thrust Zones) of Buday and Jassim (1987) (Fig.2).The area is part of the Western Zagros Fold-thrust Belt, which is developed from colliding of Arabian and Iranian Plates and sedimentary fills of Neotethys basin (Alavi, 2004). The aim of this study is to record a new historical development and geological setting of intermontane basin in the Iraqi part of the Zagros Fold-thrust Belt. The study achieved in the through re-interpretation of the sedimentologic (sedimentary facies) and stratigraphic works of Bellen, *et al* (1959), Buday, (1980) and Al-Barzinjy, (2005) about the area during Tertiary.

Intermontane basins are commonly elongate, narrow and evolved during late orogenesis and are associated within volcanism (Einsele, 2000). Small superficial, extensional intermontane basin exists in the present Andes Mountain is due to warping during subduction (Mail, 1990). Clevis *et al* (2004) has mentioned basins on the thrust- sheets under the name of "top thrust-sheet basin" , which are formed due to detachment faults. They assumed them as common features in foreland basin. Allen and Allen (1990) referred to generation of intermontane basins on the megasuture blow thrust sheets. These basins resemble the intermontane basin of Iraq where the oldest intermontane basins are those mentioned by Buday and Jassim (1987) in which molasses are deposited during Paleogene and located in the Tanjero-Balambo Zone. However, , maps are published maps by Buday (1980); Jassim and Goff (2006) (Fig.3) showed that these basins have started from Paleocene and continued till Middle Miocene and located in the present position of Thrust and Imbricates Zones.

Al-Hashmi and Amer (1985) separated Red Bed Series from Khurmal Formation (time equivalent of Sinjar Formation) by positive land (Fig. 4A, B, C). Surdashy (1989) has also separated the Red Bed Series as intermontane basin from the basin of Kolosh Formation during Paleocene and Eocene (Fig.4D). In the Tectonic Scenario of Iraq, Numan (1997) separated the Red Bed Series from the main basin of Iraq during Paleocene. He indicated the Red Bed Series in a basin between Kata Rash and Walash volcanic arcs, which resembles more or less the intermontane basin, since it is separated by positive land (Fig.5A). Lawa (2004) mentioned and showed (by sketch) that piggyback (intermontane basin) started in the early Paleocene which was filled with molasse deposit (Fig.5 B, C). According to the above studies, at the Early Paleocene,

the narrow strip of Halabja, Said Sadiq, Sulaimanyia City, Ranyia and Rawandoz waslocation of a paleohigh (positive land), which separated the area that are located to the north and south of these towns. The southern and northern areas are called (previously) Mio and Eu-geosynclines, respectively, while in the present study they are called Main and Sub-Foreland Basins. The Main Foreland Basin occupies (as assumed in this study) the Low and High Folded Zones while the Sub-Foreland Basin occupies a southern part of the Thrust Zone and whole Imbricated Zones. But, during Campanian till Middle Eocene one large basin existed, which is called Early (proto) Zagros Foreland Basin (Fig. 6C and 7C).

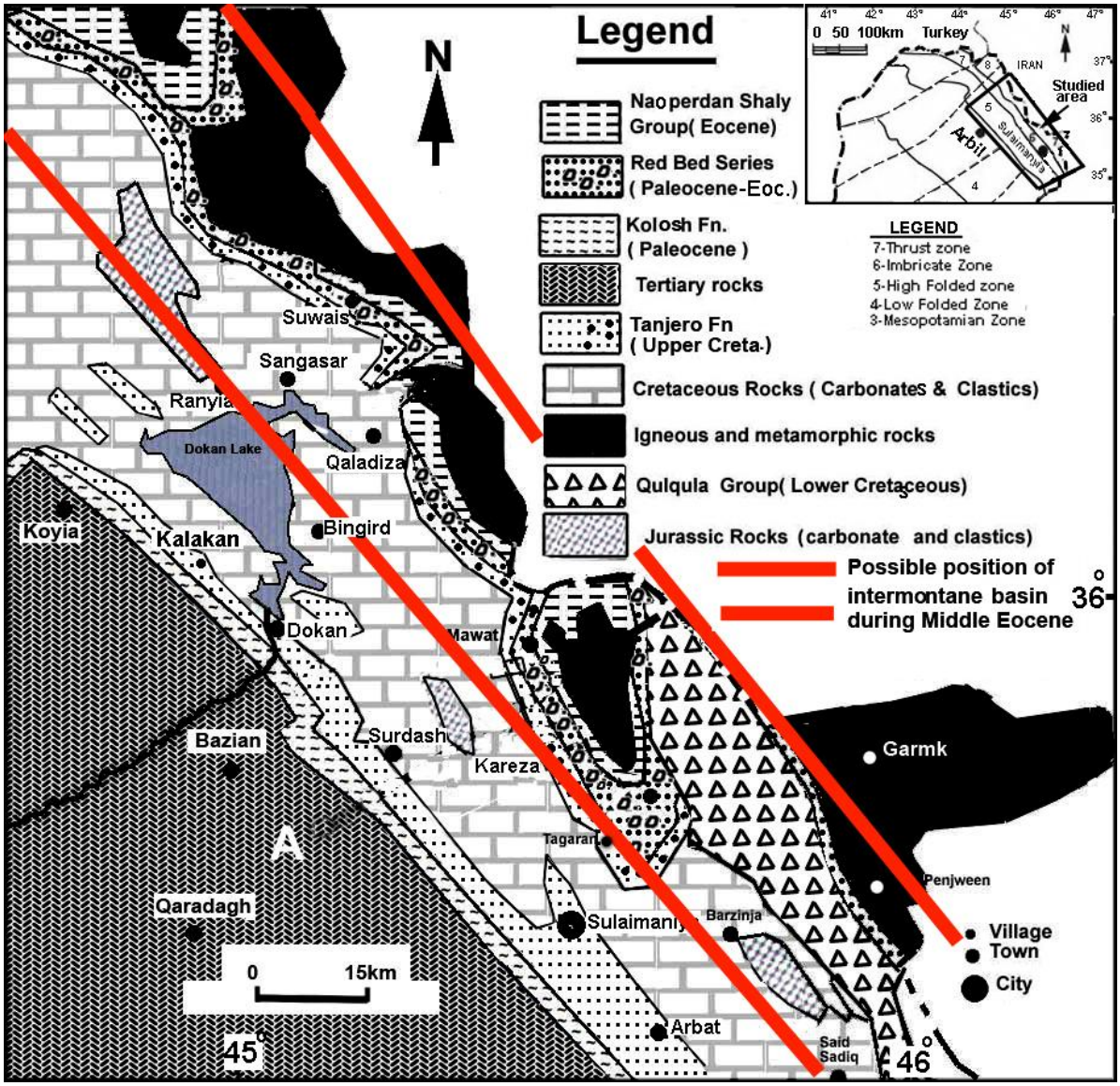

Fig.1: Simplified geological map of the studied area (modified from Sissakian, 2000) showing location of intermontane basin during Middle Eocene.

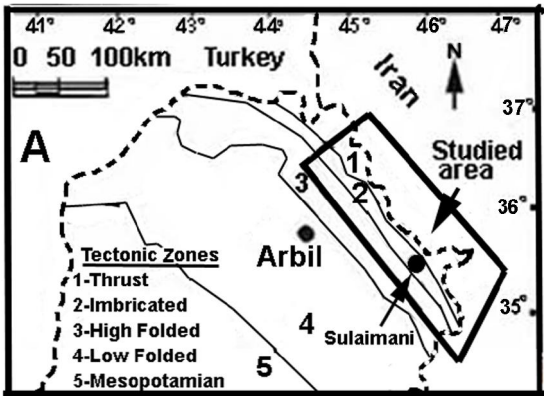

Fig. (2) A: Location map of the studied area.

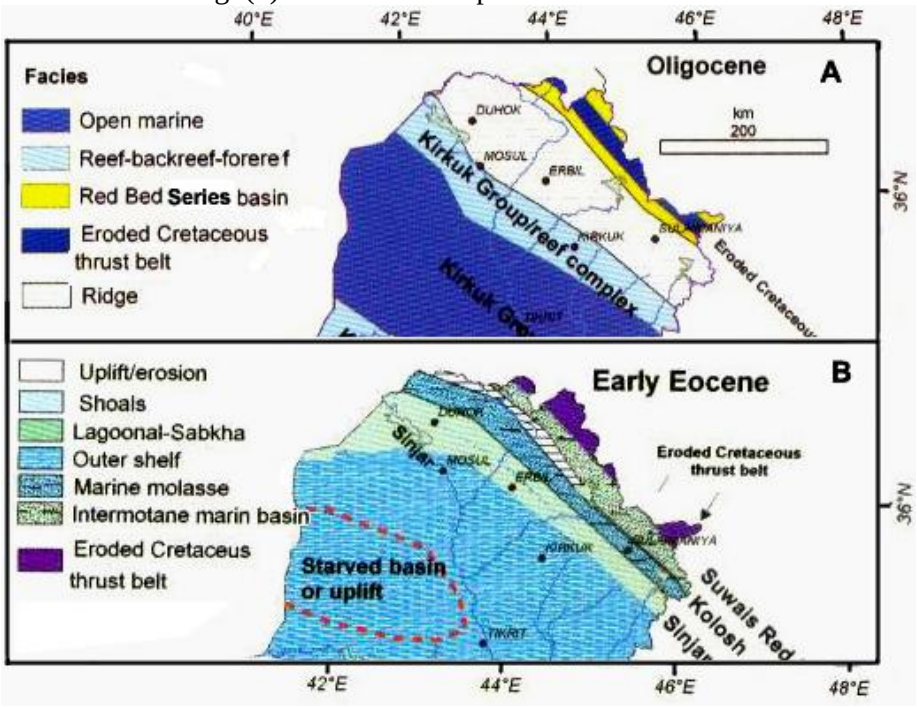

Fig.(3) A and B: Early Eocene and Oligocene paleogeography of the Iraq, showing intermontane basin in the northeastern Iraq (after Jassim and Goff, 2006).

GEOLOGICAL SETTING

The recent sedimentological and stratigraphical studies amended the geology of the studied area through simplifications of the tectonics. Due to this geographic position and history of the development of the intermontane basins can be realized with the type of separation from main water body. Among the studies that are indirectly related to this idea are the study of Karim and Surdashy (2005a and 2005b) which changed the tectonic setting of Tanjero Formation from subduction trench to early Zagros Foreland basin during Maastrichtian. They combined both Mio and Eogeosyncline in one single basin. Another study is that of Al-Barzinjy (2005), which concerned mainly with relation between Red Bed Series and Kolosh Formation. He concluded that both them (Red Bed Series and Kolosh Formation) are deposited in a single basin and there was no any paleohigh between the two units during Paleocene and Early Eocene. According to the Al-Barzinjy (2005), the Red Bed Series was deposited in the present position of the Imbricated Zone as coastal facies, while at the same time; Kolosh Formation is deposited in the basin plain, in the location of the present day High Folded Zone.

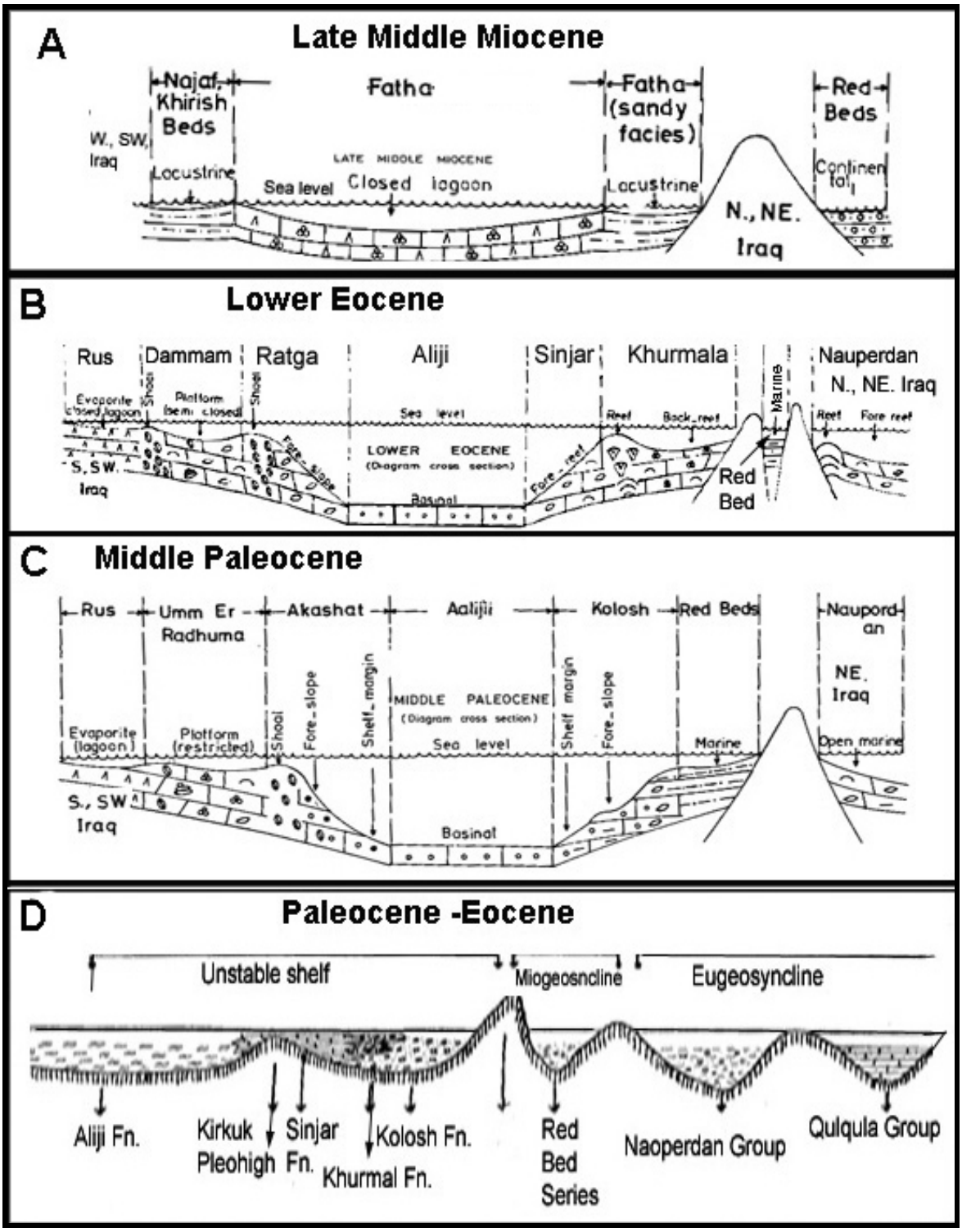

Fig.4: Different ideas about timing, tectonic setting and geographic location of the intermontane basin by different authors.

A, B and C: By Al-Hashmi and Amer (1985). D: By Surdashy (1989**).**

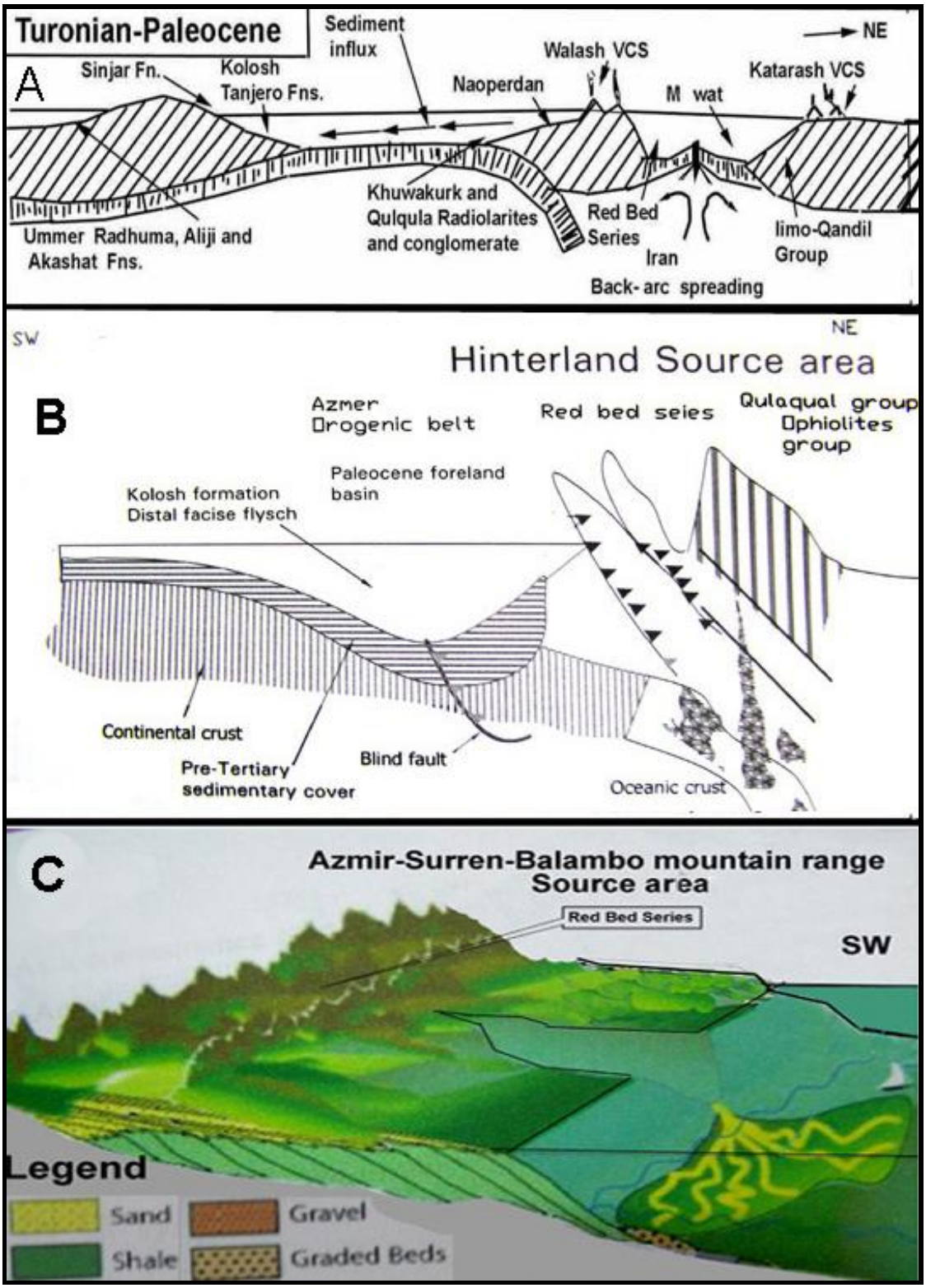

Fig.5: A): Tectonic position of Red Bed Series between Kata Rash and Walash Volcanics, by Numam (1997). (B, C) Model and cross section of Early and Middle Paleocene paleogeography and tectonic setting of piggy back (intermontane) basin (Lawa, 2004).

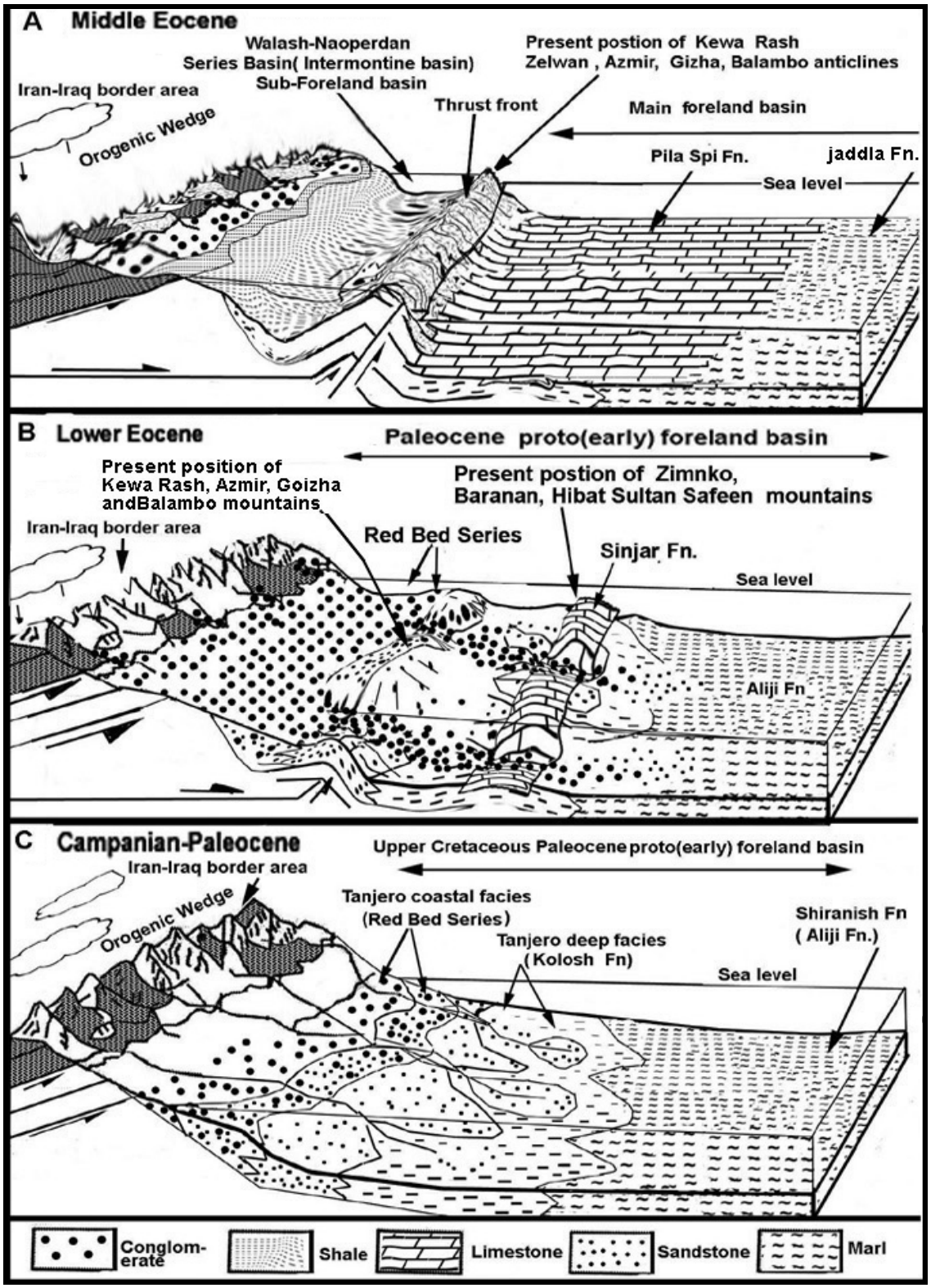

Fig.6: The conclusions of present study as shown by conceptual models of paleogeography and tectonic evolution of the intermontane basin in Iraq.
A: Middle Eocene, B: Lower Eocene, C: Upper Cretaceous and Paleocene**.**

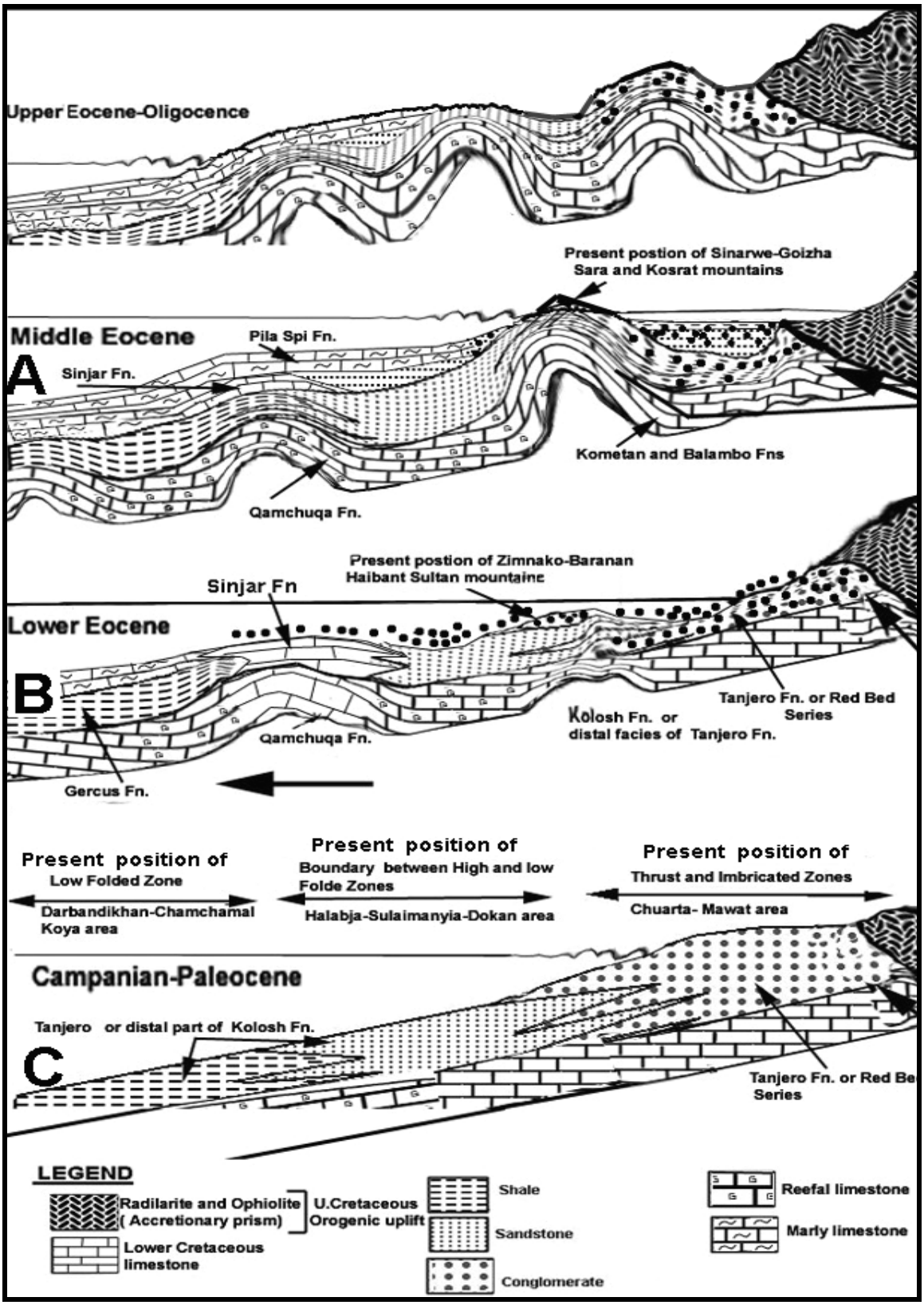

Fig.7: Cross sections of the same ages and models that are shown in the fig. (6) showing generation of intermontine basin during Middle Eocene as inferred from present work.

FIRST APPEARANCE OF INTERMONTANE BASIN

The first appearance time of the intermontane basin could be known only through a sedimentological study of a studied area. This includes the study of the types, calibers and distribution of the terrigenous sediments in both Imbricated and High Folded Zones. During the study of these sediments the hydrodynamic and lithology (mineralogy) are taken into consideration. The first and the prominent terrigenous sediments cutoff occurred during Middle Eocene. This cutoff is demonstrated by extensive deposition of nearly pure lagoonal carbonates of Pila Spi Formation. This deposition was relatively sudden and covered most part of the northern Iraq especially the High and Low Folded Zones (Main Foreland Basin). These carbonates lack clastic interbeds, which indicate the separation of the Sub-Foreland (Intermontane) Basin from the main foreland basin by a narrow paleohigh (Fig.6A and 7A). The present position of the paleohigh nearly coincides with of the boundary High and Imbricated Zones. The cutoff of the clastic sediments and deposition of carbonates is well documented by Dunnington (1958) by isopach facies map (Fig.8). On the map, he assumed the Imbricated and Thrust Zones as source area and showed that the carbonate deposition is located to the south of boundary between High Fold and Imbricated Zones.

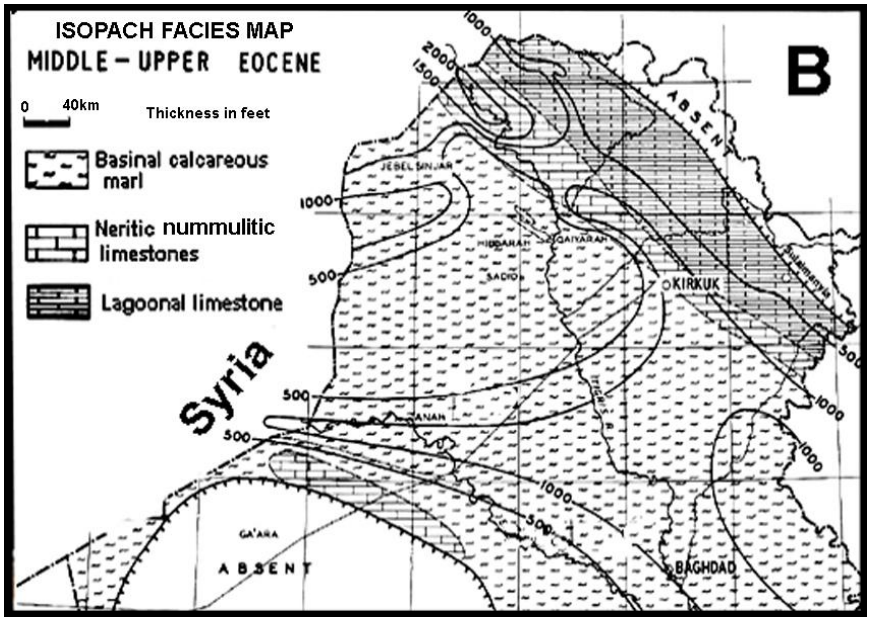

Fig.8:Isopach facies map of Middle–Upper Eocene showing extensive carbonate deposition (After Dunnington, 1958).

INTERPRETATION OF CLASTIC SEDIMENTS CUTOFF

The clastic cutoff and deposition of carbonates are clear evidences for separation of the source area (present days Iraqi Thrust Zone and Sanandij-Serjan Zone of Iran) from the main body of the water that was covering the rest of Iraqi territory. The deposition carbonates (Pila Spi Formation) started during Middle Eocene (Bellen, *et al.* 1958; Buday, 1980) therefore, at this time a paleohigh was developed that was led to the total cutoff the clastics and an intermontane basin was formed to the north of the paleohigh and concurrently the area that now covered by Imbricated and Thrust Zones are subsided (Fig.6A and 7A). But the paleoghigh was too narrow to supply sufficient clastics to main foreland basin to be detected. Instead of transportation of sediments to the south and southwest, the clastics were trapped in the post Middle Eocene intermontane basins (areas of the subsidence) and deposited as Walash Naoperdan Group.

The generation of these basin associated with retreat of the source area, northeastwards to a position which may coincide with the present position of Sanandij-Sirjan Zone, inside Iran. The paleohigh was too small and tight to perform as new source areas. Other consequences of the separation of the Early Zagros Foreland Basin into Main Foreland Basin and intermontane basin was restriction of current circulation and wave activities in addition to cease of fresh water influx. Due to this, semi-restricted lagoonal sediments (dolomite and limestone) are deposited which were isolated from sediments and fresh water influx from northeastern source areas. The most important characteristics of the generated intermontane basin is the fineness of the clastic sediments as compared to the that deposited in the coastal area of the early (proto) Foreland Basin before separation. Karim and Surdashy (2005a and b), Al-Barzinjy (2005) concluded that during Upper Cretaceous and till Middle Miocene the area of the sub-Foreland basin (previous Eugeosyncline) was deposition locus of the thick pile of conglomerates and sandstone (Tanjero Formation and unit one and two of the Red Bed Series). This position was coastal area for the Early Foreland basin during Late Cretaceous and till the Middle Eocene.

In contrary to the Main Foreland Basin, in the intermontane (Sub-Foreland) Basin, the conglomerates are missing and fine clastics are deposited. These fine clastics coincide with the principle of sedimentation and with the deposition of carbonates (Pila Spi Formation) in the main water body. The fineness of clastic are attributed to three reasons, the first is retreating of source area into Iranian land, due to subsidence of the previous coastal area. The second is generation of a barrier (the paleohigh) in front of the paleocurrent direction, which led to a decrease of dynamic energy of the transportation and sedimentation. The third is that the intermontane basin is formed in the frontal part of the foreland fold-thrust belt, which decreased the accommodated space for submarine turbidity currents. The fine clastics are represented by Walash Naoperdan Group (flysch facies), which consist mainly of shale, sandstone limestone and igneous rocks (Fig. 6A and 7A) that deposited at early stage and later, changed to molasse facies (upper part of the Red Bed Series) when the basin filled with sediment. During the deposition of flysch facies, it is possible that the biogenenic carbonates (Naoperdan Limestone) were deposited in the shallow areas where there are no turbidite.

POSSIBLE PALEOCENE INTERMONTANE BASIN

During Late Paleocene Sinjar and Khurmala Formations, were deposited at the boundary between High and Low Folded Zones, inside main foreland basin (inside previously so called miogeosyncline).These formations consist of reefal facies. They have limited distribution as compared to Pila Spi Formation which, occurs as, northwest-southeast strip about 15km wide along the above mentioned boundary. The Sinjar Formation is supposed to be deposited in submerged high as reefal facies by (Al-Hasmi and Amer, 1985 and Surdashy, 1989) (Fig.4B and D). About this paleohigh and possibility of Paleocene intermontane basin, it deserves to clarify two points in this study. The first is that the Sinjar Formation was deposited at the top of Kolosh Formation which consists of flysch facies (basinal sandstone and calcareous shale). The top of this unit represents the shallowing episode due to filling and tectonic uplift, during which Sinjar Formation was deposited. While in Sub-Foreland (Intermontane) Basin the clastics (sandstone) of the Red Bed Series (part one and two) were deposited, in Chuarta, Mawat, and Qandil areas (Al-Barzinjy, 2005).

The second is that unlike to Pila Spi Formation, Sinjar and Khurmala Formations, in most places, contains coarse clastic interbeds. At Sartak Bamo valley, Baranan Mountain (Fig.8 A and B), Barda Asin (east of Zarain town) and Sagram anticlines and Darbandikhan dam site (Fig.10), Sinjar Formation contains terrigenous conglomerates. According to Al-Banna, *et al* (2007), at Dohuk area the equivalent of Sinjar Formation (Khurmala Formation) contains conglomerates, sandstones, shales and marls (Fig.11). These authors showed that the limestones beds are sandy

also. This means that the Sinjar and Khurmala Formation were not separated by positive paleohigh from the source area and the intermontane basin was not formed yet. The Sinjar Formation is possibly separated partially and intermittently, in some places, by irregularities (submerged high) that prevented high influx of clastics and turbidity current to the basin of Sinjar Formation (Main Foreland Basin). In these places, Sinjar Formation is composed of pure limestone and without conglomerate interbeds. These areas such as Glazarda and Bazian, where there are more or less occurrences of pure reefal limestone of the formation (Fig.6B). Therefore, the map and tectonic setting of the Middle Eocene is shown in the figure (12), which indicates position of the paleohigh and location of the deposition of Pila Spi Formation and Walash - Naopewrdan Group.

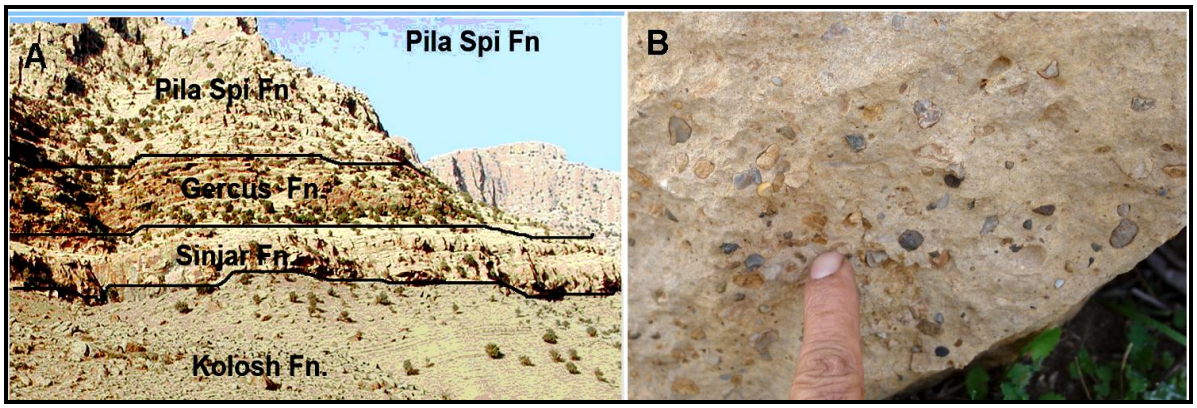

Fig. 9: A) Sections of western side of Sartaq Bamo valley (east of Darbandikhan dam) showing main exposed units, the pure carbonate of Pila Spi Formation(200m thick) can seen at top of a section is 450m thick. In many places Sinjar Formation contain conglomerate and terrigenous clasts.
B) The photo shows pebbly limestone of Sinjar Formation at Baranan (Glazarda Homocline) mountain south of Sulaimanyia city.

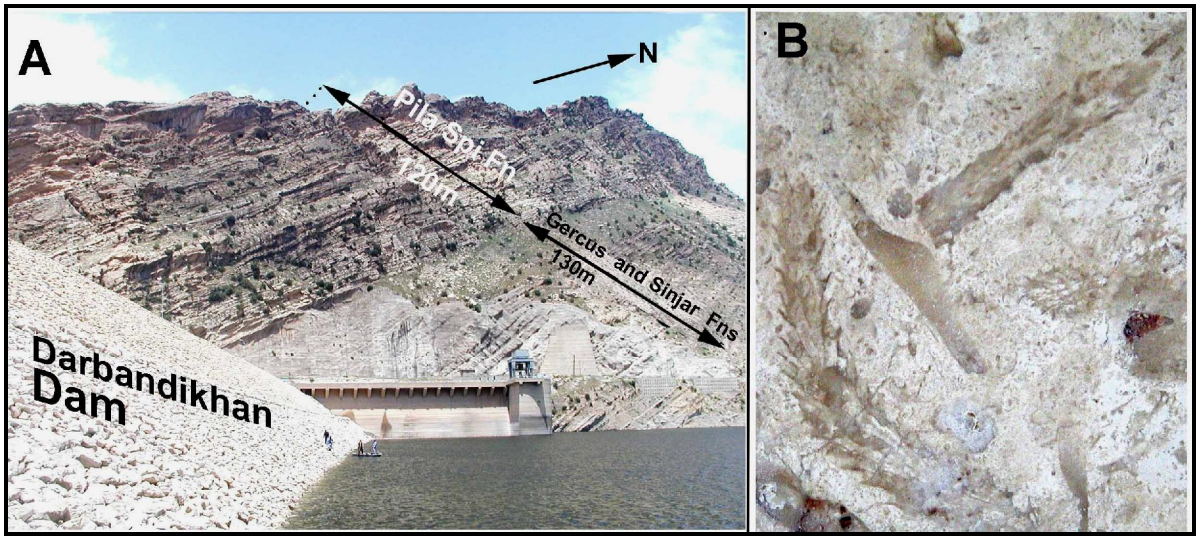

Fig. 10: A) Outcrop section of Pila Spi, Gercus and Sinjar formations in the main Foreland Basin (previous Miogeosyncline). Sinjar Formation contains interbed of conglomerate and sandstone,, while Pila Spi Formation is exclusively limestone.
B) Polished slab (4cm wide) of the latter formation contains algae.

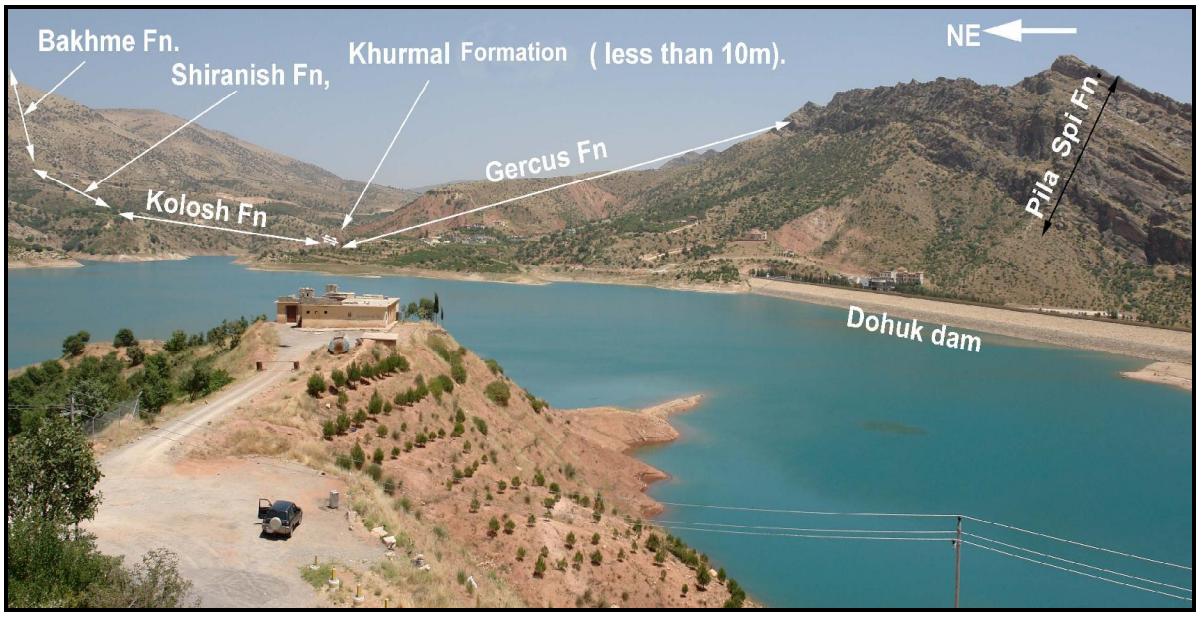

Fig.11: Eastern part of Dohuk dam valley showing thick outcrop of Pila Spi Formation and clastics of pre –Middle Eocene. The Khurmala Formation is less than 10m thick. The clastic influx cutoff is very clear with deposition onset of Pila Spi Formation.

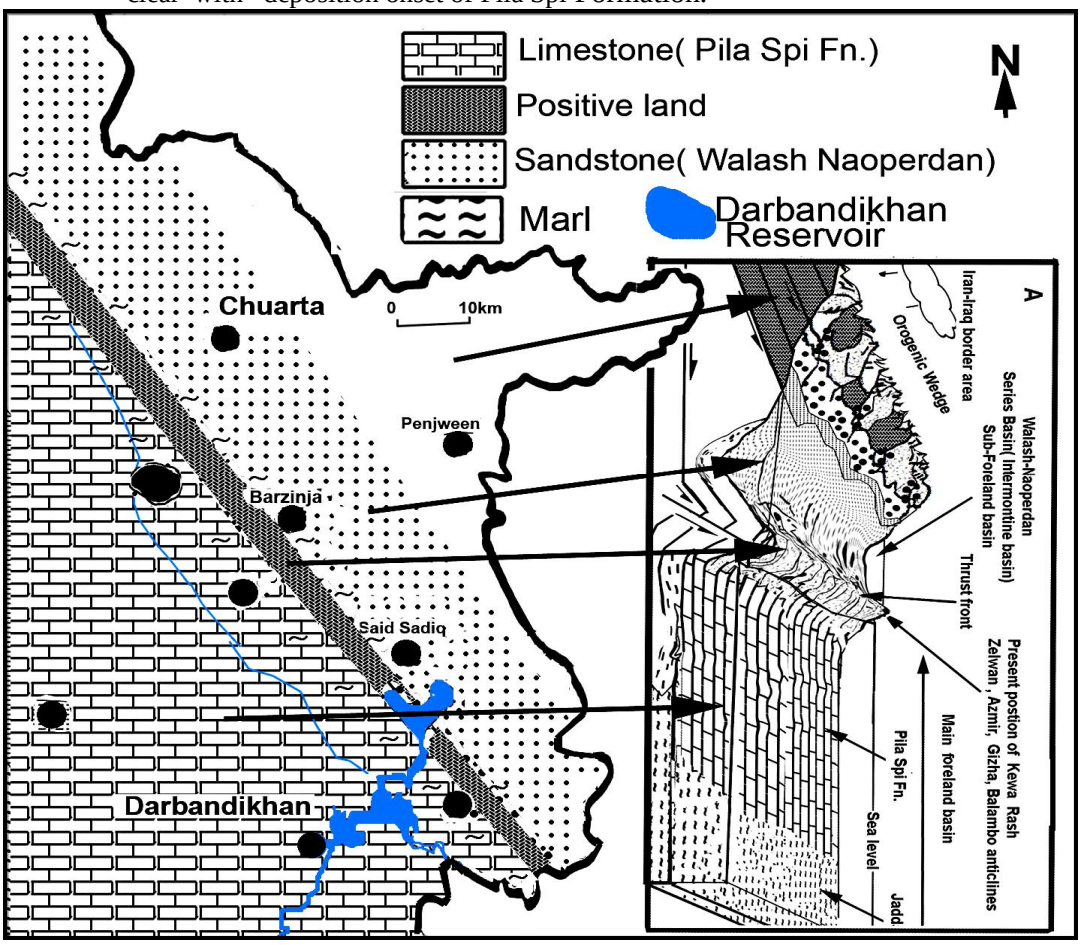

Fig.12: Lithofacies map during Middle Eocene and geologic block diagram of the same age showing intermontane basin as inferred from the present work.

CONCLUSION

- The previous Early Paleocene as starting point fore evolving of the intermontane basins is changed to Middle Eocene.
- The Pila Spi Formation and Walash Naoperdan group are connected with this development as sediments of the main basin and intermontane basin respectively.
- The reason for this new age is total terrigenous clastic cutoff influx from source areas to the previous clastic dominated basin.
- The study solved the problem of great uncertainty that associated with history and tectonic of Walash-Naoperdan Group.

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