LTHOLOGICAL INDICATORS FOR THE OLIGOCENE UNCONFORMITY, NE IRAQ

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ABSTRACT

The Oligocene gap is considered as one of the major and widespread unconformities and interruption in the sedimentary record in the north and northeast Iraq. In the High Folded and Foothills Zones, the gap extends from Oligocene to the Middle Miocene; in the former zone, it separates Pila Spi Formation from Fat'ha Formation; whereas in the latter it separates Anah and Fat'ha formations. The Anah Formation is of Late Oligocene age and is marked by a conglomerate at the base of Fat'ha Formation. The unconformity is studied lithologically and stratigraphically in six different sections, in these sections the conglomerate has different compositions and textures. Texturally, it is grouped into ortho and polymictic conglomerates, while according to the composition they include conglomeratic limestone, sedimentary breccia and both well and badly developed paleosol. These lithologies indicate different depositional systems and source areas; possibly deposited in different times. From sequence stratigraphic point of view; the studied unconformity indicates a type of one-sequence boundary (SBI) during the sea level fall.

الدلائل الصخارية لعدم توافق الأوليجوسين في مناطق من شمال شرق العراق

بختيار محمد أمين

المستخلص

تعتبر فجوة الأوليجوسين إحدى الفجوات الرئيسية واسعة الإمتداد في مناطق شمال وشمال شرق العراق، متمثلة بفترة عدم ترسيب وانقطاع في العمود الرسوبي. إن امتدادات هذه الفجوة في نطاق الطيات العالية تمتد إلى ما قبل المايوسين الأوسط فاصلاً تكويني بيلاسبى والفتحة. أما في نطاق أقدام الجبال، فإن الفجوة تفصل بين تكويني عنة ذات عمر الأوليكوسين المتأخر والفتحة وتوجد طبقة من المدملكات في أسفل تكوين الفتحة. تم دراسة الصخارية والطباقية لسطح عدم التوافق في ستة مقاطع مختلفة، حيث ظهر أن المدملكات في المقاطع الستة لها تراكيب وأنسجة مختلفة والتي تتكون نسيجيا من Ortho and Polymictic Conglomerate، بينما من ناحية المكونات تتكون من المدملكات ذات الحبيبات الجيرية والبريشيا الرسوبية والتربة القديمة ذات المنشأ الجيد والرديء، والتي تؤكد وجود عدة أنظمة ترسيبية كانت تستلم رسوبياتها من مصادر مختلفة مع احتمالية ترسيبها في أوقات مختلفة. كما أكدت الدراسة أيضاً إن سطح عدم التوافق هذا يمثل النوع الأول من أنواع الحدود الطباقية التتابعية التي تكونت أثناء انخفاض مستوى سطح البحر.

INTRODUCTION

According to Bellen *et al*. (1959) and Buday (1980), the contact between Pila Spi and Fat'ha formations is represented by a Basal Fars Conglomerate, southwest of the High Folded Zone. Bellen *et al*. (1959) called it as Basal Fars Conglomerate. This conglomerate now covers the top of Pila Spi Formation in many places, except where it is removed by erosion. These places are such as Takia (Qishlakh anticline), Derbandikhan, southern side of Zimnako Mountain and southwestern side of Haibat Sultan Mountain. The area of distribution of the Pila Spi Formation is a narrow strip, which is located in the contact between High Folded Zone and Foothill Zone (Fig.1).

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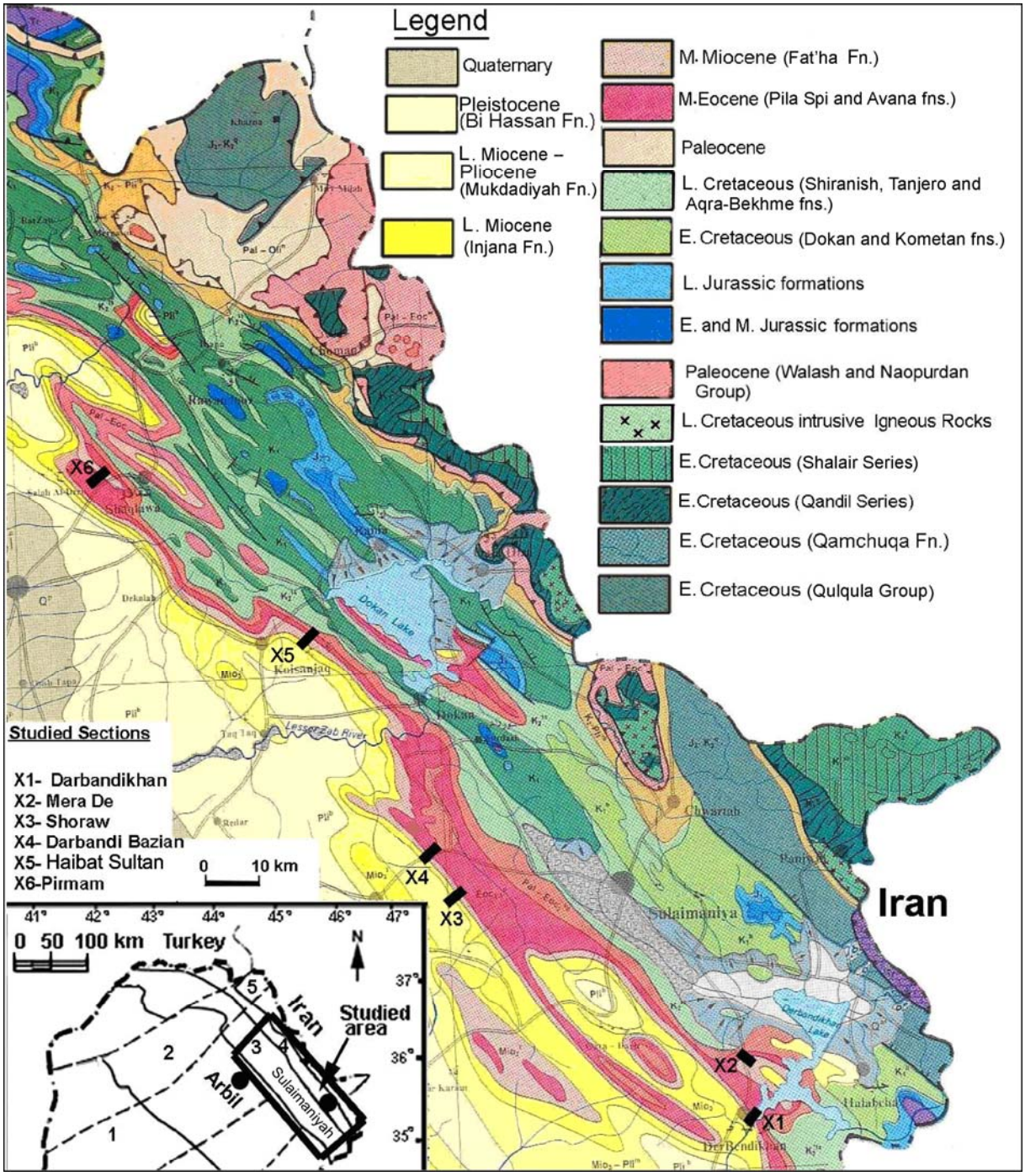

Fig.1: Geological map of the studied area (after Sissakian, 2000) showing location of the studied sections

Tectonically, the outcrops, when manifested on the tectonic map of Iraq, are located between Cham Chemal – Erbil and Sulaimaniyah – Zakho Subzones (Al-Kadhimi *et al*., 1996). This area was uplifted and suffered from subaerial weathering and erosion during Oligocene (Dunnington, 1958 and Buday, 1980) (Fig.2). Pila Spi Formation, which underlies the conglomerate, is composed generally of well-bedded, white or gray dolomitic limestone; occasionally changes to chalky limestone, at the upper part. It represents typical lagoonal limestone of Eocene age (Buday, 1980). The total thickness of the formation in the studied area ranges between (6 – 200) m. In some areas, such as Sartak Bamo the conglomerate is underlain by beds of milky white and fossiliferous limestone with alveolina forams. These beds belong to Avanah Formation (Karim, 1997). The overlying formation is Fat'ha, which consists of alternation of red claystone, green marl, limestone and gypsum, with rare sandstone beds, in the uppermost part.

In some areas, such as southwestern limb of Hanjera and Qshlaq anticlines, there is a bed of fossiliferous white to grey limestone of (2 – 4) m thick, between the conglomerate and Fat'ha Formation. To the south of the studied area, Baba Shekh (2001) found a limestone bed (2 – 4 m thick) at the lower limb of Ashdakh anticline (Awa Spi area), in southwest of Sangaw town, which contains miliolid forams. According to him, this bed is located between two conglomerates. He indicated the age of the bed as Oligocene.

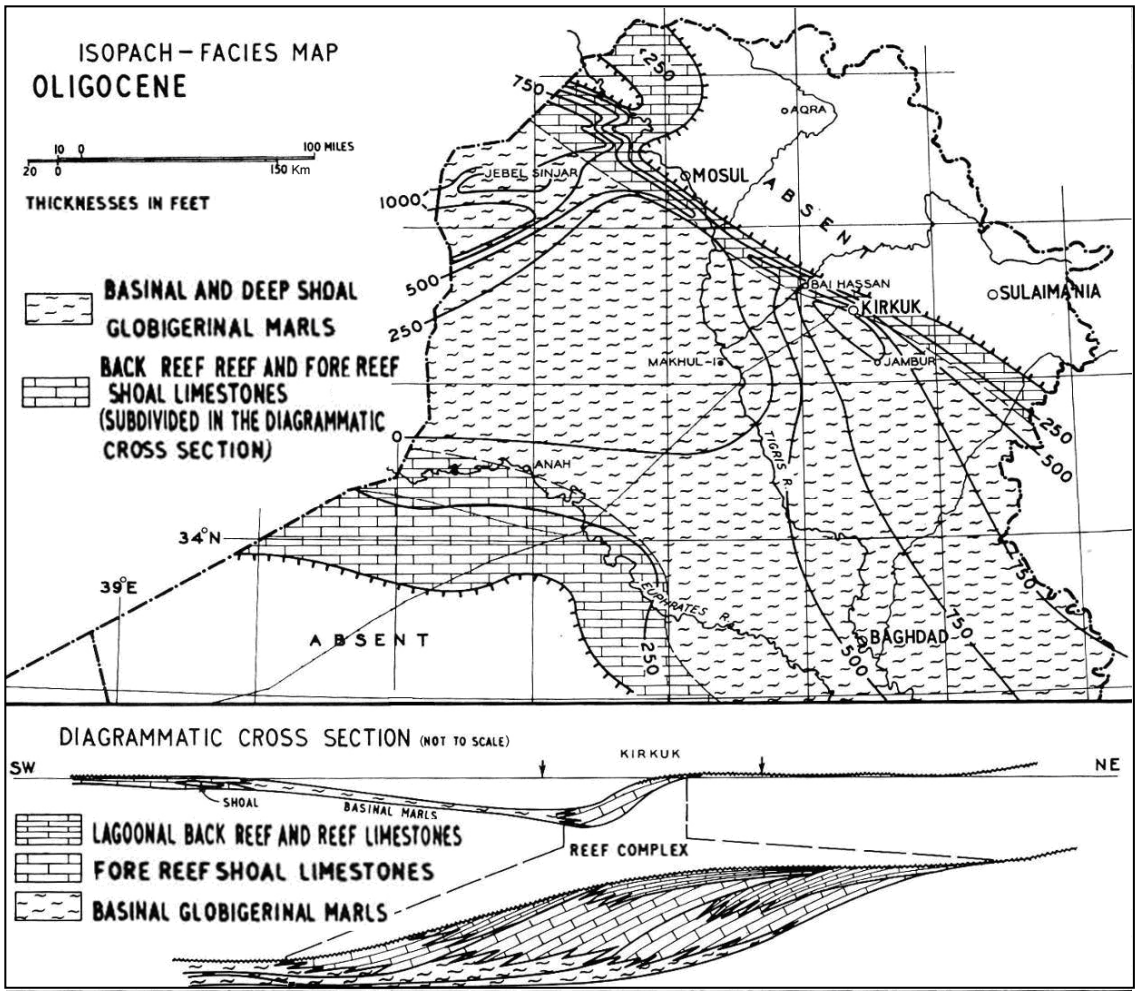

Fig. 2: Isopach facies map and related geologic cross section of Oligocene, showing area of non-deposition (after Dunnington, 1958)

LITHOLOGICAL REPRESENTATION OF THE UNCONFORMITY

The Oligocene unconformity is of parallel type (paraconformity) and it is represented by three types of conglomerates, in the studied area. The first type is pebbly and gravelly red claystone, which is assigned in this study as paleosol, the second and third types are orthoconglomerate and sedimentary breecias, respectively:

▪ Paleosol

The paleosol is exposed at least in three places, which appears as several lithified and compacted light brown beds, which have darker color (light brown) than the overlying Fat'ha Formation. The reason for remaining of the paleosol during the Middle Miocene transgression is that the environment of Fat'ha Formation was relatively quiet; therefore it was not eroded by transgressive shorelines. The three studied paleosol sections are:

1- Mera De Section

This section is located in the northeastern limb of Darbandikhan anticline, which is locally called Birky anticline, about 1 Km southwest of Mera De village and 10 Km north of Darbandikhan town (X2 in Fig.1). At this location the lower part of Fat'ha Formation and the complete section of Pila Spi Formation are exposed along a recently excavated road cut. All layers of the northeastern limb are nearly vertically dipping (85°); in between the two formations the section of paleosol can be seen clearly, which has darker color than the overlying Fat'ha Formation and consists of the following three horizons (Fig.3):

 Upper Horizon: It is about 30 cm thick and consists of boulder and gravel-sized clasts of limestone, which are floating in red matrix of lithified clay (red claystone), directly located at the base of the Fat'ha Formation (Fig.4). The matrix (red claystone) and clasts are considered, in this study, as badly developed (during Oligocene) lateritic soil due to subaerial exposure of the studied area (Fig.2). It includes only angular and sub-rounded rock fragments of Pila Spi Formation, which are transported from nearby outcrops and rested within the soil surface, during Oligocene.

– **Middle Horizon:** This horizon is nearly similar to the upper horizon, but contains smaller and less rock fragments (Fig.4). It has thickness of about 1m. The smaller particles of this section are subjected to leaching during long time in moist soil on gentle slopes during Oligocene.

Generally, the upper and middle horizons represent badly developed soil profile on the gently sloping limestone terrain during Oligocene.

– **Lower Horizon:** This horizon is developed on the uppermost part of the Pila Spi Formation, which is partially weathered. It begins, at the top of the horizon, as mixture of calcareous red claystone and weathered limestone, which slightly resembles calcret. Directly below the base of the horizon it changes to nearly fresh limestone of the Pila Spi Formation.

2- Pirmam Section

This section is located at the lower part of the southwestern limb of Pirmam anticline on the left side of the paved road connecting Erbil city to Salahaddin town, about 500 m to the west of the water pumping station, at the convex side of the first turn of the road (X6 in Fig.1). At this locality, the new eroded small valley bottom shows paleosol profile (about 30 cm thick), which is located between the Pila Spi and Fat'ha formations. This section is nearly similar to that of the Mera De, but with less thickness and finer grains. The following three horizons are identified:

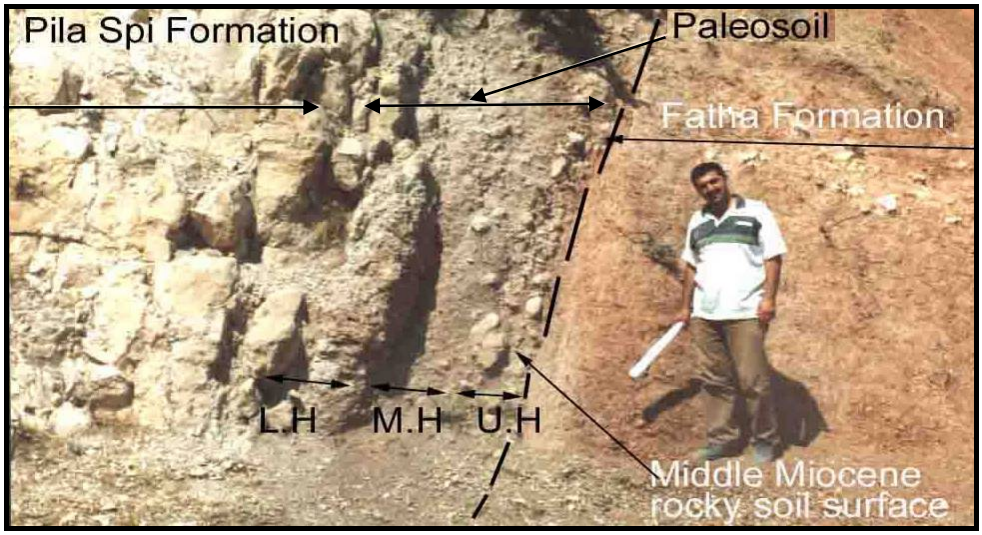

Fig.3: The contact between Fat'ha and Pila Spi formations, south of Mira De village. The strata are overtrned and the paleosol is developed between the two formations. L.H, M.H and U.H are indicating upper, middle and lower horizons, respectively

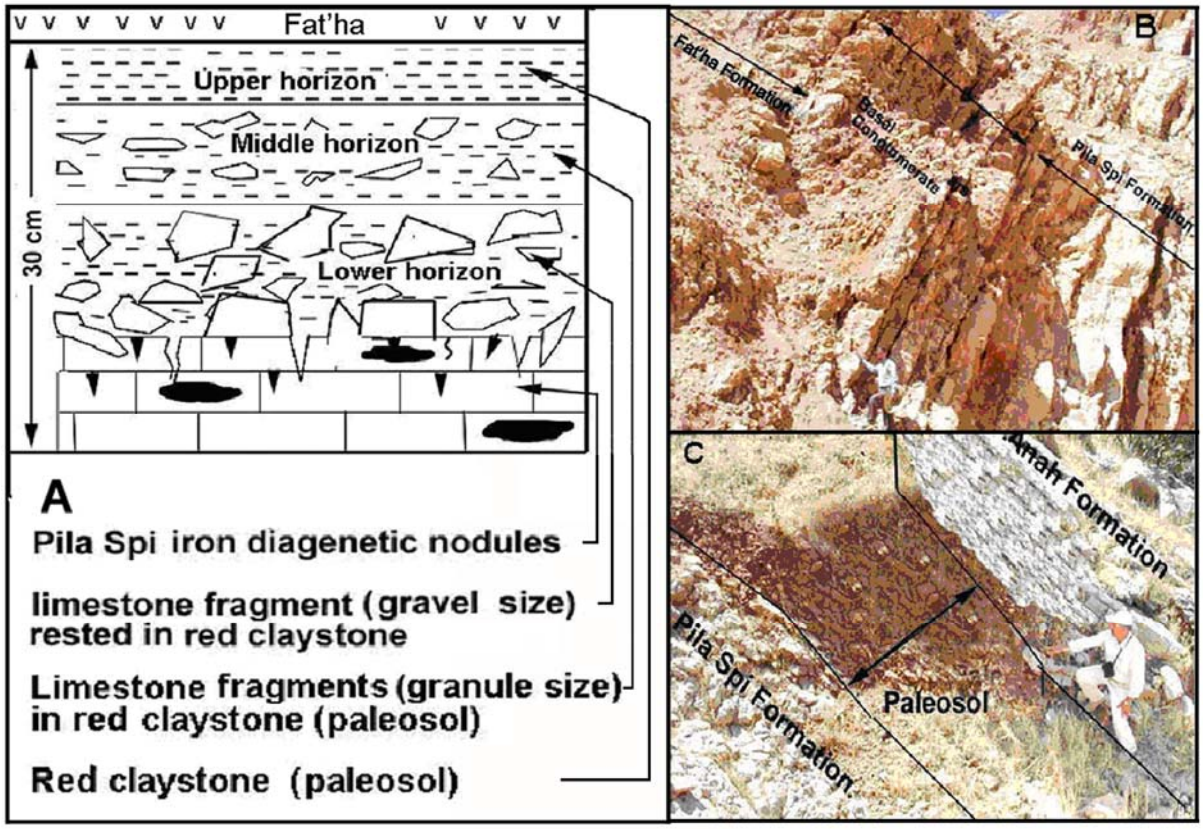

Fig.4: **A)** Diagramatic sketch showing horizons of the paleosol at the top of the Pila Spi Formation at the southwestern limb of Pirmam Anticline
B) Several beds of Oligomictic conglomerate at Darbandi Bazian Gorge, which are composed of limestone clasts of pebble and cobble sizes
C) Paleosol section between Pila Spi and Anah formations, north of Shoraw village, southwestern limb of Hanjira anticline, in the eastern side of Darbandi Bazian Gorge

– **Upper Horizon:** This horizon is composed of the red claystone of the same type of red claystone of Fat'ha Formation, but with darker color.

– **Middle Horizon:** This horizon is developed on partially weathered limestone of Pila Spi Formation, which consists of mixture of limestone fragments and red claystone matrix. The fragments are angular and mainly consist of cobble-sized clasts of Pila Spi Formation. This horizon grades, towards the base, to coarser grains, some of which are covered with green coating.

– **Lower Horizon:** This horizon consists of slightly weathered limestone of Pila Spi Formation, which grades to fresh limestone of the formation.

In this section, the limestone contains nodules of iron oxides, westwards (along the strike) the lithology of the boundary zone changes to sedimentary breccia.

3- Shoraw Section

This section is located on the southwestern limb of Hanjira Anticline, about 5 Km east of Takyia Town (X3 in Fig.1). The soil profile in this area is located between Pila Spi and Anah (Late Oligocene) formations. Anah Formation is composed of creamy limestone with small white spots representing miliolid forams. At this locality, the profile is homogenous and cannot be separated to different horizons. It consists of limestone rock clasts and red clay (Fig.4C). The clasts are partially weathered and seem to be derived from Pila Spi Formation. The Anah Formation is overlain by Fat'ha Formation with sharp contact. The lithology of all horizons shows no evidences of erosion and transportation, so they are included in the paleosol facies of the boundary zone.

▪ **Basal Conglomerates**

Field observation in the studied area showed that the most abundant lithological representation of the unconformity is conglomerates. In three different areas (sections X4, X5 and X6, in Fig.1), the conglomerates are studied texturally and compositionally by visual estimation using the comparison chart (Tucker, 1988). In each area, more than four in situ conglomerate specimens are inspected by this method; they are recognized in the following three sections and subdivided into the following three types:

– **Orthoconglomerate**

It is recognized in Darbandi Bazian Section only:

4- Darbandi Bazian Section

This section is located at the outlet of the Qulla Rash valley, 6 Km northwest of Takyia town near the Darbandi Bazian Gorge (X4 in Fig.1), which is located between Pila Spi and Fat'ha formations. Texturally, these types of conglomerates are mainly composed of clasts (gravels), which are self-supported (grain supported) with sandy matrix and some calcitic or ferruginous cement. The grains show moderate degree of roundness and sorting (Fig.5). Because it is grain supported, it is called orthoconglomerate (Pettijohn, 1975 and Selley, 1988). Lithologically, the conglomerate is composed mainly of different colored chert clasts (80%) with some gray limestone clasts (20%). It is possible that the chert clasts are derived from erosion of older conglomerates such as those of Tanjero Formation, which according to Karim (2004), Karim and Surdashy (2005) consist mainly of chert and reach 500 m in thickness. The other possibility is that the chert clasts are derived from erosion of Qulqula Radiolarian Formation, which was exposed at that time.

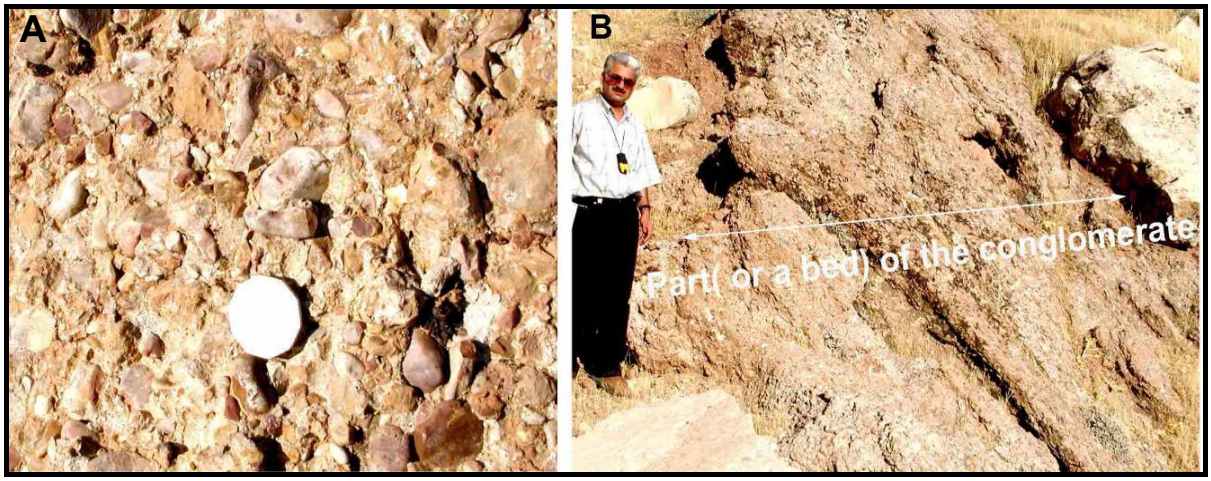

Fig.5: **A)** Close up photo of the orthoconglomerate, which is composed mainly of chert and some limestone. The color of the conglomerate is dark brown
B) An orthoconglomerate bed (2 m thick) exposed at Qulla Rash valley, Darbandi Bazian area

Because the conglomerate consists of different types of rock fragments, therefore it is called polymictic conglomerate (Pettijohn, 1975) due to including more than one type of clasts. This type of conglomerate is found in the southwestern limb of Qshlaq Anticline (Fig.6) at a valley called Qulla Rash. At this locality, the thickness of the conglomerate bed is about 2 m (Fig.5B). From the lithology and texture, it is clear that the bed is most possibly transported from relatively long distance during Oligocene, based on high sphericity and relatively well sorting. This type of texture (high sphericity and well sorting) is most possibly attributed to rivers, which were responsible for draining the lands in the northeast of the studied area and transported the sediments for relatively long distance. While, in the areas where paleosol is present, the erosion was not so effective to erode the soil and deposit conglomerates. The imbricated pebbles indicate southwards paleocurrent direction. There is a bed of tough and gray limestone above the conglomerate (Fig.6), which may belong to Anah Formation as it contains fossils of Oligocene (Baba Shekh, personal communication, 2008) (Fig.7). This place has recorded geographic position of latitude N 35° 48' 03" and longitude E 45° 21' 13".

– Oligomictic Conglomerate

It is recognized in Haibat Sulatn Section only:

5- Haibat Sultan Section

This section is located in the southwestern side of Haibat Sultan Mountain (X5 in Fig.1) about 200 m northeast of tunnel's outlet, which is under construction, hitherto. The clasts (cobbles and pebbles) of this conglomerate are composed of partially recrystalized grey or milky colored limestone (Fig.8A). As the unconformity indicates subaerial erosion, the sub-angular clasts were shortly transported by river during the gap, which were deposited between Pila Spi and Fat'ha formations. During this time, the river received only sediments from limestone source area.

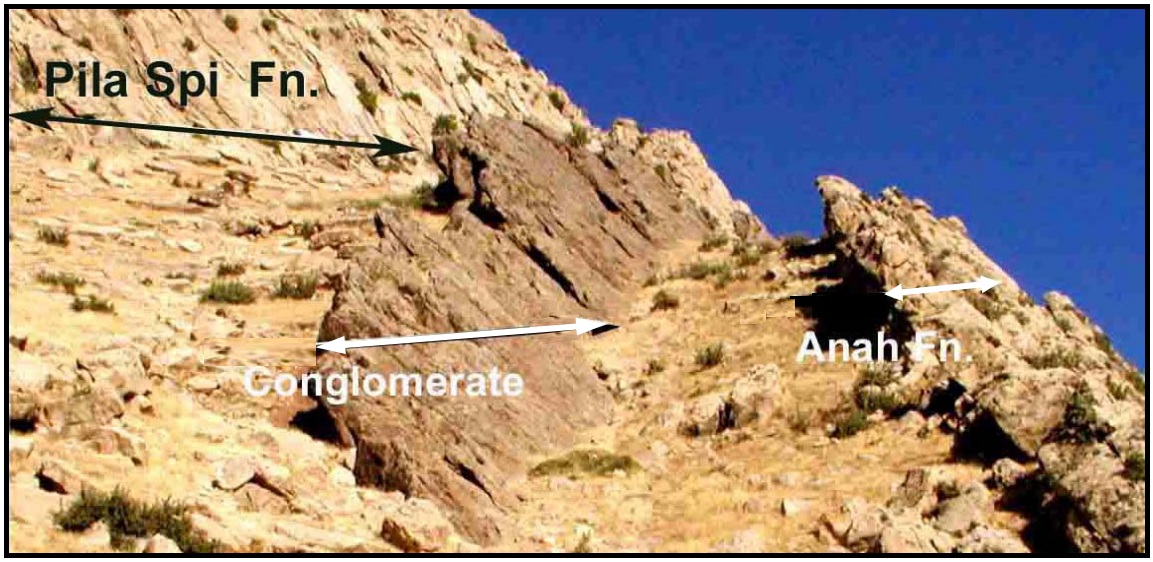

Fig.6: Southwestern limb of Qshlaq anticline showing position of the conglomerate between Pila Spi and Anah formations
(In this photo only one bed of the conglomerate is exposed)

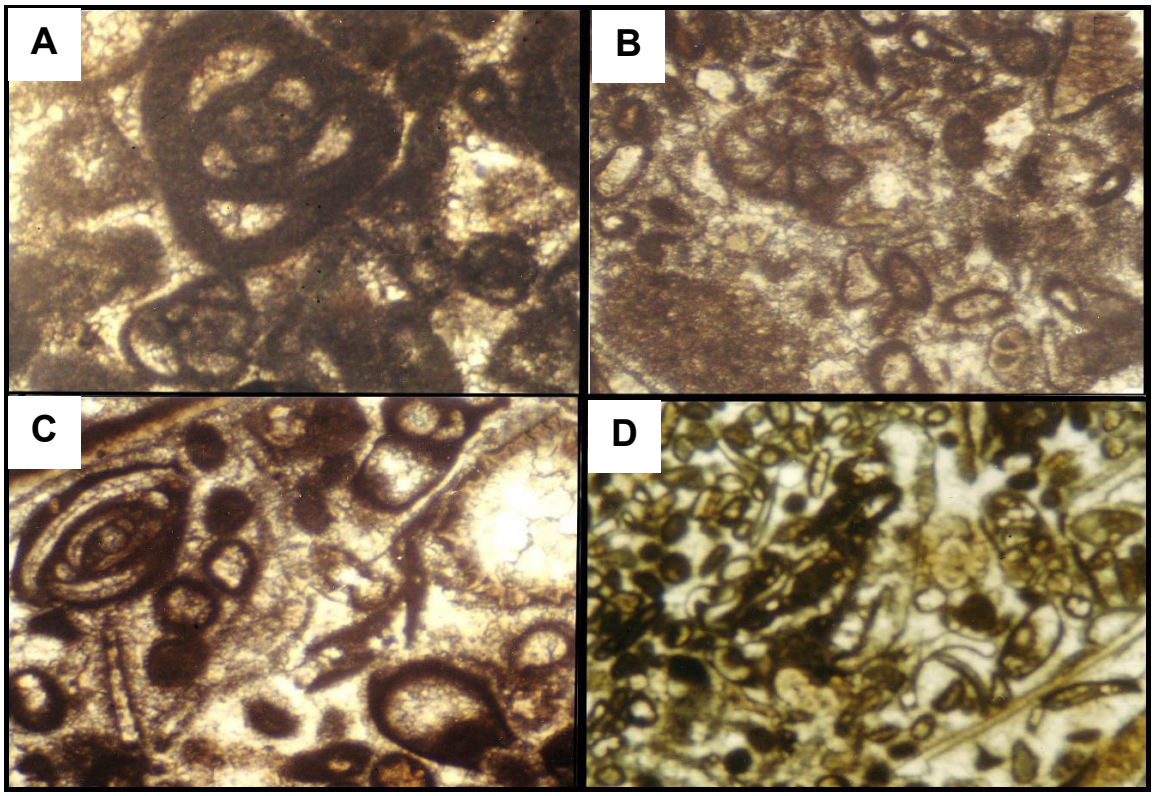

Fig.7: Different types of fossils in the limestone beds (possibly of Anah Formation) that overlies the studied unconformity (conglomerate), 10 Km south of Sangaw town, the northeastern plunge of Ashdagh Anticline
A) *Triloculina* sp. and *Quinquiloclina* sp., **B)** *Rotalida* sp., **C)** *Pergo* sp. and **D)** bioclastic grainstone

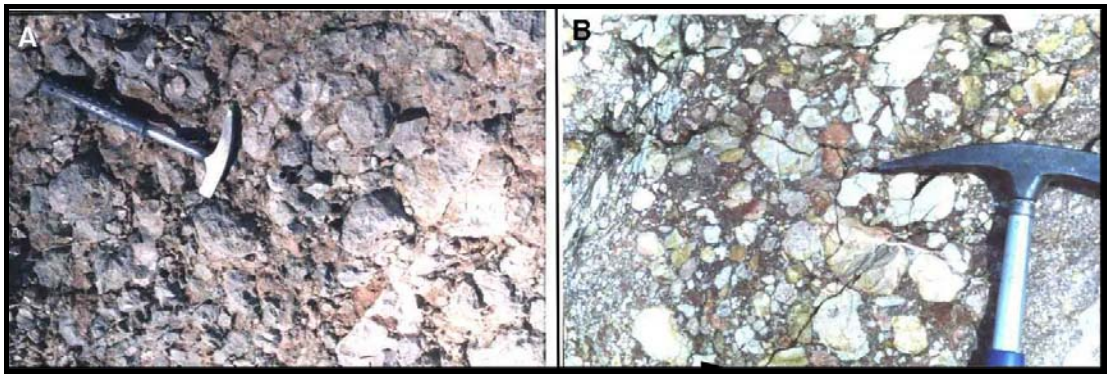

Fig.8: **A)** Oligomictic conglomerate (2 m) at the southwestern side of Haibat Sultan Mountain, beside the road crossing the homocline
B) Sedimentary breccias at the contact between Pila Spi and Fat'ha formations, in the left side of Darbandi Khan Dam site, shows graded bedding with angular grains

– Sedimentary Breccia

It is recognized in Darbandi Khan Section only:

6- Darbandi Khan Section

This section is located in the southwestern side of Darbandi Khan (X1 in Fig.1). In this type of breccia, the grains consist of angular clasts (in the size of cobbles and pebbles) and of milky limestone with some chert clasts (Fig.7B). This indicates proximal source area with short distance of transportation and rapid deposition. It is clear that this type of breccia is not tectonic, as it contains several types of clasts such as chert, grey and white limestone. In the classification of conglomerates, Pettijohn (1975) assumed breccias as a major group of conglomerates.

SEQUENCE STRATIGRAPHY

When the principles of Sarg (1988) and Haq (1991) are applied to the studied unconformity, in the studied area, the unconformity is regarded as the type one sequence boundary (SB1), which is formed by erosion during the major fall of sea level. The sea level fall is most probably induced by tectonic uplift of the studied area due to migration of deformation front of Zagros Fold Thrust Belt. During Oligocene, the deformation front (more or less) affected the studied area. The conglomerates have limited lateral extent (lensoidal shape) with brown color and imbricated pebbles, in each studied section of the studied area, therefore they represent ancient valley channel fill.

According to Vincent *et al*. (1998) and Nichols (1999), these valley channels are scored during sea level fall by stream rejuvenation. The exact time of the regression is unknown but most probably was during Early Oligocene. Thus the conglomerates represent the most proximal sediments of the low stand system tract, which deposited on sequence boundary. According to Emery and Myer (1996), the sequence boundary, during sea level fall, subjected to erosion and pedogenesis (soil development), which is mostly characteristic of type one sequence boundary. The citation of those authors can be applied to the studied unconformity as the erosion; transportation can deposit orthoconglomerate after long transportation, while short transportation deposits sedimentary breccias. On gentle slopes when there was no runoff, the paleosol was developed.

In literature, in spite of weathering and long time span (that are associated with this sequence boundary) there is no citation for sediments of distal low stand system tract, neither siliciclast nor carbonates. The nearest sediments are the limestones of Anah Formation, which in the studied area overlies the unconformity**.**

CONCLUSIONS

- The Oligocene unconformity in Northeast Iraq is represented by different lithologies such as plaeosol, orthoconglomerate (both polymictic and oligomictic conglomerate) and sedimentary breccia.
- In some localities, such as Awa Spi and Sangaw vicinities, the unconformity is overlain by Oligocene limestone, which may represent Anah Formation. In these localities the conglomerate must be called "Anah Basal Conglomerate" instead of Fat'ha Basal Conglomerate.
- From the form of the basal conglomerate, it is proved that the uplifted area consisted of weathering resistance gentle sloped paleohigh, only in some place dissected by rivers. The existence of sedimentary breccias indicates some steep slopes.
- The unconformity consists of type one sequence boundary without deposits of distal lowstand system tract, which is attributed to weathering resistance of Pila Spi Formation during Oligocene time.

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