LTHOLOGICAL INDICATORS FOR THE OLIGOCENE UNCONFORMITY, IN 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 northeastern Iraq. In the High Folded and Foothills Zone, the gap extends from Oligocene to the Middle Miocene and separates Pila Spi Formation from Fatha Formation; it separates Pila Spi and Anah formations. The latter is of Late Oligocene age and is marked by a conglomerate at base of Anah 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 and possibly deposited in different times. These conglomerates may indicate the boundaries between different cycles of Kirkuk Group. From sequence stratigraphic point of view; the studied unconformity indicates a type one-sequence boundary (SBI) during the sea level fall.

الدلائل الصخرية لعدم التوافق العائد للاوليجوسين في مناطق شمال شرق العراق

الملخص

تعتبر فجوة الاوليجوسين إحدى الفجوات الرئيسية واسعة الامتداد في بعض مناطق شمال وشمال شرق العراق ، متمثلة بفترة عدم ترسيب وانقطاع فى العمود الرسوبي . ان امتدادات هذه الفجوة فى منطقة الطيات العالية تمتد إلى ما قبل المايوسين الأوسط فاصلا تكويني بيلاسبى والفتحة . اما في مناطق يفصل بين تكويني بيلاسبي وعانة ذات عمر الاوليكوسين و يقع في قاعدة تكوين العانة . تم دراسة الصخارية والطباقية لسطح العدم التوافق في ستة مقاطع مختلفة، حيث ظهر ان المدملكات في المقاطع الستة لها تراكيب وانسجة مختلفة والتي تتكون نسيجيا من Ortho and Polymhctic Conglomerate, بينما من ناحية المكونات تتكون من المدملكات ذات الحبيبات الجيرية والبريشيا الرسوبية والتربة القديمة ذات المنشاء الجيد والرديء، والتى تؤكد وجود عدة انظمة ترسيبية كانت تستلم رسوبياتها من مصادر مختلفة مع احتمالية ترسيبها في اوقات مختلفة. ان المدلكات ربما تدل على الحد الفاصل بين الدورات الرسوبية لمجموعة كركوك . كما أكدت الدراسة أيضا إن سطح عدم التوافق هذا يمثل النوع االاول من أنواع الحدود الطباقية التتابعية التي تكونت اثناء نزول مستوى السطح البحر .

INTRODUCTION

According to Bellen *et al*.(1959) and Buday (1980), the contact between Pila Spi and Fatha formations is represented by a Basal Fars conglomerate bed, in the area of southwestern boundary 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 between High Folded Zone and Foothill Zone (Fig.1).

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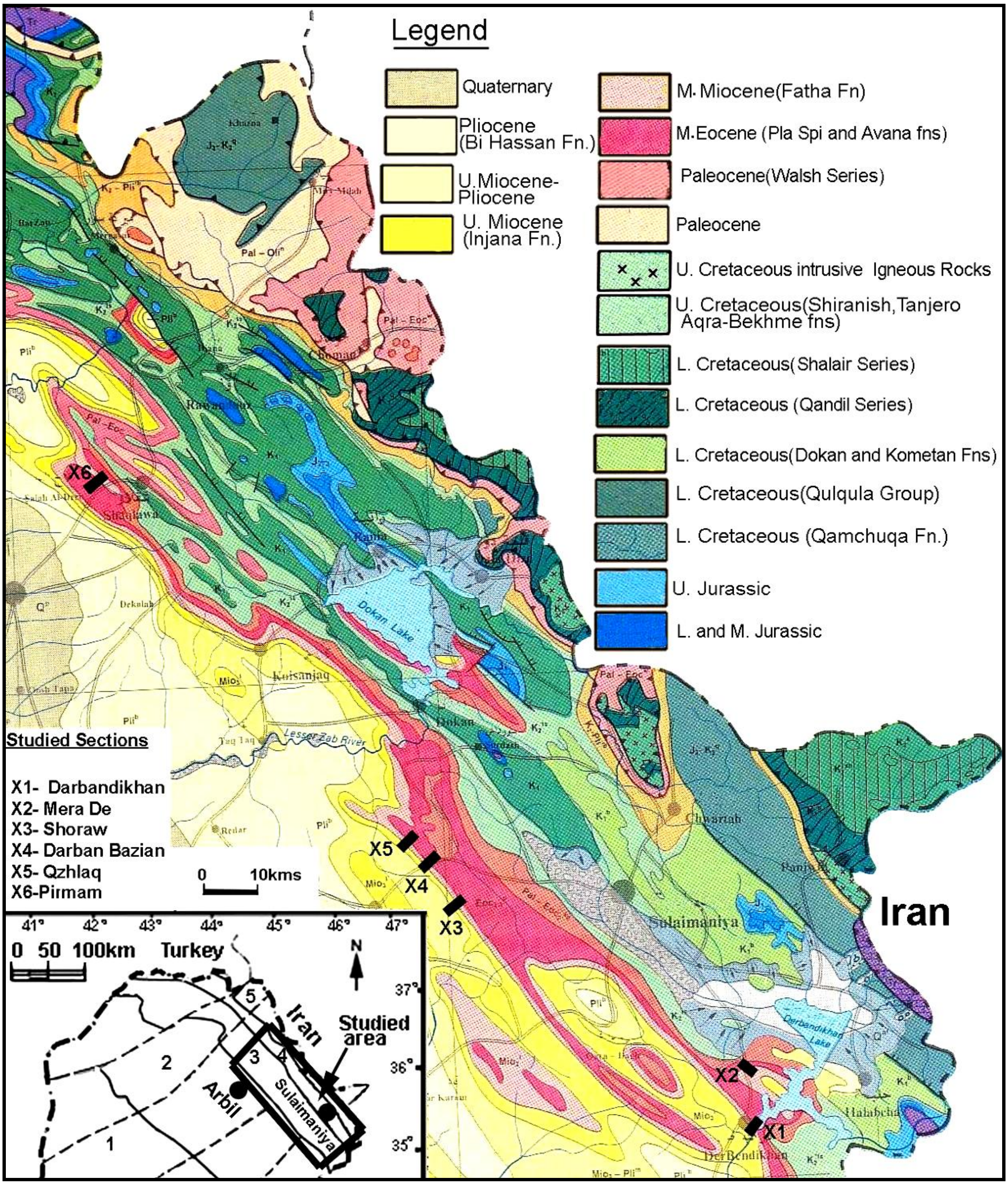

Fig.1: Geological map of the studied area (Modified from Sissakian, 2000) showing location of the studied sections.

Tectonically, the outcrops, when manifested on the tectonic map of Iraq, are located between Chamchemal−Erbil and Sulaimaniya−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 (as cited by Karim, 1997). The overlying formation is Fatha Formation, which consists of alternation of red claystone, green marl, gypsum and limestone with rare sandstone beds, in the upper most part.

In some areas, such as southeastern 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 Fatha 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), at southwest of Sangaw town which contains miliolid forams. According to this author, this bed is located between two conglomerates. He indicated the age of the bed as Oligocene.

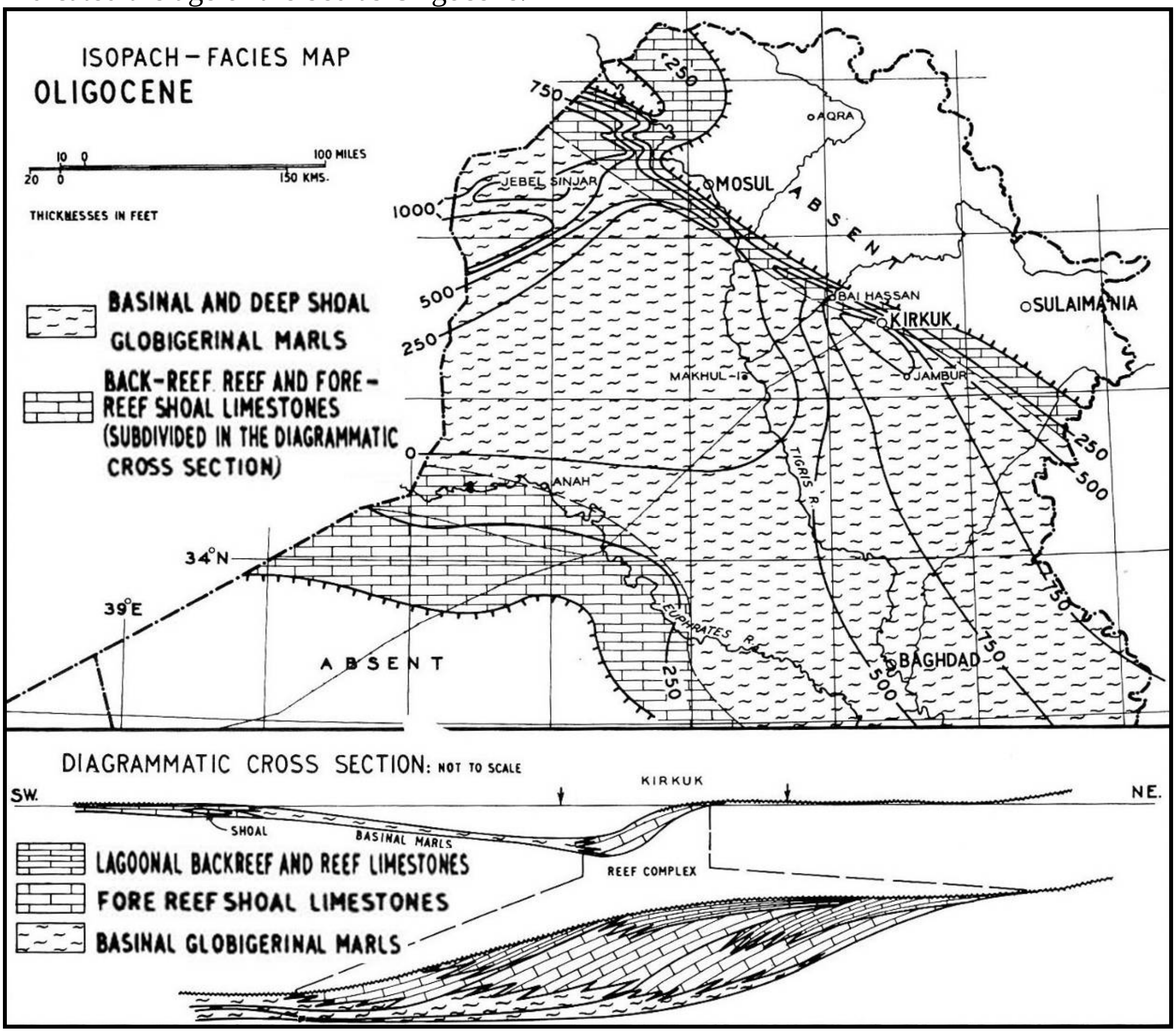

Fig. 2: Isopach facies map and related geologic cross sections of Oligocene, showing area of non-deposition (Dunnington, 1958)

LITHOLOGICAL REPRESENTATION OF THE UNCONFORMITY

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

Paleosol

The paleosol is exposed at least in three places which are appear as several lithified and compacted light brown beds which have darker color (light brown) than the overly Fatha Formation. The reason for remaining of the paleosol during the Middle Miocene transgression is that the environment of Fatha 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 1km to the southwest of Mera De village and 10 Km to the north of Darbandikhan town. At this location the lower part of Fatha Formation and complete thickness of Pila Spi Formation are exposed along the recently excavated road cut. All layers of the northeastern limb are nearly vertically dipping (85^o), in between, the two formations the section of paleosol is clearly can be seen, which has darker color than the overlying Fatha Formation and consists of the following horizons (Fig.3):

- **The Upper Horizon (U.H):**It about 30cm 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 Fatha Formation (Fig.4). The matrix (red claystone) and clasts are considered, in this study, as badly developed (during Oligocene) lateritic soil by the subaerial exposure of the studied area (Fig.2). It included only angular and sub-rounded rock fragments of Pila Spi Formation which are transported from nearly by outcrops and rested on the soil surface during Oligocene.
- **Middle Horizon (M.H):**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 returned to leaching during long time in moist soil on gentle slopes during Oligocene. But the larger particles (supposed to be surface of Oligocene soil) of the previous horizon were continuously moved and replaced by large particles from the upper related slope.
- **Lower Horizon:**This horizon consists most upper part Pila Spi Formation which is of partially weathered. It begins, at the top of the horizon, from mixture of calcareous red claystone and weathered limestone which slightly resemble calcret. At the base of the horizon it changes to nearly fresh limestone of the Pila Spi formation. Generally the above horizons represent badly developed soil profile on the gently sloping limestone terrain during Oligocene.

2- Pirmam section

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

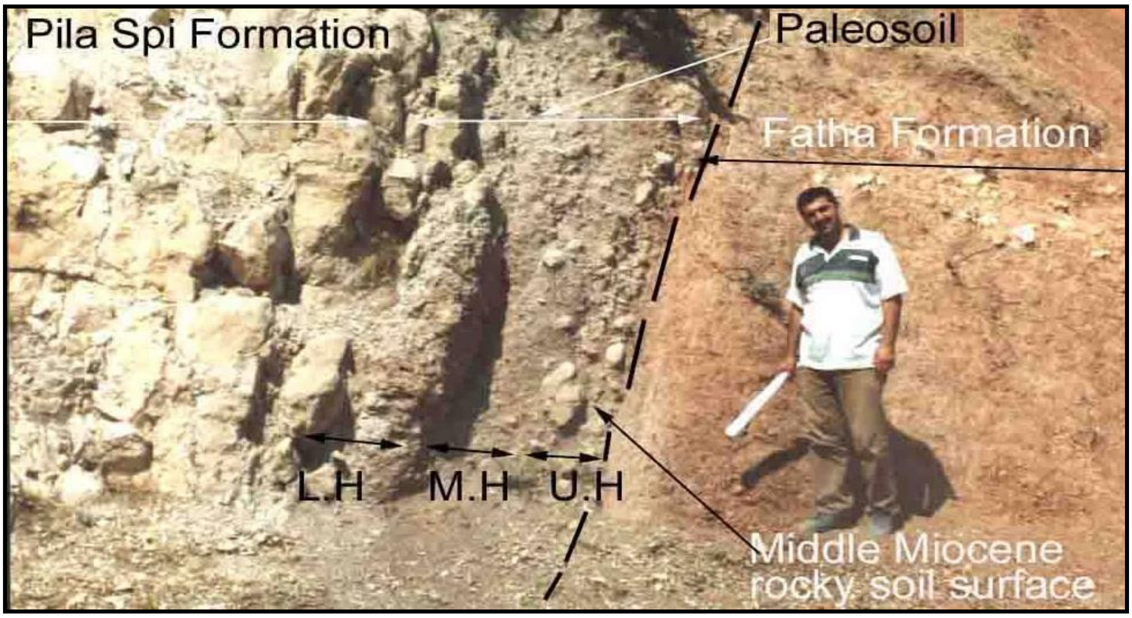

Fig.3: The contact between Fatha and Pilaspi formations at south of Mira De Village. The strata are nearly vertical and the paleosol is developed between the two Formations. The L.H M.H and U.H are indicating upper, middle and lower horizons respectively.

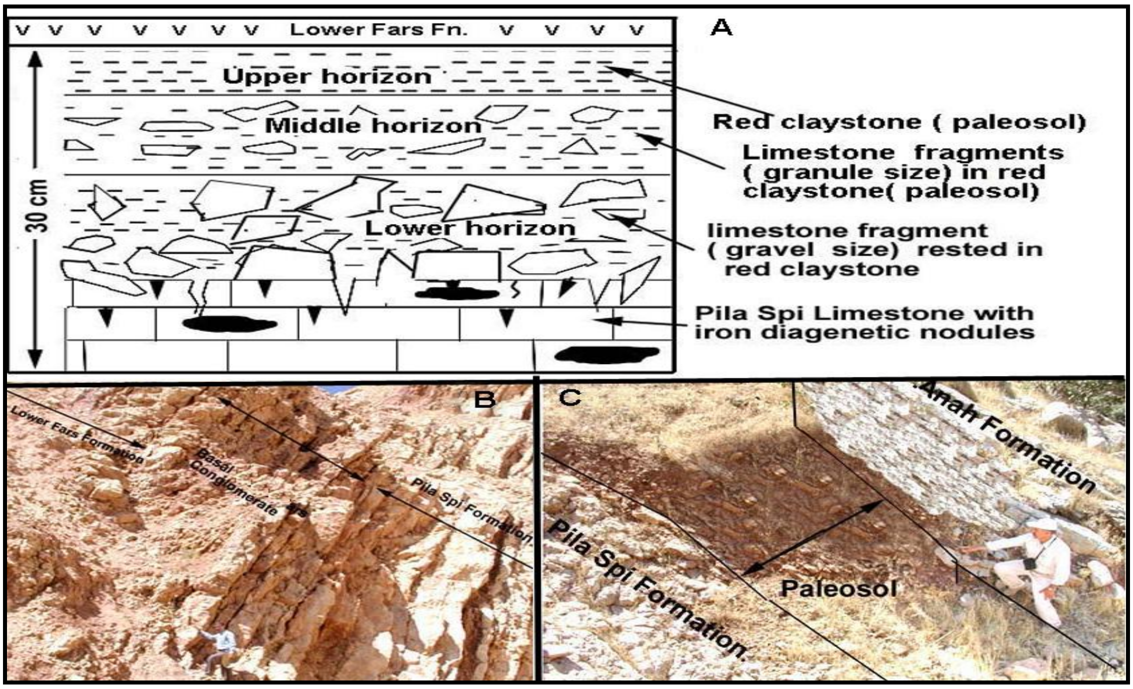

Fig.4: A: Diagramatic sketch of showing horizons of the paleosol at the top of the Pila Spi Formation at the southwestern limb of Piramam an Anticline.
B: Several beds of Oligomictic conglomerate at Darbandi Bazian Gorge, which are composed of limestone clasts of pebble and cobble size.
C: A paleosol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

−**Upper Horizon:** This horizon is composed of red claystone of the same type of red claystone of Fatha Formation but with darker color.
−**Middle Horizon:** This horizon is developed on partially weathered limestone of Pila Spi Formation, which consistis 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 grain (boulders) 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 area the limestone contains nodules of iron oxides. In this locality, westwards (along the strike) the lithology of the boundary zone changes to sedimentary breccias.

3- Shoraw section

This section is located on the southwestern limb of Hanjira Anticline about 5km to the east of Takyia Town. 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 derived from Pila Spi Formation. The Anah Formation is overlain by Fatha 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 Conglomerate

Field observation of the studied area showed that the most abundant lithological representation of the unconformity is conglomerates. In three different areas (Fig.4B, 5, 6 and 7), the conglomerates are studied texturally and compositionally by visual estimation using the comparison chart (Tucker, 1988). In each area, more than four in situ specimens are inspected by this method, which are divided into following three types:

−Orthoconglomerate

It is recognized in Darbandy Bazian only:

4- Darbandy Bazian Section

. This section is located at the outlet of the Qulla Rash valley at the 6km to the northwest of Takyia Town near the Draband Baziabn Gore which is located between Pila Spi and Fatha 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). As it is grain supported, it is called orthoconglomerate (Pettijohn, 1975 and Selley, 1988). Lithologically, the conglomerate mainly composed 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 Surgadshy, 2005) consist mainly of chert and reach 500m in thickness. The other possibility is that the chert clasts are derived from Erosion of Qulqula Radiolarian Formation which is exposed at that time.

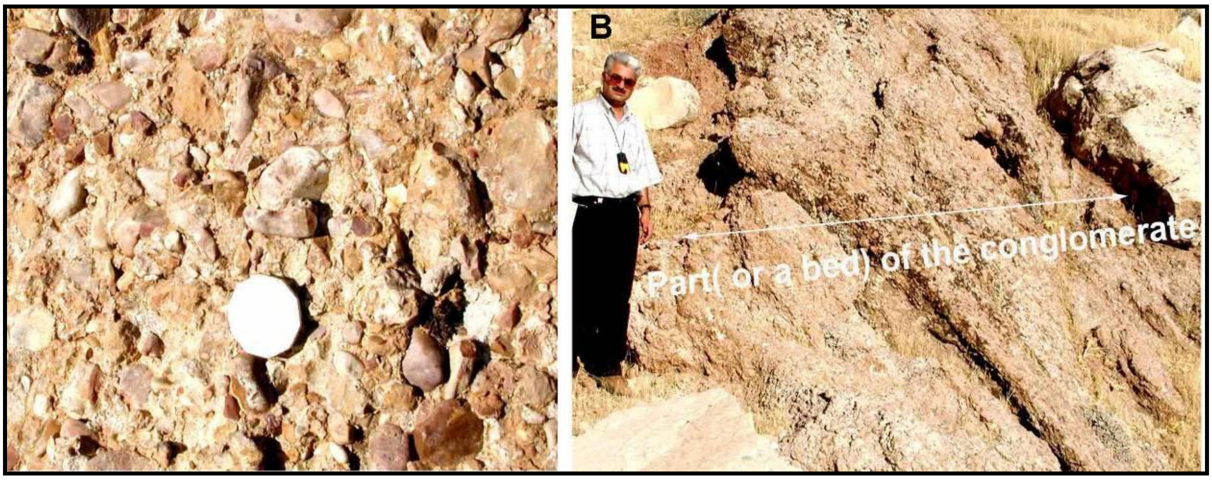

Fig. 5 **A**) Close up photo of the orthoconglomerate, which is composed mainly of chert and some limestone. The color of the conglomerate is dark brown.
B) An orthoconglomerate beds (2m thick) exposed at Qulla Rash valley, Darbandi Bazian area.

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 at a valley called Qulla Rash. At this locality, the thickness of the conglomerate bed is about 2m (Fig.5B). From the lithology and texture, it is clear that the bed is most possibly transported from relatively long distance during Oligocene age based on high sphericity and relatively well sorting. This type of texture (high sphericity and well sorting) is most possibly attributed to a rivers were responsible for draining the lands in the northeast of the studied area and transported the sediment for relatively long distance. While, in the area of the paleosol the river was not running to erod the soil and deposit conglomerates. The imbricate 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(S.Baba Shekh, personal communication, 2008) (Fig.8). This place has recorded geographic position of N 35^{0} 48^{-} $03^{=}$ and E 45^{0} 21^{-} $13^{=}$.

Oligomictic conglomerate

It is recognized only in Haibat Sultan Section only:

5-Haibat Sultan Section

The clasts (cobbles and pebbles) of this conglomerate are composed of partially recrystalized grey or milky colored limestone (Fig.7A). It is found at the southwestern side on Haibat Sultan Mountain; about 200m to the northeast of tunnel out site which now under the construction. 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 Fatha formations. During this time, the river received only sediments from limestone source area.

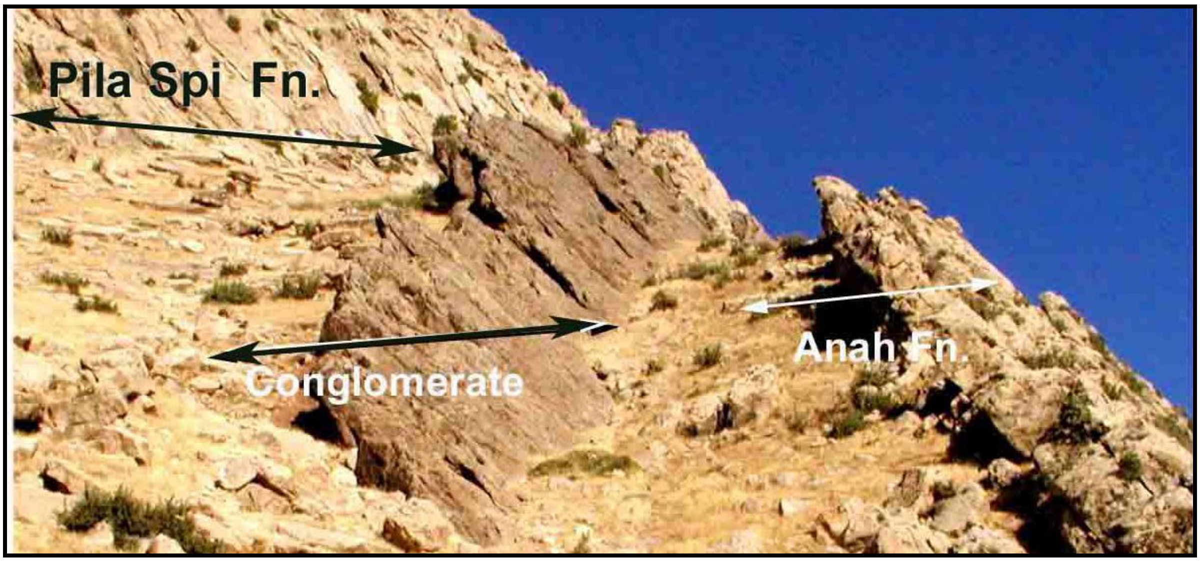

Fig.6: Southwestern limb of Qshlaq anticline showing position of conglomerate between Pila Spi and Anah Formations
(In this photo only one bed of the conglomerate is exposed)

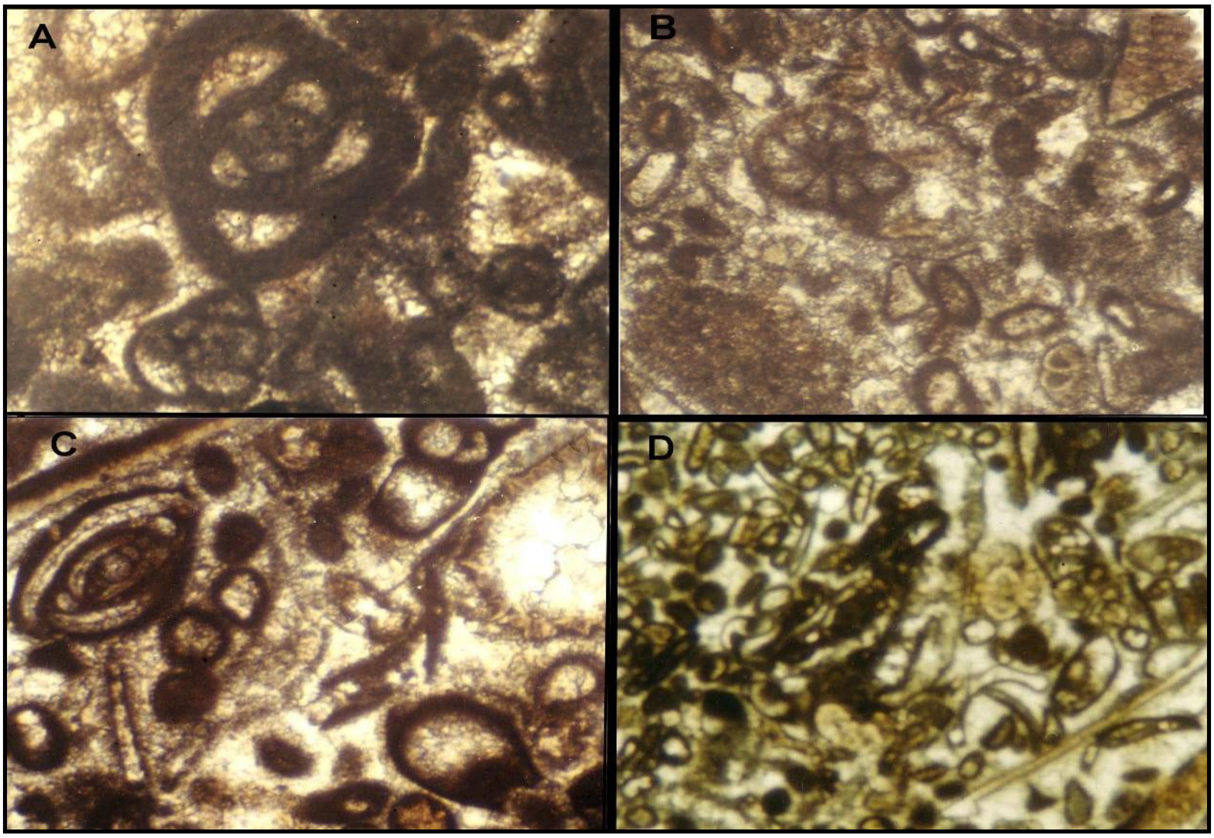

Fig.7: Different type of fossils in the limestone beds (possibly Anah Formation) that overlies the studied unconformity(conglomerate) at 10 kms south of Sangaw town at the northeastern plunge of Ashdagh Anticlines
A) *Triloculina sp*. and *Quinquloclina sp* **B)** *Rotalida sp*. **C)** *Pergo sp*., **D)**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

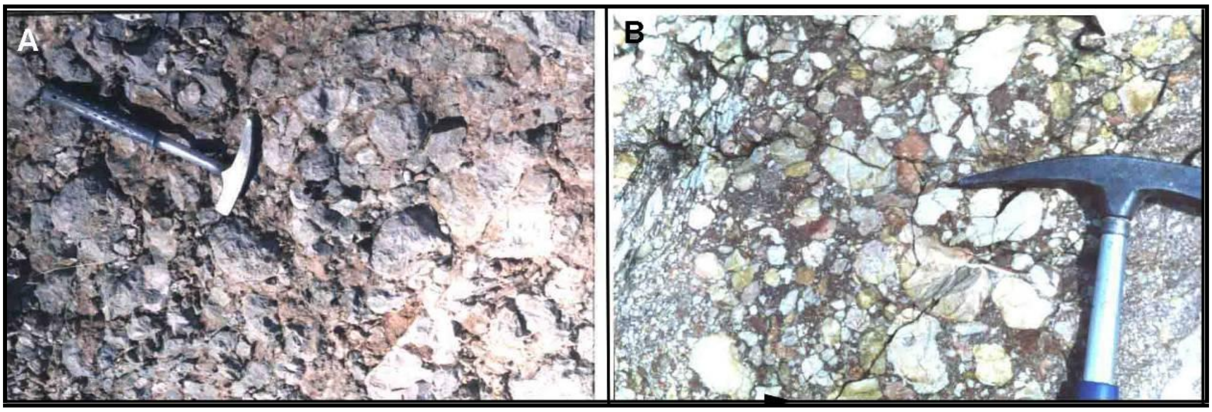

Fig.8: **A)** Oligomictic conglomerate (2 m) at the southwestern side of Haibat Sultan Mountain, beside the road crossing the Homocline.
B) Sedimentary breccias at the contact between Pila Spi and Fatha formations, In the left side of Darbandikhan dam site, shows graded bedding with angular grains.

Sedimentary breccia

It is recognized in Darbandy Khan Section only:

6- Darbandy Khan Section

It is found at the southwestern side of Zimnako anticline (Darbandikhan area). 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 transport action and rapid deposition. In the field, it is clear that this type of breccia is not tectonic, as it contains several types of clasts such as cherts, grey and white limestones. In the classification of conglomerate (Pettijohn, 1975) has assumed breccias as a major group of conglomerates.

SEQUENCE STRATIGRAPHY

When the principles of Haq (1991) and Sarg (1988) are applied to the studied unconformity, this 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 the Oligocene, the deformation front (more or less) affected the studied area. The conglomerates have limited lateral extent (lensoidal shape) and brown color with imbricated pebbles in each studied sections of the study area, therefore they represent ancient valley channel fill.

According to Nichols (1999); Vincent *et al* (1998) these valley channels are scored during sea level fall by stream rejuvenation. The exact time of the regression is not known 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. This citation of these authors can be applied to the studied as the erosion; transportation can deposit orthoconglomerate after long transportation while short transportation deposit sedimentary breccias. On gentle slope when there is not 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 of sediments of distal low stand system tract neither of siliciclastic nor carbonates. The nearest sediments are the limestone of Anah Formation, which in the studied area overlies the unconformity.

CONCLUSIONS

- The Oligocene unconformity between the of the High Folded and Foothill zones is of parallel type and represented by different lithologies such as orthoconglomerate, polymictic conglomerate, oligomictic conglomerate, sedimentary breccias.
- In some localities such as Awa Spi and Sangaw area, 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 Fatha basal conglomerate.
- From 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 at Oligocene time.

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