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Lithofacies and sedimentary structures studies of Injana Formation in Zakho area, Northern of Iraq

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ABSTRACT

The current study of Injana Formation (Late Miocene) at Zakho area, Northern of Iraq. The topic depending mainly of field observations of the outcrop of Injana Formation at the Zakho area. The thickness of formation in Zakho section is about 250m, The formation consists of three major lithofacies: sandstone, mudstone and gravely sandstone. Injana Formation classified to five sublithofacies depending on a description of the physical character such as color, hardness and grain size. These sublithofacies are different in thickness. The study revealed that Injana Formation is represented by eighteen sedimentary cycles which mean a change in deposition environment, these cycles are distinguished finning upwards cycles. Sedimentary structures were observed in the present study such as bedding, channel, cross bedding, ripple marks, graded bedding, traces fossils, mud balls and massive bedding, the recognize the sedimentary structures which leads interpretation the condition of transportation and subenvironments of formation. Finally, we inferred that Injana Formation environments depending on study the sedimentary structures, Lithofacies and sedimentary cycles that Injana Formation was deposited in fluvial environment (meandering rivers), different in their condition of deposition from the base of the formation to the top. large thickness of some beds and without sedimentary structures gives evidence duration of flooding.

Keywords: Lithofacies. Sedimentary structures. Injana Formation. Miocene. Duration of flooding.

1. Introduction

Rock of the Tertiary period are occupied large areas of the surface and subsurface succession in Iraq. Injana Formation marks the beginning of the molasses deposits formed by Alpine Orogeny during the continent- continent collision [1]. The distributed of Injana Formation in Iraq show in (Fig.1). The Injana formation was previously named as Upper Fars Formation and later changed in Iraq to the Injana Formation [2]. This study is one of the most important studies because the widespread the sediments of the formation, and it covered a large areas of the Iraq. It was described by Busk and Mayo in Iran in 1918. [3] studied the Injana Formation in Al-Najaf-Karbala area, he mentioned that Injana Formation environment it the meandering rivers of fluvial depositional environment. [4] studied the injana Formation in the middle part of Iraq

sedimentologically and inferred the environment to be meandering fluvial environment. The upper contact with the overlaying Mukdadiya Formation is conformable and gradational based on the first appearance of pebbly sandstone. The environment of deposition is fresh to fluvial [5]. The main aims of the study are describe in detail the lithofacies, sedimentary cycle and sedimentary structures study. The different sedimentary structures which leads to interpret the variation and type of sedimentary environment from the base to the top.

2.Study Area

The study area is located within Zakho area at south Zakho city, between the latitude (37.089250) to the North and longitudes (42.659655) to the East (Fig.2).

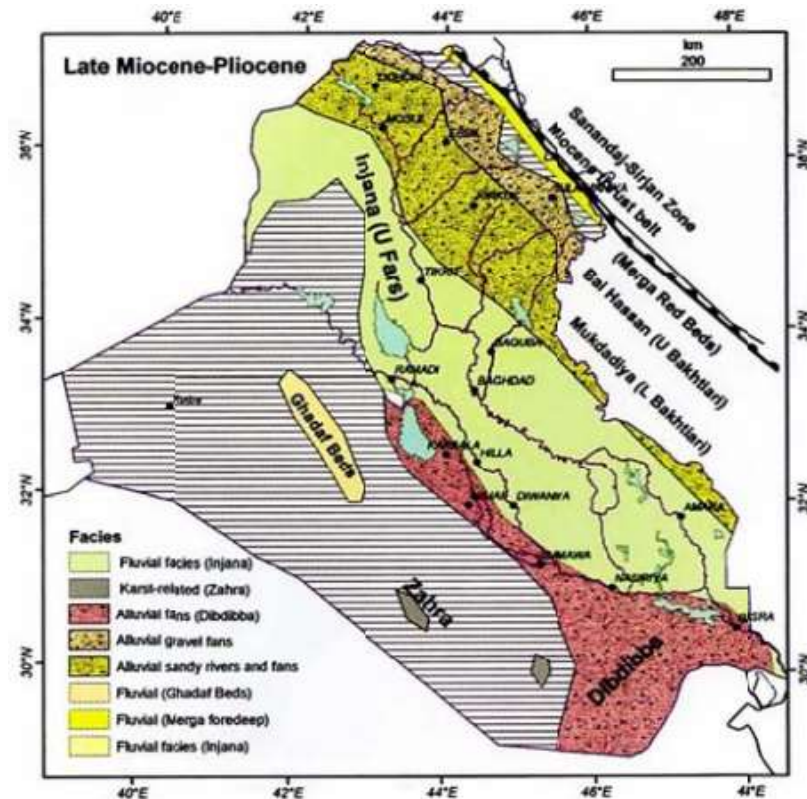


Fig. 1: Late Miocene-Pliocene Sequence [6].

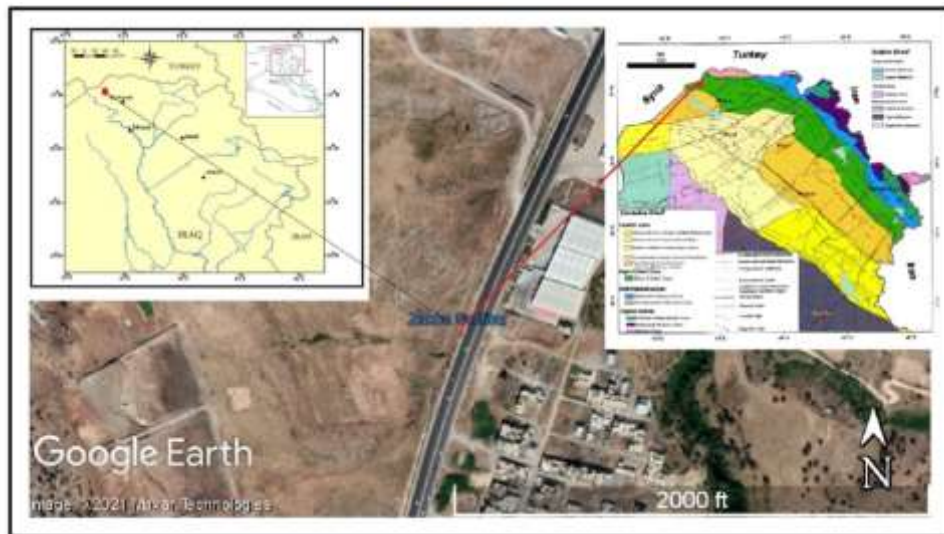


Fig. 2: Tectonic and location maps of the study area [6].

3. Geological setting

The studies area is located at High Folded Zone [7]. During the close of the Middle Miocene, the sea begin its final regression from the Iraqi territory leaving behind as it regressed a trail of shore line marine clastic followed behind by fluvial deposits deposited on the newly emerged land area [8].

The upper contact of the injana formation with the Mukdadiya Formation is transitional, its upper limit is marked by the first consistent appearance of gravel show in (Fig.3). The lower contact of the Injana formation with the underlying Fatha Formation is conformable show in (Fig.3).



Fig. 3: The upper and lower contacts of studied formations.

4. Geology of the Studied Area

The geology of the studied area include the formations that appear it's outcrops within the study area: in

4-1. Fatha Formation

The age formation is middle Miocene. Fatha Formation is type locality is located at the Al-Fatha area (15) km north of Biji city in the area where the Tigris river crosses the mountain Makhul-Himren, Fatha Formation composed of beds of anhydrite, limestone and gypsum [6]. The lower contact Fatha Formation is conformable, the underlying unit usually Jeribe and Euphrates formations taken at the appearance of gypsum bed, upper contact of Fatha Formation is always overlain gradationally and conformably by Injana Formation, the upper contact is taken on top of last gypsum bed and the appearance of sandstone [8]. The formation is represented by neritic limestone at the base passing into not evaporate silt-grad clastic [9].

4-2. Injana Formation

Injana Formation is widespread in Iraq, the type section of formation located in the Injana area within the Hemrin fold near Baghdad-Kirkuk road [6]. The age of the formation is Upper Miocene [10]. [11] mentions that Injana Formation composed of siltstone and sandstone succession with limestone in the lower part of formation, Injana Formation contains a bed of mud balls, but the Injana Formation in northern of Iraq consists of the succession clastics for deposition cycles that has (cycles of Fining upward) from mud and sand, The deposition environment for the formation is a continental fluvial environment, whose deposits are mainly came from

the sediments of northeast of Iraq and under fluvial environment [12]. Injana Formation in study area consist of sandstone, mudstone, and gravel. Thickness of formation about 250 m in study area. The lower contact of the formation with the underlying Fatha Formation is conformable. The upper contact of the formation with the Mukdadiya Formation is transitional, its upper limit is marked by the first consistent appearance of gravel in sandstone.

4-3. Mukdadiya Formation

The age of Mukdadiya Formation is Pliocene [13]. The exposed part of the formation located within the Unstable Shelf area, the formation is consist of lmost from terrigenous clastics and grains size from silt to gravel [13]. The grain size of the terrigenous clastic increasing in size vertically towards the top in the central parts of the basin, on the foothill zone, the Mukdadiya Formation consist of the fine sediments from mudstone and sandstone, whereas, marginal areas, pebbles were found in the extreme northeastern [14]. In study area the Mukdadiya Formation can be divided into nine coarsening up-ward cycles are composed of a three lithofacies such as mudstone, sandstone and Sandy Gravelly lithofacies. The thickness of the Mukdadiya Formation in Zakho area is about 105m.

4-4. Bai Hassan Formation

The type section of Bai Hassan Formation located in Bai Hassan village, the description of Bai-Hassan Formation is similar to Mukdadiya Formation, the main differences between Mukdadiya and Bai Hassan formations are in the grain size and grain size, Mukdadiya Formation has grain size less than Bai Hassan Formation and, BaiHassan Formation is

younger in age from Mukdadiya Formation, Bai Hassan Formation consists of coarse conglomerates alternating with thick claystone and sandstones [16]. Bai Hassan Formation consists of two members, the conglomerate member conglomerate with lenticular bed of sandstone and the claystone member (silty to sandy, calcareous claystone) [15]. In study area Bai Hassan Formation can be divided into five coarsening up-ward cycles are composed of a six lithofacies are matrix-supported conglomerates, clast-supported conglomerates s, laminated sandstone, massive conglomerate, limestone, Mudstone Lithofacies. the thickness of the Bai Hassan Formation about 160 m.

5. Methodology

The research methods includes several stages, such as the preparatory and field work stages, as follows:

5-1.Preparatory Work Stage

This stage includes collecting the necessary informations about the study area through reading the reports, researches and studies related to the Zakho area or related to the same subject and benefit from it. Also collecting the topographic and geological maps for the study area and around it to benefit from it in the field work.

5-2.Field Work Stage

The present study is consists three parts: lithofacies, sedimentary structures and sedimentary cycles studies, the one section was selected from the study area, the thickness of section is (250m). the research incorporates field description of one succession in detail for its lithology, contact, sedimentary structures and facies.

6. Sedimentary structures

There are several types of sedimentary structures were observed in Injana Formation at Zakho section:

6-1.Bedding

Bedding is horizontal because the deposits from which the sedimentary rocks formed were originally deposited as horizontal beds, it is series of visible beds within rock [17]. Bedding is one of the most distinctive features of sedimentary rock, and its occurrence is often associated with the development of many of the sedimentary structures that are dealt with in this study. bedding that was showed in the sequences of formation (Fig.4).



Fig. 4:Bedding in sequence sandstone.

6-2.Cross bedding

It form because in flowing water or air, sand grains move as migration dunes and ripples. Sand is payed up the shallow side of the ripple to the crest, where it then avalanches down the sleep side. Cross bedding is very common structure in the river channel. Cross bedded strata are useful indicator of current direction and indicate the top and the bottom of the bed, also interpret that the depositional environment was water or wind [18]. During the present study we were determined two types of are planar and trough cross bedding (Fig.5).



Fig. 5: Planar and trough cross bedding.

6-3. Ripple marks

Ripple marks are characteristic structures of the shallow water sedimentation. They are caused by wave piling up the sediments into long ridges. Ripple mark can give an indication of wind direction and old water streams [19]. Ripple marks is one of the important Sedimentary structures within Zakhro section, it was observed in Injana formation are Asymmetrical ripple marks and these are created by a one way current, for example in a river (Fig.6).

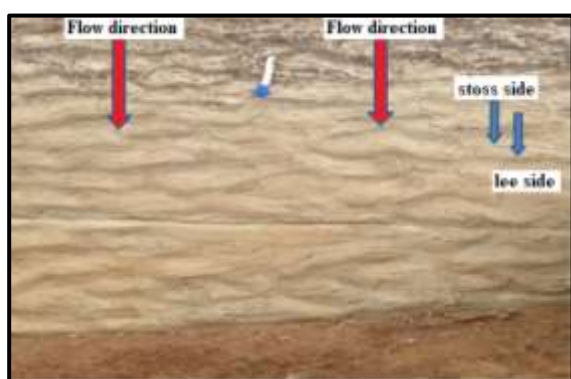


Fig. 6:Ripple marks in Injana sandstone

6-4.Graded bed

Graded beds form by deposition from a decaying current and may range from centimeter to several meters in thickness [20]. It is a layer with a vertical change in particle size usually from coarse grains at the lower of the bed to progressively finer grains toward the upper. It was observed in Injana Formation within the Zakhro section. It is represented by coarse grains at its base and grades upward through progressively finer grains toward the top (Fig.7).



Fig. 7: A graded bed has coarse at the bottom of the bed and progressively finer grains towards the top.

6-5. Biogenic sedimentary structures

It (trace fossils) are biologically produced structures and include trails, tracks, borings, burrows, fecal pellets and other traces made by organisms. [17]. Borings are holes made by organisms in hard surfaces either for protection or in search of food. They are likely to be formed and preserved in places where a hard rock surface has been exposed to animal activity for a certain length of time before being covered under a blanket of transgressive sediments. The holes are generally smooth and are either vertical or

inclined at various angles. Occasionally, the boring organism may be found preserved in the hole itself. Various organisms [21]. Cruziana ichnofacies commonly occurs in deep water within subtidal zones, the water energy is medium to low [22]. The Cruziana trace was observed in Injana Formation (Fig.8). This trace gives evidence of duration of flooding.

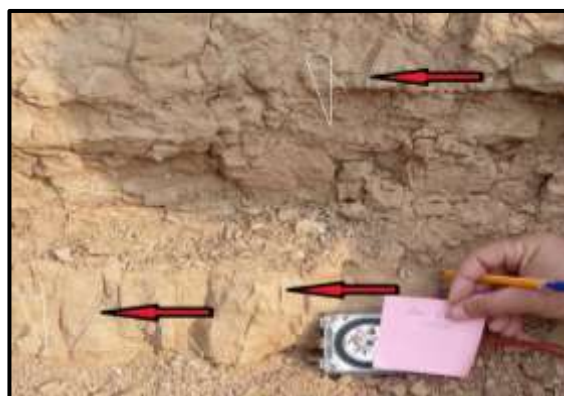


Fig. 8:Traces fossils in Injana Formation

6-6.Massive bedding

A thick bed which is structureless. There are several factors that lead to the existence of beds in massive, such as diagenesis and burrowing in addition to nature of some sediments [18]. In the present study, this large thick bed gives evidence of duration of flooding. Massive bedding was shown in the sequences of formation (Fig.9).



Fig. 9:Massive bedding in Injana Formation.

6-7.Mud balls

Mud balls originate and may be generated by load structure [23]. Mud balls occur in diverse sedimentary environments [24]. The size of mud ball varies from 1 cm to about 50 cm [20]. Mud balls are believed to form as a result of foundering and breakup of semi-consolidated sand or limy sediments [22]. Mud balls are widely common in structures of the river environments. Mud balls take various shapes, spherical, subspherical, and are recognized in Zakhro section (Fig.10).



Fig. 10: Mud balls in Injana Formation

6-8.Channel structures

Channels are concave upward structures that truncate beds at their margins. The channels are filled with coarser grains than the surrounded material [23].

It largest predepositional interbed structures. These may be kilometers wide and handred of meters deep. They occur in diverse environment ranging from subaerial alluvial plains to submarine continental margin [24]. Channel are structures that show a U-shape or V-shape [25]. They are formed by erosion, principally by currents but in some cases by mass movements [22]. Channels gives evidence of high energy environment. It was observed at sedimentary section (Fig.11).

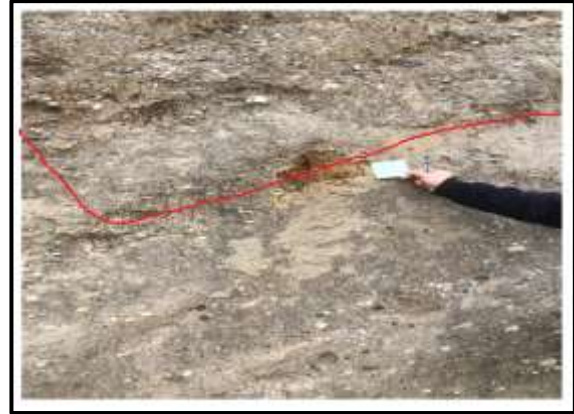


Fig. 11: Channels in Injana Formation.

7. Description of the Studied Section

The present study includes one exposed section on the surface. The samples were taken from Zakho Section.

7-1.Zakho Section

This section is located in the Zakho city nearby the Iraqi Turkish border at latitude (37.089250) and longitude (42.659655). the thickness of section is (250) m, (Fig.12) shows stratigraphic sequences column of Zakho section.

7: Sedimentary lithofacies:

Depending on the field observations, the clastics sediments of the studied section was divided into three main facies:

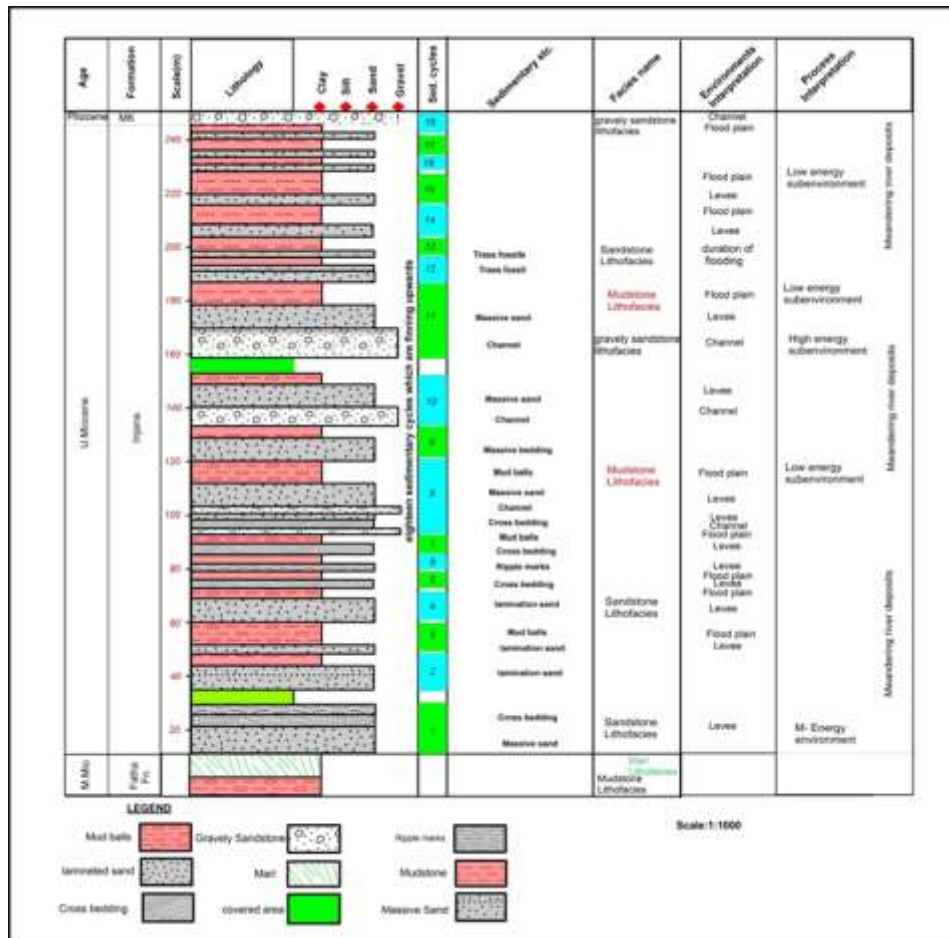


Fig. 12:A stratigraphic Column of (Zakho) Section.

8. Sedimentary lithofacies in Injana Formation at Zakho Section

Based on the field observations, the clastics sediments of the Zakho Section were divided into three main lithofacies:

8-1. Mudstone lithofacies

This lithofacies was observed in lower, middle and top parts of the studied section. The total thickness of this lithofacies is (70) m. Which gives indicator that the sedimentation was happened in low energy environment. The mudstone lithofacies didn't divided into lithofacies the cause that no difference in this facies, only one sublithofacies in the studied section. Mudstone lithofacies gives an interpretation that it is deposition in flood plain subenvironment while the large thickness of this facies gives evidence of duration of flooding.

8-1-A. Mudstone sublithofacies contents mud balls

Mudstone sublithofacies contents mud balls is composed of clay and siltstone, it was observed at middle part of the Zakho section as in sample 6, 8, 14 and 20. Thickness of this facies is large reaches to (28) m. Thickness of this facies is very large, their color red (Fig.13). This subfacies does not give any sedimentation environment.



Fig. 13: Mudstone sublithofacies contents mud balls.

8-2. Sandstone lithofacies

This facies is one of important lithofacies in the studied section, thickness of this facies reaches to (80) m. This lithofacies was observed in lower, middle and top parts of the studied section, this lithofacies were divided into four of sublithofacies are

8-2-A. Trough cross bedded sandstone sublithofacies

Trough cross bedded sandstone sublithofacies is consist of fine to coarse grained sandstone. thickness of this facies is very small about (3) to (4) m (Fig.14). It was observed at lower part of the sedimentary section. Their color ranges from gray to light color.



Fig. 14: Trough cross bedded sandstone sublithofacies.

8-2-B. Planar cross bedded sandstone sublithofacies

Planar cross bedded sandstone sublithofacies is composed of fine grained sandstone, it was observed at middle part of the Zakho section as in sample (12) and (13). Thickness of this facies is large reaches to (3) m. Thickness of this facies is very small, their color gray (Fig.15).

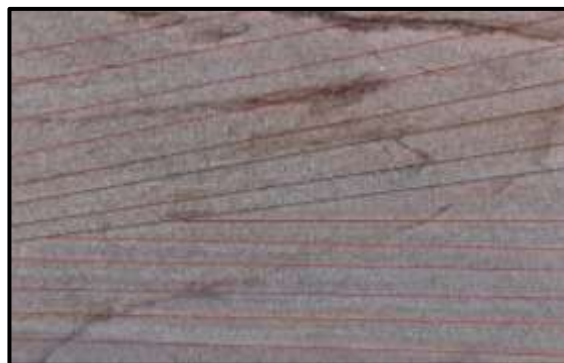


Fig. 15: Planar cross bedded sandstone sublithofacies.

8-2- C. Massive sandstone sublithofacies

This sublithofacies has wide spreading in Injana Formation, this facies mainly consist of sandstone, represented by coarse to medium grain size and poorly sorted sandstone, massive sandstone sublithofacies was existence at lower, middle and upper parts of the sedimentary section. Thickness the facies is large reaches to (30) m, this facies has colour from gray to red, The most important sedimentary structures in this sublithofacies is massive bedding (Fig.16).



Fig. 16:Massive sandstone sublithofacies.

8-2-D.Sandstone sublithofacies contents ripple marks

Sandstone sublithofacies contents ripple marks is one of important lithofacies in the studied section, it was observed at lower part of the Injana Formation, and this facies mainly consist of sandstone, this facies has color from gray to white and content heavy minerals (Fig.17). It hardness is medium to hard, this facies is consists of (ripple marks) very clear (Fig18). Thickness of this facies is small reach to (4) m.



Fig.17:Heavy minerals within sublithofacies contents ripple marks.



Fig. 18: Sandstone sublithofacies content ripple marks

8-3.Gravelly sandstone lithofacies

This facies is small in Injana Formation, it was located in middle part of Zakho section, thickness of this facies is small ranging from (12) to (15) m. This

subfacies gives an interpretation that it is deposition in channel subenvironment (Fig.19).



Fig. 19:Gravelly Sandstone lithofacies.

9. Isopach map of Injana Formation

Eight coordinates of the thickness of Injana Formation in Iraq were taken from the southeast to the northwest. In the current study, we depending on thickness information. It is typical fluvial sediments [4], which were developed by the rapid erosion and uplifted mountains in the north and northeast part of Iraq and the deposition in basins suffering continuous subsidence in basin. (Fig. 20, 21, and 22) shows that the contour lines, depending on this contour map, the thickness Injana Formation more than 300 m in Aqra area while in north Salah Al-Din less than 20 m. Represents isopach map of Injana Formation appears the largest thickness in the north of Iraq (Aqra area), the lowest thickness of Injana Formation in the Al-jernaf section. Represents profile of Injana Formation from NW to SE of Zakho and Zurbatiya areas, Injana Formation has the largest thickness in the Aqra area, which thickness more than 300 m, while the Zurbatiya area has thickness is the lowest, thickness of 110 m. The difference in the thickness of formation, in the Aqra area reached to 314m cause high uplift in source rocks and there is subsidence in the basin in addition to the deposition near from the source. While in north Salah Al-Din reached to 30 m causes low uplift in source rocks and there is no subsidence in the basin in addition to the deposition far from the source.

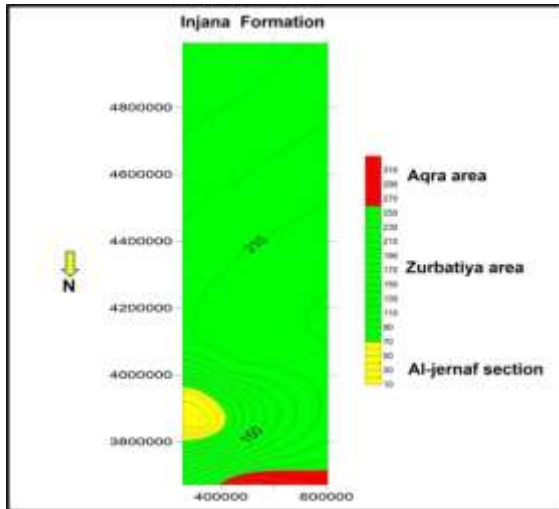


Fig. 20: The contour map of the Injana Formation.

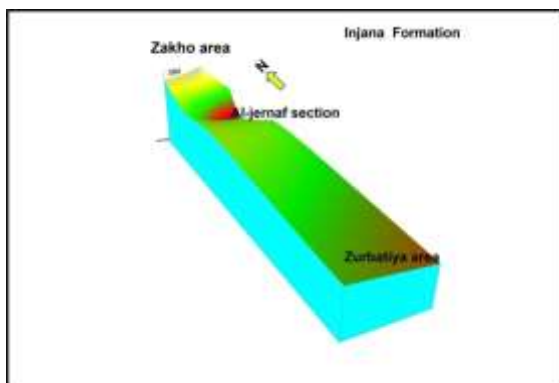


Fig. 21: The contour map of the Injana Formation

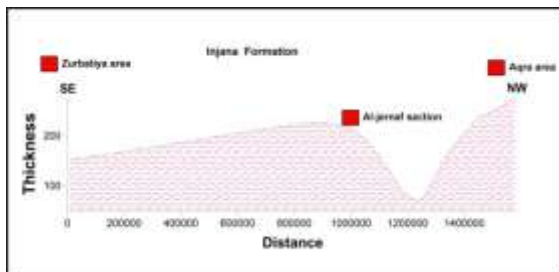


Fig. 22: Profile from NW to SE of the Injana Formation.

10. Sedimentary Model of Injana Formation

Depending on the results in this research and that were observed from sedimentary structures and lithofacies, the ideas were collected for constructing the sedimentary model for how deposition formation of the present study area in the area of (Zakho) in South of Iraq will distinguish it by the sedimentary model. depending on the information in this present study, we worked sedimentary models for injana Formation in the study area. Finally, depending on the information in this present study, we worked sedimentary model for Injana Formation in the study area as in (Fig.23).

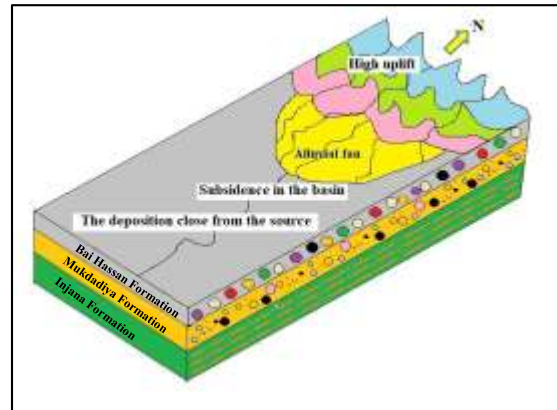


Fig. 23: Depositional Model of the Lat Miocene-Pleocene Formation in Zakho area.

11. The Molasse Basin in Iraq.

During the continent- continent collision between the Arabian plate and the Iranian plate, the Iraqi Molasse basin was formed over the Foreland basin. The Molasse basin includes three formation are Injana, Mukdadiya and Bai Hassan Formations. Injana Formation was deposition in Late Miocene, while Mukdadiya and Bai Hassan Formations were deposition in Pliocene, the areas located in north and northwest of Iraq and it source areas for Molasse rocks as in (Fig. 23) The Iraqi Molasse basin consist of one coarsening upward megacycle[26], this the cycle represented by increasing in size of Injana Formation to Mukdadiya and Bai Hassan Formations. During Miocene started with marine transgression represented by the Serikagni Formation and finished with marine regression represented by the Dhiban Formation, these formation were followed by Middle Miocene and change environments from deep sea to isolated environments, in the end all basins were affected to disappear with the beginning of the late Miocene(Molasse basin), It is transformation point from marine environments to continental environments (Injana, Mukdadiya and Bai Hassan Formations). From the current study, the Molasse sediments are a group of rivers that formed the Injana and Mukdadiya sediments, while the Bai Hassan Formation is a group of fans. The sedimentation history of the Molasse sediments started in the late Miocene, the crease in low uplift cause of creased grains size the low uplift formed a small grain size, such as the Injana Formation, while the high uplift formed a big grain size such as the Mukdadiya and Bai Hassan formations, the high and low uplift may has played role on changing grain size.

Conclusions

The following is a summary of the conclusions that have been drawn from this study:

- 1-The recognized main lithofacies from field studied within from Injana Formation are the mudstone, sandstone and Gravely Sandstone lithofacies.
- 2-The main lithofacies of the formations were divided into several sublithofacies.

3-The lithology were identified in each formation, it composed of the mudstone, sandstone and gravely Sandstone.

4-Many sedimentary structures are observed which are bedding, cross bedding, ripple marks, graded bed, traces fossils, massive bedding, mud balls and channel structures.

5-The floodplain sediments which low energy environments the represented by the mudstone facies, while levee deposits which middle energy environments the represented by the sandstone facies. The channel deposits the represented by gravely sandstone facies high energy environments.

Sedimentary sequence of these facies are meandering rivers environments.

6-Injana Formation was represented by eighteen sedimentary cycles which are finning upwards and this corresponds to with Basi's opinion, [27] is also composed of fluvial finning upwards cycles.

7-The large thickness of mudstone no sedimentary structures gives evidence of the duration of flooding.

8-The Cruziana trace was observed in Injana Formation gives evidence duration of flooding.

9-Drawing a stratigraphic column for studied formation.

10-The thickness of the Injana Formation in Zakho section is about 250m

References

- [1] Beydoun, Z.R., (1993); Evolution of the Northeastern Arabian Plate Margin and Shelf Hydrocarbon Habitat and Conceptual future potential. *Revue de l. Institute Francais du Petrole*, vol.48, p. 311-345.
- [2] Al-Rawi, Y. T., Al-Sayyab, A. S., Al-Jassim, J. A., Tamar-Agha, M. Y., Al-Sammarai, A. I., Karim, S. A., Basi, M. A., Dhiab, S. H., Faris, F. M., and Anwar, F., (1992): New name for some of the Middle Miocene –Pliocene formation of Iraq (Fatha, Injana, Mukdadiya, and Bai Hassan Formations), *Iraq. Geo. Jour*, V. 1, P. 1-18.
- [3] Al-Baidari, A.P.Y., (1997); Sedimentology, geochemistry and assessment of Injana Formation at Al-Najaf-Karbala aera;Unpubl.Ph.D.Thesis, Baghdad Univ, 32-35p.
- [4] Basi, M.A.,2007. Subsurface sedimentological study of Injana Formtion (Late Miocene) in the area extended from Baiji to Samara cities, central Iraq. *Iraq. Bull. Geol. and Mining*3 , p.43-51.
- [5] Jassas H. A. and Al- Sa'ady, Y., (2009): The study of Environmental conditions and Land- Use Land-Cover, In Tersaq Area South East Mandili, Report No. 3252,(GEOSURV).
- [6] Jassim, S. Z. ,and Goff, J. C.; (2006): Geology of Iraq. Dolin, Prague and Moravian Museum Bron, (pub), 525 P.
- [7] Fouad S. F. A. (2014): Tectonic Map of Iraq, Scale 1: 1000000 3rd edition, IRAQ GEOLOGICAL SURVEY. Baghdad, Iraq.
- [8] Jassim, S. Z. ,and Karim, S. A., (1984):.Final report on the regional geological survey of Iraq, vol.4, Paleogeography. Manuscrip report, Geological survey of Iraq. 64 P.
- [9] Al-Naqib, K.M. (1959): Geology of southern area of Kirkuk Liwa, Iraq, Iraq petroleum Company.
- [10] Bellen, V.R.G., Dunnington, H.V., Wetzel, R. and Morton, D.M. (1959): Lexique stratigraphic international, V. 3, Asie Fascicule, 10a-Iraq, Paris, 333 p.
- [11] Al-Juboury, A. I. ;(1994): Petrology and provenance of the upper Fars Formation Northern Iraq. *Acta Geological Universitatis Commenianae* (Slovakia), Vol. 50, PP. 45-53.
- [12] Dunnington, H. V.; (1958): Generation, Migration, Accumulation, and Dissipation of oil in northern Iraq. *Amer. Assoc. petroleum Geologist Habital of oil*, L. G. Weeks (ed), PP. 1194-1251.
- [13] Buday, R.T. (1980): Stratigraphy and paleogeography. In: Kassab, I.I.M. and Jassim, S.Z. (Eds.), *The Regional Geology of Iraq*. V. 1: D.G. Geol. Surv. and Min. Invest., Baghdad, 445 p.
- [14] Enad, T.H., (2007): Stratigraphic and sedimentologic study of the Mukdadiya Formation in Badra area waist Provenance, MSc. Thesis, Baghdad University Unpublished, 136P.
- [15] Deikran, D. B., (2003): the study of finite strain in the Hamrin North FoldCentral Iraq, unpub. Ph. D. Thesis Univ. Baghdad.
- [16] Al- Rubaiay, A. T. and Al- Maamar, A. F. and Hattab, A. A., (2010): Integration of Remotely Sensed Data and GIS Techniques to study lesser Zab River Basin Report NO. 3328.
- [17] Mc.Geary.(2007): physical geology, Emeritus of California state University at Sacramento. p 615.
- [18] Selley, R.C.,(1976): An Introduction to Sedimentology. Academic Press, London.417p.
- [19] Tarbuck, E. J. and Lutgens, F. K.; (1984): An Introduction to physical Geology.Elga Scientific Publication Ltd. Valletta. Malta. P629.
- [20] Pettijohn, F.J., Potter, P.E. & Siever, R. (1987): Sand and Sandstone. Springer-Verlag, New York. P533.
- [21] Reineck, H.E. & Singh, I.B. (1980): Depositional Sedimentary Environments (2nd edition). Springer-Verlag, Berlin.
- [22] Boggs, S.J.,(2006): principles of Sedimentology and Stratigraphy, Pearson prentice-Hall, 662p.
- [23] Tucker, M.E., (1988); Technique in sedimentology. Black Well. Oxford, 394p.
- [24] Selley,R., C., (2000); Applied sedimentology, Academic Press., London, 521p.
- [25] Al-Dahaan, S.,(2020): Sedimentary Rocks, Al Najaf Al Ashraf Province. Iraq. p 360.
- [26] Adeeb, H.G., (2006) Tectogenesis of the Alpine Molasse Basin in Northern Iraq. Unpublished Ph D. Thesis. University of Mosul, 204p.
- [27] Basi, M. A.(1973): Geology of Injana area, Hemrin South. M.Sc. Thesis. Baghdad University.

دراسة التراكيب الرسوبية و السحنات الصخرية لتكوين انجانة في مقطع زاخو شمال غرب العراق

حسين زكام احمد، عبدالسلام مهدي صالح، لفقة سلمان كاظم

قسم علوم الارض التطبيقية، كلية العلوم، جامعة تكريت، تكريت ، العراق

الملخص

الدراسة الحالية لتكوين انجانة(المايوسين المتأخر) في منطقة زاخو شمال غرب العراق، البحث اعتمد بشكل رئيسي على الملاحظات الحقلية لمكشف تكوين انجانة في منطقة زاخو، السحنات الصخرية تتكون بشكل رئيسي من طبقات الحجر الرملي والحجر الطيني و حجر رملي حصوي، تكوين انجانة صنف الى عدد من السحنات الصخرية اعتمادا على الخصائص الفيزيائية مثل اللون و الصلابة و الحجم الحبيبي والفرز، السحنات الصخرية في التكوين مختلفة السمك. الدراسة توصلت بان تكوين انجانة يمثل ثمانية عشر دورة رسوبية تنعم نحو الاعلى. ومن اهم التراكيب الرسوبية التي لوحظت في التكوين هي التطبق و التطبق المتقاطع و علامات النيم و التطبق المتدرج و المتحجرات الاثرية و الكرات الطينية و التطبق الكتلي، وهذه التراكيب الرسوبية تعطي دليل على عمليات النقل والبيئات الثانوية لتكوين، توصلت الدراسة بان تكوين انجانة ترسب في بيئة نهريّة (انهار التوائية)، ان السمك الكبير في بعض الطبقات وخلوها من التراكيب الرسوبية وتواجد المتحجرات الاثرية تعطي دليل على فترة طغيان مائي.