Stratigraphy and Lithology of the Avroman Formation (Triassic), North East Iraq

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(Received 6/6/2006 , Accepted 20/9/2006)

ABSTRACT

Stratigraphy and lithology of the Avroman Formation (Triassic) were studied in Iraq and Iran. The study introduced new documentations about stratigraphy, lithology, fossil content and environment of deposition. Stratigraphically, it is very difficult to study the formation due to intense deformation, imbrication and even thrusting. However, it overlain by Qulqula Radiolarite Formation and Merga Red Beds in Iraq and Iran respectively while the underlying formation is not known as the lower boundary is not exposed. Lithologically, the formation consists mainly of pure limestone and no dolomite and marly limestone as previously mentioned. Microfacies include; grainstone, packstone and wackestone with association of oncoids, pelets, oolith and bioclasts. The fossils are relatively rare (except stromatolite or oncoids) and include gastropods, pelecypod green algae, echinoderms and forams. Environmentally, the formation was deposited in shallow isolated platform which was characterized by agitating warm normal marine water.

الطباقية والصخارية لتكوين أفرومان (الترياسي)، شمال شرق العراق

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الملخص

تمت دراسة الطباقية والصخارية لتكوين افرومان (الترياسي) Avroman Formation من الناحيتين المختبرية والحقلية داخل العراق وايران. ادخلت هذه الدراسة معلومات جديدة حول الطباقية والصخارية ومحتوى المتحجرات وبيئة الترسيب للتكوين. من الصعب دراسة التكوين من الناحية الطباقية بسبب التشوهات الحركية من بينها التراكب والزحف. كما تم ملاحظة تكوينين مختلفين يعلوان التكوين وهما تكوين قولقلة والطبقات الحمراء تابعه لوحدة مركة (Merga Red Bed) داخل العراق و ايران على التوالي اما حد السفلي فطبقاتها غير معروفة بسبب عدم انكشاف على السطح. من الناحية الصخارية يتكون التكوين من الحجر الجيري النقي ولا يحتوي على معدن الدولومايت وحجر المارل كما ذكر سابقا. تتالف السحنات الدقيقة من

الحجرالجيري الحبيبي والواكي والرصوص والمتكونة من ترافق المكونات التالية: الدمالق، الانكوليث، السرئيات والفتات الحياتي كما ويحتوي التكوين على القليل من المتحجرات والؤلفة من بينها (ماعدا stromatolite او oncolite) بطنية القدم وشوكية الجلد والطحالب الخضراء والفورامنيفرا. ترسب التكوين في بيئة ضحلة على منصة منعزلة ذات بيئة مائية دافئة ومتحركة.

INTRODUCTION

Avroman Formation is introduced by Bolton (1958) in Buday (1980) consists of a sequence of light colored, thick bedded, partly crystalline limestone with interbeds of marly limestone. He mentioned also that the age is Upper Triassic (Carnian and Noric) and has the thickness of about 600 m. Till now no type section is defined for the formation. In the tectonic subdivision of Iraq, Jassim et al. (1987) put the Avroman limestone in the Qulqula-Khuakurk Subzone and gave it the rank (status) of formation. They indicated its outcrops in the northeast Iraq, on the border with Iran where the Suren and Avroman Mountain (or locally called Shakhy Awraman) summits coincide with the border with Iran (Fig.1). In Iraq, the outcrops are located to the north of Said Sadiq, Khurmal and Tawella towns.

The aim of this study is to record and explain new data of the formation that are found in the filed which are concerning fossils content, stratigraphy and lithology. All these are used to indicate the environment and paleogeographic of the basin in which the formation was deposited.

STRATIGRAPHY AND LITHOLOGY

During several field trips which aimed to study the distribution areas of outcrops in Iraq and Iran, it was observed that the stratigraphy of the formation is obscured by intense deformation inside Iraqi borders and by metamorphism in the Iranian territories. The deformation caused the imbrication and possible thrusting and sliding of the rock, so that it is difficult to identify the lower, middle and upper parts of the formation. Sliding of many large blocks of limestone of the Avroman Formation is common. They slid toward southwest and now rested on either Qulqula Formation or on outcrop of Avroman itself. In future work it is important to find and describe a type section for the formation. Now this work is difficult because of mine field that cover few outcrops of the formation. The formation is exposed along the summit and upper slope of the Avroman and Suren mountains (Fig.3). Structurally, these mountains consist of deformed and unidentified anticlines. The lower boundary and some thickness of the lower part of formation are not exposed. Therefore, the stratigraphy of the formation is not clear. The upper boundary is tectonic and erosional and the formation is overlain apparently by two different rock units. In Iran (near the border with Iraq), it is overlain by Merga Red Beds (or may be Red Bed Series) which could be seen directly to the north of the border inside a small syncline on the summit of Suren anticline (Fig. 1 and 2). The boundary in this locality is erosional and sharp which shows long time of gap that extend from Upper Triassic to Miocene.

Merga Red Beds crop out as a strip which extending from southwest of Penjween town and end when they enter the Avroman mountain for two kilometers. They consist of red claystone sandstone and lensoidal conglomerate (Fig.1, 2 and 3D). In Iraq, it is overlained by Qulqula Radiolarite Formation which consists of alternation of thick packages of radiolarite cherts, shale and bituminous limestone. This formation is exposed along lower slope of southwestern side of the Avroman mountain which can be seen to north of Nawe, Kani Askan, Bardabal, Tazade, Gulla Khana, Zargat and Walasmit villages. The boundary of the Avroman Formation with Qulqula Radiolarian Formation is most possibly tectonic represented by thrusting of latter formation on the former one.

The studied lithology in field and under polarized microscope show many differences with that originally specified by the Buday (1980). These differences include absence of marly limestone and recrystallization. Field observation and thin section study showed the following facts:

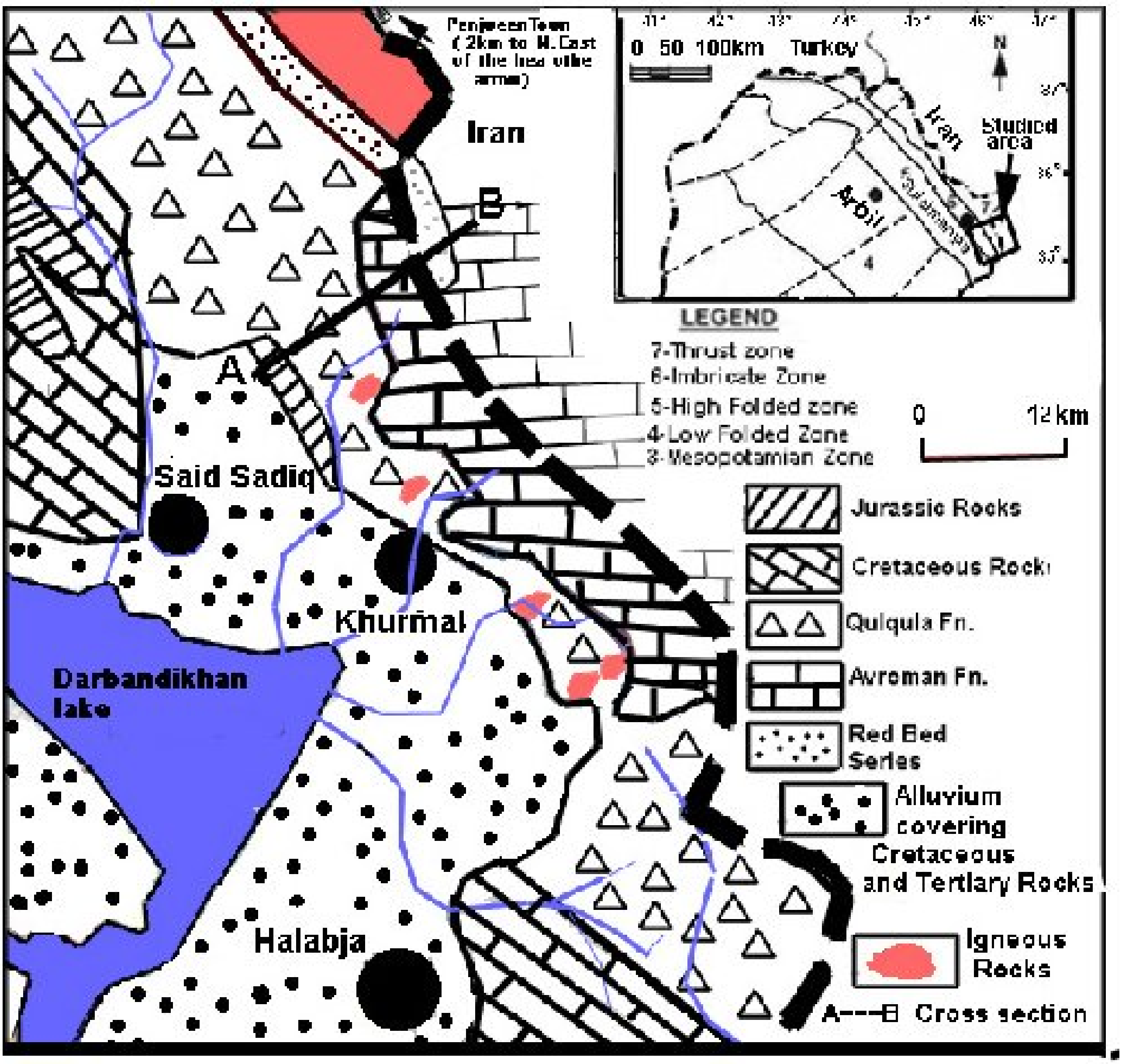

Fig. 1 : Location and Geological map of the studied area showing distribution of outcrops of the Avroman Formation inside Iraq and Iran. The A---------B bold line is representing the direction of the geologic cross section in the fig.2. (Modified from Sissakian, 2000).

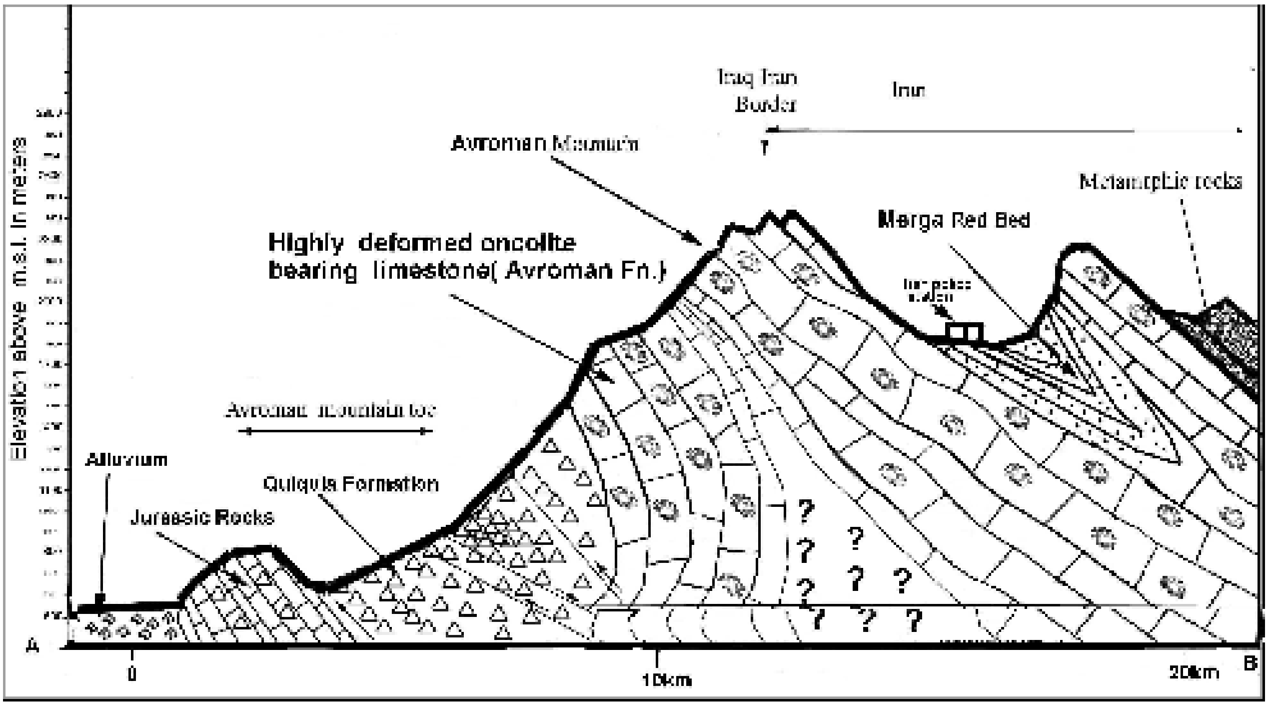

Fig. 2 : Geological cross section of the Avroman Mountain inside Iraq and Iran (modified From Ali and Ameen, 2005). The minor deformations are not shown.

1- The lithology is entirely composed of nearly pure limestone which has strong reaction with dilute HCl and no any marly limestone sequences or beds are recorded earlier inside Iraq and Iran (Figs.2 and 3).
2- The rock consists of microfacies of grainstone, packstone, wackstone and mudstone which contain all or one of the following allochems: oncoids, ooids, pellets and bioclasts. The rock of the formation show very little recrystallization so that the original constituent can be identified clearly (Fig. 4, 5, 6 and 7) under microscope or in hand specimens (Fig. 4, 5, 6 and 7). The constituents, both matrix (micrite) and allochems have sharp contact and show no diffused boundaries and ghost structures.
3- Instead of crystallization nearly all samples show intense fracture on microscopic and mesoscopic scale (Figs. 4 and 7). These fractures, in some cases, are so dense that transformed into breccias. But, in spite of this, the boundary between the clasts with theirself and the matrix is sharp.
4- All the factures are filled with coarse crystalline secondary calcite so that the rock is now sound and hard.
5- In many places both Avroman and Qulqula formations are mixed, as can be seen to the east of Zargat Village. So the previously mentioned marly limestone may be included in the latter formation.

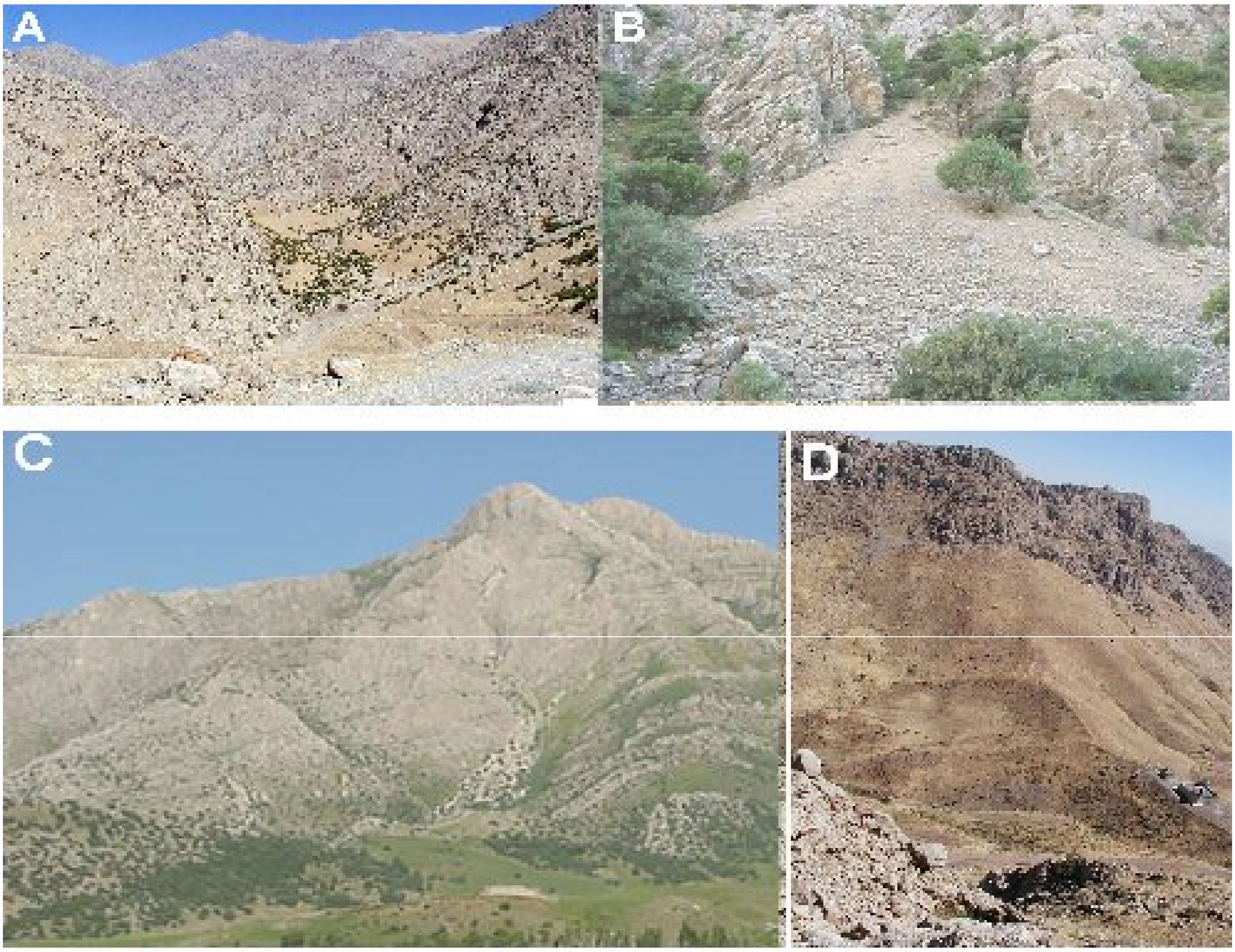

Fig. 3 : General view of the Avroman Formation outcrops in Iran and Iraq.

A). On the southwestern side of Avroman mountain, 3km north of Khurmal town in Iraq.

B) Outcrops in Iran, 5km south of Marwan (Marvan) Town, physical weathering is formed a talus cone.

C) Outcrops in Iran, east of Dezli village.

D) The photo is representing a small syncline on the summit of Suren Mountain where Merga Red beds in exposed on the Avroman Formation; the Iranian police patrol building is 50m X 50m.

FOSSIL CONTENTS

The most common fossil skeletons are the following:

Oncolites:

Oncolites are a type of stromatolite that found in the formation and consist of spherical structure (SS-type). The concentrically arrangement of laminae around a nucleus is developed when nucleus is rolled freely. The nucleus may be shell fragments or sand grains. This type of stromatolite is called oncoid which formed by processes of trapping and binding of sediment by microbial organism such as primitive blue green algae (Cynaobacteria) and fungi with the aid of direct precicipitation of carbonate minerals (Hoffman, 1976; Pettijohn, 1975; Blat et al., 1980 and Selley, 1988). The comparisons of the oncolites in literatures with that of the present study showed that the oncolite of the present study have nearly the same characteristics and shows better developed in form than those can be seen in the websites. This is because they have nearly spherical shape and the laminae are more concentric and continuous (Fig. 4 and 7). The elongated oncolites are developed on elongate nuclii only (Fig. 7). Sometimes, composite oncolites are formed and consist of several smaller bodies grown together and enveloped by lamina of later growth. Moreover, their size ranges gravel coarse sand (3cm to 2mm) (Fig. 4 and 7). In many cases, the oncolites show fracturing and micro-faulting (Fig. 7B, C and G).

Ooliths:

Ooliths and pisoliths are smaller than oncolites (0.5-2 mm) and the lamina are formed by chemical precipitation of calcium carbonate. In the present study, ooliths exist with oncoids could be formed by a process of organic accretion. Tucker (1991) referred to the possibility of development of ooliths by organic precipitation and he called them micro-oncoids (Fig.6).

Other fossils:

Other recorded fossil and their skeletons associated with the oncolite and ooliths are calcareous solitary green algae, gastropods, echinoderm and forams (Fig.5). The recorded bioclasts include echinoderm plates and spines.

ENVIRONMENT OF DEPOSITION

Most of the studied samples that contain oncolites belong to grainstones which are characterized by filling of the intergranular pores with spary calcite instead of micrite. According to the classification of Dunham (1962) and Folk (1962) the name of this microfacies can be called oncolite- ooliths grainstone and oncolite oo-sparite. According to these authors the depositions of these rocks occur in shallow environments that characterized by more or less agitating and warm waters. It is possible that some ooliths are transported to deeper water where the large oncolites exist in less agitating water. According to the classification of Hoffman (1976) the low domal and planar stromatolite are found in protected tidal flat while the columnar stromatolites exist in the inertidal and subtidal environments. In Iraq, Salae (2001) studied stromatolites in Barsarin Formation, west of Dokan Dam. He found many types of stromatolites such as flat type, blister and stratiform stromatolites. He showed that these stromatolites are mainly grown in intertidal and subtidal environments.

The oncolites, as unattached stromatolites are produced by mechanical turning or rolling which expose new surfaces to algal growth. Galner (2002) found oncolite in shallow water that intermittently exposed to meteoric water in rocks of Silurian of Gotland, Sweden. Dozet (2000) found oncolite in the Jurassic rocks of Central Slovena in micritic limestone with other fossils such as coral, sponge, gastropods, pelecypods echinoderm, foraminiferas and algae. In the present study, most of these fossils that are mentioned by the latter authors are found in rocks of Avroman Formation (Fig.4, 5, 6 and 7). Whalen, et al. (2002) discussed in detail the growth of oncolites in wide range of platform facies and large oncolite occur in fore reef and slope facies. They showed that, on the platform, a deposition of these structures is more common during TST than other system tracts. The absence of clastic interlayers between the pure limestone beds in addition to the mentioned microfacies and fossils implies that the formation was most probably deposited on isolated platform with warm and more or less agitating water. It is possible that it grades to calm deepwater below fore slope in which mudstone may be deposited (Fig. 8). This assumption agree with result of the study of Sadooni and Alsharhan (2004) whom mentioned that major transgression was occurred during Middle Triassic and shallow marine carbonate sedimentation is prevailed in stead of clastics at the east of Rutba–Khleisia high which include (in a regional scale) the area of present study. Lehrmann et al. (1998) discussed in detail Triassic isolated platform in South China under the name of Great Bank of Goizhuo. The fossils and facies of this platform can be compared with the f with that of Avroman Formation especially the oncoids and oolith bearing facies.

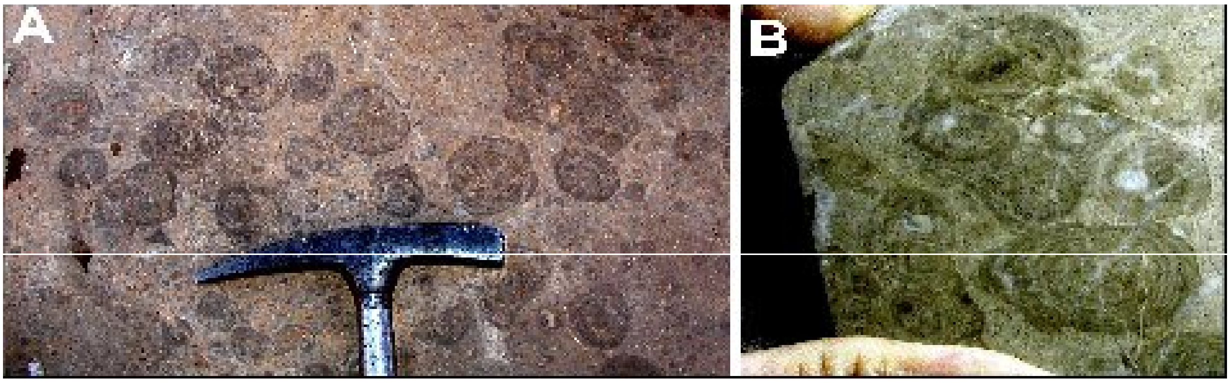

Fig. 4 : A: Simple and composite oncoids in the limestone of the Avroman Formation as seen in polished slabs.
B: The well developed laminae can be seen, some time disrupted by post depositional fracturing.

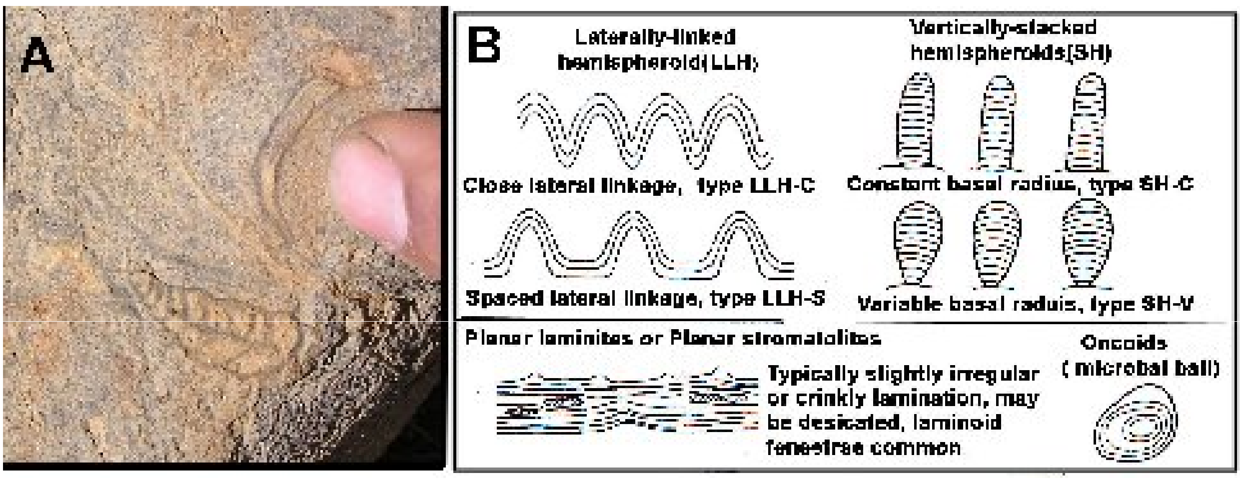

Fig. 5 : A: hand specimen of bioclastic limestone of the Avroman Formation containing skeleton of gastropod and fragment of pelecypod.
B: Classification of stromatolite by Logan et al. (1964 in Tacker, 1996). In the present study the last one: oncoids (microbal ball) is found.

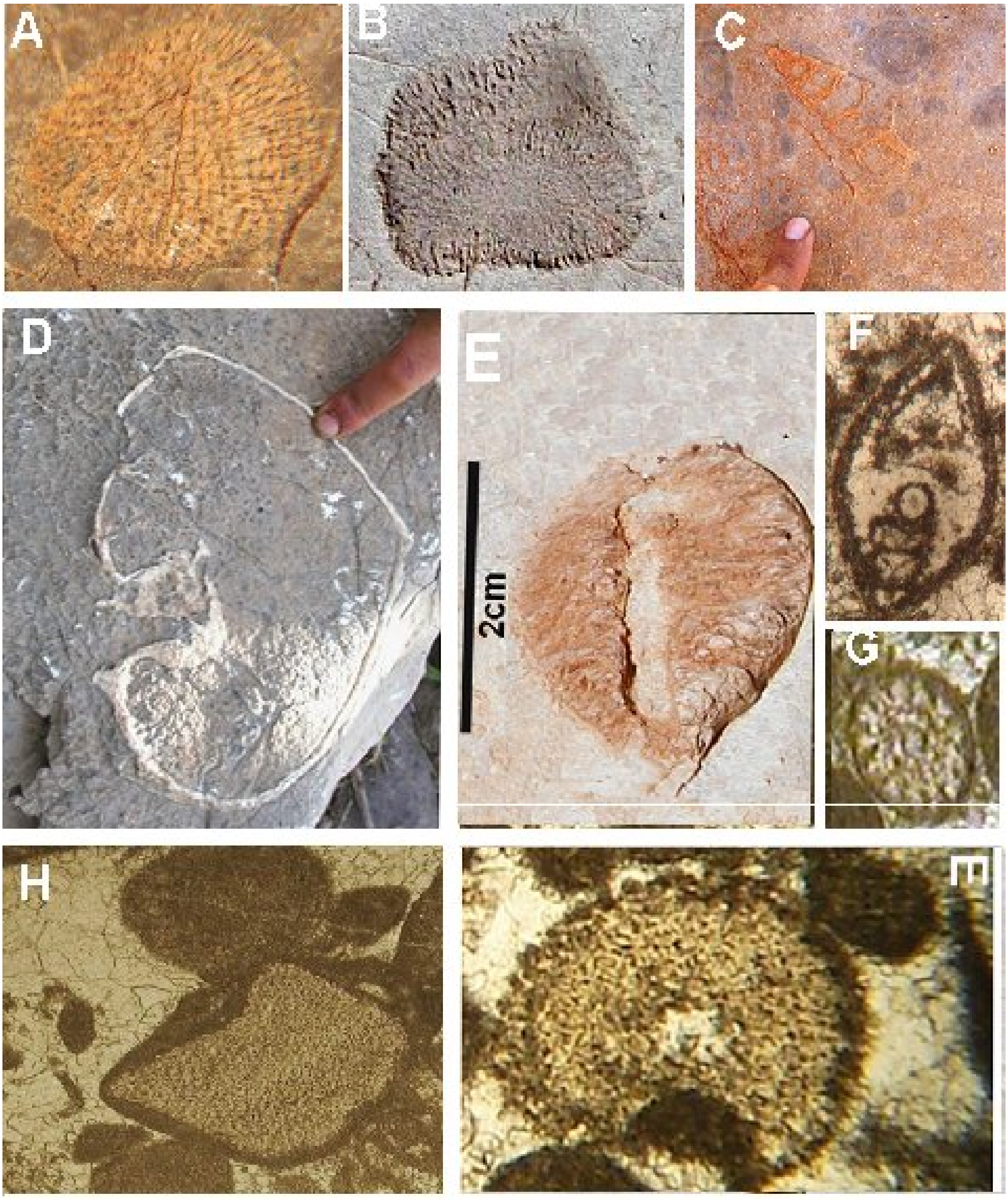

Fig. 6 : Different types of fossils and their bioclasts in Avroman Formation.
A and B: solitary colony of green algae, X5.
C: Gastropod shell in oncolites bearing limestone.
D and E: two different type of echinoderm.
F: Unknown foraminifera, X20, PPl.
G: Cross section of green algae steam, X30, PPL.
H and I: Echinoderm plate and spine cross section, PPL X30, X50.

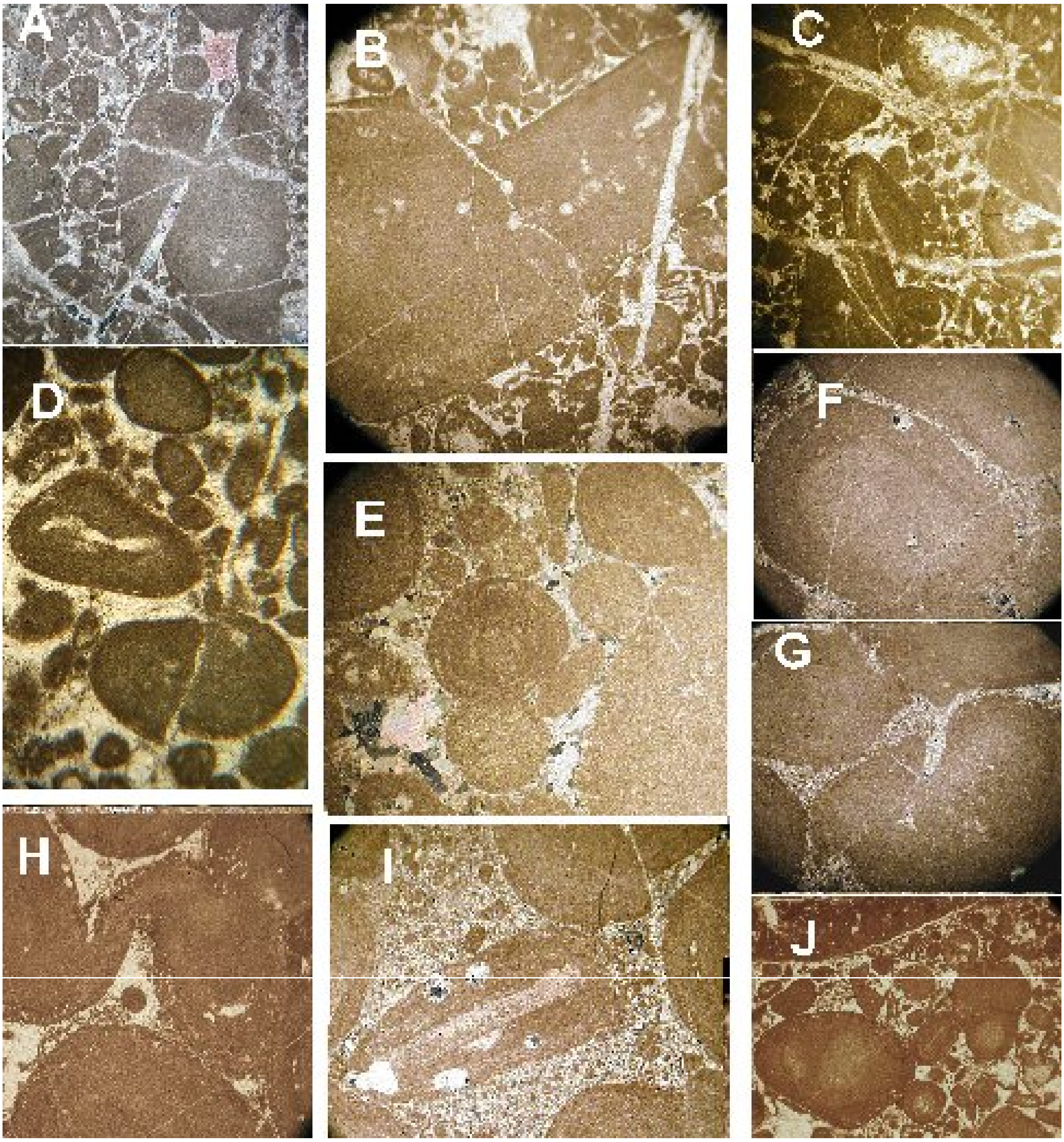

Fig. 7: Different types of oncolites and ooliths as seen in thin section under plane polarized light.

A: Fractured oncolite in grainstone X5.

B: Faulted oncolite in grainstone (down throw is perpendicular to paper) X8.

C: Faulting of elongate oncolite in peletal grainstone, X 5.

D: Faulting of oval oncolite in oncoilte –peletal grainstone, X8.

E: Well developed oolith (in the center) in the rock of oncolite –oolitic grainstone, X8.

F and G: Well developed oncolite with micritic nucleus, X8.

H: Synsedimentary plastic deformation of oncolite X10.

I: Elongate oncolite in grainstone which is nucleated around a shell fragment, X8.

J: Peletal and oolith grainstone, X15.

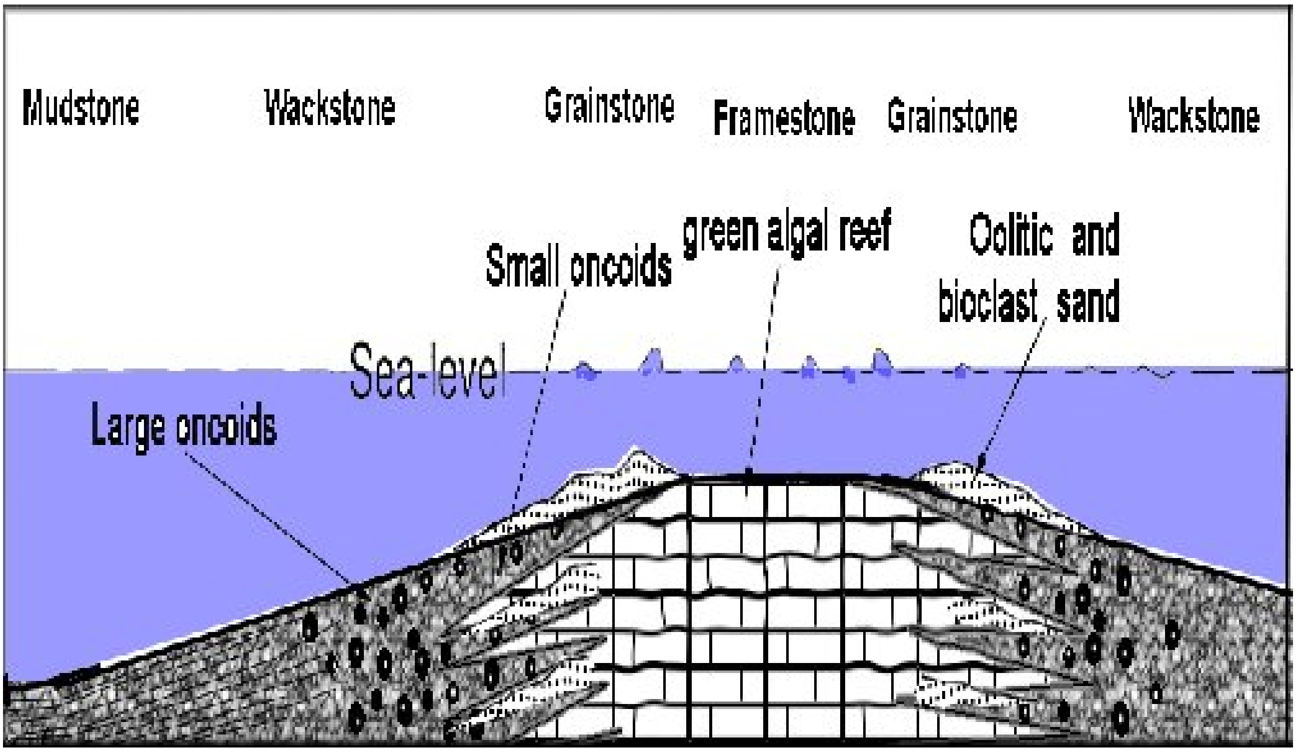

Fig. 8 : Isolated platform, a suggested environment for Avroman Formation showing where the large oncoids, ooids are developed.

CONCLUSION

This study has the following conclusions:

1- The formation is composed of pure limestone without marl and dolomite

2- The formation is overlained by Qulqula Radiolarite Formation and Merga Red Beds in Iraq and Iran respectively; whereas underlaying formation is not exposed.

4- The main constituents of the formation are oncolite, oolith, pellet and fossils.

5- The environment of the deposition was shallow which is represented by an isolated platform with agitating water.

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