TYPES OF STROMATOLITES IN THE BARSARIN FORMATION (EARLY JURASSIC), BARZINJA AREA, NE-IRAQ

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Key words: Barsarin Formation, stromatolite, Jurassic, lagoon, Iraq, Barzinja area

ABSTRACT

The present study aims to recording and describing, for the first time, the occurrence of Barsarin Formation in the Barzinja area (north east of Iraq) and to provide more details on the limestones succession that is contain both laminated and nodular massive beds. 68 samples have been collected from this succession of which more than 68 thin-sections have been obtained and studied under binocular and polarized microscope. Based on the thin sections studies and field observations in the outcrop, it is proved that both, laminitic and massive limestones are belonging to cryptalgal stromatolite. Morphologically, the examined stromatolites can be divided into four types: 1-planer, 2-wavey, 3-Columnar and 4-Spheroidal (oncoidal) stromatolites. The first two types occur as laminated limestone (mat) while the other two types form more or less massive limestone beds. The formation as a whole was deposited in a semiclosed lagoon (as a part of rimmed shelf) of an attached carbonated platform which is persisted in a low energy lagoon. The laminitic and massive limestones were deposited in protected lagoonal within an intertidal and subtidal environments respectively. The lower part suffered from short duration of wave agitation and bioturbation which represented by occurrence of rip up clasts around which oncoids are grown.

انواع الستروماتولايت في تكوين بارسارين(جوراسي المبكر) في منطقة برزنجة ، شمال شرق العراق

هيام صالح داود و كمال حاجي كريم

المستخلص

ان الهدف من هذه الدراسة هو استكشاف و وصف ، لتكوين بارسارين للمرة الأولى في منطقة برزنجة (شمال شرق العراق) وكذلك محاولة الوصول إلى معلومات وافية حول تعاقب الحجر الجيري الرقائقي والعقدي. تم أخذ ثمانية وستين عينة من المقطع و تم عمل نفس العدد من الشرائح الرقيقة حيث تمت دراستها تحت المجهر العادي والمجهر المستقطب. استنادا الى دراسة الشرائح والملاحظات الحقلية فقد تم التوصل بان كلا النوعين من الحجر الجيري الرقائقي و الكتلي المتماسك ينتميان إلى الستروماتولايت الطحلبية التي تنقسم حسب شكلها الظاهري إلى اربعة أنواع:

1-مستوية، 2- تموجية ، 3- عمودية، 4- عقدية. الستروماتولايت المستوية والتموجية تشكلان الحجر الجيري الرقائقي بينما العمودية والعقدية تشكلان الحجر الجيري الكتلي المتماسك. بيئيا، ترسب التكوين في بحيرة شاطئية شبه مغلقة (semi-closed lagoon) كجزء من الرف القاري الكاربوناتي. في هذة البيئة ، ترسب كلا النوعين من الحجر الجيري (الرقائقي و الكتلي المتماسك) في بيئتي البين مدية وتحتالمدية على التوالي. فالجزء السفلي من المقطع قد تعرض لفترات قصيرة للامواج وكذلك التعكرات الحياتية حيث يظهر ذلك واضحا من قلع الحبيبات(بواسطة الامواج) التي تشكلت حولها بعد ذلك الستروماتولايت العقدية.

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INTRODUCTION

This paper focuses on laminated and nodular limestone of Barsarin Formation (Upper Jurassic) from northeastern Iraq. The studied area is located 2 km to the northeast of Chinara village, about 10 km to the east of Barzinja Town (Fig.1). According to the tectonic classification of Iraq by Buday and Jassim (1987), and Jassim and Goff (2006) this area is located in the Imbricated Zone and consists of large and small anticlines which are overturned towards southwest (Fig.2). The Zagros Thrust boundary is no more than 5km far from the studied section. The sampled section runs along a road cut which is located about 1km north to Bywak village (Fig.1 and 2). Where the terrain conditions permit, other sections are examined such as the one located south and east of Chinar village but they are partly exposed. A total number of 70 samples have been collected, and petrographically investigated. According to Bellen *et al* (1959), the Barsarin Formation was defined by Wetzel in 1950 in unpublished report. The type section is located near the Barsarin village in the Rawanduz area (Erbil Governorate), approximately 200 km to the northwest of the studied area on the same mountain chain.

The studied section has thickness of about 63 m, which increases and become more massive toward west, while in Ru Kuchuk the thickness reaches 60 m and consist of limestone, dolomitic limestone with laminated and fluffy textures with brecciated and folded beds. Jassim and Goff (2006) attributed the existence of breccias to dissolution of anhydrite which observed in some outcrops in Ser Amadya and Kurrek Mountains (Bellen *et al*., 1959). According to these authors the environment of this formation is lagoonal often evaporitic. They have not found fossils due to strong recrystallization and dolomitization.

ORIGIN OF THE LAMINATIONS

Most of the studied section except lower part consists of the very thinly laminated limestone with few meters of massive limestone beds (Fig. 4 and 5). These laminations are the most diagnostic features of the limestone in the section and can be recognized in both hand specimens and in thin sections. The lamination consists of regular alternation of light and dark grey dolomitic and partially recrystalized limestone (Fig. 4B and C). The thickness of these laminae ranges between 3 mm to several cm. The lamina are parallel and either planar or more or less crinkled (Fig.6).

The boundaries between the laminae are sharp, due to the pressure solution and formation of stylolites. The constituents of the laminae (as a whole) are highly modified by recrystallization, dolomitization and pressure solution. The dark and light laminae are only distinguishable in some thin section due to recrystalization while the stylolites are well observed in the thin section than in hand specimens. But the laminae, when seen by naked eye or hand lens, seem to be well differentiated by surface weathering, by which the light lamina appear as granular (silty) zones, while the dark ones show smoother and clotty texture Fig. (6C). The present appearance of the stromatolites and their modification are similar to what shown by Park (1976) in the figure (7). Therefore, there is no direct information that may show specific microbes that may have been responsible for this stromatolite. But the microbial or bacterial origin is clear from columnar and oncoidal stromatolite that is shown in the figure (7 and 8). The pressure solution is generated low amplitudes sharp peaked stylolites which run parallel to the laminae (Fig.5A and B). In lower part of succession the laminae consist of pure micritic carbonate although now transformed to coarse crystals. This part has few massive beds which contain ostracods and ostracod fragments (Fig. 5, 6D and 10B).

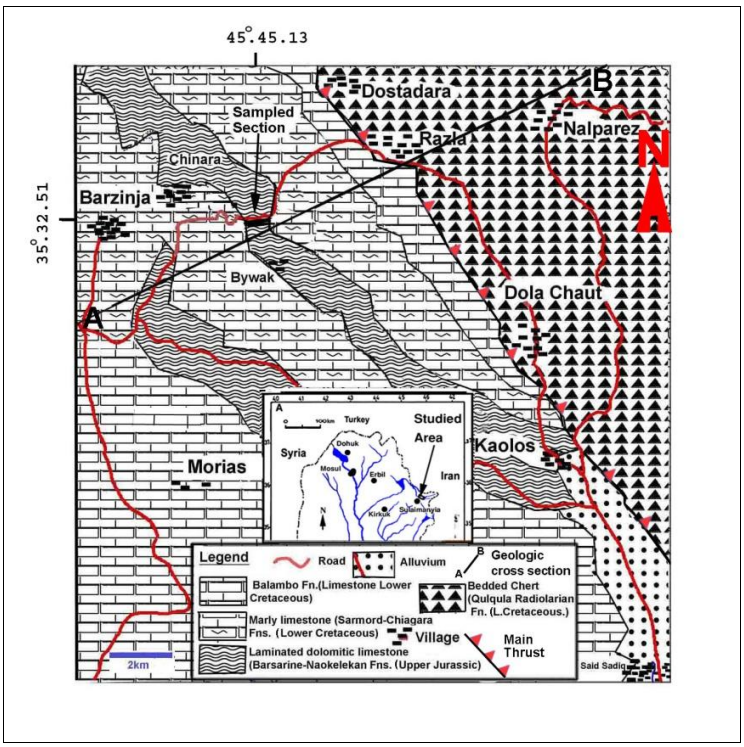

Fig.1. General geologic map of study area showing location of studied section (From Sissakian, 2000)

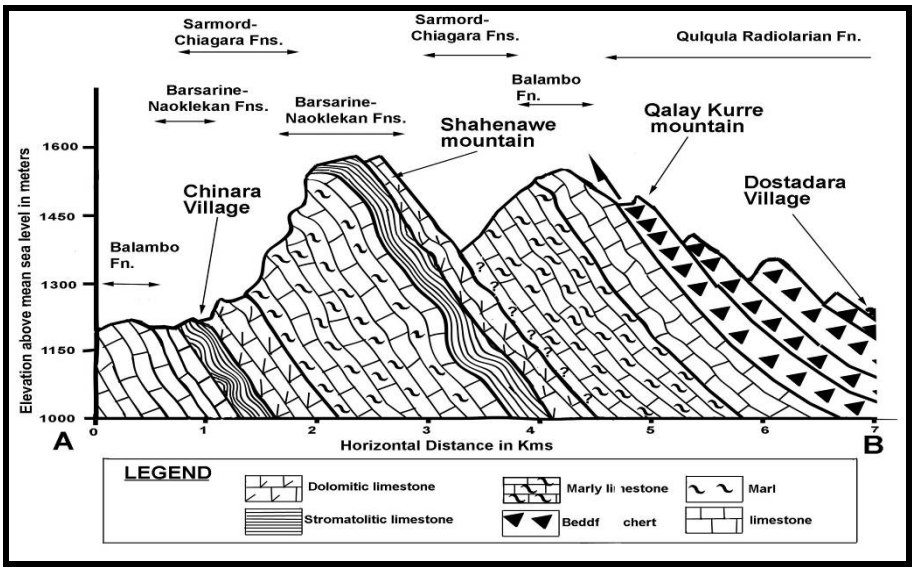

Fig. 2: Geologic cross section passing through the studied section (Note the overturned beds: in the left side)

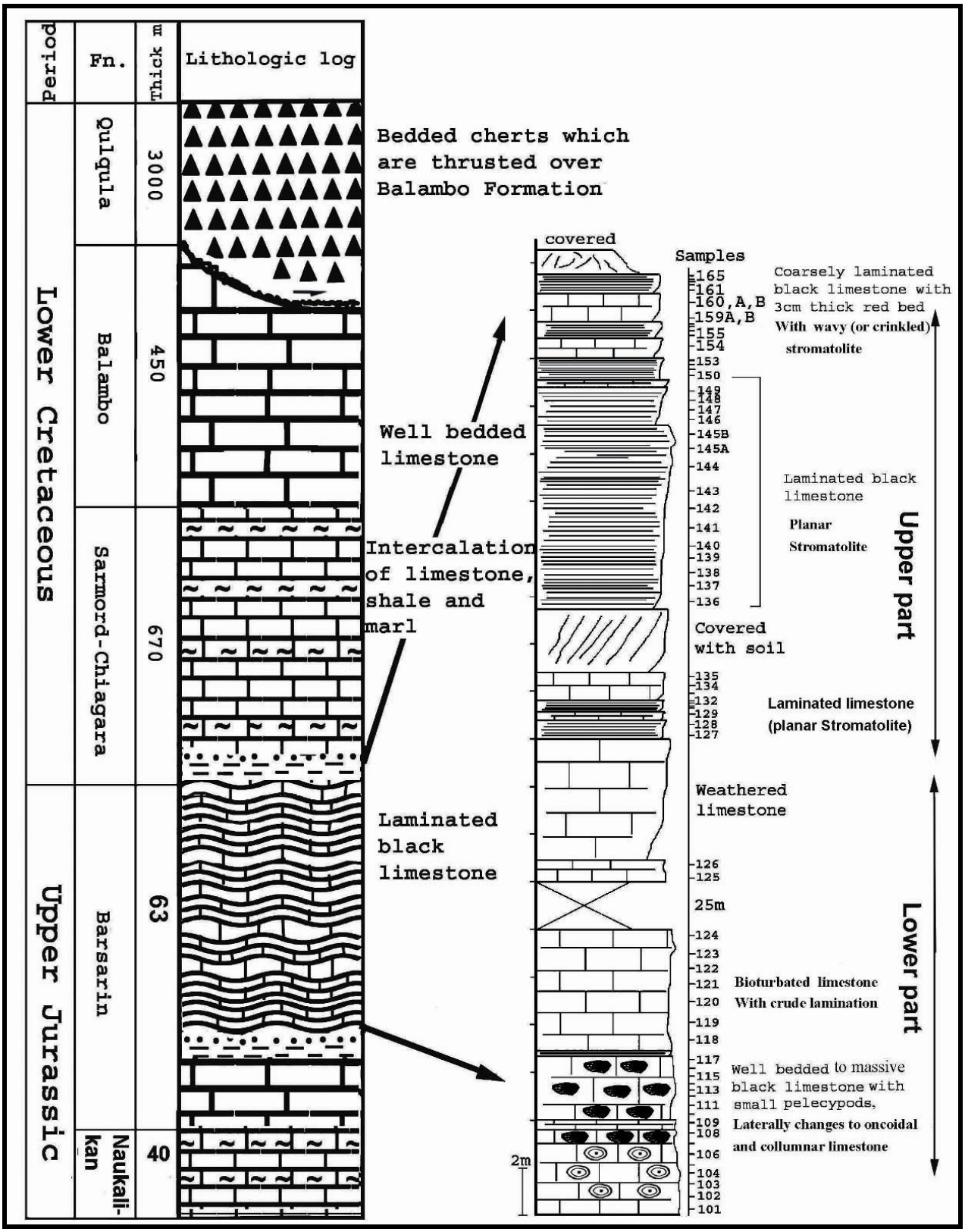

Fig.3: Stratigraphic column of the studied section with location of the samples

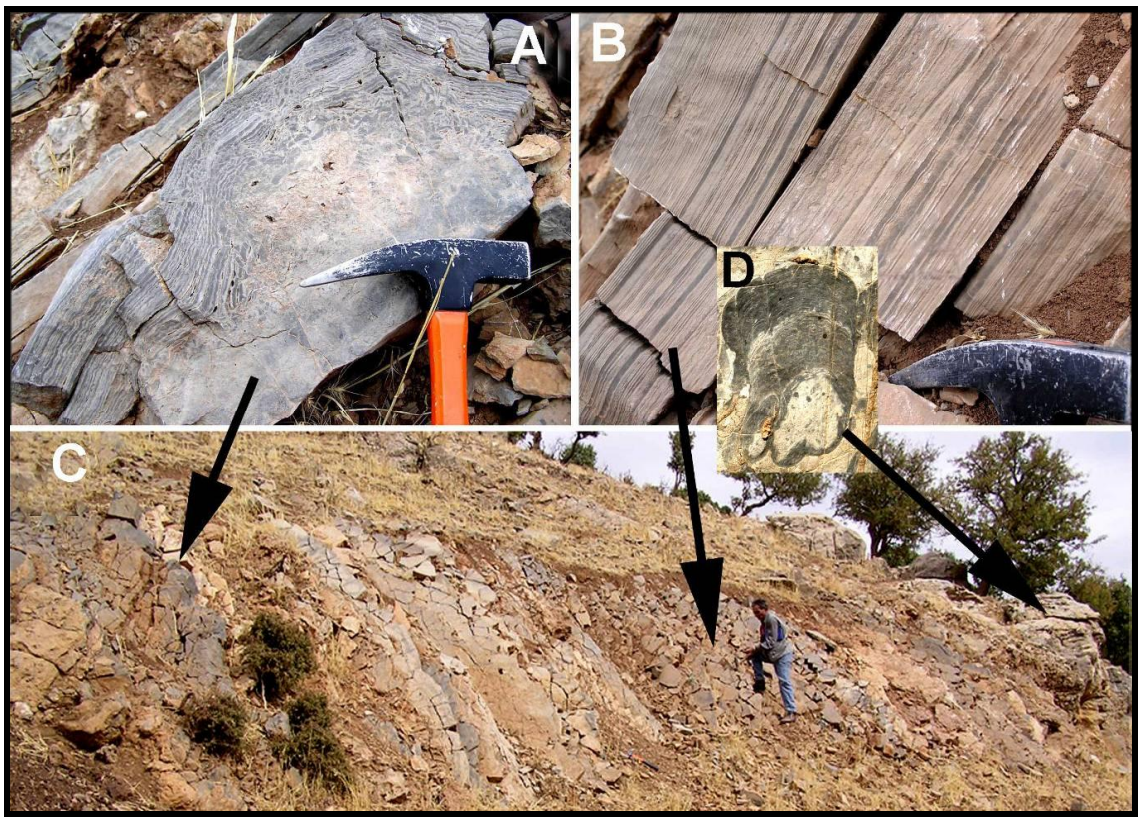

Fig.4: A) disturbed and wavey stromatolite near the top of the formation. B) Planner stromatolite (laminitic limestone) in the upper part of the formation. C) Part of a sample section showing the planer and crinkled (wavy) stromatolite. D) Hemi-spheriodal stromatolite in the lower part of Barsarin Formation.

Fig.5: The lower part of the section showing the massive interval which contains oncoids and

columnar stromatolite. It is located about 150m to the west of the sampled section.

The massive beds change laterally at the distance of 150m to nodular limestone and the thickness of the beds increase. The inspection of the nodules showed that they consist of oncoidal and columnar stromatolites. The oncoids were developed around white irregular rip-up limestone clasts. The laminae of the oncoids are dark grey or black. The asymmetrical growth of the oncoid forms columnar stromatolite (Fig.9). The microfacies of the formation belong to bindstone and sheetstone when the classification of Dunham (1962) and Insalaco (1998) are considered respectively. The possibility of some buffling exists too especially in the lower part of the section which contains some columnar stromatolite.

The laminated sediments show small corrugation and irregularities in thickness in upper part which serve to distinguish them from the laminae deposited purely by physical processes in lower part of succession (Tucker, 1996). The presence of two types of laminae implies changes of the nature or size of the carbonate material that are deposited through time. These changes in types of the sediments may be achieved by currents or by variation in the types of organisms that lived and accumulated at a given place (Blatt *et al*. 1980). The uppermost part of the section contains a red layer (5 cm thick) and gypsum pseudomorph in the form displaced elongate calcite crystals analogous to satin spar gypsum. In the Ranya area, at 140 km to the northwest of the studied area, Salae (2001) studied stromatolite and attributed the origin of these laminations in Barsarin Formation to algal mat. He found many types of stromatolites such as flat type, blister and stratiform that are mainly grown in intertidal and shallow subtidal environments.

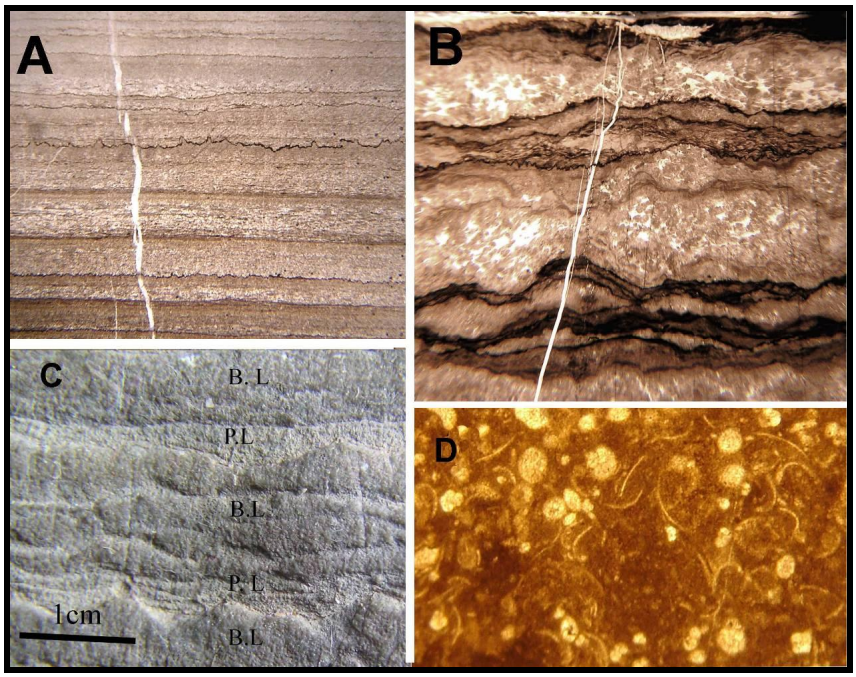

Fig.6: A) planar stromatolite (laminitic limestone) which has being dolomitized and changed into stylolaminated due to pressure solution (x 10 N.L). B) Disrupted and amalgamated crinkled stromatolite with low amplitude stylolite (black lines), the white spots are deformed birdseye's structures(x 10 N.L). C) Weathered hand specimen showing crinkled lamination and two types of laminae: The biogenic (B.L) and

physically deposited laminae (X 10, P.L) can be distinguished. D) Bioclastic limestone consists of ostracods, bivalve fragments and gastropods.

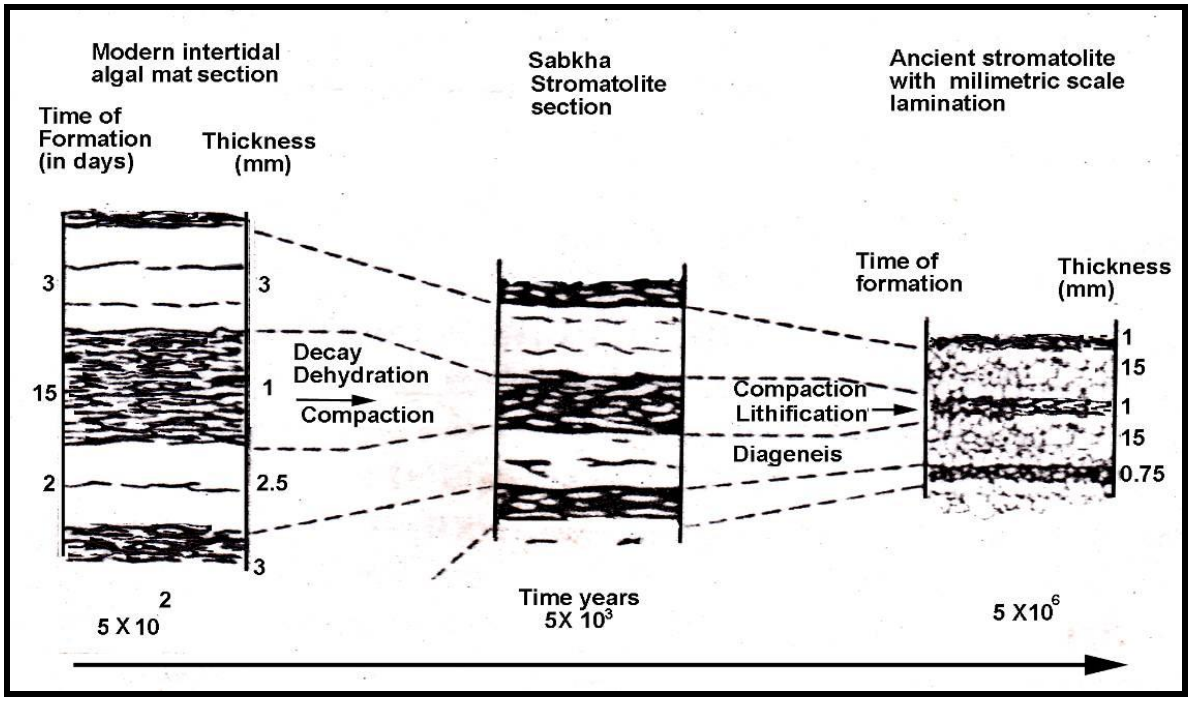

Fig.7: Modification of the stromatolite by diagenesis (Park, 1976) which is applicable for the present study.

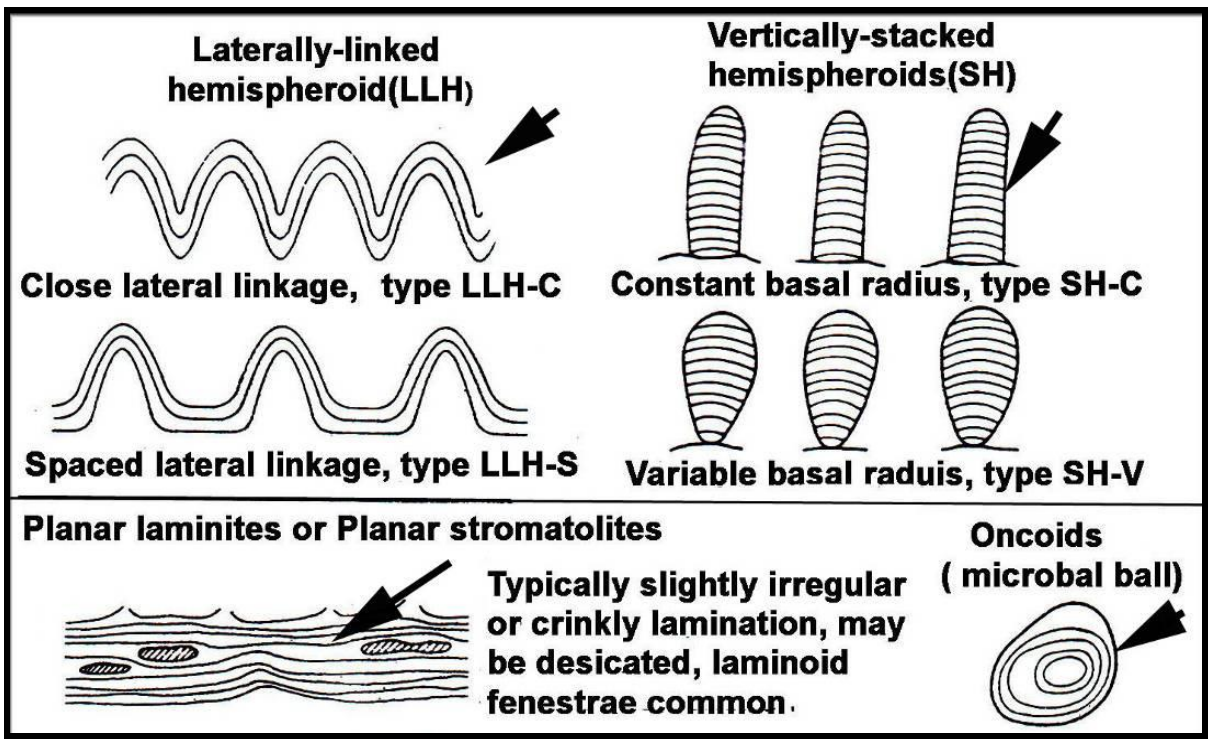

Fig.8: morphotype of stromatolites/ (Logan *et al*, 1964: in Tucker, 1996) those that are indicated

by black arrow are found in the present study.

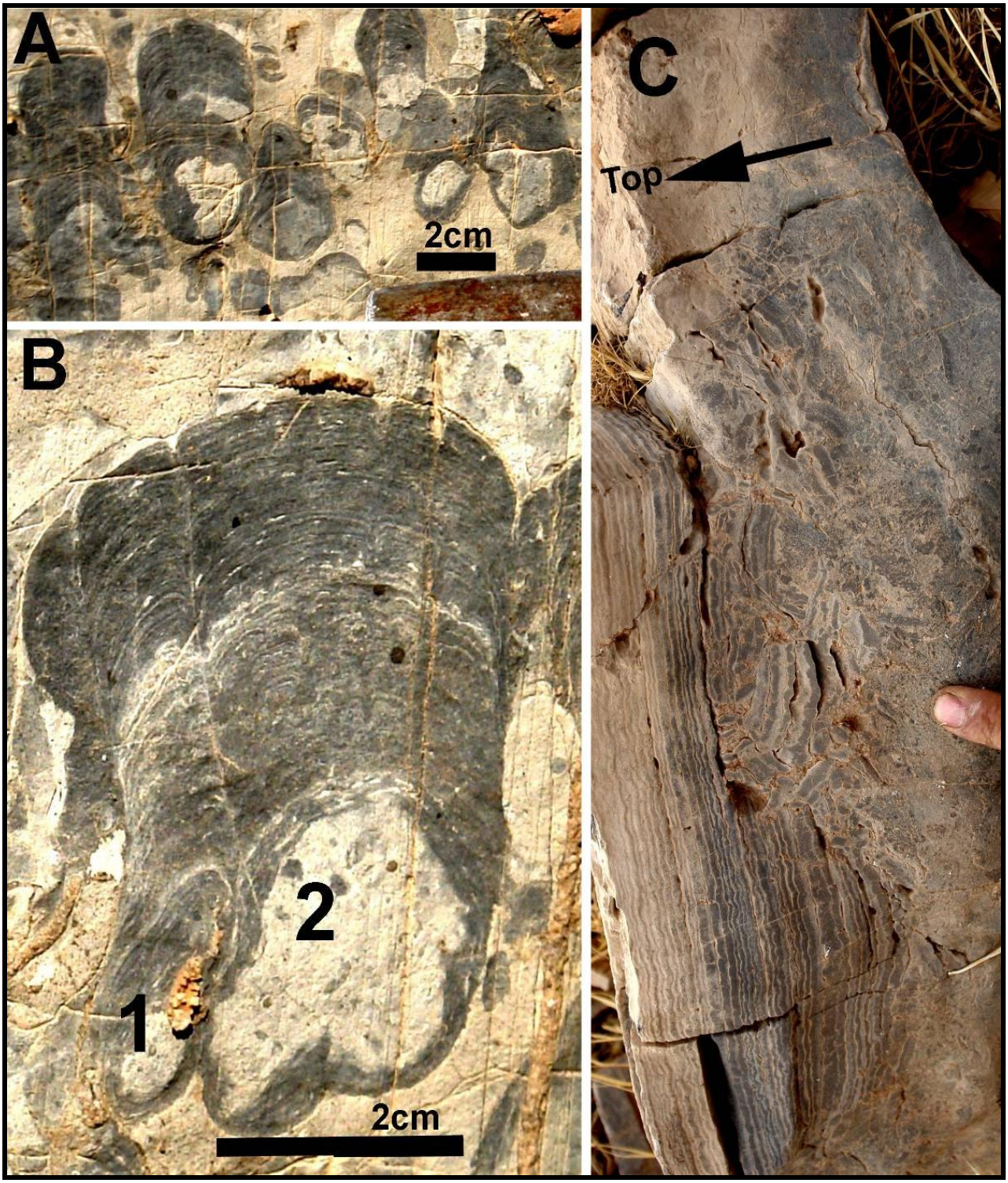

Fig.9: A) Several oncoids developed around rip up clasts, on the oncoids a columnar stromatolite are developed in the lower part of the formation. B) Two oncoids (indicated by 1 and 2) grown on the irregular rip up clasts (white). C) Parallel and crinkled stromatolite in the upper part of the formation.

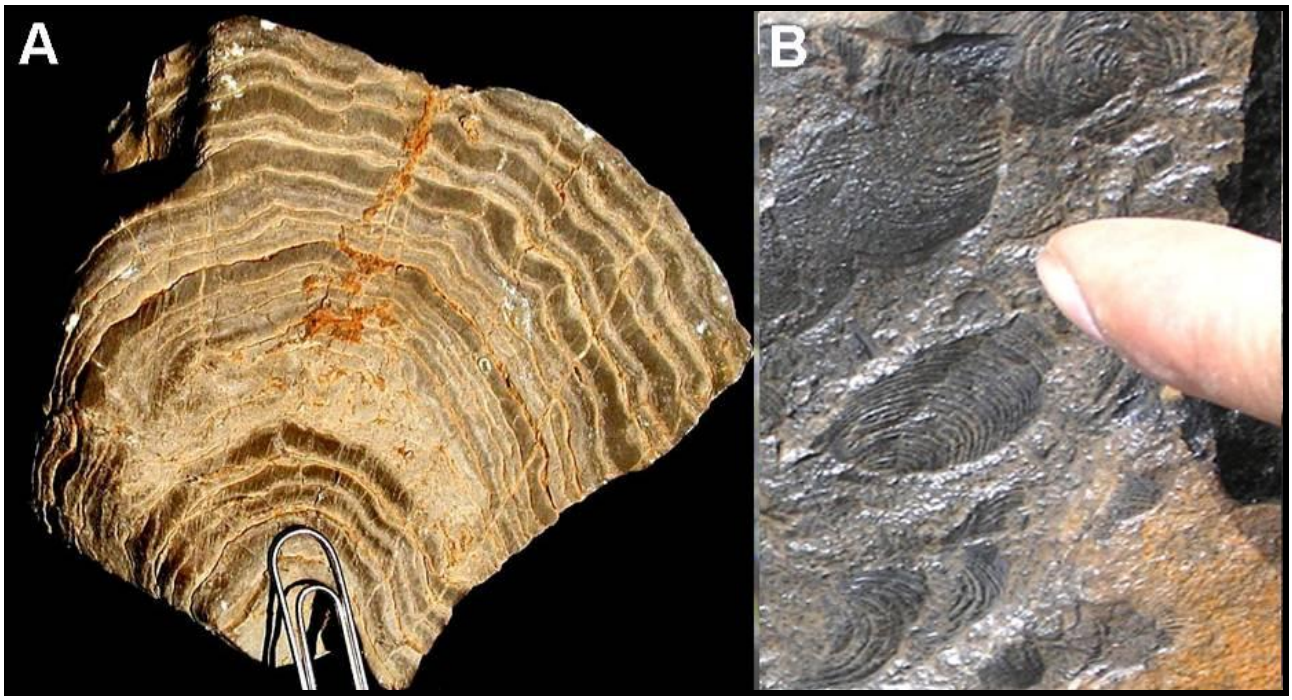

Fig.10: A) wavey stromatolite which is folded and formed hemi-spheriodal body in the upper part of the Formation. B) Cast of small pelecypods in the lower part of the Barsarin Formation in the lower part of the section.

DEPOSITIONAL ENVIRONMENTS

The stromatolites, that are produced by algal and/or cyanobacterial mats, are deposited in the restricted circulation shelf and tidal flats in addition to sabkha and salinas (Wilson, 1975). According to the classification of Hoffman (1976) planar stromatolites are formed in the intertidal zone. Based on our interpretations, the Barsarin Formation contains very well developed millimeter laminations which imply very specific depositional environments. The graving animals such as pelecypods prevented the development of stromatolites (Browne *et al*. 2000). This is true for the upper part of the section which is represented by restricted lagoon (intertidal zone) in which the graving animals were not survived. Therefore, well developed milimetric lamination of microbal origin is developed.

The lower part was deposited in shallow subtidal with lesser restriction in which pelecypods and ostracods are survived and grazed on microbes. This part shows some evidence of high energy during short times. This is represented by rip up clasts (intraformational conglomerate or breecias) that eroded from the bottom. On these clasts concentric laminae are developed as oncoids (Fig. 9 and 10). In some case the microbial limestone (dark grey) is mixed with the nonbiogenetic limestone (light grey) but it is not known if the mixing is generated by bioturbation or by wave activity (Fig. 11). From all above citation it is inferred that the formation is deposited on an attached platform. The evidence for attached platform is that the upper part of the formation contains several thin beds of red claystone and terrigeneous sandstone (Fig. 12).

According to Tucker (1991), Nichols, (1999) and Einsele (2000), ramp is gently sloping sea bottom (less than a degree) with generally high energy inner–ramp near shoreline which passes off-shore to quiet and deep-water outer ramp. They added that large reefs are generally not present on ramp. When one looks at the lateral and vertical distribution of carbonate facies and grain size, he realizes that the platform topography that

fit the carbonate successions of Barsarin Formation, in studied area, is rimmed shelf (Fig.12). The formation shows rapid grains size and facies change both specially and temporarily. Another evidence of the rimmed platform is that no lithoclast and ooids are observed. But the problem is that the clear barrier is not found in this study, although the massive limestone (with oncoidal and columnar stromatolite) of the lower part may represent the lagoon ward part of the barrier (back reef).

Fig.11: Mixture of biogenetic (possibly microbial) limestone and nonbiogenetic (physical limestone) in the lower part of the section.

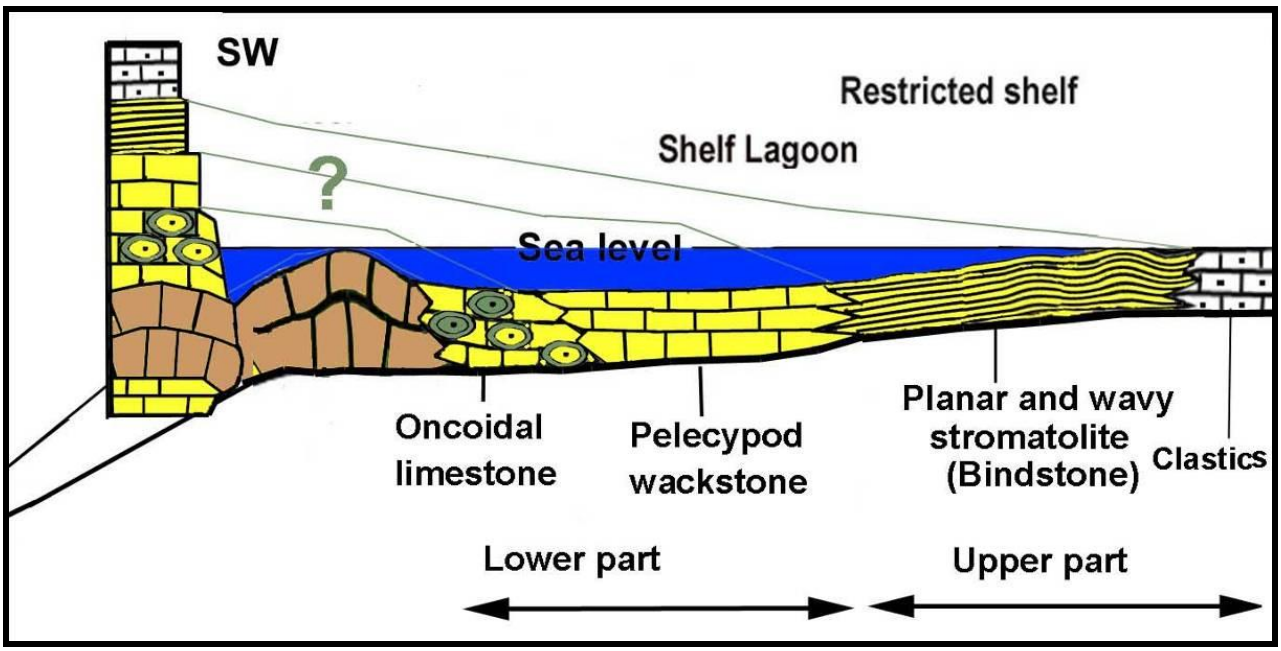

Fig.12: Proposed environmental model of the Barsarin Formation in the studied area.

CONCLUSION

1-For the first time the Barsarin Formation is recorded and described in the Barzinja area.

2-Four types of stromatolites have been identified in the studied area.

3-Two types of depositional environments: the intertidal of the upper part and shallow subtidal of the lower part of succession, also have been identified.

4-The recorded microfacies are bindstone and wackestone.

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