

Petrography, Facies Analysis, and Depositional Environment of the Sargelu Formation (Middle Jurassic), in a Selected Section, Northeastern Iraq

Noor T. Al-Tae^{1*} noortalal@uomosul.edu.iq¹ Department of Geology and Petroleum, College of Science, University of Mosul, Mosul, Iraq.

* Correspondence author.

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Abstract

The study deals with the sedimentology of the Middle Jurassic Sargelu Formation and its implications for facies analysis and depositional environment. The studied section is located in Sulaymaniyah City, between the Sargelu and Goshan villages, within the Highfolded zone, northeastern Kurdistan Region of Iraq. In the study area, the Formation is characterized by a succession of limestone interbedded with thin beds of dolomite and thin shale. It overlies the Sehkanian Formation and underlies the Naokelekan Formation. Twenty-two thin sections from the limestone succession were chosen for petrographic analysis using a polarizing microscope to determine their petrographic constituents. The petrographic study of carbonate units showed that they consist mainly of skeletal grains (calcospheres, radiolaria, pelecypods, planktonic foraminifera, and ostracods). The successions were affected by several diagenetic processes such as recrystallization, dolomitization, compaction, and Pyritization. Three different microfacies were recognized that showed a wide range of facies associations. These are further subdivided into eight sub-microfacies, suggesting the deposition of the Sargelu Formation in the deep shelf and deep marine basinal environments.

Keywords:

Facies analysis, Jurassic, Deep marine, Sargelu Formation, Iraq.

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1. Introduction

The Sargelu Formation is a Middle Jurassic carbonate succession, deposited in the Unstable Shelf of northeastern Iraq, between the High and some nearby Low Folded Zones (Buday, 1980; Jassim and Goff, 2006). Given the importance of hydrocarbons, it is necessary to define their environment in previously unstudied locations to provide a comprehensive overview, especially for the current study site. The first description of the Sargelu Formation was done by Wetzel (1948 in Bellen et al., 1959) in Sulaymaniyah City (Surdash anticline). Previous studies on the formation have been conducted using various surface and subsurface detectors and have described the mineralogical, field, and lithological characteristics (Bitman et al., 2004; Al-Ahmad,

2006; English et al., 2015; Al-Trim et al., 2022; Rasoul et al., 2024). All sedimentological and stratigraphic studies of the formation suggest that the Sargelu Formation was deposited in an open, deep marine shelf environment extending to the slope and basin (Buday, 1980; Koutsoukos, 1985; Abdullah et al., 2015). This study aims to identify the main petrographic components, diagenetic processes, facies associations, and to reconstruct the depositional environment of the Sargelu Formation in the studied area.

2. Geological setting and location

The studied section is located in Sulaymaniyah City, lying between the Sargelu and Goshan villages, in the northeastern Kurdistan Region of Iraq. The latitude is 35°17'46.1"N and the longitude is about 45°22'49.6"E.

Tectonically, the investigated section belongs to the Western Zagros Fold–Thrust Belt in northern Iraq. It occupies the transitional area between the High Folded and Low Folded zones of the Unstable Shelf as defined (Buday, 1980; Jassim and Goff, 2006). According to Fouad (2015), the succession is located at the High Folded Zones–Thrust Zone boundary, which arose in the northeast, forming the Zagros Fold–Thrust–Belt (Figure 1A and B).

The Sargelu Formation is part of the Arabian Plate (AP7) Tectonostratigraphic Megasequence, which started from the Late Toarcian–Early Tithonian (Mid– Late Jurassic) (Sharland et al., 2001). During the Permian and Triassic, the Neo-

Tethys opening began and continued to its maximum width during the Late Triassic to Middle Jurassic (Saadouni and Al-Sharhan, 2004). Sedimentation then occurred in a limited, deep aquatic environment during the Middle Jurassic, and the basin During the Kimmeridgian–Early Tithonian, progressive basin restriction promoted widespread evaporitic conditions (Jassim and Goff, 2006; Tobia, 2019). Wetzl (1948 in Bellen et al., 1959) described the lithologic composition of the Sargelu Formation in the Surdash anticline, and the Sargelu–Naokelekan contact as sharp and conformable, transitioning from thin bituminous black shales with chert bands into well-bedded grey stromatolitic limestone.

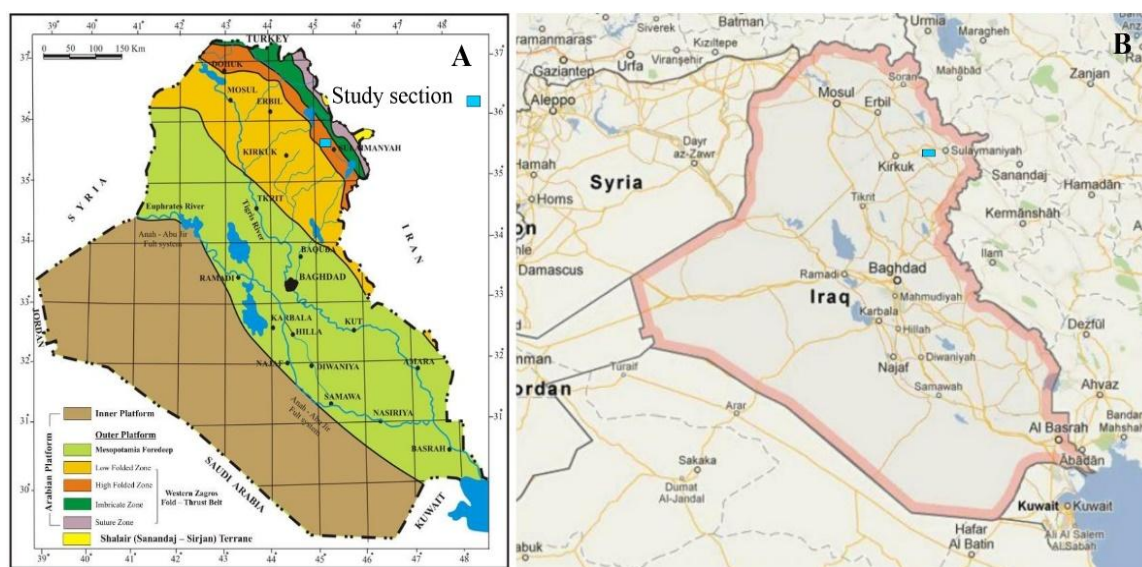


Fig. 1: A. Tectonic division, from Fouad (2015) of Iraq, showing the location of the section. B. Geographical location of Iraq

The Middle Jurassic Sargelu Formation of Iraq accumulated during the development of the Mesopotamian intra-shelf basin, which became separated from the Neo-Tethys Ocean as a consequence of rifting along the northeastern margin of the Arabian Plate (Jassim and Boday 2006).

3. Lithostratigraphy

The Sargelu succession attains a thickness of approximately 78 m in the studied section. Both its basal and upper boundaries are conformable, with gradual transitions to the underlying (Sehkanyan Formation) and the overlying (Naokelekan Formation)(Fig. 2A, B). The Sargelu Formation begins with 10 m-thick yellowish-white bioturbated limestone, followed by a sequence of alternate limestone beds (not exceeding 1m) with

shale beds (30 cm – 1m), this sequence reaches about 53 meters thick. Then, followed by a succession of yellowish-white limestone and dolomitic limestone beds reaching 10 meters thick. After that, the yellowish-white limestone beds continue, with shale beds 1m thick between them. Finally, the limestone continues to the end of the studied section, with thin chert layers interspersed with dolomitic limestone beds, which ends with limestone of the Naokelekan Formation (Figure 2).



Fig. 2: The contact of the Sarjelo Formation, A: the lower contact with the underlying Sehkanyan Formation, and B: the Upper contact with the overlying Naokelekan Formation

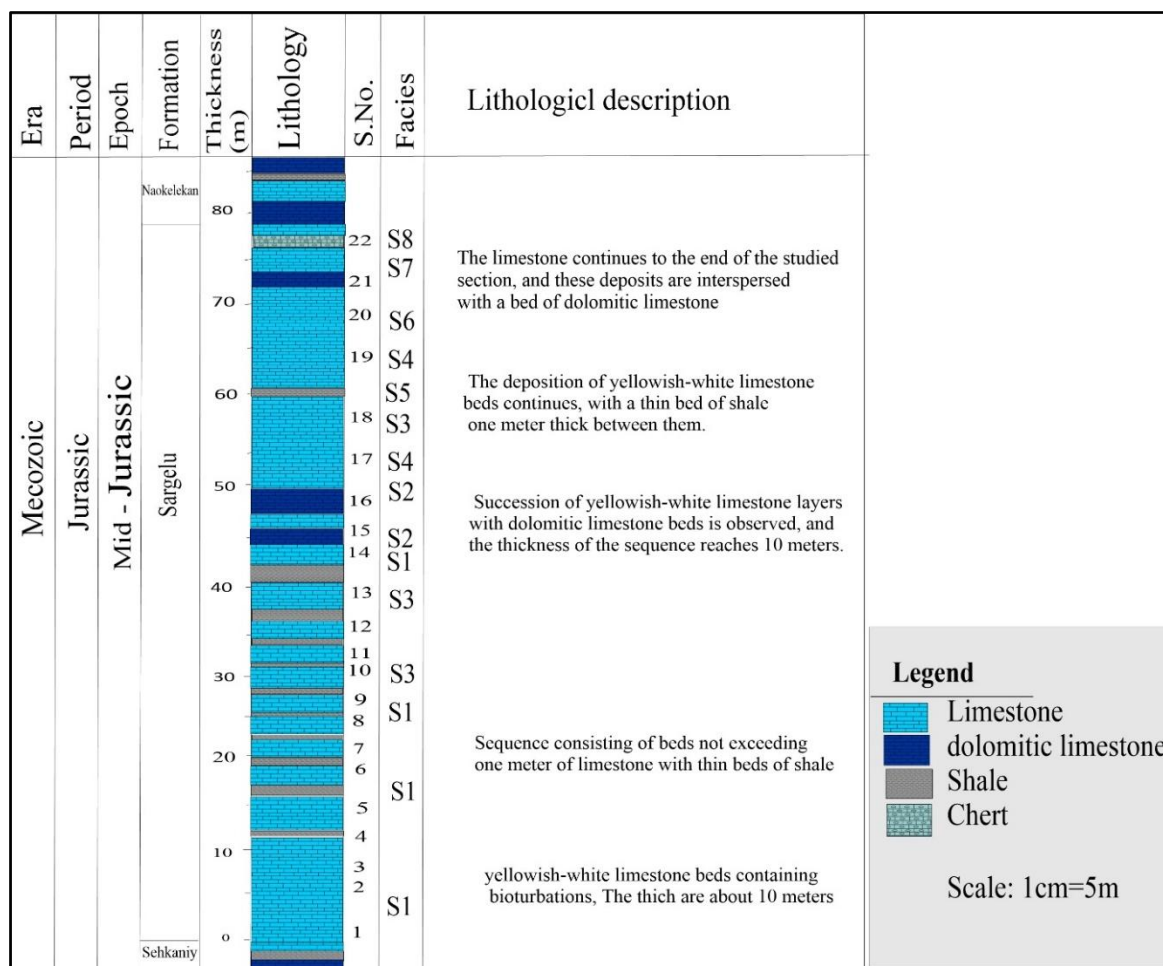


Fig. 3: Lithological column of the Sargelu Formation

4. Petrography

The Sargelu Formation is characterized by well-preserved fossils that enable researchers to identify different facies and infer the depositional environments. The skeletal grains include both whole and/ or biogenic debris in various shapes

and sizes. The diverse fossil assemblage includes the following:

Pelecypods characterized by their long and curved forms, with particularly common filaments, indicative of Aalenian - Bathonian age, and representing pelagic Posidonia shells "Posidonia sp". (Murry,2006). They are observed as thin,

curved shells ranging from 170 μm to 3 mm in length (Pl. 1-A). They often exhibit a wavy appearance due to physical compaction (Pl. 1-B). Posidonia was interpreted as filaments (Flügel, 1982). Whereas the formation of coral limestone referred to Bositra (Pl. 1-A, 1-C). The latter is distinguished by its curved shell structure; they occur in both shallow- and deep-marine settings (Kuhry, 1976).

Calcspheres are typically less than 0.5 mm in diameter and are generally spherical in shape (Horowitz and Potter, 1971; Tucker, 2003). Their origin remains uncertain; some authors interpret them as chambers of foraminifera (Flügel, 1982). However, Mesozoic calcspheres are particularly abundant in pelagic limestones, especially in basinal and basin-margin settings (Wilson, 1975; Flügel, 2010, 2004). In the present study, calcspheres are recognized by their small size and oval to spherical shape, which are filled with sparry calcite (Pl. 1-D, 2-C).

Foraminifera identified occur as skeletal grains, such as planktonic forms, typically with small size, spherical chambers, and commonly filled with calcite or pyrite, like Globigerina (Pl. 1-E). Most of the specimens were affected by diagenetic changes, including recrystallization and compaction. Ammonites possess a planispiral coiled shell in the larval stage; their shell are often large (Benton and Harper, 1997). They are commonly found in pelagic, relatively deep-sea water deposits (Tucker, 1981; Wilson, 2002). In the Sargelu Formation, large but poorly preserved ammonite shells are found on the lower parts of the formation (Pl. 1-F). Their shells were commonly affected by dissolution, which was subsequently filled with sparry calcite cement.

Radiolarians are planktonic fauna that inhabit deep-basin marine environments and were found in pelagic limestones (Bishop, 1972; Kuhry et al., 1976). In the Sargelu Formation, the radiolarians are observed particularly in the lower parts. They exhibit spherical shapes; post-depositional dissolution processes often result in the preservation of empty molds of radiolarians, which are occasionally infilled by pyrite during subsequent diagenetic stages (Pl. 2-B).

Bioclasts are fossil fragments formed through the breakdown of skeletal remains; they provide information about the type of water energy (Flügel, 2004). In the Sargelu Formation, the bioclasts primarily consist of reworked skeletal fragments of

Posidonia, foraminifera, ostracods, and radiolarians (Pl. 2-C).

Ostracods are characterized by their bivalve, oval-shaped calcareous shells and are known to inhabit a wide range of environments (Abawi et al., 2000; Awadeesian, 2015). In the studied samples, ostracods occur in moderate proportions and often show post-depositional diagenetic modification, such as recrystallization or partial dissolution (Pl. 2-D).

The overall pelagic microfaunal assemblage includes radiolarians, calcspheres, planktonic foraminifera, and pelagic ostracods, collectively reflecting deposition within a deep marine, low-energy environment. These microfossil components provide valuable paleoenvironmental and paleoecological information about the sedimentary conditions of the Sargelu Formation. The examined rocks are dominated by micrite between and within the grains and microfractures of the rock (Pl. 1-D). The presence of micrite indicates deposition in low-energy marine environments (Friedman, 1985; Boggs, 2006). One of the prominent features observed in the Sargelu Formation carbonates is the presence of sparry calcite, which commonly fills pores, groundmass, and fossils (Pl. 2-E).

The formation was affected by many diagenetic processes, which are as follows:

Bioturbation: the Sarglo Formation deposits exhibit varying levels of bioturbation, particularly within the limestone and bituminous shale layers. These bioturbations are characterized by faint to moderate intensity due to the deep, semi-reduced depositional environment, which limited the abundance of organisms capable of remobilizing the sediments (Pl. 3-D).

Compaction: the process that occurs at burial depths up to 1000 meters (Flügel, 2010). In carbonate sediments, compaction leads to a decrease in sediment thickness and a reduction in intergranular porosity (Meyers, 1980; Lingman, 1980). Cementation plays a key role in regulating the magnitude of compaction (Bathurst, 1975), which can limit or inhibit further compaction (Flügel, 2010). Both mechanical and chemical compaction played important roles in modifying the formation deposits. Variations in mechanical compaction are reflected by observable textural features. by the presence of elongated shells, deformed bioclastic shells, shell debris, microfractures, and elongation of limestone

clasts (Pl. 3-A). Chemical compaction is indicated by dissolution, as increased matrix porosity and fractures, resulting from diagenetic processes represented by stylolites (Pl. 2-A).

Cementation: refers to the precipitation of calcium carbonate from saturated solutions, occurring in or between grains, pores, and fractures, resulting in the development of sparry calcite crystals that enhance rock cohesion (Larsen and Chilingar, 1979). Although cementation is not the dominant diagenetic process throughout the Sargelu Formation, several distinct types of carbonate cement have been identified:

Drusy Cement: Consists of calcite crystals growing progressively from pore walls toward the center. This cement type was observed in the lower stratigraphic parts of the study section (Pl. 3-B). It forms under vadose or phreatic freshwater conditions (Flügel, 1982; Bathurst, 1975; Scholle and Ulmer-Scholle, 2003).

Granular Cement: Composed of euhedral to subhedral calcite crystals found in voids within fossils and channels (Pl. 3-C). This type is commonly deposited in vadose, freshwater phreatic, and burial environments (Flügel, 1982; Bathurst, 1975; Flügel, 2004; Scholle and Ulmer-Scholle, 2003).

Blocky Cement: Made up of large, equant calcite crystals lacking preferred orientation. It forms following the dissolution of grains or earlier cement and is abundant within the Sargelu Formation deposits, filling channels, fossils, and voids (Pl. 3-D). This cement type commonly forms in aerated phreatic, vadose, and deep burial settings (Flügel, 2004; Scholle and Ulmer-Scholle, 2003).

Dissolution: Partial dissolution in the Sargelu Formation leads to the formation of various types of secondary porosity. Vuggy porosity develops due to dissolution processes during diagenesis (Tucker, 2001; Machel, 2004). It influences both grains and the micritic matrix and is noted in the middle beds of the formation (Pl. 1-E). **Fracture porosity:** This type results from a combination of dissolution, compaction, and tectonic activity. It occurs predominantly in the lower beds of the Sargelu Formation (Pl. 1-C).

Neomorphism is the process by which a mineral phase changes from one crystalline form to another (Lingman, 1980), accompanied by alterations in crystal size, shape, and structure (Flügel, 2004). This process may result in either an increase or a decrease in crystal size (Bathurst,

1975). The transformation of micrite into microspar. These features are especially notable in association with *Posidonia* shells "halobiid bivalves" (Pl. 2-F).

Pyritization: Authigenic minerals produced under reducing conditions (Edgar, 2013). Reducing conditions are necessary for pyrite formation (Larsen and Chilingar, 1979). This typically occurs in the early stages of burial and is formed by local chemical reactions (Wilkin et al 1997). Consequently, the lack of oxygen promotes the development of a reducing environment in deep marine settings, leading to dolomitization by removing sulfates from seawater (Berner, 1971). In the Sargelu Formation, two types of pyrite were found as patches and framboidal (Pl. 1-F, 1-C).

Dolomitization: it occurs in many ancient carbonate rocks as a mosaic of anhedral crystals with irregular intercrystalline boundaries (Land, 1973; Blatt et al., 1980). Two main dolomite type textures have been observed in the Sargelu Formation (Randazzo and Zachos, 1984):

Floating-rhomb porphyrotopic fabric: This texture forms during early stages of heterogeneous dolomitization and appears variably throughout the studied section (Pl. 2-B).

Sutured mosaic texture: It is characterized by late, homogeneous dolomitization of compacted limestone rocks, accompanied by dissolution of the structural components, tightly packed, relatively large, anhedral dolomite crystals arranged in a mosaic pattern. This texture results from dolomitization of micritic limestone or dolomitization with associated skeletal dissolution (Randazzo and Zachos, 1984). This type of fabric is found in different beds of the formation (Pl. 3-A).

5. Facies analysis

Detailed petrographic analysis of the Sargelu Formation. It is observed that the lithofacies in the studied section are characterized by a limestone facies containing fragmented ammonite and *Posidonia* shell debris; however, these components could not be fully documented hard to reach and to the presence of broken fragments resulting from scraping processes within the exposed section. Additionally, a shale (mudstone) facies was identified, which represents one of the most prominent lithofacies within the studied interval. A detailed microfacies analysis enables dividing the

facies into three major microfacies and eight sub-microfacies, which are as follows:

A. Lime - Mudstone Microfacies

This microfacies represents one of the least abundant facies within the formation deposits. It is present in the lower stratigraphic part of the succession and consists of micrite with a minor proportion of skeletal grains, which constitute less than 10% of the total facies components. This microfacies corresponds to (SMF3) (Wilson, 1975; Flügel, 2004), and represents deposition within the deep basin zone (FZ1) on the deep basinal water zone. This facies includes:

Bositra Lime-mudstone Sub microfacies (S1)

It occurs in the lower interval of the formation and is dominated by micritic material with filament remains of Bostirea. (Pl. 1-C). It was affected by crystallization, physical compaction, and cementation processes.

Radiolarian Dolomitic Mudstone Submicrofacies (S2)

This microfacies, composed of bituminous dolomite with radiolarians, appears in the middle-lower stratigraphic parts of the succession (Pl. 2-B). It is influenced by dolomitization, showing floating and mosaic dolomite textures (Randazzo and Zachos, 1984).

B. Lime - Wackestone Microfacies

This facies consists of allochems around 10% to less than 50% of the microfacies components and micritic matrix. The allochems are composed of Posidonia remains, planktonic foraminifera, filament elements, and Calcispheres with associated debris, forming about 10% of the total components. Petrographic criteria allow this microfacies to be further classified into:

Posidonia/ Foraminifera Wackestone Submicrofacies (S3)

This submicrofacies is composed of planktonic foraminifera (Globigerina) as the dominant skeletal grains, along with filminte (Posidonia). Additionally, some calcispheres and ostracods are also present (Pl. 1-E). It is identified within the lower stratigraphic part of the succession. The micritic matrix contains a significant amount of organic matter and shows evidence of diagenetic alterations, including crystallization, physical compaction, and

cementation. This microfacies is comparable to the SMF3 category defined by (Wilson, 1975; Flügel, 2004) and represents deposition within the deep basin facies zone (FZ1) in the deep basinal water zone.

Filament Wackestone Submicrofacies (S4)

This microfacies is composed of filamentous material with some pelecypod, planktonic foraminifera, and ostracod shells. This microfacies is affected by recrystallization, granular cementation, and physical compaction, resulting in few fractures (Pl. 3-C). This microfacies characterizes the upper succession of the formation and can be correlated with SMF3 (Wilson, 1975; Flügel, 2004) standard microfacies. The depositional setting corresponds to the Facies Zone (FZ1) in the deep basinal water zone.

Bioclastic- Lime Wackestone Submicrofacies (S5)

This microfacies consists of bioclastic debris composed of filamentous, pelecypod, Posidonia, and ostracode debris. It is affected by recrystallization and compaction, with small amounts of pyrite (Pl. 2-C). This microfacies occurs within the middle stratigraphic part of the section. This microfacies is composed of grains that may constitute up to 40% of the rock composition. This microfacies can be correlated with the standard microfacies SMF10 (Wilson, 1975; Flügel, 2004), and the depositional setting corresponds to the Facies Zone (FZ2) on the deep shelf as

C. Lime - Packstone Microfacies

This microfacies consists of allochems within the micrite substrate, which constitute between 50% and 90% of the facies composition. These grains are represented by various shells, including filamentous, pelecypod, Posidonia, calcispheres, planktonic foraminifera, and ostracods. This microfacies is affected by both physical and chemical compaction and dissolution, as well as dolomitization, as follows:

Filaments-Bositra Lime Packstone Submicrofacies (S6)

This microfacies consists of a high concentration of compacted Bositra shells with smaller proportions of filamentous shells. This shell makes up approximately 50% of the microfacies. Diagenetic processes affecting this

microfacies include recrystallization, intragranular cementation, and physical and chemical compaction of the shells (Pl. 1-A). This microfacies occurs in the upper part of the formation and can be correlated with the standard microfacies SMF1 (Wilson, 1975; Flügel, 2004) and was deposited within the deep shelf (FZ1).

Filaments -Lime Packstone Submicrofacies (S7)

This microfacies consists of a high concentration of filamentous shells only. This shell makes up exceed 70% of the microfacies. Diagenetic processes affecting this microfacies include recrystallization, pyritization, and physical-chemical compaction of the shells (Pl. 1-B). This microfacies occurs in the upper stratigraphic part of the succession. This

microfacies corresponds to SMF1 (Wilson, 1975; Flügel, 2004) and was deposited within Facies Zone1 (FZ1) (Wilson on the deep basinal water zone).

Bioclastic Lime Packstone Submicrofacies (S8)

This microfacies consists of filamentous, Posidonia, and ammonite, as well as planktonic foraminifera bioclastic debris. It is affected by recrystallization and compaction. This microfacies occurs within the middle part of the studied section. (Pl. 3-D), composed of grains that may constitute up to 60% of the rock composition. This microfacies s can be correlated with the standard microfacies SMF10 (Wilson, 1975; Flügel, 2004) and was deposited in the setting of Facies Zone2 (FZ2) on the deep shelf.

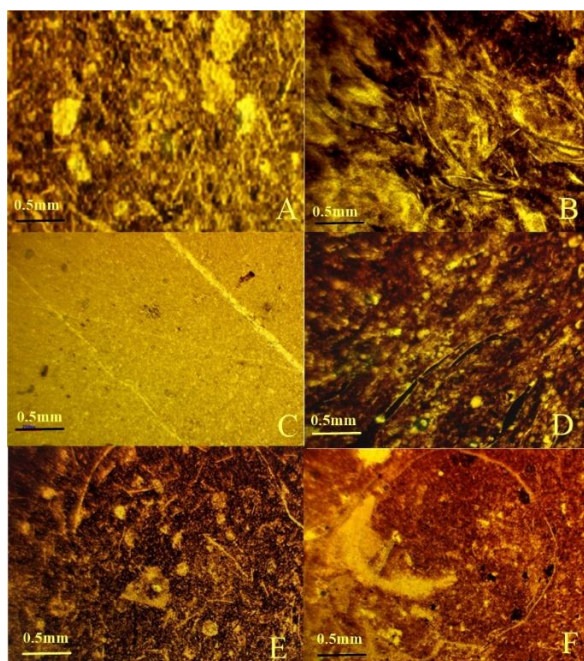


Plate1: A: Pelecypods is represented by Filaments–Bositra Lime Packstone Submicrofacies affected by Recrystallization, pyrite and dolomitization in the upper stratigraphic of section, B: Filaments-Lime Packstone Submicrofacies Diagenetic affecting this facies include recrystallization, pyritization, and physical-chemical compaction of the shells in the upper part of the formation, C: Bositra Lime-mudstone Submicrofacies effected by Dissolution, Pyritization, facies filled by granular cement, present in the lower stratigraphic part of the formation, D: Calcspheres filled with sparry calcite, radiolarian, micrite between and within the grains, vuggy porosity, framboidal pyrite, E: Posidonia Foraminiferal Wackestone Submicrofacies, Vuggy porosity, Presence of Compaction features and pyrite mineralization, F: Ammonite, Pyritization Pyritization replacement in the central region of the ammonite.

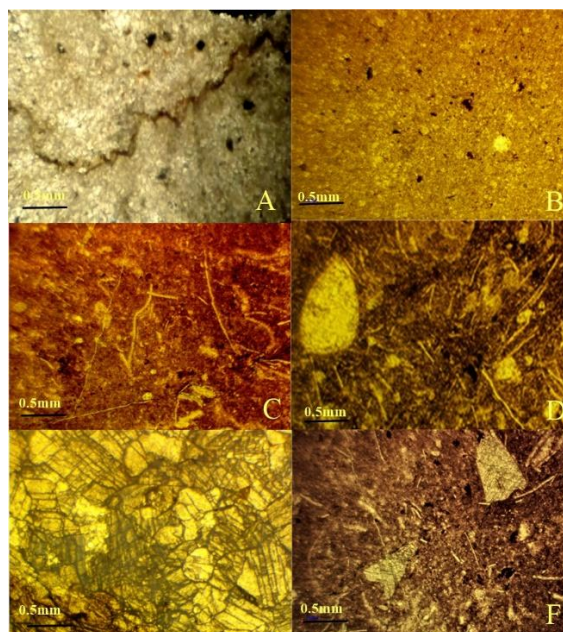


Plate2: A: Pyritization, stylolites Result of chemical compression found in the central part section, B: Radiolarian Dolomitic Mudstone Submicrofacies, showing floating and mosaic dolomite textures, Pyritization, dissolution, cementation in Radiolarian grain in the middle stratigraphic and lower part of the section, C: Bioclastic- Lime Wackestone Submicrofacies, filamentous, pelecypod, Posidonia, and ostracode debris. It is affected by recrystallization and compaction, with small amounts of pyrite. This facies restricted to the central part of the investigated section: D: Ostracoda Recrystallization, vuggy porosity, framboidal pyrite, pelagic pelecypod, in the upper part of the section; (E) sparry calcite, F: Posidonia shells—neomorphism in the central parts of the section.

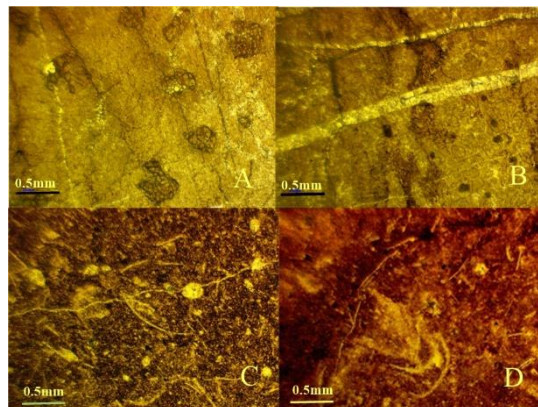


Plate3: A: Sutured Mosaic Texture, elongation of limestone clasts, compaction, Framboidal Pyrite, Microfractures, Pyritization, Partial Recrystallization, Fracturing, Compaction, B: Drusy Cement, Pyritization, C: Filament Wackestone Submicrofacies, Granular Cement, D: Bioclastic Lime Packstone Submicrofacies, fossils, and voids filled by Blocky Cement.

6. Depositional Environment

Numerous lines and/or evidence have been used to interpret the Sargelu Formation's depositional environment. There was a noticeable variation in the microfacies types along the studied section. According to Dunham (1962), packstone microfacies represent the dominant facies, followed by wackestone microfacies, whereas

mudstone microfacies were the least frequently encountered.

A. Big transition from S7 what interpretation

As paleontological evidence, the microfacies contain Bositra, which is considered an indicator of Middle Jurassic deep environments (Friedman and Sanders, 1978; Nichols, 1999; Scholle and Ulmer-Scholle, 2003)

Similarly, the presence of Radiolaria indicates semi-anoxic deep marine environments (Kuhry et al., 1976; Friedman and Sanders, 1978; Tucker, 2001). Poor preservation of these fossils is noted due to intense diagenetic alteration. Posidonia is observed throughout the formation, indicating deep marine conditions adapted to low oxygen levels (Krumbein and Sloss, 1963; Kauffman and Sageman, 1990), and is dated to the Middle Jurassic (Aalenian–Bajocian) based on (Murray, 2006). Posidonia appears as monovalved specimens in the studied microfacies, suggesting slow and quiet deposition, which allowed shells to embed into the seafloor (Al-Tarim et al., 2022).

Planktonic foraminifera, such as Globigerina, are also present alongside Posidonia (Haq and Boersma, 1978), typically small in size and affected by recrystallization and dissolution. Their presence supports deposition in deep basal marine environments (Murray, 2006). The scarcity of benthic foraminifera is evidence of an anoxic environment (Al- Tae et al., 2024).

Ammonite shells are rare within the formation evidence of deep water, and show signs of diagenetic alteration, including recrystallization and compaction, which have obscured details of their internal structures. These shells typically represent deposits from deep marine settings (Benton and Harper, 1997). Calcspheres are also present in the Sargelu Formation and are often associated with planktonic foraminifera and Radiolaria. This association makes it difficult to distinguish between the calcareous spheres and calcified Radiolaria. Most of the unstructured calcareous spheres likely originated from calcified spherical Radiolaria (Wilson, 1975).

The shale present in the middle and upper stratigraphic section suggests a decrease in current strength, along with the presence of horizontal lamination and absence of other sedimentary structures, supporting the interpretation of a deep marine basinal depositional environment.

Moreover, the presence of various forms of pyrite serves as an indicator of low-oxygen conditions (Hudson, 1982; Al-Tae et al.,2024), indicating deposition under open deep-marine conditions. As shown in Figure 4, the sea level is constant at the beginning of the formation's deposition in the Deep Basin environment, then it fluctuates to end in the Deep Shelf environment. Based on the identification of biotic components,

analysis of sedimentary facies, and environmental interpretations, a depositional model was developed to represent the sedimentary setting of the Sargelu Formation at the studied locality (Figure 5).

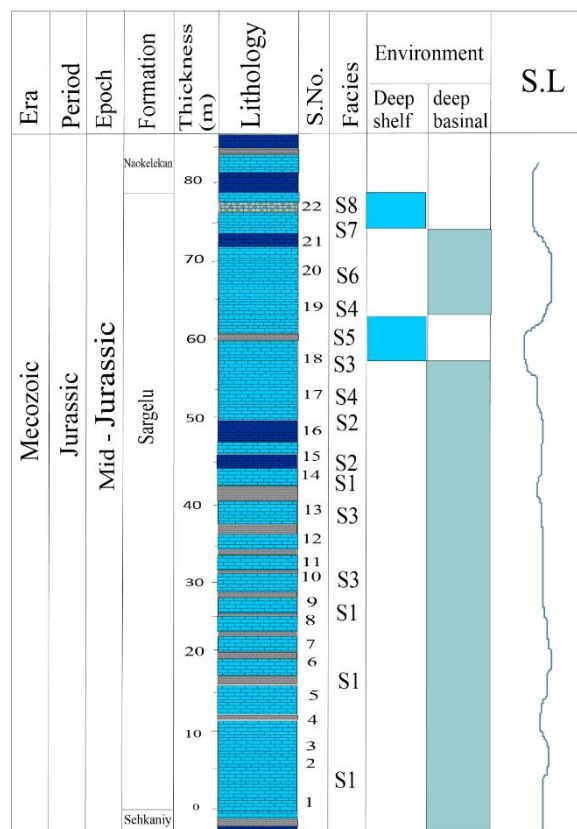


Fig. 4: Sedimentary log showing Microfauna sites and environments with sea-level (S.L.) changes of the study section

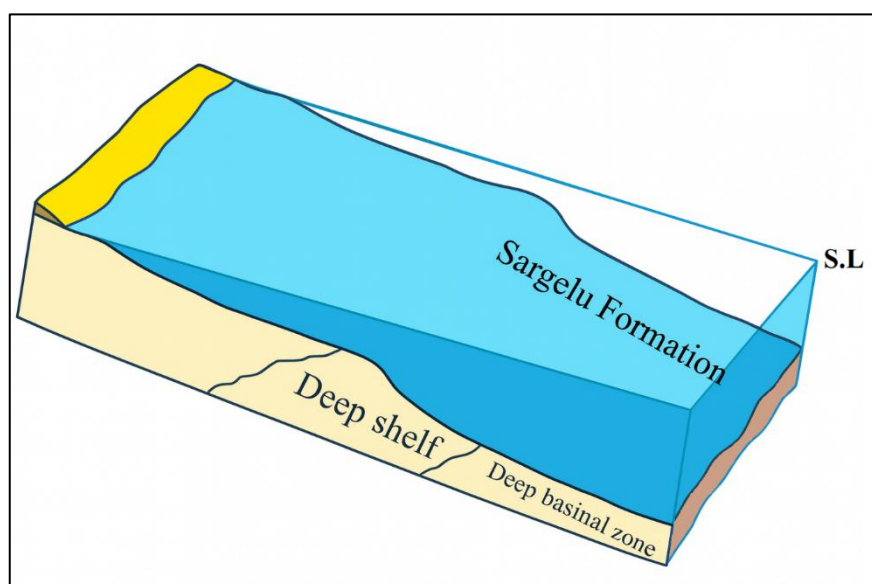


Fig. 5: Depositional model of the Sargelu Formation in the studied area

7. Conclusions

The total thickness of the Sargelu Formation in the section is approximately 78 meters, mainly composed of limestone deposits accompanied by shale interbeds and dolomitic limestone layers.

Petrographically, pelagic organisms such as filaments, Bositra, pelagic Posidonia shells, Ammonites, radiolarians, calcispheres, planktonic foraminifera, and pelagic ostracods exhibit evidence of multiple diagenetic modifications (Recrystallization, dissolution, Cementation, compaction effects, and Dolomitization).

Three main microfacies, including lime mudstone, lime wackestone, and lime packstone, were further classified into eight secondary types after comparing them with the standard facies.

Facies and paleontological evidence indicate that the Sargelu Formation accumulated within a deep-water realm, extending from deep-shelf environments to deep basin waters.

8. Conflict of Interest

The authors declare that they have no conflict of interest.

9. Funding Statement

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البتروغرافية، السحنات الدقيقة والبيئة الترسيبية لتكوين سارجيلو (الجوراسي الأوسط)،

في مقطع مختار من شمال شرقي العراق

نور طلال الطائي^{1*} 

noortalal@uomosul.edu.iq

¹ قسم علوم الارض والنفط، كلية العلوم، جامعة الموصل، الموصل، العراق.

* الباحث المراسل.

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الملخص

تناولت هذه الدراسة رسوبيات تكوين سارجيلو الجوراسي الأوسط، من خلال تحليل السحنات والبيئة الترسيبية. يقع المقطع المدروس في مدينة السليمانية بين قريتي سارجيلو وكوشان ضمن نطاق الطيات العالية، شمال شرق إقليم كردستان في العراق. يتميز التكوين في منطقة الدراسة بمتتابعات من الحجر الجيري وطبقات رقيقة من الدولومات والصخر الزيتي الرقيق. يكون حد التماس العلوي مع تكوين ناوكليكان وحد التماس السفلي مع تكوين سهيكانيان. تُرست 22 شريحة رقيقة من تتابع الحجر الجيري لتكوين سارجيلو من الناحية البتروغرافية باستخدام المجهر المستقطب لتحديد مكوناتها الصخرية. أظهرت الدراسة الصخرية للوحدات الجيرية بانها تتألف بشكل رئيس من الحبيبات الهيكلية التي اشتملت على الكرات الكلسية، الراديولاريا، فاسية القدم، الفورامنيبرا الطافية واللاوستراكود. فضلا عن تأثير صخور التكوين والعديد من العمليات التحويرية مثل إعادة التبلور والدلمة والضغط، وتأثرها بالبيريت. تم التعرف على ثلاث سحنات دقيقة مختلفة أظهرت مجموعة واسعة من الارتباطات السحنية، التي قسمت بدورها إلى ثمانية سحنات دقيقة فرعية، تشير إلى ترسيب تكوين سارجيلو في بيئات الرصيف العميق ونطاق المياه البحرية الحوضية العميقة.

الكلمات المفتاحية:

تحليل السحنات، الجوراسي، الحوض العميق، تكوين سارجيلو، العراق.

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