

A Preliminary Documentation of the Coral Reefs from Libya

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Abstract

Corals studies in Libya are very limited, although they play an important role in the oil exploration as they form excellent reservoirs of coral reef buildups at some oil fields of Sirt Basin (e.g. Intisar "Idris" and Sahabi Fields). Both fields are produced from Paleocene coral reefs. Meanwhile, in Cyrenaica, corals are of less importance as they are not reported in subsurface tertiary rocks, which probably in the environmental settings of these sediments out of the core of reef as occurred in the surface. Meanwhile, corals are reported from older (Jurassic) subsurface successions as in Concession NC-152, but the cementation diagenesis leads to blocking and destroying the porosity. This study presents the first surface documentation work of eight scleractinian coral species from the exposed sediments in northern Libya, where six taxa is reported from Al Jabal al Akhdar region, these include a) an association of huge colonies of *Caulastrea* sp. and *Stylophora* sp., from the Middle Eocene Darnah Formation at West Darnah road cut section. The co-existence of the fast *Caulastrea* sp. with the slow *Stylophora* sp. is due to the competition strategy; b) *Antiguastrea* sp. which is reported from the Oligocene Algal Limestone of Al Bayda Formation at Daryanah-Abyar Roadcut section; c) *Cyphastrea* sp. and *Aleveopora* sp. from Oligo-Miocene Al Faidiyah Formation at Al Fayyah cement quarry and d) *Tarbellastraea* sp. From Middle Miocene Benghazi Formation at Benghazi Cement Quarry. In addition, two species *Astraeaopora* sp. and *Actinacis paroraiare* reported from the Upper Miocene sediments of formation "M" in As Sahabi area.

Keywords

Cyrenaica Corals, Benghazi Cement Quarry, *Persististrombus coronatus*

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1. Introduction

This paper deals with corals built up in the Cyrenaica. Coral refers to coral carbonate accumulation which has original topographic relief that lives in association with other organisms including algae and foraminifers as major contributor Guilcher [1]. The differential pattern in these associations seems to be controlled by both the paleo-relief and the eustatic sea level [1].

The documented subsurface coral occurrences in Libya are very limited and are mainly obtained from the oil exploration activities, where coralreef forms an excellent reservoir as evidenced from some previous reports of oil fields in Sirt Basin (e.g. Intisar “Idris”) [2]. Examples are the reefal buildups (Rugose/cup coral with encrusted coralline red algae with excellent biomoldic porosity due to leaching as in Gheriat Formation along the eastern edge in Kutla graben in Sirt Basin [3]. The older Jurassic branching cup corals with the interior skeleton are completely filled with calcite cement and lime-mud matrix resulted in blocking the porosity, which are occasionally reported from the base of core #7(16199’) in Well A1-NC152 by [4].

However, the most comprehensive surface coral occurrences in the previous works that are presented by [5] who report about fifty species of corals, mostly of scleractinian type, from the oligocene sections of Umm ad Dahiy Formation, Abu Hashish Formation, Ar Rahlah Member of Maradah Formation and Al Khums Formation from Al Hufrah and Ar Raqubah Oil fields in Sirt Basin. Among the most important reef-builders species include *Madracis decaphylla*, *Stylophora parvistella*, *S. thirsiformis*, *Monticulastraea ex gr. daedalea*, *Athecastraea maradahensis*, *Astraeopora decaphylla*, *Agathiphyllia gregaria* and *Actinacis rollei*.

2. Locations

The studied corals are obtained from two regions:

1) The Al Jabal al Akhdar region which is located in northern Cyrenaica. It is a huge anticlinorium extending in SW-ESE ridge located between 32° to 33°N and latitudes and 20° to 23°E longitudes. The documented corals herein are from four well known localities, these are: a) West Darnah Roadcut section; b) Daryanah-Abyar Roadcut section; c) Al Fatayah cement quarry; iv) Benghazi (Hawari) cement Quarry in **Figure 1**.

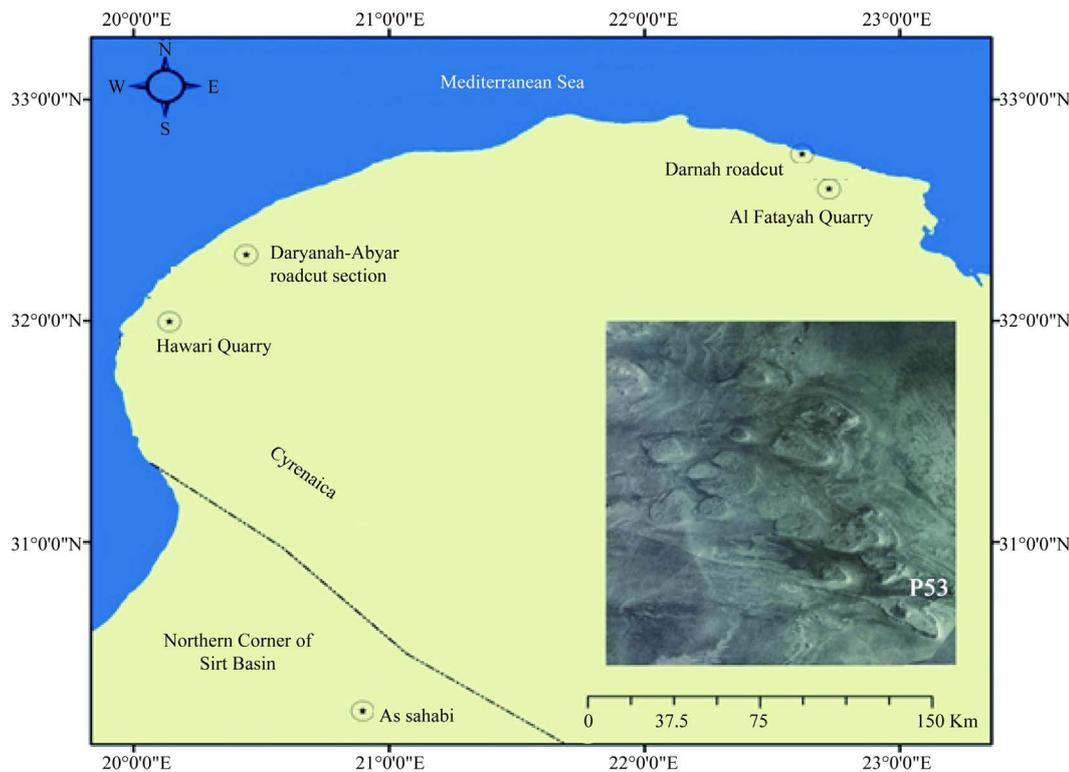


Figure 1. Location map of the studied coral-exposures in Northeast Libya, with As Sahabi “in the vicinity of P53” aerial photograph shows the coral patches [6].

2) The As Sahabi region, which is located in the northeastern corner of Sirt Basin, covering an area of about 375 km². It is bounded by longitudes 20°48'08" to 20°54'45"E and latitudes 30°10'58" to 30°17'36"N, within a tectonic province called the Ajdabiyah Trough. The documented coral specimens came from the scattered clusters of patch coral reef P53 and P119 area at the western edge of the Sabkhat al Qunayy in **Figure 1**.

3. Stratigraphic Background

The Al Jabal al Akhdar area in Cyrenaica region, northeastern Libya has a long geologic history, ranging from the Paleozoic to Late Miocene. The tertiary exposed rocks in this area are represented by nine rock units separated from each other by unconformity surfaces in **Figure 2**, these are from bottom to top as follows:

1) Al Uwayliyah Formation composes of chalky limestone, soft and enriched with planktic and calcareous nannofossils of Landenian age at its upper exposed section, However, it is well bedded and hard with rare planktic foraminifers of Danian age at its lower exposed part, although its middle part is not exposed, a series problem in the definition of Al Uwayliyah Formation, this issue was discussed by [7]. There are no reefal facies in this formation [8] [9].

2) Apollonia Formation is a well bedded chalky limestone, of mudstone-wackestone texture, with common chert nodules. The foraminifers are indicative of Ypresian—Lutetian age. There are no reefal facies in this formation. This formation exhibits interfingering relationship with the overlying Darnah Formation.

3) Darnah Formation is a thick bedded to massive limestone of grainstone to Packstone locally becoming rudstone in texture, this Formation is enriched in larger benthic foraminifers (*Nummulites*, *Discocyclina*, *Orbitolites*, *Sphaerogypsina*, etc.) with coralline red algae and/or coral facies at some places. This formation is dated as Middle Eocene based on the *Nummulites gizehensis* as example. Corals are among the local bioclasts occurrence as in West Darnah Roadcut section.

4) Shahhat Marl is dated as Late Eocene based on the presence of *Nummulites fabianii* and *Gaziryinabulchellus* [10]. There are no reefal facies in this formation [8].

5) Al Bayda Formation, the lower member “Algal Limestone Member” of Al Bayda Formation [11] [12]. It consists of algal limestone enriched in red algae and thick oysters with some *Nummulites fichteli* and *N. vascus* [13]. This formation yields common corals enough to make reef at several places [14]-[17].

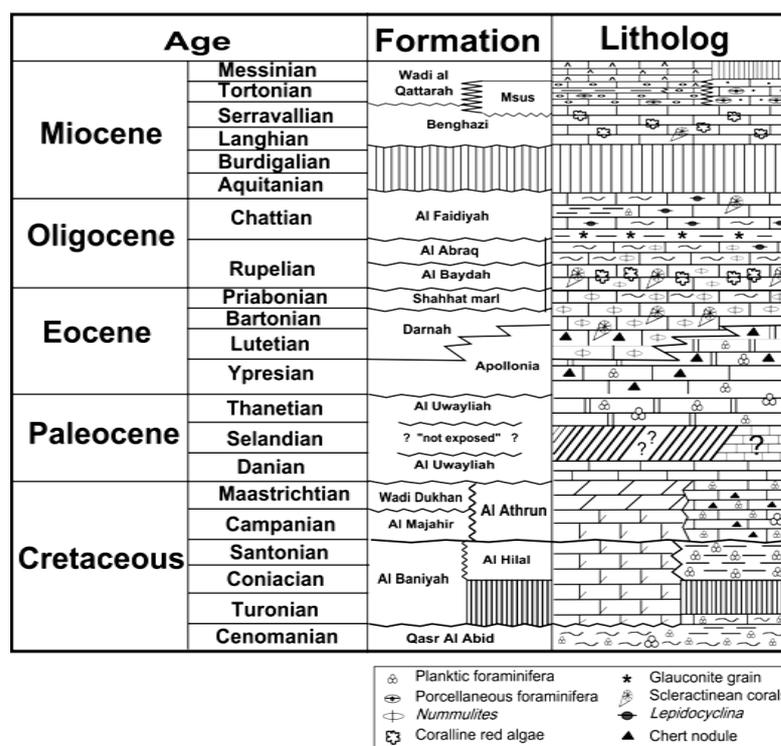


Figure 2. Stratigraphic chart of the exposed rock units in Al Jabal al Akhdar, NE Libya.

6) Al Abraç Formation is dated as Middle-Late Oligocene, it is skeletal limestone with abundant *Operculina-complanata africana* and *Lepidocyclina* spp. It is deposited under shoal-channel complex [12]. There are no reefal facies in this Formation [17] [18].

7) Al Faidiyah Formation is dated as Late Oligocene—Early Miocene which was updated by [12] to be Miocene age. Hence the age dating of this formation is still enigmatic. Lithologically, it is gradually changed upwards from glauconitic marl to skeletal marl and Limestone. Corals are among the reported local bioclasts in Al Fatayah Quarry section.

8) Benghazi Formation is dated as Early-Middle Miocene [11] [12] [19]. It consists of massive fossiliferous limestone, made of fine crystalline, hard, enriched in red algae. *Amphistegina* sp., and *Miogypsina globula* indicated a depositional settings under shallow marine of mid ramp setting [20], which is interrupted with lagoonal facies as interpreted by the occurrence of the peloidal-miliolidfacies [14] [17].

Wadi al Qattarah Formation is dated Late Miocene [12]. It is composed of thin bedded of oolitic/peloidal grainstones with highly cross bedded at some levels changed upward to evaporitic facies with common giant gypsum crystals which referred to the Mediterranean salinity crisis during the Messinian [12] [21].

Stratigraphy of As Sahabi Area

The As Sahabi area according to Muftah [1] consists of four superimposed rock units separated from each other by disconformity surface, these are from bottom to top:

a) Formation “M” (Tortonian); it consists of semi-consolidated bioclasts exposed in the floor of the Sebkhah, totally or partially decalcified and gypsified. Erosional relief of shallow Miocene coral reef, echinoids *Clypeaster* and *Echinolampas* and pelecypods, gastropods, bryozoans and *Balanus*.

b) Formation “P” (Messinian); it consists of lattice of gypsum crystals in a very sparse mineral matrix of dark sand and clay with very few fossils.

c) Sahabi Formation (Messinian-Pliocene); it was subdivided into six members:

i) Member “T”. It consists of cross bedded sand with abundant marine fauna and trace fossils (e.g. *Ophiomorpha*).

ii) Member T.X. Reddish clay and vertisol with cracks accessible in one area only.

iii) Member U-1. Sands with clay lenses and clay balls incorporating with common well preserved bones, teeth, jaws and skulls of land mammals.

iv) Member U-D. Cross bedded and bioturbated sandy dolostone.

v) Member U-2. Interbedded sand and clay with dolomitic crusts with mammals remains.

vi) Member V. Sands and sandy clays with lenses of dolomite and gypsum crystals common root casts.

d) Formation “Z” (Pleistocene) is the youngest formation and consists of very complex fossil soil with paleo-caliche and terrestrial snail (e.g. *Helix* sp.).

4. Cyrenaican Coral Reef

The collected coral specimens used in this study are mainly derived from four localities located in the North east Libya (Cyrenaica) and one locality in As Sahabi area in **Figure 1**. These are 1) Benghazi Cement Quarry section where, one species has been collected from Benghazi Formation (Middle Miocene); 2) Al Fatayah cement Quarry section, where, one species has been collected from Al Faidiyah Formation (Late Oligocene); 3) West Darnah Roadcut section, where three species have been collected from Darnah Formation (Middle Eocene); 4) Daryanah-Abyar Roadcut section, where one species has been collected from the Algal Limestone Member of Al Bayda Formation (Early Oligocene); 5) As Sahabi where, two species have been collected from formation “M” (Late Miocene). The documented coral reefs from these localities are listed below in chronostratigraphical order.

4.1. Eocene Reef

The Eocene rocks of Al Jabal al Akhdar in **Figure 2** are composed of two formations, the older Apollonia Formation, which was deposited in open marine waters as suggested by the planktic foraminifers and the mudstone textured facies as well as the presence of chert nodules with sponge spicules? The upper Darnah Formation on the other hand are deposited in more shallower neritic water with warm water conditions allowing to the accu-

mulation and growth of the *Nummulites* (nummulitic bank) and corals (coral reef) at some areas such the vicinity of Darnah city (West Darnah Roadcut section Lat. 32°53'00"N and long. 21°55'01"E). At this section, two species are documented the species are left as open named because more statistical work needed for the future work. The *Caulastrea* sp. (Figure 3 and Figure 4(A)-(B)) dominates the colony as it is considered the fast growing coral over the low growing *Stylophora* sp. (Figure 4(B)-(C) and Figure 5).

4.2. Oligocene Reef

The Oligocene rocks of Al Jabal al Akhdar in Figure 2 are composed of two formations, the older Al Baydah Formation, which was deposited in mid ramp waters as suggested by the common presence of larger benthic foraminifers in addition to common red algae and coral *Antiquastrea* sp. in Figure 6. The documented coral reef in Al Bayda Formation played an important role in the development of the caves and dolines and other small scale karstic features in the area [14] [15] [21].



Figure 3. Close-up view of *Caulastrea* sp. at West Darnah Roadcut section.

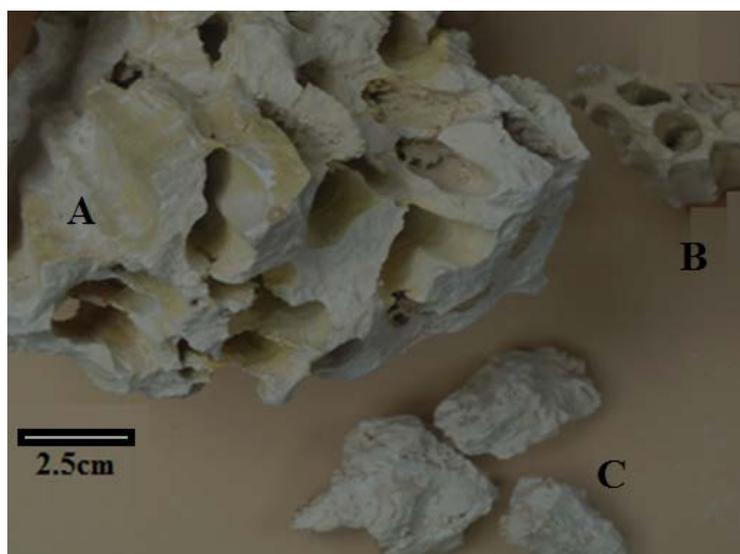


Figure 4. (A) *Caulastrea* sp.; (B) *Caulastrea* with *Stylophora* sp.; and (C) *Stylophora* sp. at West Darnah Roadcut.



Figure 5. Close-up view of *Stylophora* sp. at West Darnah Roadcut section.



Figure 6. Coral species *Antiguastrea* sp. from Al Baydah Formation at Daryanah-Al Abyar road-cut.

4.3. Upper Oligocene Reef

The reef framework in Upper Oligocene Al Faidiyah Formation at Al Fatayah cement quarry is constructed of two genera of corals *Cyphastrea* sp. **Figure 7(A)** and *Aleveopora* sp., and **Figure 8(A)-(B)** with encrusted red algae, shell fragments, bryozoans and larger foraminifers (nummulitids and lepidocyclinids).

4.4. Miocene Reef (Al Jabal al Akhdar, Cyrenaica)

The Miocene *Tarbellastraea* sp. coral of Benghazi Formation in **Figure 9** is reported locally at Benghazi (Al Hawari) Cement Quarry.

4.5. Miocene Reef (As Sahabi Area)

The As Sahabi coral reef is mainly of scleractinian type. They are growing in forms of small scale patch reefs extending parallel to the western edge of Sabkhat al Qunayyin, in NNE-SSW trending pattern. The diversity of the As Sahabi corals is very low, restricted to only two species in the Tortonian formation “M”. The first type is *Astraeaopora* sp. **Figure 10(A)** and **Figure 11(A)** but is completely replaced by gypsum at some levels. The other coral type present in As Sahabi is *Actinacis parorai*, shown here in (**Figure 10(B)** and **Figure 11(C)-(D)**). It is closely similar to the specimen figured by [5] from the Rupelian Wadi Ar Rijl in Al Hufra Oil field of Sirt Basin. It was previously misidentified as *Stromatolites* [22]. In addition to rare occurrences of encrusted coral growing on *Persististrombuscoronatus* as substrate in **Figure 12(A)-(B)**.



Figure 7. (A) *Cyphastrea* sp. from Al Faidiyah Formation at Al Fatayah Quarry, (B) Thin section from the same colony shows mouldic porosity (in black). Field of view = 6 mm, (XPL).

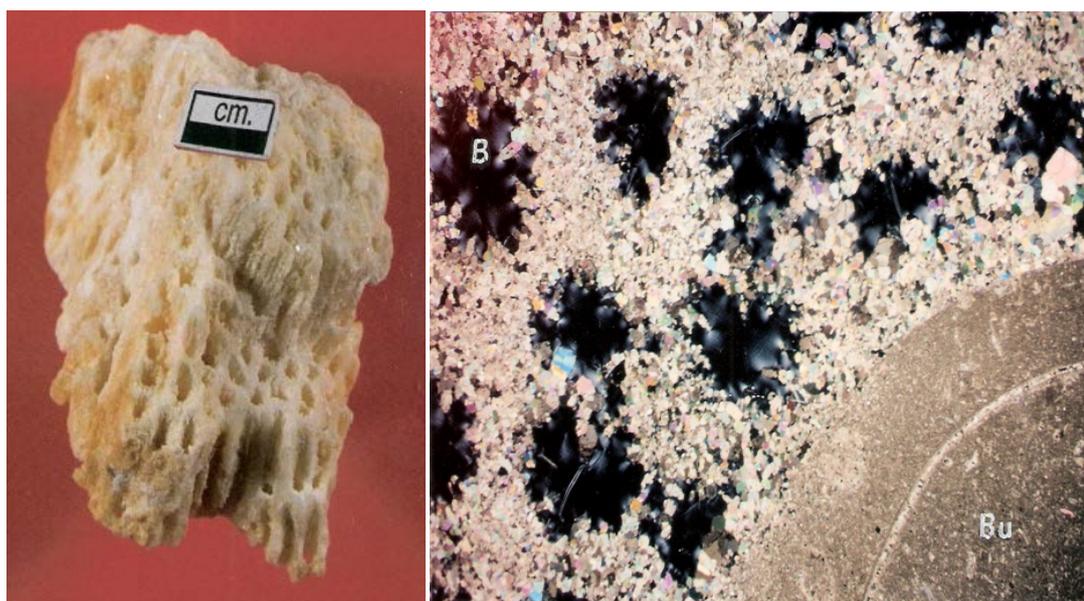


Figure 8. (A) *Aleveopora* sp. from Al Faidiyah Formation at Al Fatayah Quarry, (B) thin section from the same colony shows boring by bivalves (Bu) mouldic porosity (in black). Note: Wall has been replaced by Calcite. Field of view = 6 mm, (XPL).



Figure 9. (A) *Tarbellastraea* sp. from Benghazi Formation at Benghazi (Al Hawari) Cement Quarry, (B) Thin section from the same colony shows mouldic porosity (in black). Field of view = 6 mm, (XPL).

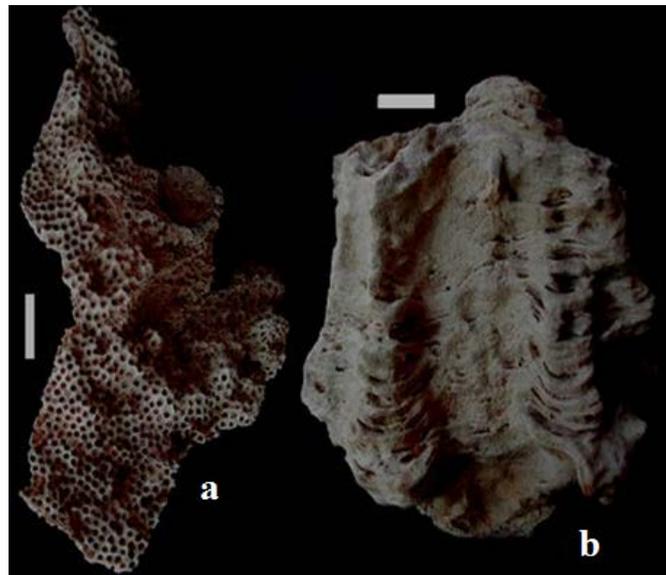


Figure 10. (a) *Astraeaopora* sp., (b) *Actinacis parorai* (Bar scale = 2 cm), As Sahabi area.

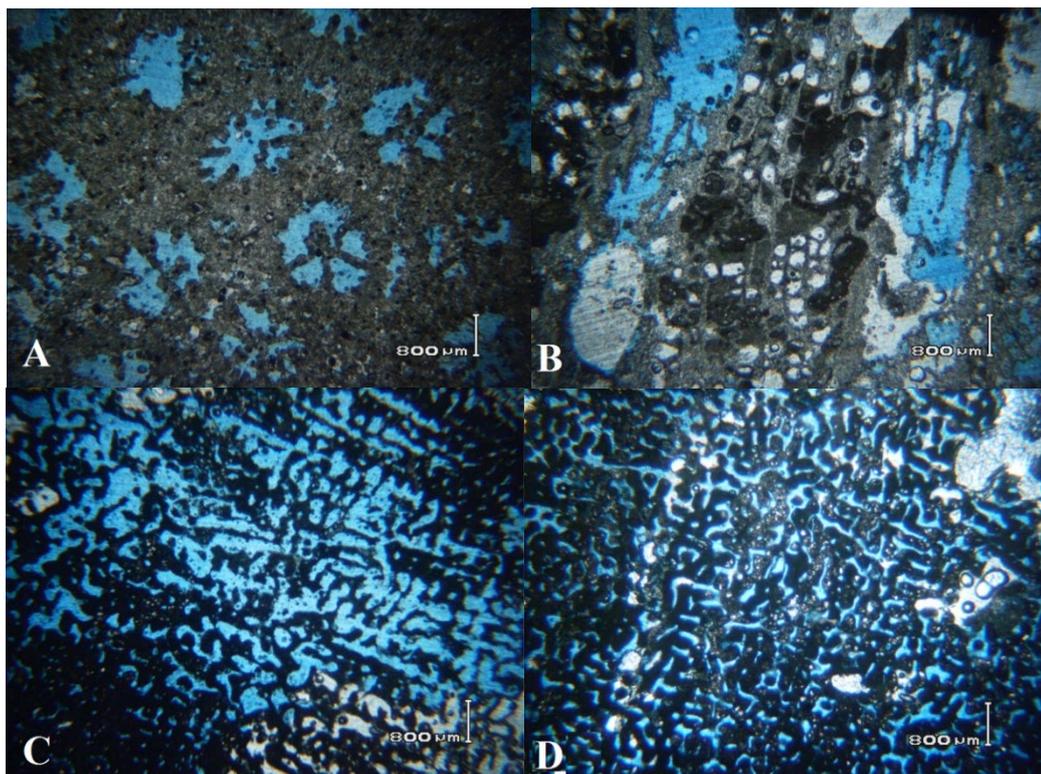


Figure 11. (A)-(B) *Astraeaopora* sp., (A) Transverse section and (B) Longitudinal section. (C)-(D) *Actinacis parorai*: (C) Transverse section and (D) Longitudinal section.

5. Conclusions

The Al Jabal al Akhdar area and As Sahabi area display conspicuous exposures of the scleractinian coral reef. Only eight species are documented herein, six from The Al Jabal al Akhdar area and two from the As Sahabi area.

The reefal facies of Al Jabal al Akhdar is restricted to the Middle Eocene Darnah Formation, Early Oligocene

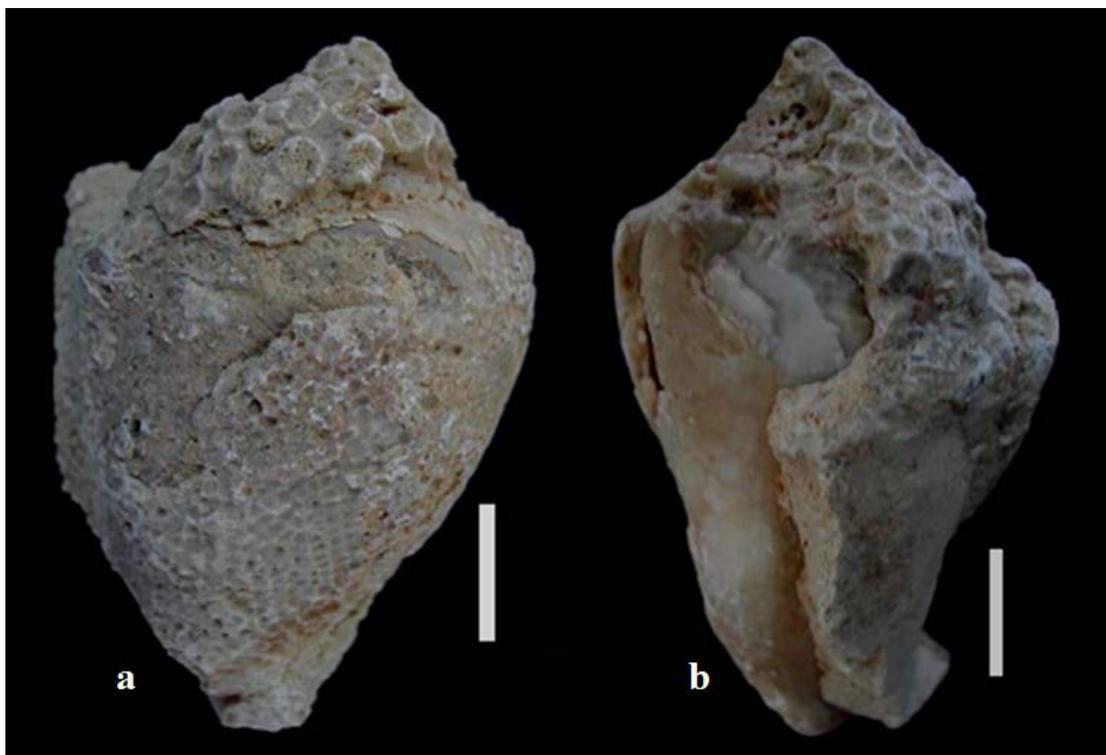


Figure 12. (a)-(b) Encrusted corals on *Persististrombus coronatu*. (Bar scale = 2 cm).

Al Bayda Formation; Upper Oligocene Al Faidiyah Formation and Middle Miocene Benghazi Formation. Only the Upper Miocene formation “M” is developed in As Sahabi area.

Diagenetic processes at some subsurface records rule the effectiveness of coral buildups to be good reservoirs, although in the surface show excellent porosity and permeability.

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