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Environmental Geological Studies on Bicess Island Area, Northwest Libya

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Abstract

Due to the few number of islands encountered in the States of the continent of Africa bordering the Mediterranean Sea, Bicess Island may be considered as one of the most important geological features in Libya. The study represents an attempt to identify the threatening of wild birds on Bicess Island through the studying of the various geomorphologic and structural features as well as the stratigraphic sequence. Bicess Island is located west of the Alkhoms City at the mouth of Wadi Bicess which marks the junction of the Nafusa Mountain base with Mediterranean coast. The genesis of Bicess Island is mostly due to the breaking down caused by wave action with the help of the structural effects in the region. The length of the island reaches 240 m, while the width is varying between 40 m and 160 m. The depth of water at the southern part of Bicess Island reaches about 4 m and varies between 7 m and 12 m at the northwestern part and the northeastern part respectively. Bicess Island posses a rocky beach occupied by algae and characterized by highly steeped and irregular cliffs as well as coasts associated with bays and peaks. The presence of dense plant cover on Bicess Island as well as its separation of being surrounded by sea water caused the human activities to be very limited and the occupation of the island by a great number of wild birds build their nests within the holes existing in rocks belonging to Alkhoms Formation. Caves were found at the base of cliffs. The shape of the caves appears as long cylinders extend along zones of weakness with radius become less to the interior of the rocks. On the roof of the caves there were a lot of joints which became wider forming explosive holes. Land destructions by waves and landslides are the most important factors threatening wild bird lives. In order to protect wild bird populations as well as the unique morphological and geological features, the present study recommends Bicess Island to become a natural reserve.

Keywords: Libya; Bicess Island; Caves, Bird life; natural reserve

Introduction

Globally, more than a billion people live near the coast and many of those reside only a few meters above sea level or behind an encroaching hazard, the edge of the coastal cliff (Small et al., 2000; Nicholls and Small, 2002). Various studies have documented the extent of coastlines that are undergoing erosion (USACE, 1971; Habel and Armstrong, 1978; Griggs and Savoy, 1985; Pope et al., 1999; Komar, 1997; Terich, 1987; Kelley et al., 1989; Carter et al., 1987; McCormick et al., 1984); Griggs, 1999). Because of the desirability of living directly on the coast, which in many regions means living on a cliff above an eroding coastline, there are significant short and long-term risks associated with the population migration to, and more intense development of, those areas. Coastal erosion has become an increasingly publicized regional and national issue that is going to affect the Nation for many decades.

In many coastline areas, irregular coasts may become more organized and aligned as a result of sea action which may deposit sand bodies in the form of barriers and tongues either at points where coastlines changing their direction suddenly or in the front of river estuarine gulfs or through bays entrance or sometimes between land margins and adjacent islands. As waves enter shallow waters nearby the beach, they become broken where their lower parts become forced by friction at the bottom. The wave crest with its powerful energy may advance forward and become broken. Waves may differ in their crest volume; some may resemble the sand rippling, while others appear in the form of strong storm waves supported with the high wind speed capable to destroy the beach components at the lowered coastlines (Elatrash et al., 2006). When waves attack beaches, they become eroded strongly or weakly depending on the original morphology of the beach. The degree and speed of erosion of the beach may depend on many factors, such as the degree of resistance of the rocks that form the beach and the intensity of wave action attacking the beach.

Location of study area

Bicess Island is situated west of Alkhoms city at the mouth of Bicess valley (Fig-1). The current study represents an attempt to identify the threatening of wild birds on Bicess Island through the studying of the various geomorphologic and structural features as well as the stratigraphic sequence of the area.

Method of study

Field investigations including determining the different geomorphologic and structural characteristics of the Island and collecting representative samples of the stratigraphic sequence documented with petrographic investigations using a polarized microscope with photo-camera.

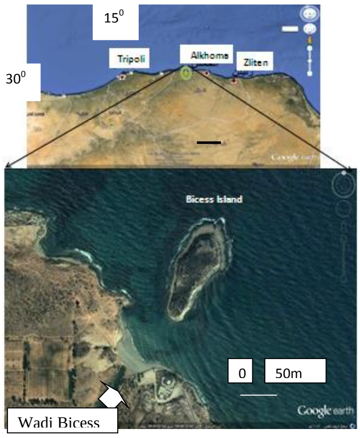

Fig 1: Satellite image showing location of study area and the conjunction of Wadi Bicess with Mediterranean Sea at Bicess Island.

Geomorphology

The area of study represents the junction of the Nafusa Mountains with Mediterranean coast. The interface of Nafusa Mountain is situated to the west of Alkhoms city and may consider as a surface of erosion intersected by a number of valleys with many tributaries. The most tributaries in the region exhibiting parallel drainage patterns and cutting sedimentary rocks in the direction of Mediterranean Sea. The most essential geomorplogical features include Wadi Bicess and Bicess Island.

Wadi Bicess surrounded by rocky cliffs with highest point reaches to 220 m from sea level. Bicess Island is located near the shore line, reaches about 30 m high and descends steeply sides (Fig-2). The width of the island varies between 160 m at its northern part and 40 m at its southern one, while the length of the island reaches to about 240 m. The water depth is about 4 m in the south, and varies between 7 m and 12 m at the northwestern and northeastern parts respectively. Generally, the beach of the island is rocky and permitted the accumulation of water and some sort of algae and gastropods on its surface (Fig. 3).

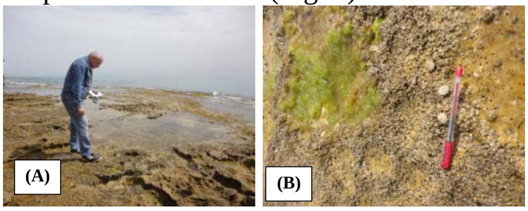

Fig 3: (A) Accumulations of shallow water. (B) Accumulations of algae and gastropods on Bicess Island beach.

The most important observed erosion features are sea cliffs, caves, blow holes, and wave-cut platform. Sea cliffs are the most important erosion features formed by the wave action along the shore of Bicess Island. Erosion processes can carve a cliff face slowly into hard rocks and rapidly into soft rocks (Sunamura, 1983). The amount of wave-induced erosion is a function of the energy expended against the cliff by the waves, through the compressional force of impact and the tractive force of uprush (Trenhaile, 1987; Sunamura, 1992). However, some initiate as scarps of large landslides or faults (Moore et al., 1989; Kershaw and Guo, 2001).

Caves are formed at the base of cliffs which have been subjected to sea wave action. Caves appear in the form of cylinder-like tunnels along zones of weakness and decrease in diameter as we head towards the inside. Many joints have been identified in the roof caves which become wider and swell up forming blow holes. The holes occur as a result of the continued compression action which causing water to flare-up through the cave and flow-out into air. The emergence of water through the caves occurs due to compression strength of waves when rush violently inside the cave at the bottom of the collar hole (Figs 4 and 5).

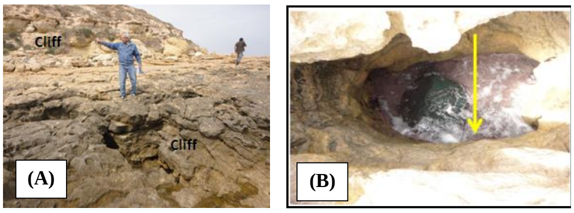

Fig. 4: (A) Formation of cliffs on the rocky beach of Bicess Island. (B) Close-up view showing the creation of a blow hole. Note the presence of water in its collar.

Erosion effects of wave action and the retreat of cliffs lead to the development of wave-cut platform (Fig. 5). The rocky material that resulted from the erosion may swing in motion by the waves in the tidal zone. The swing motion of this rocky material along the wave-cut platform that gently-slopes towards the sea, may enhances the erosion process and result in more polished surface of the platform.

The erosion phase in the area of study could be considered as the youth stage where Bicess Island is characterized by irregular, highly-steep cliffs and has coasts occupied by capes and bays.

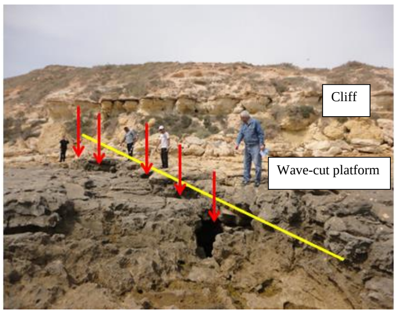

Fig. 5: The emergence of water through the caves occurs due to compression strength of waves when rush violently inside the cave at the bottom of the collar hole. Note the zone of weakness (yellow solid line) in the rocks along which the holes were formed.

Bicess beaches exhibit a variety of geomorphologic features resulted from deposition, the most important is the pelagic zone or the Beach which denotes areas from the shore marked either by accumulations of gravel and sand in zones laying between low-tide and high-tide limits, or may be just a bunch of unstable boulders and gravel rolled by waves at the bottom of cliffs. It is noted that, the pelagic zone on the elevated coasts of Bicess Island considered narrow due to deep water levels close to land margin, while lowered coasts exhibit broad pelagic zones within high-tide and low-tide limits. Also, pelagic zones form inside bays limited by two land apexes. The margins of land apexes subjected to wave action and become gradually eroded causes deposition on the interior margins of the bay close to the main cliff (Fig. 6).

Fig. 6: The pelagic zone of Bicess Island (Gulf-shaped pelagic zone). Note the steep coastal cliff with rocky headlands.

Stratigraphic Sequence

Beds outcropping in Bicess area show rock units of Alkhoms Formation (Middle Miocene) which mainly include, from base to top, sandstones, sandy-limestone followed by limestone. The sea-cliff exposures eroded into marine terraces. The stratigraphic sequence is shown in Table (1) and Figs (7 and 8).

The petrographic studies of Alkoms Formation (Alnaqaza Member) revealed that, it consists of medium-grained sandstones mainly composed of sub-rounded quartz particles (Fig. 9A). This sandstone horizon is overlain by fossiliferous sandy-limestone beds deposited in a shallow water environment (Figs 9B and 10A). This is followed by a sandy-limestone beds deposited in a relatively deep environment (Fig. 10B). The presence of quartz grains engulfed inside the micrite component may indicate the role of winds as a transporting agent in the environment of deposition. Stratified limestone (chalky) covering a sandy-limestone denoting transgression of the sea during Miocene.

Table (1): The stratigraphic sequence at Alkhoms area (modified after Mann, 1975)

Description	Thickness meters	Member	Formation	Age
Gravels and boulders	-		Recent Valley Deposits	Quaternary
Coastal- calcareous sandstones	10-20		Eolian Deposits	
Eolian materials intercalated with gravels and silica grains as will as rare calcarous shells.			Eolian-Marine Deposits	
Clay, sandy limestone associated with salts and gypsum crystals	1-3		Sabkha Deposits	
Calcarenite with sporadic siltstone lenses	30-40		Qarqaresh	
Siltstone, conglomeratic sandstone with calcareous and gypsiferous shells	15		Jefara	
Consolidated & looes gravel, inter- calations of calcareous shells.	25		Qasar Al-Haj	
Clay, sandy-calcarenite, conglomer- ate, marly-limestone, limestone	100		Alkhoms	Mio cene
Dolomitic limestone to dolomite with chert nodules	200		Nalut	LateCretceous
Marl. Claystone + gypsum crystals	380	Yefern Marl	Sidi Assed	
Dolomitic limestone to dolomite + quartz annd quartzite interbbeds	30-45	Ain Tobi		

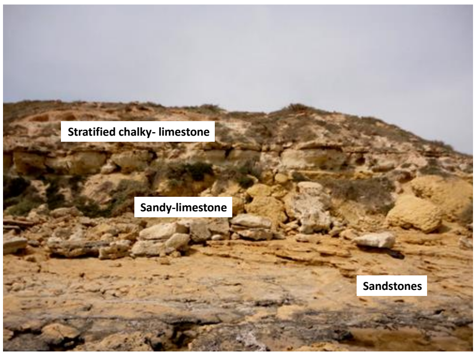

Fig. 7: The stratigraphic sequence of Bicess Island (sea transgression).

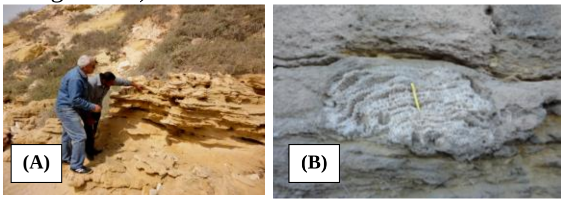

Fig. 8: Alkhoms Formation; (A) Cross-bedded sandstone. (B) Coral reef in fossiliferous sandy-limestones.

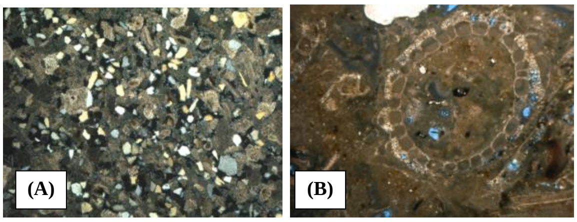

Fig. 9: A microscopic photos (x2.5) of Alkhoms Formation; (A) shows sub-rounded medium-grained sandstone. (B) Denoting the fossiliferous sandy-limestone.

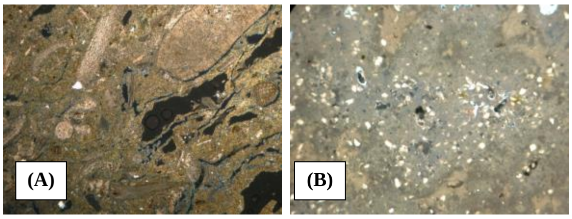

Fig. 10: A microscopic photos (x2.5) of Alkhoms Formation; (A) denoting the Bivalves and Bryozoas in fossiliferous sandy-limestones of Alkhoms Formation. (B) Quartz grains within the micrite component of the sandy-limestone.

Sea waves control on the deformation of the coast

As a result of erosional and depositional processes, the shore line of Bicess Island extends nearly N67W - S67E perpendicular to the resultant wave energy (Abdelgalil, 2009). When waves reach the base of a cliff, they can erode the cliff material directly or they can erode loose material that has collected at the cliff base which destabilize the cliff and ultimately induce failure of the overlying material (Edil and Vallejo, 1980). It is the combination of subaerial and marine processes, as well as the nature of the constituent materials, that create distinctive coastal cliffs (Pethick, 1984).

The creation of Bicess Island played a principal role in the power concentration as a result of the breakdown of waves on its body (Fig. 11). The shore platform seaward of the coastal cliff in Bicess Island is widest where the cliff receives the most intense daily action of waves. Consequently, the northern shoreline of the island becomes more eroded than the other sides. The western and eastern shoreline sides were more eroded than the southern one. The width of the sea platforms in Bicess Island is about 40 meters to the north, 20 meters to the west, 10 meters to the east and become less to about nothing to the south (Fig. 12). Moreover, Bryan and Stephens (1993) noted that, the shore platform seaward of the coastal cliff in Hanauma Bay, Hawaii, is widest where the cliff receives the most intense daily heating and therefore the most intense salt weathering.

Fig. 11: The breakdown of sea waves on the rocky peaks of the island. Note the more extended sea platform to the north compared to the less extended ones in west, east and south.

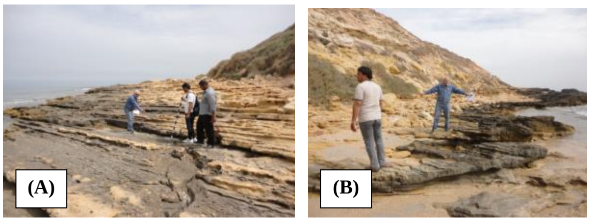

Fig. 12: (A) Extended sea platform in the west; (B) Less extended sea platform in the east.

The catastrophic action of waves and structural effects

Coastal morphology often correlates closely with tectonic setting (Inman and Nordstrom, 1971). The genesis of Bicess Island is mostly thought to be related to the catastrophic action of sea waves coupled with the structural controls in the region, where it is noted that, the island has influenced by a number of faults that extend NE- SW in the same direction of the resultant wave energy (Fig. 13). Field observations show that, the rocky capes extend NW-SE, where erosion by broken wave action is found to affect the area essentially in the NE-SW, parallel to the vertical joint assemblages developed in the area, which could result in the formation of cliffs. Joints and faults can serve as locations of high susceptibility to slope failure in otherwise stable rock (Benumof and Griggs, 1999; Griggs and Trenhaile, 1994). Wave energy may erode the lowermost rocks that gradually broken and cause the destruction of the uppermost rocks in the form of erratic blocks down cliffs. Waves attack the weaker zones of the fractures and joints and form inlet while the more resistant rock is left behind as points (Fig. 13B).

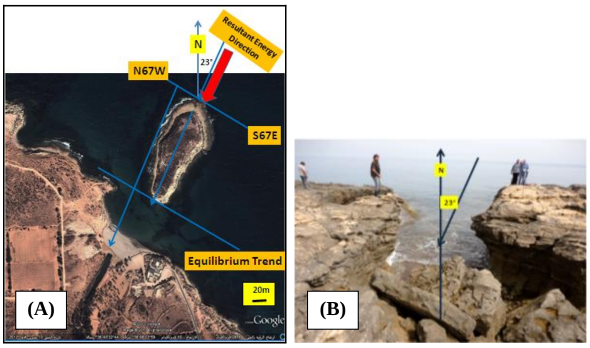

Fig 13: (A) The orientation of Bicess shoreline parallel to equilibrium trend; (B) The structural control on Bicess island genesis. Note the NE-SW faults run parallel to the resultant wave energy.

Threatening the lives of wild birds

The presence of dense vegetation on Alkhoms Formation rocks in the Bicess island (Fig. 14A) as well as its separation by water on all sides may helped in the inexistence of human activity on the island (or less frequent to some extent), hence, the reproduction of wild birds took place which used to build their nests within Alkhoms formation rocks.

Field observations showed the large number of wild birds on the island (Fig. 14B), and as due to the proximity of the island from the shore line, some holidaymakers who frequented during the summer find it easier to catch the young birds that existed in their nests built in rock gaps of Alkhoms Formation. The main problems facing the area of study may include land destructions by waves and landslides which acting negatively on lives of wild bird populations on the island.

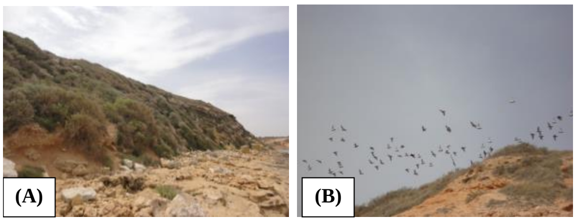

Fig 14: (A) The presence of vegetation on Alkhoms Formation rocks protected bird nests on the Bicess Island; (B) Large number of birds live among Alkhoms Formation rocks in Bicess Island.

Conclusions

The geomorphologic features in Bicess region is mainly represented by the Bicess valley and Bicess island which located close to beach line. The beach of the island is rocky which permitted some sort of algae to grow on its surface.

Erosion landforms on the island are represented mainly by sea cliff**s**, caves, blow holes and sea platforms. Bicess Island characterized by irregular, highly steep cliffs and having shorelines consisting of peaks and bays, therefore the erosion phase on the island could be considered in the youth stage.

The bed units outcropping belong to Alkhoms Formation (Middle- Miocene) which mainly represented from base to top by sandstones and sandy-limestone followed by limestone. Microscopic (petrographic) studies of Alkhoms Formation rocks (Alngaza Member) convinced that they consisted of medium sandstone characterized by subrounded quartz grains deposited in a relatively shallow environment; followed by fossiliferous sandy-limestone deposited in shallow environment as well as sandy-limestone deposited in relatively deeper environment; indicating the sea transgression phase during the Miocene.

The shore of the island facing the catastrophic action of the waves becomes more eroded than the other parts. Therefore, the northern coast of the island is more eroded followed by the less eroded parts in the west, east and then south. Hence, the broadness of the sea platform in the northern island reaches about 40 m, while 20 m to the west, 10 m to the east and almost non-existent to the south.

Bicess Island has affected by NE – SW fracture system parallel to the resultant wave energy direction which helped the catastrophic wave action on the island. Therefore, Bicess Island genesis is mostly thought to be related to the catastrophic action of waves coupled with the structural controls in the region.

The presence of vegetation on Bicess Island as well as its separation of being surrounded by sea water caused the human activities to be very limited and the occupation of the island by a great number of wild birds. Land destructions by waves and landslides are the main factors threatening wild bird lives.

Recommendations

The present study recommends the Bicess Island to be a natural reserve as to protect the island and its components that represented by the unique geological and geomorphologic features and as well wild bird populations.

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الملخص العربي

عنوان البحث: دراسه جيوبيئيه بمنطقة جزيرة بسيس – شمال غرب ليبيا

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تمثل جزيرة بسيس أحد المعالم الجيولوجيه الهامه بليبيا وربما يرجع ذلك لقلة عدد الجزر المتواجده بدول قارة افريقيا المطله على البحر المتوسط. تقع جزيرة بسيس غرب مدينة الخمس عند مصب وادى بسيس، حيث تمثل منطقة التقاء قدم جبل نفوسه مع ساحل البحر الأبيض المتوسط ؛ و بصفة عامه تقع واجهة الجبل الى الغرب من مدينة الخمس حيث تقطعها شبكه من الأودية ذات المياه الموسمية؛ و يعزى نشأة جزيرة بسيس فى الغالب الى الفعل الهدمى للأمواج بمساعدة التأثير التركيبى بالمنطقه. يصل طول الجزيره الى حوالى ٢٤٠ متر بينما يتراوح عرضها مابين ٤٠ متر و ١٦٠ متر. يصل عمق الماء الى ٤ متر جنوب الجزيره ، بينما يتراوح مابين ٧ متر شمال غرب الجزيره و ١٢ متر شمال شرق الجزيره ؛ بصفه عامه شاطىء الجزيره صخرى مصحوبا بالطحالب وبعض الأصداف .

تتميز جزيرة بسيس بجروف غير منتظمة شديدة الانحدار و بسواحل تكتنفها الرؤوس و الخلجان ؛ كما ساعد وجود غطاء نباتى على صخور جزيرة بسيس و انفصالها لكونها يحيط بها الماء من كل الجوانب

على قلة تردد الانسان عليها و بالتالى تكاثر الطيور البريه حيث تضع اعشاشها بين الصخور ؛ و لقد أوضحت المشاهدات الحقلية كثرة عدد الطيور البريه سواء من خلال كثرة مخرجات الطيور على صخور الجزيره أو عددها وهى تطير من أعشاشها عند احداث أى صوت عالى و أيضا سهولة الامساك بفراخ الطيور المتواجد أعشاشها بالفجوات الكثيرة المتواجدة بصخور تكوين الخمس والمغطاة بالغطاء النباتى .
لوحظ تواجد تراكيب جيولوجيه و ظاهرات جيومورفولوجيه نادرة أهمها الجروف و الكهوف في هيئة أنفاق اسطوانيه الشكل تمتد داخل الجروف متتبعا خط الضعف الصخري ، وتتناقص أقطارها كلما اتجهنا نحو الداخل ، و لقد لوحظ وجود فواصل في صخر سقف الكهوف تتسع مكونه ثقوب انفجاريه تنبثق المياه خلالها مندفعة في الجو بواسطة قوة ضغط الأمواج حينما تندفع المياه بعنف في داخل الكهف أسفل قصبة الثقب.
تتمثل أهم المشاكل التي تهدد حياة الطيور البريه؛ بتواجد الجروف البحرية المرتفعة الشديدة الانحدار و التي تتعرض إلى تأثير الأمواج، حيث تعمل قوة حركة الأمواج على تعرية الطبقات السفلية فتنهار التي فوقها على هيئة كتل صخرية أسفل الجروف .
للحفاظ على جزيرة بسيس و ما تحتويه من حياه بريه و تراكيب جيولوجية و ظاهرات جيومرفولوجية نادرة يوصى أن تكون جزيرة بسيس محميه طبيعية.