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Title: GEO-ARCHEOLOGY OF PHOENICUS (GREEK AND ROMAN HARBOUR) IN RAS EL-HEKMA, NW COAST OF EGYPT

ABSTRACT

Abstract
The new kingdom period heralded a doctrinal advancement within the Phoenicus is a submerged ancient harbour during the Greek and Roman Period and during the II World War. This name means the land of the Phoenicians; it is an excellent windward shore of the two islands of Hanafish, the twin islands described in the Book of Stadiums. One of them rises 4.5 meters above the water; nonetheless, the other protrudes above the surface of the water. Both of them are about half of a qas away from each other, and about 1.25 nautical miles from the land. Fourtau (1914) and Abd El Maguid (2001) state that sailing ships and steam ships are in the habit of taking shelter in them in case of storms. Some geo-archaeological and archaeological remains have been discovered sub-water, in the front shore area and in the back of harbour during a survey on the eastern side of the Ras El Hekma, an area of Egypt's NW coast. The study area is allocated in NW the coast of Egypt. It looks on the Mediterranean Sea, west of Alexandria City for about 235 km and 70 km to the east of Marsa Matruh. It is occupied by sedimentary rocks pertinent to the Tertiary and Quaternary Eras. The western coastline consists of Pleistocene, separated polygons of limestone sheets, and fossil limestone; however, there are coastal platforms, fluvial forms, and solution holes.

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1. Introduction

Phoenicus was among the largest and most active ancient harbours along the northwestern coast of Egypt. Figure (1), Figure (2), and late glacial melted formations raised above sea levels, creating beaches, rivers, and inland landscapes, submerged. Submerged environments, around the world, offer a wealth of time-stamped documents that carry untold stories. There are a particularly large number of archaeological sites in various regions of Egypt and the Levant, whose civilizations share many cultural features from antiquity. To facilitate more detailed studies and entertainment, these submerged environments must be listed and addressed. To address this, a foreshore, backshore, and depth survey are conducted, to a depth of 10 m at the port site along the northwestern coast of Egypt, starting from the shallowest site of Phoenicus to the last submerged platform of the harbour.

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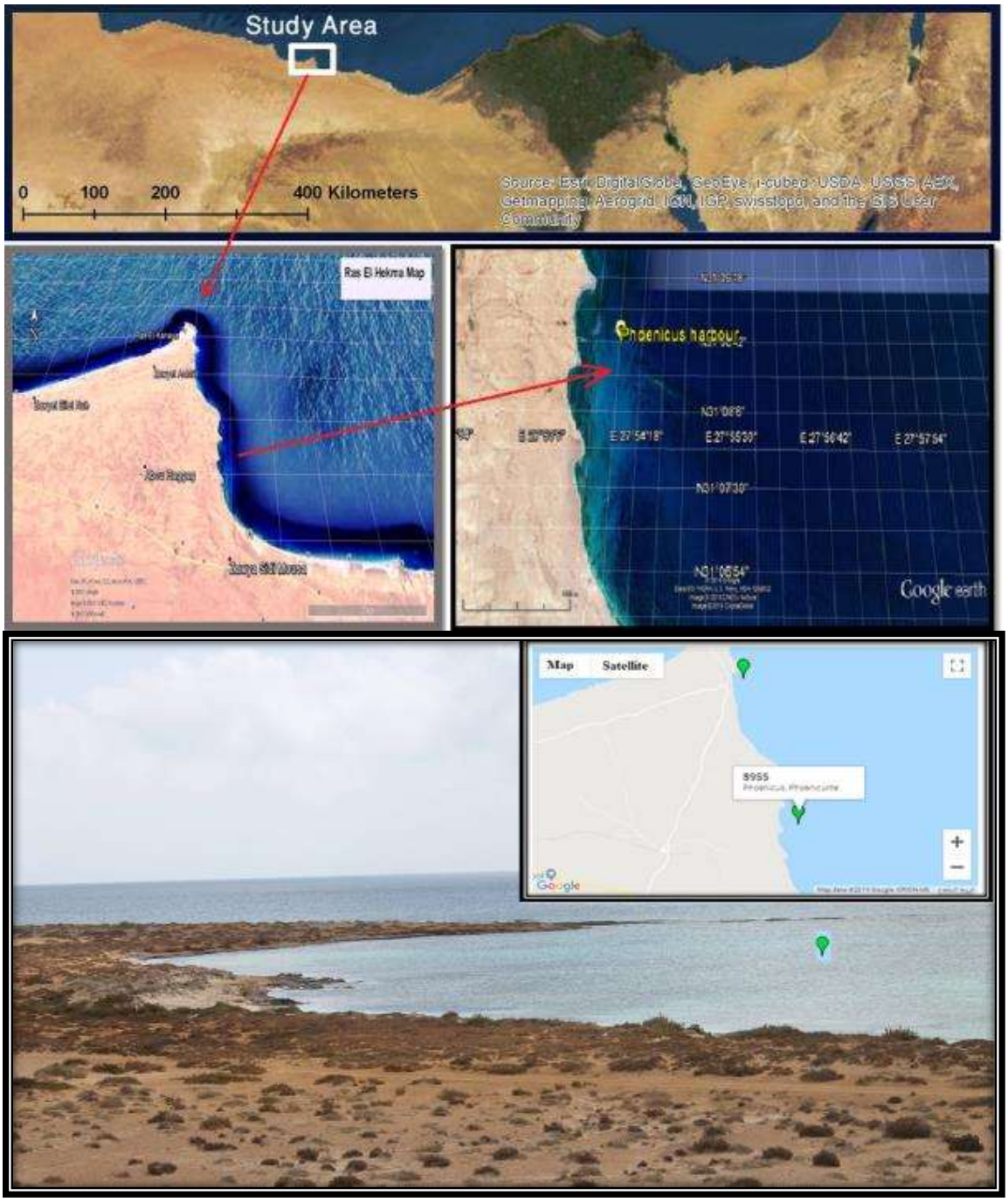

Fig. (1) General location of the study area. Fig. (2) Detailed location of Phoenicus submerged harbour. **http://www.ancientharboursantiques.com/the-catalogue/egypt-libya**

Phoenicus harbour site, allocated at the easternmost point of Ras El-Hikma, was famous which the Bedouins called Al-Balaat due to its rocky shoreline; it is interspersed with cracks and faults that separate the surface and expose it in the form of tiles owing to the spread of cracks and joints, pillars, and ordinary pottery found by researchers during their surveys. The remains found along the current coastline, indicate their

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location. These remains date back to the Greek and Roman eras. The remains of artillery bases, also, indicate that this port has been used during the World War II. Such ports ceased to function as a result of seismic disturbances and the gradual rise of the northwestern edge of the bay; it is likely that a combination of geological and human factors have led to its abandonment during the Arab conquest Figure (3).

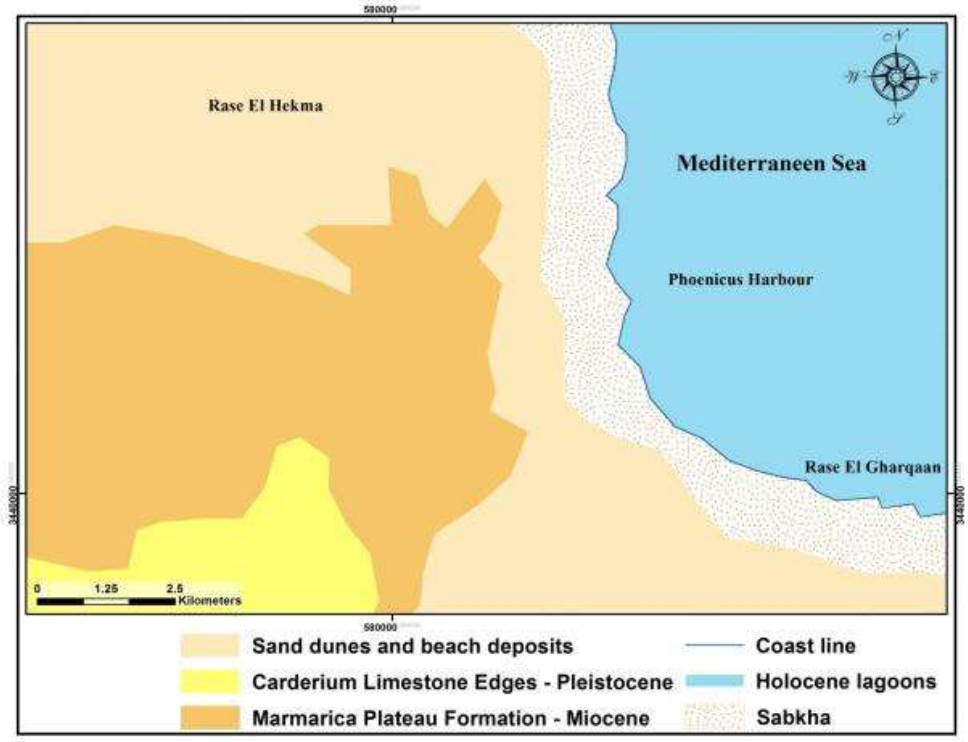

Fig. (3) Geology map for Phoenicus Harbour Area by Researcher by Arc GIs 10.3.1.

1.1. Background and Rationale

During the Greek and Roman era, the prime location of Egypt, the northeastern African coast, and the ancient trade routes encouraged the establishment of ports the primary spaces for the assimilation and integration of the cultures of the greater Mediterranean basin. The northwestern part of the Egyptian coast, along with the cultural interaction zone in the eastern Mediterranean, has served as a strategic geographical channel between Europe and Asia for ancient traders. The Roman Empire, initially, has denoted its importance, establishing several ports such as Alexandria, Al-Qalaa, and Hawara to cater to trade.

1.2. Research Objectives and Questions

The aim of the current study is to identify the geomorphological and geo-archaeological characteristics of the submerged port site between Ras Al-Gharqan and East of Ras Al-Hekma, in addition to what changes have occurred during the recent years. With a focus on the port of Phoenicus and the impact of sea level change in the Holocene era on the geomorphology and geo-archaeology of the port, Landsat images

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are implemented to conduct some analyses to map the area and collect all the changes occurring to this submerged port by conducting a changeable inference analysis, through the use of geological and geo-archaeological survey techniques to measure the rate of coastal erosion. The study, also, aims to identify the remains of the ancient breakwaters of the port. The study is based on a detailed geological and geomorphological survey, mapping, sampling, as well as X-ray images on different dates to measure the rate of erosion and sedimentation on the coast, and GIS techniques. The study aims to investigate the impact of sea level change during the Holocene on the study area. The northwest coast during the Pleistocene may have been formed of separate polygons of limestone sheets and fossil limestone; nevertheless, there are coastal platforms, river forms, and solution holes, demonstrating their impact on submerged harbours, broken sea, sea capes and islands during the last century as in Fig. (4).

Fig. (4) Some Collected Greek and Roman Amphora near the Coastline of the Study Area.

The research delves into the circumstances leading to Phoenicus Harbour's initial shelter and subsequent abandonment. To uncover the latest changes to this area, submersible-cut geo-archaeological digs are implemented. The primary goal of research is to investigate the geomorphological changes at the submerged Phoenicus Roman harbour in the northwestern coast of Egypt.

2. Geomorphological Features of Phoenicus Harbour:

The location of the port of Phoenicus is characterized by several geomorphological forms. It is a natural harbour protected by the marine rocky headland (Ras Al-Hikma), especially from the northwesterly winds and the resulting waves on the shoreline and the port, especially since the location of the port is on the remains of the Wave-cut platform and its coastal rock formations are from the remains of the Miocene and Quaternary eras. Through studying geological and topographic maps, field studies, and satellite image analysis in a geographic information systems environment, it became clear that the surface formations and geomorphological forms in the study area are known.

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They are limestone rocks, Cardium limestone, Cretaceous limestone, Oolitic limestone and sandstone formations. The most important erosion forms along the shoreline and the port background are the cliffs, marine terraces, holes, gaps and the marine erosion platform. As for the sedimentary forms, they are the rough, medium and fine sandy beaches, white sand dunes, lakes, salt marshes and sand dunes. Geomorphological factors and processes affect the formation and engineering of the port and shoreline phenomena. These are the natural and human factors represented in the geological, morphological, marine and wind processes of waves, currents and tides, the direction, slope and ruggedness of the shoreline and man as an important human factor. The rapid urban development of the northern coast, which resulted in a change in the morphology of the shoreline and an increase in rapid erosion and sedimentation processes, resulted in human intervention in the presence of solutions by creating marine engineering facilities and barriers to protect the shoreline from erosion and sedimentation processes. Fig. (5).

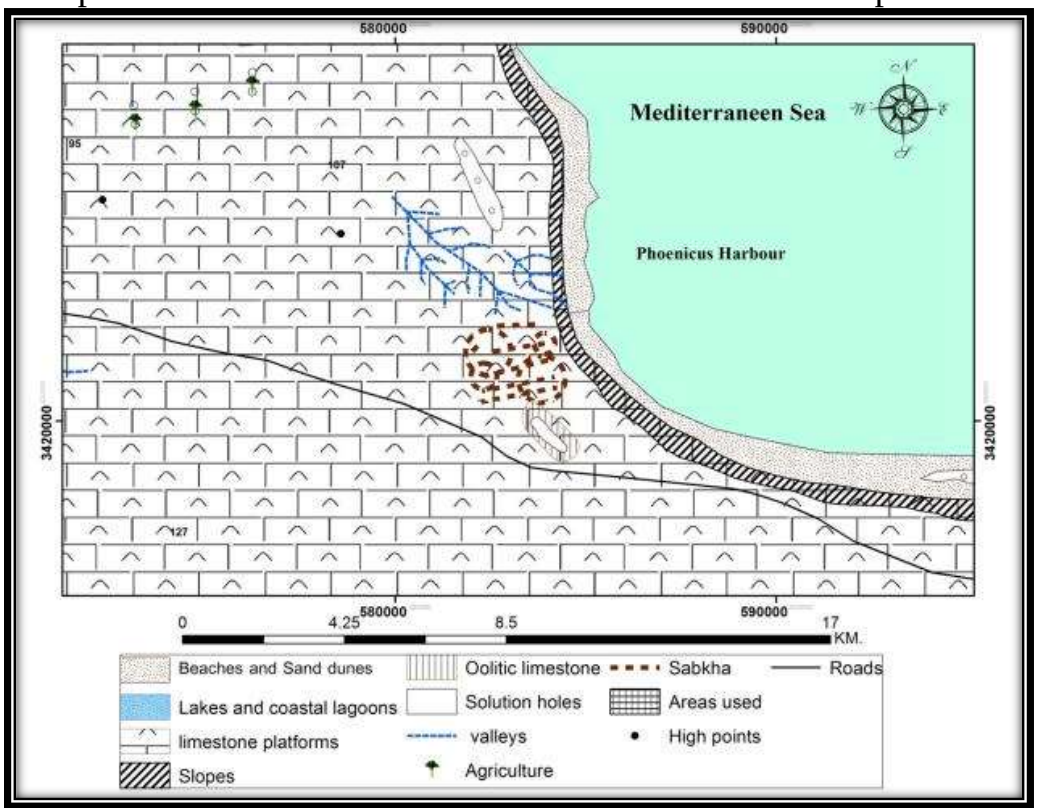

Fig. (5) A Geomorphological Map of the Study Area by Arc GIs 10.3.1

There are sandy dunes in the area; moreover, aerial photos show their migration. Weathering processes, either mechanical or chemical, create numerous solution phenomena in the pure white limestone. Marine, water (rainwater), and wind erosion processes then play a role in removing the remnants of weathering processes and revealing the area in a new form as shown in Fig. (6), (7), (8), (9), (10).

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Fig (6), (7), (8), (9), (10) A Submerged Platform, A Notch and Solution Hole, and Submerged Caves

2.1. Description of the Site

Natural and human modifications, along with some large-scale environmental interactions, have affected Phoenicus' ancient harbour. The Romans built several harbours on the northwestern coast. In addition to reusing some of the harbours that remained from the Greek era, the Romans left their impact on them, changed the size of ships, and carved out the natural quays to use as anchorages. Oral records and sources reveal that despite the richness of maritime activity, the harbours lack the necessary protection to withstand harsh weather figure (11) and (12).

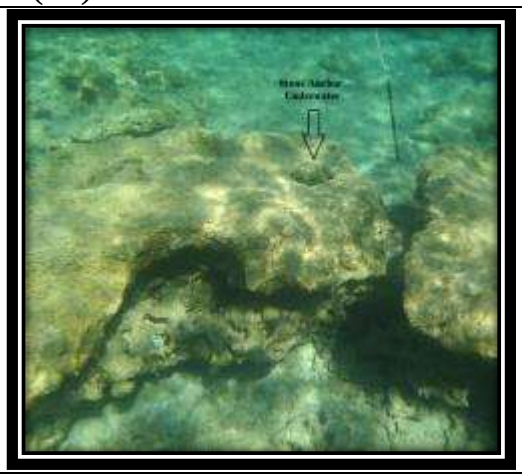

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Figure (11) Anchor in the Part of a surface and a Submerged Platform

Figure (12) Remains of Submerged Breakwaters in Phoenicus Harbour from Image to Google Earth Pro@ 2015.

2.2. Geological Setting

The general geology of the area is manifested by a regional northward dip of the structural plateau, two major NE-SW monoclines forming Ras El Hekma and Ras Alam El Rum Headlands and a synclinal basin at Baqqush separating the two monoclines. The geologic succession is totally made of sedimentary rocks belong to Quaternary and Tertiary periods. The Quaternary rocks are represented by dune sand accumulations, calcareous loamy deposits, and Oolitic limestone beside the "Cardium limestone". The Tertiary rocks are represented by pink limestone and the fossiliferous limestone "Marmarica Limestone "alternating with sandstone and clay beds. The clayey members are rather common along the western part of the area. The chalky and sandy limestone is dominating in the eastern part of the area *(Hammad et al.,1986*).

3. Geo-archaeological Significance

The necessity for the present study comes not only from the geomorphological changes that are occurring along the coast but also off the coast. The cross-section surveys of the sea bottom reveal that the offshore Phoenicus harbour has transformed into a stone and sand trap, accumulating countless tons of thousands of stones of diverse sizes and types from archaeological or maritime incidents. Consequently, the enormous quantities of the aforementioned sediments bury the limited organic tissues used as time indicators, linking the harbour to historical events and ancient sources during the Greek and Roman times, during the II World War; nonetheless, there are artillery bases dating back to that period as in figure (13).

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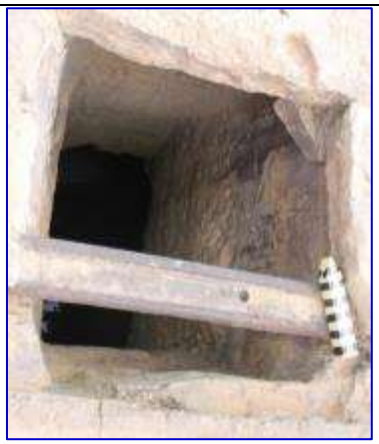

Fig (13), (14): II World War Archaeological, Roman Well.

Ancient sources identify Phoenicus as one of the largest and most active ancient anchorages along the northern coast of Egypt, where parts of Amphora's are discovered which it back to 300 BC and a stone anchor. Furthermore, Roman well is demonstrated as in figure (14). Ball cites it in 1942 in a map of marine sites in Egypt as in figure (15). Researchers, also, note the presence of walls, extending towards the coast. The geomorphological characteristics are examined for location, but coastal erosion and other geomorphic processes, along with the Holocene Sea level change, have altered the coastline from the Greek and Roman periods to these recent times.

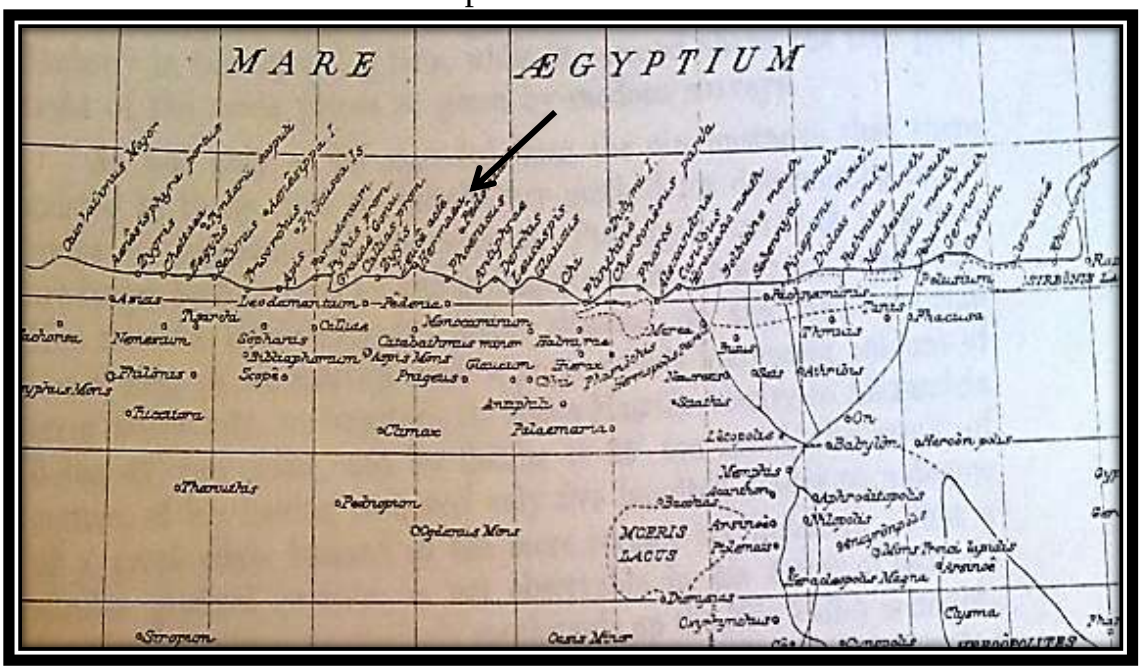

Fig (15) A Location of Phoenicus Harbour in Ancient Egypt, (Ball, 1942)

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3.1. Geo-archaeology: Definition and Scope

Geoarchaeology is the study of the interaction between human cultures and the natural world. As an interdisciplinary field that draws upon the combined expertise of archaeology, Earth Science (geology, geomorphology, and soil science), ecology, geography, and other disciplines, geo-archaeology, as a methodology, are applied to the concepts, information, and analytical techniques of Earth Science to answer archaeological questions comprehensively to facilitate the work of archaeologists and efficiently carry out archaeological research. The field provides critical knowledge that contributes to interpreting all phases of culture or civilization's development, as well as its interaction with and alteration of the environment. Although geo-archaeological applications are broad, the research, typically, focuses on archaeological sites, environmental contexts, and geological records.

Geo-archaeologists study things such as sediments, soils, and stratigraphy. They also look at micro- and macro-stratigraphic evidence of natural and cultural processes, as well as the time and space scales over which happen. Archaeological site formation often serves as the primary focus owing to its crucial role in the creation and survival of archaeological deposits, the interpretation of these features, and their impact on the research process. Geo-archaeologists have the investigatory tools to address scientific and resource management issues, and the need for preserving archaeological sites requires that archaeologists and Earth scientists collaborate on a common intelligibility requisite to inform both research and development planning efforts (Donald, 1996).

3.2. Importance of Geo-archaeology at Submerged Sites

Geo-archaeology is an applied interdisciplinary field that focuses on studies in which natural environmental factors, as well as intentional or unintentional human intervention, shape sediments and processes. Geo-archaeology tries to clarify the interactions occurring between past societies and their surrounding specific environmental contexts. The results of these studies attempt to interpret the sequences and changes by dominantly pinpointing the role of both anthropogenic factors and natural environmental factors, as well as their interactions. Through a variety of archaeology-related concepts, theories and methods bear resemblance to the subfield of geography known as physical geo-archaeology. Researches are conducted in various earth sciences fields, including pedology (soil science, land use), phytosociology (paleo-ecology), climatology (paleo-climate), hydrology (geomorphology, paleo-hydrology), and sedimentology.

Furthermore, when conducting an archaeological study, it is crucial to give special attention to geo-archaeology and comprehend the notion of "cultural resource management". Recognizing and utilizing the harbourance of geo-archaeological methods to fully investigate different sites, planning any interventions can help us find hidden

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evidence and avoid the need for expensive excavations. As a result, significant amounts of money, energy, and time can be saved. Furthermore, scientific preliminary studies play a crucial role in assisting decision-makers in considering necessary implementations, providing evidence and results that can predict restoration and maintenance interventions, leading to further protection at the targeted archaeological sites. Generally, by combining the skills and knowledge of various earth sciences with those of archaeology teams, geo-archaeology should be utilized as an innovative interdisciplinary research approach in any archaeological investigation process (Donald, 1996).

4. Methodology:

A ground survey is conducted within the submerged harbours to map the area's geomorphology for the sake of identifying any visible remains. There is an incorporation of the results into the GIS. In addition to the geophysical survey, a geological column is, also, used, of the entire submerged harbour area to look at the order of deposition and when these sediment changes occurred. A field survey is explored to map the fossil landscape to the present underwater seafloor of the study area; in addition, there is an assessment of the accessibility of any man-made structures below the water depths. We used the survey field to examine the transformation of the fossil landscape towards the current underwater seabed of the study area and to assess the accessibility of any man-made structures below the water depths.

A regional GIS database incorporates information from both contemporary and ancient sources, including geographical texts, charts and maps, ancient harbours, and a GIS database of archaeological evidence, involving aerial images, satellite images, and landscape data. This data is supplemented with historical aerial photographs, management books, re-harbours, publication archives, and personal observations shore-based surveys. The geo-archaeological survey and the diachronic method used in the regional GIS-based database make it clear that there are many unexpected stratigraphic results unknown before. Additionally, the study explores the nature of the modifications made to the adjacent underwater sea-beds during historical periods.

5. Results and interpretations

Water levels rise after the Roman period. The water level rises by a meter or more across the Mediterranean. The changes in Phoenicus' harbour have diminished over a more recent period. In comparison, the area has experienced a significant tectonic activity, such as subsidence movements that have submerged the harbours on Egypt's northwestern coast over the past two millennia, creating submerged quays that now border it to the north, more than a kilometer wide. Some geo-morphological and geo-archaeological indicators are used to define the Holocene shoreline such as doing sample Analyses to the submerged platform block as in fig (16) and take photo to this profile,

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measuring some photomicrograph of the limestone and showing the primary inter-granular porosity (In). Note the thin film of isopachous cement coating the ooids (black arrow). Micritization of some ooid grain is, also, observed.

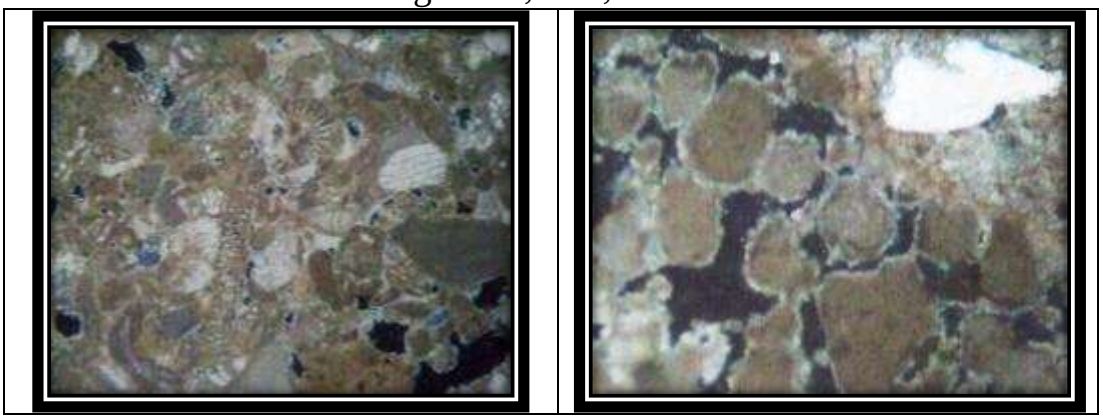

Fig (16) A thin Section in a Submerged Platform Block

5.1. Geo-archaeological Discoveries

Phoenicus harbour is allocated on the northeastern side of the triangle, a short distance from the headland; it is constructed inside a bay and protected from the northern waves by Marine Rocky Shore, and bordered to the west by some coastal dunes accumulated upon calcareous ridges, in addition to Mouths Valley. At the moment some archaeological evidence is discovered by the authors under sea water, it can be as part of Phoenicus ancient harbour; all explored indicators lies under recent sea level for about 3-4 m as a result of sea level change and monoclinal subsidence. The three field campaigns' underwater archaeological investigation reveals that Phoenicus' submerged harbour experiences an active development from approximately the 3nd century BC to the II World War.

On the surface, the study collects and documents pottery evidence from these periods. Surveys and diving reveal that the main axis of the Roman dry docks runs parallel to the prevailing northerly wave direction. Alternating Quaternary limestone, part of an eroded carbonate coastal ridge, occupies the study area. Some geomorphic coastal landforms are monitored along the shore, such as multi-level marine notches, platforms, and caves, made by the Holocene Sea level. Furthermore, some solution micro-landforms, like solution holes, channels, pits, and residual pinnacles are made by sea water on carbonate rocks as in Fig (17) which shows geo-archaeological map content: geological, geomorphological, and archaeological indicators.

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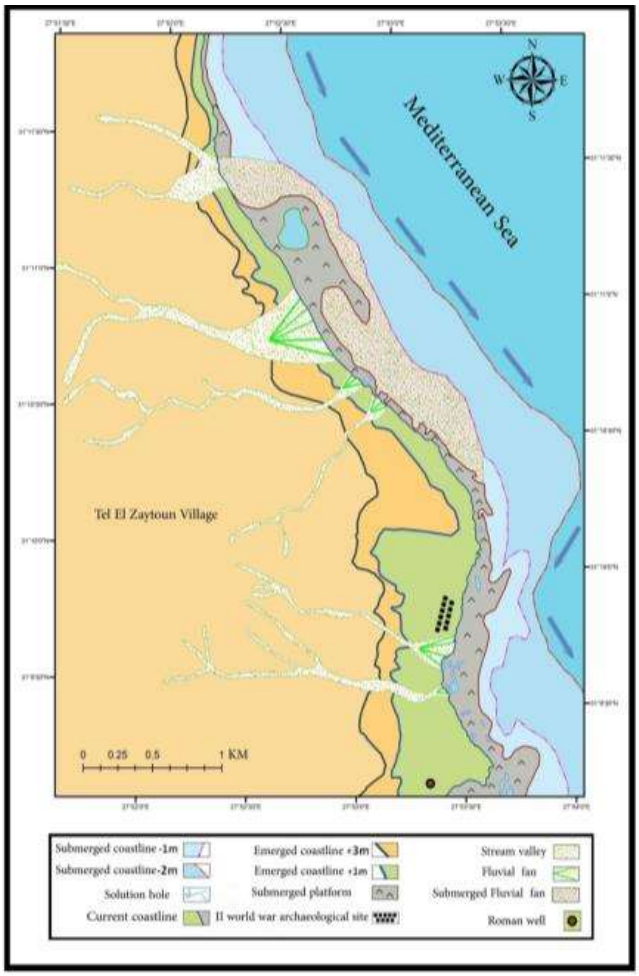

Fig.17: A Geomorphological and Archaeological Map by Arc GIs 10.3.1

6. Discussion:

The investigation reveals that the establishment of Phoenicus harbours, comprising Facies I, II, and III, takes place from the 300 BD to II world war. Some archaeological remains (Amphora) date back to the fourth century, which is the beginning of the late Roman era, according to the examination and analysis by Dr. Mohammad Mustafa Abd El Majeed (2017). The widespread use of the name Phoenicus extends to historians whose name is attributed to the Phencian land. During the Greek and Roman eras, the cultural harbour gains widespread recognition; it is, furthermore, expanded during the British occupation. The Bedouins, who inhabit the area from their ancestors, recount those camels' carried goods to the ships; they exchange the most imported goods with the people's provisions (barley and olives). The harbour coastline is receding owing to the increasing wave, Weathering processes and erosion activity, as shown in Fig. (5). Ras El Hekma is far west so it cannot protect the bay; however, there are other headlands protecting it. The erosion processes have, repeatedly, eroded this

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cape, making it insufficient to shield the harbour from northwesterly winds. As a result, the harbour no longer meets the natural criteria to remain stable.

Conclusions:

Some geo-morphological and geo-archaeological indicator has been measured in the ancient harbours site in the eastern side of Ras El Hekma area. Some emerged notches and platforms are apparent. Marine terraces and caves indicate sea level change. Some archaeology remains which belong to Roman period accumulated by waves on the beach refer to the submerged Phoenicus harbour in those places on depth about 2 m under water, referring to sea level change. Some geomorphological and geo-archaeological indicators are measured in the ancient harbour site on the eastern side of the Ras El Hekma area. Some emergent notches and platforms, in addition to marine terraces and caves, indicate sea level change. Waves on the beach accumulated some archaeology remains from the Greek and Roman period, denoting a change in the sea level at a depth of about 4–5 m in Phoenicus harbour.

This paper aims to investigate the changes at the site by applying these available independent scientific tools without making any intervention, such as the complete excavation of remains or preparing any theoretical models. Only relatively low-cost geophysics, remote sensing, and field survey tools are applied. Phoenicus' sunken environment and coastal events, which situate the site in a shallow atmosphere since the Hellenistic and Roman times, shape it. Evaporites, rip-rap, stretches on nearby offshore mudbanks, liquefaction, and slides still play very influential roles in the status of the remains of the site. They need more future monitoring or site order conservation. This underscores the stark contrast between the site's "as if nothing happened" scenario and its actual circumstances. The bespoke stato-dynamical condition of Phoenicus, with its sea-face utilizing the descriptive and protective functions of some soil types, makes it a case study for the present research intent. The outcomes of the integrated approach can be a blueprint that may be useful for further geomorphological-based research into submerged archaeological areas.

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