Posters

P1. Geoarchaeological Research in the Harbours of Ancient Korkyra (Corfu, Greece)

Kalliopi Baika (Aix-Marseille University, National Center for Scientific Research (CNRS), Aix-en-Provence, France; Ephorate of Underwater Antiquities, Hellenic Ministry of Culture and Sports, Athens, Greece)

Diamanto Rigakou (Ephorate of Antiquities of Corfu, Hellenic Ministry of Culture and Sports, Corfu, Greece)

Garoufalia Metallinou (Ephorate of Antiquities of Corfu, Hellenic Ministry of Culture and Sports, Corfu, Greece)

Andreas Vött (Institute of Geography, Johannes Gutenberg-Universität Mainz, Mainz, Germany)

Peter Fischer (Institute of Geography, Johannes Gutenberg-Universität Mainz, Mainz, Germany)

Claudia Finkler (Institute of Geography, Johannes Gutenberg-Universität Mainz, Mainz, Germany)

The ancient harbour-city of Corfu at the entrance of the Adriatic Sea was a prominent Archaic thalassocracy and one of the first Greek city-states to acquire a substantial war fleet of triremes in the beginning of the fifth century BC. She was also strategically located for controlling the commercial sea-lanes that connected the Greek world with the Adriatic Sea and the west already since the Archaic period. Geo-strategical aspirations led to the development of substantial harbour infrastructure to support thriving commerce and naval supremacy at sea from early times. However, the evolution of the harbour system and in general the maritime façade of the ancient city is today obscure and altered due to significant geomorphological changes, severe human impact and heavy urbanism since antiquity, as well as during the Byzantine period and up to modern times.

An interdisciplinary geoarchaeological approach was initiated in 2013 (continuing into 2017) in order to decipher this complicated harbour and coastal environment. The project is led by the Ephorate of the Antiquities of Corfu, in collaboration with the Institute of Geography (University of Mainz) in association with the Centre Camille-Jullian (CNRS/Aix-Marseille University).

The methodology combines the study of the archaeological stratigraphy in the harbour and coastal zones with geological investigations involving extended vibracoring campaigns, conducted in conjunction with electrical resistivity measurements and the development of other innovative methodologies.

The ancient city developed on a fortified peninsula and was served by several harbour basins. Initial results demonstrate that these basins were gradually altered by a combination of geological changes (uplift, siltation, relative sea-level change, etc.) and human interventions (dredging), which resulted in being in part or completely concealed today under the urban tissue. Moreover, the high tectonic activity of the area and the manifold coastal dynamics make landscape reconstruction for different periods of time complicated. Nevertheless, this knowledge
is essential for comprehending the layout of the first settlement and the gradual transformation of the urban space of this major Mediterranean harbour-city throughout the centuries. This presentation will focus on the preliminary results of the 2016 field campaign.

**P2. Erosional Notches, Pits, and Potholes Offshore: Signs of Past Coastlines**

*Alyssa Pietraszek (Department of Marine Geosciences, University of Haifa, Haifa, Israel)*

*Beverly Goodman-Tchernov (Department of Marine Geosciences, University of Haifa, Haifa, Israel)*

*Dani Nadel (The Zinman Institute of Archaeology, University of Haifa, Haifa, Israel)*

*Oded Katz (Geological Survey of Israel, Jerusalem, Israel)*

During the last glacial maximum, expansive areas that are now submerged were exposed aerially. Much of this territory would have been inhabitable, or at least utilized by people. Consequently, it is presumed, and well accepted, that a significant number of prehistoric sites are now under water. While efforts have been made to investigate and locate these sites, progress is slow due to the technical difficulties of finding and identifying the more inconspicuous archaeological remains, and the sheer scale of the endeavor. Site discoveries have often been the result of chance encounters or salvage excavations following storm exposures. One possible means to narrow the effort is to better determine the location of Late Pleistocene and Early Holocene coastlines during periods of stable sea level, when people might have had the opportunity to establish near-shore permanent villages or seasonal camps. Erosional notches, pits, and potholes have been useful as sea-level indicators across the Mediterranean. These markers form during periods of stable sea level and are submerged when sea level rises, becoming a potential indicator of past sea level.

In Israel, such submerged features were recently recognized along the current coastline and parallel to it at approximately 2.5m water depth within eolianite bedrock, and in some cases are as large as 3m in diameter. Further offshore, there are continued sequences of exposed eolianite ridges at increasing depths. The study presented here aims to demonstrate that by investigating these deeper ridges and searching for notches, pits, and potholes, it may be possible to establish past areas of stabilized coastline and identify potential locations of submerged prehistoric sites.

**P3. Defining the Levantine Maritime Neolithic: GIS Analysis of a Maritime Cultural Landscape**

*Chelsea Wiseman (Department of Archaeology, Flinders University, Adelaide, Australia)*

The Levantine Neolithic (9600-4500 BC) was a period of innovation and adaptation in human history, with extensive development of agriculture, as well as increased sedentary lifeways. Though a considerable amount of current archaeological knowledge is based upon the terrestrial Neolithic narrative, the maritime narrative of the Neolithic is now receiving increased attention.
This study seeks to address questions such as whether a distinct maritime culture can be identified in the Levantine Neolithic, and what types of material culture can be considered indicators of a maritime society. To analyse the composition of a maritime society, GIS has been used to model the spatial relationships of known maritime Neolithic sites in the Levant. By establishing this overview, the concept of maritime cultural landscapes may be explored in order to contribute to discussion of the maritime Levantine Neolithic.


Areti Chalkioti (Independent Scholar, N. Kallikrateia, Chalkidiki, Greece)

The northeast Aegean has been a controversial area in the history of archaeological research. The quest for Troy and its harbors since the nineteenth century (and even earlier in travelers’ reports), the emergence of early urban centers, the hot debate regarding the opening of the straits and the connection of the Mediterranean with the Black Sea, and most recently the discovery of Epipalaeolithic sites on the islands of Lemnos and Imvros (Gökçeada) and a Middle Palaeolithic site on Ayios Efstratos, have kept a diachronic interest in the archaeological discussions. What is always apparent in the debate – although most of the times not in an explicit manner – is the maritime landscape, being as it is a place of interaction between man and the sea, covering a wide range of issues such as sea-level changes and coastal evolution, the location of harbors, sea routes, and maritime trade.

This paper addresses changes that the maritime landscape of the northeast Aegean Sea has undergone over the last 20ka years. It focuses on the implications of sea-level rise since the Last Glacial Maximum (LGM), and the diachronic evolution of the mainland coastline, the corridors, narrow channels and the islands that comprise this area. It also focuses on nodal points for coastal maritime voyaging during the Late Pleistocene-Middle Holocene period. Reconstructions of the coastal configuration of the northeast Aegean in different time periods based on the global sea-level trends and on sonar charts depicting the local High Definition (HD) bathymetry, are used as the baseline of the analysis. Key questions are: maritime crossings and the use of maritime space by early coastal foragers in this area, spanning the last millennia of the Palaeolithic till the beginning of the Neolithic period; Neolithic and Bronze Age seafaring; submerged landscapes and the identification of potential coastal settlements.

P5. Marine Geophysical Explorations in the Saronic Gulf, Greece: The Test Case of a LBA Wreck Site off Modi Islet

Maria Geraga (Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras, Greece)

George Papatheodorou (Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras, Greece)

Christos Agouridis (Hellenic Institute of Marine Archaeology, Athens, Greece)
Myrto Michalis (Hellenic Institute of Marine Archaeology, Athens, Greece)

Heleni Kaberi (Institute of Oceanography, Hellenic Centre for Marine Research, Anavyssos, Greece)

Margarita Iatrou (Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras, Greece)

Dimitrios Christodoulou (Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras, Greece)

Elias Fakiris (Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras, Greece)

Michael Prevenios (Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras, Greece)

Kordella Stavroula (Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras, Greece)

George Ferentinos (Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras, Greece)

The Saronic Gulf in Greece has revealed to date rich archaeological evidence of human occupation, on land and under water, since the Palaeolithic era. Furthermore, the discovery and excavation of a Late Bronze Age (LBA) shipwreck off Modi islet, southeast of Poros, has added valuable archaeological evidence for ancient seafaring. Marine geophysical survey conducted offshore Modi and Poros islands aims to evaluate the coastal palaeogeographic evolution of the area and to map the wreck site. The assessment of the evolution of the palaeo-shoreline over the last 20 ka is based on the interpretation and analysis of data acquired from echo-sounding, sub-bottom profiling, side scan sonar systems and marine sediments. The proposed scenarios presented here take into consideration the rate of sediment accumulation, as well as the rate of relative sea-level changes in the area, based on existing data sets. The constructed maps show that the fluctuations of the sea level have caused drastic changes at the coastal zone and have revealed sites of potential archaeological interest. The detection and mapping of scarps on the seismic profiles show that they cluster within specific levels and are in agreement with the findings of previous studies conducted within the wider area of interest. The above suggests that the sea-level rise during the last glacial-interglacial cycle did not occur gradually, but is represented by intervals of standstills. At the site of the Late Bronze shipwreck, the texture of the seafloor is characterized by rocky substrate covered by coarse-grained sediments that have produced unfavorable conditions for the preservation of the shipwreck. The acquisition of high-resolution acoustic data has established a fundamental database valuable for the monitoring and further research of the site.
P6. Submerged Prehistoric Landscapes in the Aegean Sea

Alexandra Zavitsanou (Institute of Oceanography, Hellenic Centre for Marine Research, Anavyssos, Athens, Greece)

Dimitrios Sakellariou (Institute of Oceanography, Hellenic Centre for Marine Research, Anavyssos, Athens, Greece)

Sea-level changes constitute an important parameter of the palaeo-environment within which early human beings have been evolving and interacting. Preferable living conditions have always concentrated along coastal regions. Since most of human history, sea levels have been lower than at present, and possible archaeological sites are now submerged. In addition, archaeological surface finds recovered from insular areas of low sea-level stands suggest potential early seafaring. To this end, reconstructions of the Pleistocene palaeogeography are crucial in locating prehistoric sites, studying hominin dispersals and understanding food and water resources of palaeo-landscapes. The prehistoric palaeogeography of the northeastern Mediterranean is a scientific objective of great matter for archaeologists trying to investigate hominin dispersals from Africa and Asia into Europe. It is considered a key study area especially for the Aegean because of its relevant geographical position between these three continents. Fairly accurate palaeogeographic reconstructions are based on the detection of reliable sea-level markers, including marine terraces and pro-delta sequences. These geological features are formed as a result of sea-level regression during glacial periods. However, during subsequent periods of marine transgression, many of these sea-level markers were inundated and covered by sediment due to sea-level rise. Additional vertical movements of the crust, including isostatic and tectonic movements, have caused relative sea-level changes and eventually displace sea-level markers off their expected position. For tectonically active regions such as the Aegean, submerged landscapes of different low sea-level stands (18ka, 140ka, 270ka, 370ka, etc.) may be found shifted within a wide range of a few meters (5-10m) for recent landscapes, and up to hundreds of meters (350-400m) for older landscapes. Detection and dating of well-preserved sea-level markers indicating the present position of palaeo-shorelines constitute the first step in understanding relative sea-level changes and eventually achieving a more realistic palaeogeographic reconstruction.

P7. Investigating Prehistory – A Multidimensional Approach to a Submerged Prehistoric Site in Croatia

Maja Čuka (Archaeological Museum of Istria, Pula, Croatia)

Katarina Jerbić (Department of Archaeology, Flinders University, Adelaide, Australia)

Darko Komšo (Archaeological Museum of Istria, Pula, Croatia)

Ida Koncani Uhač (Archaeological Museum of Istria, Pula, Croatia)
The poster focuses on the submerged prehistoric site in Zambratija Bay in Croatia. Its significance is multidimensional: the fact that it is a submerged pile-dwelling settlement represents a basis for undertaking interdisciplinary investigations regarding the reconstruction of settlement patterns and palaeo-landscapes. Combining comparative research on the found material culture recovered (pottery and lithics found in preliminary surveying) and geoarchaeological methods, as well as dendrochronological analysis, will yield a more holistic representation of prehistoric life in the area.

The site is situated in a natural depression in an area covering approximately 10,000m². So far more than 120 vertically placed wooden piles were marked, protruding from the seabed, indicating an architecturally complex and well-preserved site. A peat platform some 30m by 60m in size was found in the central part of what appears to be a settlement. The piles and peat were found at approximately 3m below MSL. The results of the first radiocarbon analysis of a wood sample revealed an age ranging between 4,230 and 3,980 cal BC (2 Sigma), which corresponds to the relative dating of some ceramics found at the site. The natural depression, as well as the presence of wooden piles and peat, imply that this is a pile-dwelling settlement similar to those found around Alpine lakes. Further investigations will be performed on the site with the intention to determine the relationship with the Nakovana Culture, a Copper Age phenomenon whose typical pottery was found at the site. Nakovana Culture pottery is found on the Adriatic coast across a large territory starting from Montenegro in the south to Trieste in the north, covering the entire Istrian peninsula. The pottery has been identified at many sites in Istria and in neighbouring areas along the Adriatic coast, which interestingly all represent different kinds of occupational sites.

P8. Havens of the Phoenicio-Punic Period in Western Sicily

Adriana Fresina (Soprintendenza del Mare, Regione Siciliana, Palermo, Italy)

Francesca Oliveri (Soprintendenza del Mare, Regione Siciliana, Palermo, Italy)

Antonina Lo Porto (Soprintendenza del Mare, Regione Siciliana, Palermo, Italy)

In western Sicily, in the same waters where Honor Frost conducted pioneering underwater archaeological research, many traces and remains of underwater structures testify to the evolution of harbours in the ancient Mediterranean. This poster presents recent work aiming to analyze these sites.

The Phoenician colony of Motya was founded on an island situated at the far western end of Sicily, within a stretch of water known as the Stagnone Lagoon whose shallow water gave safe haven for ships in the best Phoenician tradition. The site includes a unique dock system represented by the so-called ‘submerged causeway’.

The harbour system extension of nearby Lilybaeum (modern Marsala) has yet to be determined, although the location of its three ports is known through archaeological evidence and ancient sources.

Not too distant, the city of Selinus handled such a volume of maritime traffic that two ports were needed: one to the east and the other to the west of the acropolis. The port remains found so far consist of some architectural structures along the beach.
The site of the modern port city of Mazara del Vallo, at the mouth of the Mazara river that borders the territory of Selinunte, was probably the seat of an ancient emporium of Phoenician origin, given its fairly important position on the coast.

Finally, Eraclea Minoa was founded in the late fifth century BC by colonists from Selinunte. It was built on the left bank of the river Halycos near Capo Bianco, in the area where the river flows into the sea. The strategic importance of Eraclea Minoa's harbour is made clear from ancient sources, and it must have had both military and commercial features.

P9. A Roman Fishery at Ardenza (Livorno, Italy)

Federica Mazza (Dipartimento di storia, scienze dell'uomo e della formazione, Sassari University, Sassari, Italy; Soprintendenza archeologia, belle arti e paesaggio per le province di Pisa e Livorno, Pisa, Italy)

This work, which was conducted as thesis research at the Postgraduate School of Archaeological Heritage, University of Sassari, focused on the study of an archaeological site located at Tre Ponti, in the district of Ardenza, Livorno. It is possible to find numerous ancient shipwrecks in the stretch of sea off the mouth of the Rio Ardenza, primarily Roman-era wrecks dating to between the first century BC and third century AD, as well as transport amphoras, dolia and stone artefacts. The volume of findings has raised the hypothesis that a secondary anchorage was present in this area, likely forming part of the larger Portus Pisanus port system. It is important to underscore that we can only speak of hypotheses in the present state of knowledge, given the absence of scientific literature and ancient sources on the subject.

The area of the mouth of the Rio Ardenza, the Tre Ponti and the Rotonda di Ardenza, as seen from satellite imagery, has been subjected to intense anthropogenic processes that have altered its original appearance. What remains still legible regarding ancient artifacts are the remains of a small fishery. In addition, beneath a concrete esplanade built illegally in the 1960s, there may be traces of a channel of about three meters wide carved into the bank culminating in a circular tank (?) with a small opening to the sea.

The archaeological site is partially carved into the bank and partly built of blocks of stone and mortar. As a method of analysis, a literature review was conducted on the subject of Roman maritime installations and fishponds, while ancient sources were also analysed by searching for the toponyms ‘Ardenza’, ‘Ardensia’ or ‘Lardentia’. The presence of ancient human settlements in the area of interest was also studied up to the historical reconstruction of the area of Ardenza, Livorno. Evidence pointing to a large presence of settlements in Roman times includes the existence of a possible secondary harbour at the mouth of the Rio Ardenza, the presence of a fairly large Roman settlement located about 1km away as the crow flies, and the presence of a Roman kiln at the parking area of Tre Ponti (a short distance from the mouth of the rio). For the structural analysis, surveys were conducted at sea in the inner and outer parts of the fishery, yielding significant data. The land survey near the site was unsuccessful, given that the area is highly populated. During the cleaning of portions of the wall structures to remove marine fouling, using brushes and spatulas, traces of ceramics were discovered sealed within the wall cement. Measurements of the internal wall structures were taken, and some parts of them were further studied.
Istros/Histria is one of the oldest Milesian colonies in the Black Sea. It was founded during the second half of the seventh century BC and was inhabited without interruption until the first half of the seventh century AD. Even though the site excavation began in 1914 and continued almost uninterruptedly up to the present, the harbour location is still unknown. Considering that it is a Greek colony, the importance of the harbours cannot be underestimated, due to their influence on the city’s evolution (political, economical, cultural…) and urban fabric. The existence of these harbour(s) is documented by epigraphic sources and numismatic material. Furthermore, for the Hellenistic period, two epigraphic documents inform us about the existence of a Histrian fleet (ISM I 64, ISM I 112).

The discovery of Istros’ ancient harbors has been hindered by the location of the city in the Danube delta. Istros represents the southernmost margin of the Danube delta and is located on a beach-ridge plain within the Razelm-Sinoe lagoonal system. Deltaic areas are dynamic in time and space, being subject to dramatic morphological changes. Expressions of the relationship between nature and societies are diverse and have strongly impacted deltaic coasts, as we can see in many cases around the Mediterranean Sea.

In this respect, a palaeo-environmental study was initiated at Istros in 2015 (A*MIDEX project) and continued this year (2017). Preliminary results of our interdisciplinary research offer new perspectives about landscape evolution and harbour location.

Lake Bolsena, one of the lakes of volcanic origin in central Italy, appears almost like an inland sea thanks to its size, depth and to the presence of two small islands, Bisentina and Martana. The
first underwater archaeological finds located in the inland waters of central Italy were found in this lake in 1959 with the discovery of the proto-historic settlement of Gran Carro. Gran Carro is an extensive Villanovan settlement dating from the beginning of the Early Iron Age (ninth century BC). The site is situated near the eastern shores of the lake basin, only 100m from the present shore, at a depth of between four and five meters. It has been the subject of only modest studies over the years. Thus, knowledge of the whole context is based primarily on the analysis of surface data, and on topographical readings that have identified over four hundred poles (or piles) fixed into the lakebed in long rows, and also on the typological study of the large amount of material found. It has been possible to propose an initial reconstruction of the relationship between the water level of the lake and the settlement, which adopted pile-dwelling construction solutions during its last phase. Specifically, research conducted between 2012 and 2016 at the village of Gran Carro employed new survey recording techniques such as the foto-tecnigrafo (photo-technigraph) that allows a 3D reconstruction of the excavated layers. Furthermore, the excavations were undertaken to achieve a complete GIS topographical plan of the site. The results of these techniques have allowed us to reconstruct the settlement phases of the site, and many applications have permitted us to better study all the materials recovered during the excavations on the site.

P12. Ship Anchors in the Mediterranean from the Bronze Age to the Middle Ages: An Analytical and Experimental Study

Menna-Allah Abo El-Atta (Alexandria Center for Maritime Archaeology and Underwater Culture Heritage, Alexandria University, El Shatby, Alexandria, Egypt)

The study of anchors is important to nautical archaeology for several reasons, as anchors on the seabed represent the passing of a vessel. An anchor can be a wooden, stone, or metal object, and when found under the sea it can offer clues to the size and provenance of the vessel from which it was lost. Thus, if an anchor type can be assigned to a specific nationality, and a trail of that kind of anchor is found in the sea, it must signify a route used by ships of that nation. The poster presents aspects of an analytic study of anchors, ranging from primitive anchors, such as stones lashed with rope, to metal anchors and anchors with metal components. In addition, an experimental archaeological study comparing different shapes of stone anchors and their efficiency is also discussed. The anchor shapes considered include: (1) stone anchors with a single hole in the middle; (2) stone anchors with two holes; (3) stone anchors with three holes. All anchors in the study were of the same size and weight, and were tested in different weather conditions and types of seabed to determine their efficiency. Furthermore, the poster briefly reviews the symbolic value of anchors and different uses of anchors as religious symbols, such as votive anchors.
P13. Archaeotecture

Karl Abi Karam (Archaeological Heritage and Museums, University of Cambridge, Cambridge, UK)

The multi-ethnic and multi-religious maritime city of Tyre in Lebanon, considered to be one of the most important harbours of the ancient world, continues to suffer from an uncontrollable urban expansion due to socio-political tensions. Arguably, the integrity of the archaeological sites located at Al-Bass and Al-Mina in Tyre is at risk due to physical and visual intrusions caused by chaotic urban sprawl. Without a collective urban memory to reconcile the fragmented city, an appreciation and merging of its maritime archaeological heritage and architecture through a design-based approach must be implemented to foster communal unity. While museums are born out of the sacralisation required by national legitimization, the city of Tyre instead must be subjected to alternative methods of preservation. Therefore, the design-based theory that I have set forth, termed ‘Archaeotecture’, proposes a discreet alternative to Tyre’s museumification through the convergence of the architectural and archaeological professions that explores the notion that the process of an archaeological excavation is a form of architectural space-making.

It is an attempt to avoid drastically altering the ‘original’ aesthetics and ‘authenticity’ of an archaeological site without a visually intrusive, surface-based, ideologically driven, structural imposition by applying what can be described as a reverse-palimpsest approach. As a result, it aims to reveal Tyre’s forgotten layers and its underwater ruins in-situ through a tunnelling-creation of subterranean spaces in the form of vaulted modular compartments. Therefore, the city’s maritime legacy can be directly interacted with and easily viewed in situ, fostering a stronger spatial relationship between contemporary Tyre and its submerged and forgotten layers. Archaeotecture’s visually unobtrusive nature avoids direct ideological impositions in order to reconcile the divided city whilst promoting archaeological activities that maintain its original context within a romanticized state of ruination, whether on land or under water. Consequently, the ability to view the underwater remains without its relocation aims to maintain the overall esoteric nature of Tyre’s archaeological sites.

P14. Maritime Museums and Their Role in Preserving Cultural Heritage

Mai Tarek Ghanem (Alexandria Center for Maritime Archaeology and Underwater Culture Heritage (CMAUCH), Alexandria University, Alexandria, Egypt)

A maritime museum is a type of museum that appeared in relation to the recent appearance of the field of maritime archaeology as a sub-discipline of mainstream archaeology. The majority of maritime museums began as collections of objects retrieved from under water; objects were placed in glass cases or hung on walls with explanatory labels of varying length and academic value. More recently, many maritime museums have focused on presenting interpretative exhibitions to allow visitors to follow a particular narrative or story. Currently there are many types of maritime museums that exist around the world. They can take the shape of boats, warehouses, castles, cottages, or specially constructed buildings. There are specific museums dedicated to a single shipwreck or a group of wrecks from the same period,
such as the VASA Museum in Sweden, the Mary Rose Museum in the UK and the Viking Museum in Denmark. There are also general museums of underwater cultural heritage, such as the Bodrum Museum in Turkey that houses the remains of many shipwrecks. Moreover, there are museums of maritime history such as the Museum of Marine History in Paris, and the National Maritime Museum in Greenwich.

The poster looks at the development of maritime museums since the middle of the twentieth century, and the different methods of display and public presentation. It also examines the role that a maritime museum could play in the preservation and public presentation of Egypt’s maritime cultural heritage.

P15. Underwater Archaeology and Legacy Photographic Data: Computer Vision Photogrammetry As a Means to Enable Archaeological Reinterpretation, Sustaining Archaeological Hermeneutics and Enabling the Enjoyment of Underwater Sites by the General Public

Massimiliano Secci (CIRCE Photogrammetry Lab, Department of Architecture, Construction and Conservation, IUAV University of Venezia, Venice, Italy)

The relation between underwater archaeology and legacy data is one of routine. Most humanities sciences depend strictly on re-evaluation, re-analysis and reinterpretation of past data and information. Moreover, a cornerstone of the archaeological discipline is represented by the ability to use, re-evaluate and reinterpret archaeological data over time, according to new research questions and the availability of up-to-date technological devices and/or enquiring methods. From a strictly archaeological point of view, the ability to re-elaborate and reinterpret photographic data with photogrammetric tools could have the ability to empower and further inform the reinterpretation of archaeological sites. Photogrammetric models from either legacy or newly acquired data have the ability to empower archaeological interpretation as well as the protection and monitoring of underwater sites. The ability to recover and re-question legacy data obviously has enormous consequences on the ability to enable the archaeological hermeneutical process. Apart from this archaeological potential, legacy photogrammetric models could allow the general public to enjoy, at least virtually, underwater archaeological sites that are long gone due to full excavation or site deterioration. Clearly, for all this to happen—particularly for the archaeological part of the equation—the photogrammetric process must aim for the most accurate result, in order to enable further analysis, reinterpretation and/or reassessments. The present paper will discuss the experience with legacy data produced by the author on datasets deriving from the multi-campaign excavation of the Napoleonic brig Mercure, excavated between 2001 and 2011 by the Ca’ Foscari University of Venice.
P16. Treasure-Hunting and the Underwater Cultural Heritage

Mohamed Ahmed Khedr (Alexandria Center for Maritime Archaeology and Underwater Culture Heritage, Alexandria University, El Shatby, Alexandria, Egypt)

Treasure salvage and professional archaeology have fundamentally opposing goals, methods and consequences. For archaeologists, the priority is to understand the site through interpretation and hypotheses based on the discoveries made. Following investigations, sites are physically and legally protected for future generations. For commercial salvors, time is money and valuable artifacts have to be found and sold as quickly as possible to provide sponsors with a return on their investment.

The poster presents the term ‘treasure-hunting’ and considers how it differs from the term ‘looting.’ Factors that affect treasure-hunting (such as SCUBA diving, culture and commercial media) are discussed, along with case studies of shipwrecks that have been looted or discovered by treasure hunters, and the role of international conventions and national legislation in protecting such shipwrecks. In addition, different methods of work for professional archaeologists and treasure hunters are also investigated.

These aims are presented in several sections accompanied by a main diagram. In addition, a map chart illustrates the number of countries that have signed the UNESCO Convention on the Protection of the Underwater Cultural Heritage.

The underwater cultural heritage is a non-renewable resource, and if it is not protected, it will soon disappear.

P17. Benchmarking Maritime Cultural Resources in Syria

Colin Breen (School of Geography and Environmental Science, Ulster University, Coleraine, Northern Ireland, UK)

Lucy Blue (Department of Archaeology, Southampton University, Southampton, UK)

Kieran Westley (School of Geography and Environmental Science, Ulster University, Coleraine, Northern Ireland, UK)

Nicolas Carayon (Department of Archaeology, Southampton University, Southampton, UK)

Wes Forsythe (School of Geography and Environmental Science, Ulster University, Coleraine, Northern Ireland, UK)

Marianne O’Connor (School of Geography and Environmental Science, Ulster University, Coleraine, Northern Ireland, UK)

Ruth Plets (School of Geography and Environmental Science, Ulster University, Coleraine, Northern Ireland, UK)
A joint project between Ulster and Southampton Universities has been developed to conduct a detailed benchmarking exercise of maritime cultural resources in Syria. The project aims to develop an understanding of the nature of maritime archaeological resources in the study area of coastal Syria and assess the level of threat these resources are subject to, from both natural and anthropogenic sources. It includes a desk-based assessment of the physical and biological maritime environment of Syria and an evaluation of published and unpublished sources relating to Syria’s maritime heritage. Through the use of satellite remote sensing, a detailed assessment is being undertaken of the coastal built heritage resource across the country’s maritime zone. This poster reports on some of the project’s initial findings. The project is supported by the Honor Frost Foundation.

P18. The 2015-2017 Kyrenia Ship Conservation Project: Approaches to the Preservation of Objects Associated with the Kyrenia Shipwreck

Veronica Ford (Kyrenia Ship Conservation Project, Oxford, UK)

Cassy Cutulle (Kyrenia Ship Conservation Project, Johnston RI, USA)

In 2015, over 40 years after its excavation, many of the finds from the iconic and unique Kyrenia shipwreck were found to require urgent care to halt rapid deterioration and to ensure its long-term preservation. The personal effects of the ship’s crew, including the smaller ceramics and metals, were most in need of treatment. Thanks to financial support from the Honor Frost Foundation, under the umbrella of the bi-communal Technical Committee on Cultural Heritage and the overall coordination of the United Nations Development Programme (UNDP) in Cyprus, a conservator, Cassy Cutulle, was hired to undertake condition assessments of the collection and prioritise objects for treatment. An additional conservator, Veronica Ford, joined the project in early 2016.

In the case of the ceramics, the remedial treatment involved the renewed removal of salts that had been absorbed under water and during the long storage in Kyrenia Castle, through immersion desalination, followed by the reconstruction and restoration of the best examples of the pottery. The primary focus of the metal treatment was on stabilisation and protection from the external environment, through immersion in benzotriazole and coating using an archival acrylic adhesive. At the same time, a preventive conservation programme was implemented, which included the monitoring of pests and the installation of long-term environmental monitoring devices at Kyrenia Castle to measure fluctuations in relative humidity and temperature. The final stage of the project was to re-house some of the sensitive objects in Kyrenia Castle including in particular the wood and metals.

At its conclusion, this project achieved its essential aims: the remedial conservation of the small ceramic and metal finds, and the long-term preservation of the collection through preventive activities. In adherence to ethical conservation standards, collaboration and consultations were carried out with the original excavation team throughout the duration of the project.
P19. Attribution of Fragmented Archaeological Ceramics: A Geochemical Approach

Ivan Gorlov (Department of Museology, Russian State University for the Humanities, Moscow, Russia)

Sergey Fazlullin (Department of Museology, Russian State University for the Humanities, Moscow, Russia)

One of the problems of modern archaeology is the establishment of trade and political relations between ancient states. Such information can be obtained through the study of archaeological ceramics. Significant amounts of it can be found on the seabed in areas of risky navigation in the territory of ancient ports and anchorages. Unfortunately, such ceramics in most cases are silent, because their attribution is difficult or impossible since they are often fragmented and rounded by waves.

To date it has been shown repeatedly that ceramics from different production sites may be successfully distinguished from one another based on the results of chemical composition analysis. In addition, ceramics may be correlated with the region of production based on the comparison of the chemical composition of the ceramics and raw clays.

Ceramic attribution by chemical composition requires several steps:
Firstly: standardization of the methods used.
Secondly: the detection of marker elements and their relationships for each group.
Thirdly: the creation of geochemical passports for ceramic origin centers that characterize each center both spatially and chronologically.

It has been shown that XRF (X-ray fluorescence) has greater sensitivity than NAA (neutron activation analysis) for some elements that characterize unique composition of clays.

TXRF (total reflection X-ray fluorescence) and WDXRF (wavelength dispersive X-ray fluorescence) are among the most preferred types of analysis for the attribution of fragmented pottery, due to high sensitivity, the ability to distinguish most elements that characterize unique chemical composition, productivity, and low cost.

ICP-MS (inductively coupled plasma mass spectrometry) can be treated as an arbitration method for drawing up geochemical passports.

Different types of statistical analysis are employed to interpret results of chemical composition analysis, including cluster analysis, factor analysis (principal component analysis), discriminant analysis, and MANOVA (multivariate analysis of variance). They do not explicitly separate marker elements and their relationships, but may be used to identify those based on the contribution of the original variables in the formation of the latent variables.

Binary diagrams, which characterize the quantitative ratio of the elements, are another widely adopted method to render geochemical information from the results of chemical analysis. Using diagrams for elements with different geochemical behavior allows us to successfully characterize different pottery groups based on their chemical composition. This way of presenting data on the chemical singularity of pottery production center may be regarded as preferred.

This form of data representation is much more informative, both qualitatively and quantitatively, as it effectively solves the problem of comparing the investigated sample with existing data.

Using achievements in modern lithology and sedimentary rock geochemistry allows us to ascertain the provenance of ceramic sherds.
Information on the geochemical passports of pottery production centers can be presented in the form of tabular data on the quantitative content of the studied elements, and in the form of binary diagrams that characterize the ratio of the marker elements.

**P20. DNA From the Wine-Dark Sea: Examining the Efficacy of Extracting Ancient DNA From the Ceramic Matrix of Pottery Vessels From Mediterranean Underwater Contexts**

*Elizabeth (Lisa) Briggs (Oxford Centre for Maritime Archaeology, University of Oxford, Oxford, UK)*

There is tremendous potential for DNA studies to resolve long-standing questions in both terrestrial and underwater archaeology. For maritime studies of the ancient Mediterranean, finding a way to accurately characterise the contents of amphorae recovered from shipwreck sites would provide invaluable insight into cargo compositions and trade dynamics. Is DNA the answer? The research presented in this poster examines whether or not truly ancient DNA can be extracted from ceramic vessels that have been submerged for millennia, and if so, how this can inform our understanding of ancient trade, commodity exchange, and social transformations in the ancient Mediterranean.

**P21. Combining the Use of Fourier Transform Infrared Spectroscopy (FTIR) and Thin-section Analysis to Study Underwater Materials From the North Bay of Dor, Israel**

*Isaac Ogloblin (Maritime Civilizations Department, University of Haifa, Haifa, Israel)*

*Amanda Holdeman (Maritime Civilizations Department, University of Haifa, Haifa, Israel)*

*Ruth Shahack-Gross (Maritime Civilizations Department, University of Haifa, Haifa, Israel)*

*Assaf Yasur-Landau (Maritime Civilizations Department, University of Haifa, Haifa, Israel)*

Techniques applied to material studies in archaeology have been used to reveal information embedded in artefacts, beginning from their manufacture through their use, up to their discard and post-depositional changes. Our research presents two case studies in which such techniques have been applied to underwater archaeological artefacts. The laboratory methods, Fourier Transform Infrared Spectroscopy (FTIR) and thin-section petrography, were used to collect basic mineralogical information to facilitate understanding of diagenetic changes in waterlogged pottery and to identify origins of ballast stones. Prior to this study, the complementary use of these techniques had not been applied to the study of underwater archaeological materials in the eastern Mediterranean. In this poster, we illustrate advantages of the combination of these methods to investigate sunken artefacts. The materials used in this research were collected from the North Bay of Dor around a submerged pile of ashlar stones, ballast stones and ceramics. Thirty-one ceramics and 37 ballast stones were collected and analyzed using the combination of these laboratory methods. Minerals such as gypsum and dolomite proved difficult to distinguish using thin-sections of rocks and ceramics; however, they could be easily and quickly
distinguished in FTIR spectra, then used to locate these minerals in the thin sections. Other minerals such as aragonite and opal were identified in the FTIR, but were unidentifiable in thin sections. Minerals within metamorphic and igneous rocks, as well as iron oxide in ceramics, were problematic to recognize using FTIR. In those cases, microscopic observations were essential and lend to the advancement of FTIR interpretation. The complementary nature of mineralogical identification via FTIR and petrography illustrates the advantage in their use to obtain higher certainty in mineral identification, and thus understanding pottery diagenesis and ballast stone origins.

**P22. Geo-Archaeological Study of Rocks and Bricks From the Ninteenth Century Akko Tower Wreck, Israel**

*Amir Bar (Department of Maritime Civilizations, University of Haifa, Haifa, Israel)*

The Akko Tower Wreck is the remains of a 25m-long merchant brig, dated to the first half of the nineteenth century and built under the influence of the French shipbuilding tradition. The ship's remains were covered with a large pile of dark slate with white calcite veins. The rock pile was 6.5m wide, 10.5m long, and 1m high, including rock pieces that ranged from 70×25×10cm down to gravel. The estimated total weight of the rocks was about 60 tons, which would have been an adequate ballast weight for a brig of these dimensions. As ballast in merchantmen may have been replaced between voyages, the analysis of these stones may not necessarily indicate the ship’s home port.

Petrographic microscopy, XRD (X-ray diffraction) and SEM-EDS (scanning electron microscopy/energy dispersive X-ray spectroscopy) analyses of rock samples showed the presence of calcite, quartz and clay minerals (illite group and kaolinite-clinoclore group) in all samples, and dolomite in about half of them. The results confirm the homogeneity of the rock assemblage, which was not, however, of local eastern Mediterranean origin.

In addition to the rocks, a heterogeneous assemblage of 30 brick and brick fragments with no manufacturers’ stamps was found in the shipwreck. INAA (instrumental neutron activation analysis) indicated heterogeneity in chemical composition: five bricks were chemical loners, and one was probably from Euboea. Two groups similar in chemical composition were detected, both from unknown regions (not local): one group including four yellow burnt bricks of similar dimensions, and the other a group of six red burnt bricks of different sizes. The bricks could have been in use as part of a stove in the ship’s galley.

**P23. A New Minoan Shipwreck From the Era of the Thalassocracy at Koulenti, Off the Laconian Coast of Southern Greece**

*Elias Spondylis (Ephorate of Underwater Antiquities, Hellenic Ministry of Culture and Sports, Athens, Greece; Hellenic Institute of Marine Archaeology, Athens, Greece)*

*Yannos G. Lolos (Department of History and Archaeology, University of Ioannina, Ioannina, Greece; Hellenic Institute of Marine Archaeology, Athens, Greece)*
Christina Marabea (University of Ioannina Excavations in Salamis, Greece; Hellenic Institute of Marine Archaeology, Athens, Greece)

The aim of this poster is to highlight the character and dimensions of a newly discovered shipwreck dating from the high time of the Minoan thalassocracy in the Aegean. The wrecksite, located in the area of Koulenti off the Laconian coast in the south part of the Peloponnnesos, was identified and initially investigated in 2009 by a team of the Ephorate of Underwater Antiquities of the Hellenic Ministry of Culture under the direction of Elias Spondylis. This important new underwater find, surely the first distinctly Minoan shipwreck outside Crete, consists of a wrecked pottery cargo of the Middle Minoan III-Late Minoan I period. It was located on the rocky bottom of a steep reef at a depth of ca. 20m. The main concentration of pottery appears to have been looted, but more finds may survive on the nearby sandy bottom for future systematic excavation.

The ceramic finds raised from the wrecksite include jugs with a cut-away spout, amphoras of different types, and fragments of other larger vases. As a group, the closest parallels can be made with the material from Deposit zeta of MM IIIB-LM IA date and also in pottery (of the same date) from Tomb D at Kastri on Kythera.

Lying as it does on an important sea trade route linking Crete with Laconia, the wrecked cargo should be considered within the cultural context of its wider geographical area, and especially in relation to major coastal settlements, such as Kastri on Kythera, Pavlopetri, Old Monemvasia and Ayios Stephanos in Laconia.

Its special importance also has to be assessed in conjunction with other wrecked cargos found in Aegean waters outside Crete, and attributable to the horizon of the thalassocracy: the copper cargo from the port of Kyme in Euboea; the ceramic cargo at Sheytan Deresi off the Carian coast; and possibly also the pottery cargo in the Marmaris Hisarönü Gulf in Turkey.

P24. Anchoring the Kyrenia Ship: An Experimental Project to Reconstruct the Ship’s Anchor

Wendy van Duivenvoorde (Department of Archaeology, Flinders University, Adelaide, Australia)

Since its excavation in the late 1960s, the Kyrenia ship has become a seminal component of the corpus of archaeological evidence related to late Classical and early Hellenistic period seafaring in the Eastern Mediterranean. The excavation yielded pieces of a single, one-armed wooden hook anchor fitted with a short, lead-filled wooden stock. The remains include the heavy lead inserts of the stock, which provided the necessary weight to sink the anchor; the concretion formed around the anchor arm’s iron tip; and some small wood fragments. The original anchor had a central wooden shank, carved from a crooked-grown oak timber, that terminated in a hook, or arm. The stock of the anchor was set perpendicular to the arm, which ensured that, when deployed, the anchor would always fall with its arm down and dig itself into the seabed.

This poster discusses the anchor’s hypothetical reconstruction and the archaeological experimentation with scale models and a full-scale replica. In order to study physical aspects of its manufacture and gain a better understanding of anchor-making in the ancient Mediterranean, the Kyrenia Ship Project built a full-scale reconstruction on Cyprus using authentic materials, tools, and methods. Following in-water testing with the scale models, the full-scale anchor was
deployed from *Kyrenia Liberty* to experiment with its handling and stowage aboard the ship and to test its setting performance on the seabed. The reconstructed anchor was made by Kleanthis Moustakas and resides now on *Kyrenia Liberty*.

**P25. The Transport of Sculptures in the Ancient Mediterranean**

*Katerina Velentza (Centre for Maritime Archaeology, University of Southampton, Southampton, UK)*

From the early nineteenth century onwards, ancient freestanding sculptures of various materials, types and sizes have been discovered in the Mediterranean Sea, from the context of shipwrecks or as isolated finds. The preservation of the underwater context of those artefacts, as well as the chronology and reasons for their maritime transport, vary a lot. Despite the large number of sculptural artefacts with no associated underwater deposit, several case studies have been identified in the archaeological record that include a high preservation of shipwreck remains and contain features indicating the trade of sculptural material in different periods of antiquity. More specifically, several different types of trade have been recognised, such as the trade of terracotta figurines, the trade of bronze and marble statues of all sizes as luxury items, the trade of bronze sculpture fragments and figurines as scrap metal, and the trade of stone and mainly marble statues transported together with other stone artefacts. Some of the sculptures in these case studies have been studied before, mainly from an art historical perspective, while a large quantity of the non-sculptural shipwreck artefacts are still partially researched or remain unpublished.

In the present research, the case studies of shipwrecks with indications of the trade of sculptural artefacts are revisited. The nature of the transport and trade of freestanding sculptures, as well as the naval and structural characteristics of the ships carrying them, are assessed by the author through the study of existing publications and reports and through the direct examination of archaeological material. Therefore, different patterns and distinct reasons for the transport of statuary in the Mediterranean during different periods of antiquity are detected.

**P26. Underwater Archaeology in the Aeolian Islands: The ‘Panarea 1’ Shipwreck**

*Cristina Bazzano (Underwater Archaeological Heritage, Department of Cultural Heritage of the Sicilian Region, Palermo, Italy)*

*Roberto La Rocca (Underwater Archaeological Heritage, Department of Cultural Heritage of the Sicilian Region, Palermo, Italy)*

In July 2010 the first survey in the waters of Panarea (Aeolian Islands, Sicily), conducted by the Soprintendenza del Mare of Palermo in collaboration with the AURORA Trust Foundation, yielded evidence for four shipwrecks of Greek and Roman periods, based on a representative sampling of the cargoes. The ‘Archeorete Eolie 2010’ project included an extensive survey of the Aeolian seabeds by remote sensing systems. The shipwrecks, ranging in depth between ca. 85m and 135m, were designated as Panarea 1, 2, 3 and 4. The characteristics of the shipwrecks had
been clearly determined from previous investigations using side scan sonar. The present contribution aims to understand the first of the aforementioned shipwrecks, Panarea 1, including its chronological and cultural identification. The amphora cargo mound measures 13m in length, 4m in width, and about 3m in height from the seabed. The assemblage of transport amphoras is homogeneous and composed of Late Republic / first Imperial age amphoras: Dressel 2-4, Dressel 6 and Dressel 1. The deposition of the cargo likely indicates the original position and direction of the ship. Indeed, it demonstrates that the condition of the sea played a key role in both the sinking of the ship and the disposition of the cargo, marking the course of the ship.

P27. The Amphoras of the Maʿagan Mikhael B Shipwreck, Israel

Michelle Creisher (Department of Maritime Civilizations, University of Haifa, Haifa, Israel)

The Maʿagan Mikhael B shipwreck lies at a depth of 1.5m, buried under 1.5m of sand just 70m off the Israeli shoreline. Dated to the seventh-ninth centuries AD by 14C analysis of wood and organic samples, the 21m-long shipwreck is one of the few and largest to be dated to this period. The shipwreck has yielded a number of amphoras of various types, ages and origins. Amphoras of the LRA 1, 4 and 5 types, as well as many fragments of bowls, jugs and large transport vessels, have been identified and documented in situ. Several of these amphoras are lined with resin and bear markings in red dipinto, and at least one is inscribed with Greek letters. Production centres for these types of amphoras have been found throughout the eastern Mediterranean, from the Roman provinces of Cilicia in the north to Egypt in the south. The significance of the amphoras relates specifically to trade during the Late Byzantine/Early Islamic period in the region, and the information that can be gained concerning active trade routes, production centres and commodities through typological, petrographic and residue analyses. The Maʿagan Mikhael B shipwreck, whose finds include a number of transport jars from various sources, may well shed significant new light on the trade systems of Late Antiquity in the region.

P28. Maritime Transport Containers in the Late Renaissance: Barrels and Casks From the Gnalić Shipwreck

Katarina Batur (Department of Archaeology, University of Zadar, Zadar, Croatia)

The Gnalić shipwreck is one of the most important post-medieval underwater sites in the Mediterranean. According to archival research, the ship Gagliana grossa headed from Venice to Constantinople in late 1583, loaded with cargo of various provenance. The merchant goods, intended for market in the Eastern Mediterranean, were packed in a wide range of barrels, casks, boxes and baskets; nowadays, this site is an important source of information on maritime transport containers in the Late Renaissance period. This unique archaeological site contains well-preserved wooden barrels and casks, filled with artificially produced coloring materials, such as cones of basic lead carbonate (lead white) and iron oxide (red ochre). Although these coloring materials were often used for paint production,
they were also known as medicinal and cosmetic supplies. Additional coloring materials were identified at the site, including vermilion (mercury sulfide), stibnite (antimony sulfide), orpiment and realgar (two types of arsenic sulfide), lead oxide (minium), manganese oxide and elementary mercury, but their exact methods of packaging are not always clear. Since some of them were found in small amounts, it is possible that they were wrapped in textile. Stamps on the heads of the barrels filled with the conical lead white ingots, probably belonging to the color sellers from Venice called vendecolori, still await interpretation through research in the State Archives of Venice.

This paper gives an overview of the barrels and casks used for the packaging of coloring materials. By calculating their capacity it is possible to determine the amount of trading goods loaded in the ship, giving unique evidence about maritime trade of coloring materials in the period of the late sixteenth century. The study is part of doctoral research supported by the Croatian Science Foundation.

**P29. The Paragan Wreck: Preliminary Study of a Late Seventeenth/Early Eighteenth Century Ship From Corsica's Coast (Bonifacio, France)**

*Eric Rieth (National Center for Scientific Research (CNRS [LAMOP]); National Marine Museum, Paris, France)*

*Franca Cibecchini (Underwater Archaeology Research Department (DRASSM), Marseilles, France)*

*Hélène Botcazou (LA3M Research Laboratory, National Center for Scientific Research (CNRS), Aix-Marseille University; Ipso Facto, Centre for Research and Study in Underwater, Archaeology and Oceanography, Marseilles, France)*

In June 2015, a Corsican diver from Bonifacio, Jérôme Poggi, discovered a well-preserved hull, exposed at the surface at a depth of only 2.5m, along the coast of the little bay of Paragan. A team of experts was quickly organized in July 2015 by Franca Cibecchini, the official responsible for the Corsican region at the Underwater Archaeology Research Department (DRASSM, French Ministry of Culture). Several shards of Ligurian faience were found, dating the wreck between the end of the 17th century and the beginning of the eighteenth century. In April 2016 a field school was carried out on this wreck, organized within the International Master of Maritime and Coastal Archaeology programme (MoMArch) led by Aix-Marseille University (AMU) and DRASSM. The excavation is co-directed by Franca Cibecchini (DRASSM) and Eric Rieth (CNRS).

The wreck is orientated NE-SW and measures 4.5m at its widest point. The first hypothesis assumes the Paragan wreck was originally at least 18m long. The presumed stern was excavated in 2016. Several specific architectural signatures relate this wreck to a Mediterranean naval architecture. The ballast is mainly composed by serpentinite pebbles, which can be found both in Cape Corse and in Liguria. The main mast-step area, excavated in April-May 2017, is another clue of a Mediterranean architectural type. A survey was also opened in the area interpreted as the bow of the ship, which
revealed many different and disorganized architectural wooden pieces; these are currently being analyzed. The main objective of the excavation is to identify the architectural principles and processes of the Mediterranean shipbuilding tradition, and to make hypothetical restitutions of the original ship and its nautical qualities, in order to provide new and interesting data on coastal shipping in the modern era. Another objective is to train MoMArch students in the methods and techniques of naval architecture in the field.

P30. Amphorae and Maritime Trade in Egypt in Antiquity

Omaima Ahmed Gamal El Bastawisy El Deeb (Department of Archaeology, Flinders University, Adelaide, Australia)

Egypt played a remarkable role in ancient maritime trade that has left a rich archaeological record. The most significant artifact type found at various Egyptian sites is amphorae: the staple transport containers and storage jars of the ancient world. Amphorae used for agricultural products, such as wine and oil, and foodstuffs can be considered the most diagnostic archaeological feature visible on underwater archaeological sites, more so than on land as they were loaded aboard ships in large quantities. Plenty of amphorae in Egypt, both under water and on land, are found intact; they come in various sizes and different materials, and many feature stamps and inscriptions.

The aim of this poster is to identify the connectivity between these artefacts by shedding light on some of the most important underwater and terrestrial archaeological sites in Egypt. Alexandria, for example, is situated on a huge field of amphorae; a large number of amphorae were recovered there and date to different historical eras. Qaitbay Fort is one of the most significant Alexandrian underwater sites, featuring a number of Greek and Roman merchant vessels that carried wine amphorae imported from Greece, northern Turkey, Italy, Spain, and North Africa. These wrecks date from the fourth century BC to the seventh century AD. This poster will highlight the connectivity and significance of amphorae in ancient Egyptian maritime history, outlining various types, shapes and sizes of amphorae located at and recovered from terrestrial and underwater archaeological sites along the Egyptian Mediterranean coastline.

P31. Bending of Wooden Planks in Ancient Shipbuilding

Moshe Bram (Department of Maritime Civilizations, University of Haifa, Haifa, Israel)

When building an ancient wooden ship, the shipwright had to bend the planks to fit the desired shape of the hull. Various methods were used in order to reduce the bending effort, keep the planks bent while installing them in the ship, and keep the residual stress to a minimum. It is a well-known practice to soak wood in water and/or heat-treat it to make it pliable. This reduces the force required to impart bending strain to the wood, without damaging the basic structure of the wood material.

In this work, two methods of wood preparation were examined:
(1) soaking and boiling in water
(2) open fire heating
Sample beams were treated by both methods, then bent, dried and cooled, and then soaked in seawater. Mechanical properties – such as the amount of spring-back, modulus of elasticity, rupture strength, and the amount of bending to cause fracture – were measured using a force vs. motion testing machine.
The most interesting result was the spring-back, which was found to be in the range of 50-100%. Planks installed in a hull, and not allowed to spring back, were subjected to residual internal stresses. These internal stresses absorb a certain amount of the wood’s ability to resist load over the life of a ship. Unless the shipwright included a large safety margin, the hull structure could have failed on its first voyage.

P32. A Comparative Structural Analysis of Shell-first and Frame-based Ship Hulls of the First Millennium AD

Nathan Helfman (Department of Maritime Civilizations, University of Haifa, Haifa, Israel)

The first millennium AD experienced a significant change in ship construction. A slow transition evolved during which ships built ‘shell-first’ were ultimately supplanted by ‘frame-based’ ships. Shell-first ships were constructed with strakes edge-jointed using pegged and later unpegged mortise-and-tenons, dowels or coaks, and at times, sewing, which resulted in a strong and rigid hull. The strakes were then fitted with transverse frames independent of the keel. Frame-based ships were characterized by transverse frames; most of the frames were fixed to the keel and reinforced by longitudinal components. The hull planks were later fastened to the pre-existing frames.
The objective of this work is to focus and examine whether mechanical factors contributed to the transition in ship construction. An initial comparative linear static FEA (finite element analysis) global comparison analysis was conducted on CAD models reconstructed from archaeological shipwreck findings: Ma’agan Mikhael (400 BC) and Dor 2001/1 (sixth century BC). Both shipwrecks were found at shallow depths off the north-central shore of Israel. The Ma’agan Mikhael shipwreck, discovered in 1985, is representative of the shell-first technique. The Dor 2001/1 shipwreck, discovered in 2001, represents the frame-based technique. The application of standard global stillwater criteria revealed that both ships possessed high degrees of rigidity and low von Mises stress values. Further controlled analyses were performed on two symmetrically identical archetypal quarter hulls while varying load and construction parameters. In all the archetypal load scenarios, the shell-first samples exhibited higher rigidity and less extreme von Mises stress differences than the frame-based samples. Frame-based rigidity and stress levels were directly dependent on the number of frames added to the structure. More research is required to examine the extent to which the strength was compromised in favor of flexibility to achieve the transition from shell-first to frame-based.
P33. Ship Construction Details of the Mazarrón 1 Boat

Carlos Cabrera-Tejedor (Institute of Archaeology, University of Oxford, Oxford, UK)

Two Iron Age shipwrecks, associated with abundant ceramics of Phoenician origin, were discovered at the Playa de la Isla in Mazarrón, Spain several decades ago. This paper will discuss the presence of mixed shipbuilding techniques and hitherto unknown boat-building features documented on the Mazarrón 1 hull remains. There is evidence to suggest that an indigenous shipwright from the Iberian peninsula built the Mazarrón 1 boat. The documented features suggest that although he had knowledge of shipbuilding innovations introduced by the Phoenicians (i.e., pegged mortise-and-tenon joints), he retained traces of his own shipbuilding traditions in the construction of the hull. Through a comparative study of analogous wrecks, the paper will further argue that the hull of Mazarrón 1 represents an important source of information for increasing our understanding of ancient shipbuilding and its development, during the Iron Age, in the Western Mediterranean.

P34. The Mèdes 6 Shipwreck (France, First Century BC): An Example of Internal Stitching Technique in the Northwest Mediterranean

Alex Sabastia (Aix-Marseille University, Centre Camille Jullian (AMU, CNRS, MCC), Aix-en-Provence, France)

The Mèdes 6 shipwreck lies at a depth of 44m at some 5.5 miles SE of Hyères, off the Mediterranean coast of France. Discovered in 2010 by a team of local divers, the wreck was excavated in 2013, 2014 and 2015. The cargo is mainly composed of Dressel 1C amphoras dated to the first century BC, with the exception of a single, partially preserved Lamboglia 2 amphora. The preserved part of the hull is composed of a fragment of the keel, the remains of four planks and 14 frames. The keel and planks are assembled by mortise-and-tenon joinery and according to the shell-first conception of the hull. The frames are connected to the planking by both simple treenails and internal stitching. Internal stitching has been highlighted in the construction of sixteen shipwrecks all located in the northwest Mediterranean and dated from the third century BC to the second century AD. These shipwrecks comprise ships and boats of different sizes and types, although most of them were small ships like the Mèdes 6 that averaged 10-12m in length. This poster presents the archaeological data associated with Mèdes 6, offers some comparisons with similar shipwrecks, and considers the possible origins of the internal stitching construction technique.
P35. Identification of Wood Used in the Construction of the Two Horeiae-Type Vessels Toulon 1 and 2 (First Century AD, France)

Alba Ferreira Dominguez (Aix-Marseille University, National Center for Scientific Research (CNRS), Ministry of Culture and Communication, Centre Camille Jullian (CCJ), Aix-en-Provence, France)

Giulia Boetto (Aix-Marseille University, National Center for Scientific Research (CNRS), Ministry of Culture and Communication, Centre Camille Jullian (CCJ), Aix-en-Provence, France)

Frédéric Guibal (Aix-Marseille University, Avignon University, National Center for Scientific Research (CNRS), IRD, IMBE, Aix-en-Provence, France)

During the archaeological excavation of the ancient harbour of Telo Martius (Toulon, France) in 1985-1988, the remains of five Roman vessels were uncovered. They were recovered and conserved by impregnation with PEG and lyophilisation, and are now stored by the Regional Service for Archaeology in Aix-en-Provence. In 2010 the systematic study of the shipwreck collection began under the direction of Giulia Boetto within the framework of the final publication of the excavations.

Two of the five wrecks, Toulon 1 and 2, correspond to small boats used as harbour lighters or for fishing. They were reused, after being filled with stones, to build a jetty at the end of the first century AD. These boats, characterised by a transom bow, belong to the horeiae-type vessels known from the Tunisian mosaic of Althiburus (second century AD). The other three shipwrecks, abandoned in the third century AD, correspond to larger sailing vessels.

The poster presents the results of analyses of the wooden structures of the two horeiae-type vessels Toulon 1 and 2 in comparison with dendrological data from vessels of the same architectural and functional type found at Naples and Ostia in Italy.

P36. Frame-First and Framing-First Fishing Boats: A Phoenician Legacy?

Gianni Caira (Independent Scholar, Badolato (CZ), Italy)

Traditional wooden fishing boats are ubiquitous along the Mediterranean coastline of Spain, southern Italy, Sicily and Sardinia. A visual examination reveals, without exception, a common method of construction: planks fitted around a pre-erected framework consisting of a keelson, stem post, floor timbers and futtocks. The same type of boat construction method is also apparent at Sozopol on the Black Sea coast of Bulgaria, as well as the Iberian Atlantic coast, and it thrives at Tangier in Morocco. It is a boat-building sequence that has been described as ‘frame first’ or ‘framing first.’

This study examines and defines the construction of these fishing boats with respect to the sequence of their construction. Arguments are put forward that the same or very similar fishing boats and their methods of construction date back to the Phoenicians. Reasons for why these particular sequences of constructing a wooden hull could have persisted for almost three millennia will be discussed.
Another outcome of this study is to demonstrate how the individual hull shape of each of the subject boats was evolved to suit its particular natural environment. Subtle adjustments can be made to the principal frame(s) and table of offsets in order to alter the hull shape in response to a changing natural environment. This can be considered in a Darwinian context.

P37. A Photogrammetric Assessment of the Late Bronze Age Anchorage at Maroni-Tsaroukkas, Cyprus

Carrie Fulton (Department of Classics, University of Toronto, Toronto, Canada)

Andrew Viduka (Department of Archaeology, Flinders University, Adelaide, Australia)

Sturt Manning (Department of Classics, Cornell University, Ithaca NY, USA)

Just offshore from a complex of Late Cypriot coastal buildings at Maroni-Tsaroukkas in Cyprus (situated on the south-central coastline) is a Late Bronze Age (LBA) anchorage. An underwater survey conducted in this area in the 1990s yielded fifty stone anchors within 300m of the current coastline, in close proximity to Late Cypriot pottery. While a comprehensive survey was not possible then given the available technology, development in survey methodologies and technologies today permit a thorough and accurate investigation. We briefly returned to the anchorage in 2014 and again in 2017 to re-survey the anchorage. Due to the constant mechanical activity impacting the transport and deposition of sediment in this area, remnants of anchorages and maritime voyages are, in some cases, being buried in layers of sand and hidden from view or, in other cases, exposed through scouring and displaced from their original contexts. Because of these natural processes, several additional anchors were uncovered at Maroni-Tsaroukkas and the nearby region in this survey. In this paper, we identify the physical extent of the LBA anchorage at Maroni-Tsaroukkas, including a close analysis of large architectural blocks that are perhaps indicative of the export of stone from the area and evidence for the lading of ships. We also discuss the result of our developed methodology for implementing low-cost technologies in three-dimensional (3D) mapping by using high-resolution photography to rapidly conduct georeferenced survey transects. This assemblage not only helps us understand LBA anchoring practices, but also informs us about the connection between maritime activity at Maroni-Tsaroukkas and the hinterland of Cyprus.

P38. Towards Spatio-Temporal 3D Visualizations of an Underwater Archaeological Excavation: The Case of the Late Bronze Age Shipwreck of Modi

Foteini Vlachaki (Hellenic Institute of Marine Archaeology (HIMA), Athens, Greece)

Christos Agouridis (Hellenic Institute of Marine Archaeology (HIMA), Athens, Greece)

Eleni Diamanti (Hellenic Institute of Marine Archaeology (HIMA), Athens, Greece)

Giorgos Farazis (Hellenic Institute of Marine Archaeology (HIMA), Athens, Greece)
The poster presents the surveying and documentation methods utilised during the ongoing underwater excavation of the Late Bronze Age shipwreck of Modi (Poros), carried out by HIMA under the archaeological direction of Christos Agouridis.

Among the research interests of the documentation team was the examination of the potentials and limitations of image-based 3D modeling in the recording of an entire underwater excavation. One of the main objectives was integrating semantic, time-related and descriptive information into 3D models, in order to create advanced spatio-temporal representations of the excavated site. The results suggest that image-based 3D modeling can be an excellent and suitable method for the recording, documentation and visualization of an underwater archaeological excavation. However, it also brings along new challenges, including a change in the workflow of the excavation and the post-extraction process.

Photogrammetry was used on a daily basis to provide accurate and detailed 3D tracking of changes of the excavation trench. An image dataset was collected every day, and after its photogrammetric processing, a detailed textured 3D model was exported in 3D file format. After being imported into 3D modeling software, each geo-referenced mesh was edited, with regard to its geometry and texture, and stored—along with 3D models of artifacts and other elements—in a multimedia database, with dive-time reference.

The last step involved the importation of the produced 3D models into a game engine in order to develop a 3D interactive environment, integrating semantic information of artifact numbers, excavation depths, layers, materials, and stratigraphy.

The research team can use the spatio-temporal representations that are produced, both as a tool during excavation and as a means for the interpretation and planning of further excavation of the site.

The final goal of this ongoing work is the visualisation and animation of the excavation phases in layers, as well as the multiple interpretation scenarios, and 3D recreations of how the ship might have sunk.

P39. The Methodology and Results of the AUV (Girona 500) Survey of the Present State of the Gnalić Shipwreck Site

Pere Ridao (Computer Vision and Robotics Research Institute, University of Girona, Calatonia, Spain)

Nuno Gracias (Computer Vision and Robotics Research Institute, University of Girona, Calatonia, Spain)

Irena Radić Rossi (Department of Archaeology, University of Zadar, Zadar, Croatia)

The poster presents the methodology used with the GIRONA 500 Autonomous Underwater Vehicle for the rapid high-resolution mapping of shipwrecks. The methodology was recently demonstrated on the Gnalić shipwreck, in collaboration with the University of Zadar, during the ‘Breaking the Surface 2016’ workshop held at Biograd de Moru (Croatia). The AUV was programmed to survey the shipwreck at multiple altitudes. The data collected were used to build 2D photo-mosaics and 3D optical reconstructions with 1mm per pixel resolution, as well as
topological panoramic maps that were made available only three days after diving. After presenting the methodology and the results on the above-mentioned shipwreck, the poster briefly discusses the challenges that marine archaeology pose to underwater roboticists, as well as the contribution that this technology may bring to the archaeology community.

**P40. New Techniques For Container Studies: A 3D Reconstruction of the Amphora Cargo of the Heliopolis 2 Shipwreck (South France)**

*Marina Orts Ibañez (ARKAEOS Association / MoMArch, Aix-Marseilles University, National Center for Scientific Research (CNRS), Ministry of Culture and Communication, Centre Camille Jullian (CCJ), Aix-en-Provence, France)*

Heliopolis 2 is a deep shipwreck found at -80m and dated to the beginning of the second century BC. Located on the SE Mediterranean coast of France, it was briefly surveyed during the 1980s. No remains of the wooden hull were discovered during the campaign, and only a few amphorae were sampled and brought up to the surface. Nevertheless, several research issues arise from the study of the composition of this shipwreck’s unique cargo. The cargo consisted of Graeco-Italic amphoras that present a wide range of shapes. Some were carrying pitch. From the very beginning, this led archaeologists to assume a cargo of recycled amphoras, an unusual type of freight and a commercial practice that it is not very well known or archaeologically attested for this period.

Recently the cargo was reassessed through container analysis and amphora study. In this framework, a hypothetical 3D reconstruction of the amphora cargo was attempted. The main objective was to test this technique for the archaeological study of containers in general, in terms of saving time and acquiring more accurate data.

Methodologically, a morphological and volumetric analysis of the Heliopolis 2 amphorae was carried out, allowing all the amphorae to be compared and their morphological differences to be observed in detail.

The 3D reconstruction effort provided new data about the containers’ characteristics, and has led us to hypothesise the existence of a new subtype division of Graeco-Italic amphoras. Overall, the archaeological reassessment of the Heliopolis 2 shipwreck has revealed new information about this unique cargo carrier and has allowed us to better define its historical context.

**P41. Amphora Capacities and Standardization in the Punic West: A First Approach to the Transport Vessels Produced in the Bay of Cadiz (Sixth-First Century BC)**

*Antonio Manuel Sáez Romero (Department of Prehistory and Archaeology, University of Seville, Seville, Spain)*

*Ricardo Belizón Aragón (Independent Scholar, Ibiza, Spain)*

To date, the identification of capacity patterns of transport amphoras produced in the Punic settlements of the western Mediterranean and the Atlantic areas has remained a secondary topic in historiography, particularly in comparison with the development of typological approaches or
the study of overseas distribution. This pattern has resulted in a highly developed knowledge of
the typological evolution of amphoras from key places such as the Bay of Cadiz (southern
Spain). But at the same time, it has resulted in insufficient data on the capacities of each type, or
its relation with other traces of ancient local weight and measurement systems.
However, in recent years this line of research has been gaining more traction in relation to the
analysis of far-ranging economic changes, linked to the monetization of the Punic world, to
technical changes in the patterns of production and maritime transport, to the influence of other
Mediterranean manufacturing centers, etc. This poster presents the first results of the latest
research carried out in the Bay of Cadiz aimed at filling this gap. To achieve this goal,
information obtained from typological studies has been combined with measurements using real-
scale reproductions and specialized 3D software. The joint use of these methodologies has made
it possible to obtain data on all types manufactured in Punic ceramic workshops of the Cadiz area
between the sixth and the first centuries BC, including some amphora series created and
produced only under Roman rule.
A synthesis of these results is presented, as well as some reflections about the meaning of
variations in amphora metrology and their connection with other technological changes attested
in the shape and architecture of local vessels and their workshops. Finally, data from Cadiz will
be contextualized within a broader economic framework, comparing local patterns with the
available information from other key transport-amphora-producing areas such as inland
Turdetania, Ibiza and the Punic central Mediterranean.

P42. Coastal Erosion: New Opportunities for Understanding the Cypriot Coastscape

Georgia Marina Andreou (Department of Classics, Cornell University, Ithaca NY, USA)

Coastal erosion is a familiar problem in cultural heritage management, especially in the
Mediterranean region, an area that lends itself exceptionally well to studies of maritime trade and
connectivity. In this context, the loss of coastal land to erosion presents a serious obstacle to our
understanding of the archaeological coastscape, due to the unpredictable rate at which it exposes
and damages archaeological features. The exposure and subsequent disappearance of material
culture is seldom accompanied by systematic archaeological recording. Thus, a broad range of
past human activities associated with the coast remain unrecorded, their context poorly
understood and our understanding of past human interaction at local, regional and interregional
scales impaired. As a result, coastal erosion is both a predicament of cultural heritage
preservation and an epistemological problem.
In 2014 the Cyprus Ancient Shoreline Project (funded by the Honor Frost Foundation) employed
a series of integrated methodologies to understand, record and monitor the impact of coastal
erosion on the cultural heritage of the south-central coast of the island. In this poster, I present
some of the results of the remote sensing, lab- and field-based methodologies we implemented
with the aim to quantify the loss of information and highlight new opportunities for
understanding the Cypriot coastscape.
P43. The Maritime Landscape of Protaras-Paralimni (Cyprus) in Light of New Data From an Intensive Underwater Survey at Nissia Coves

Magdalena Ausiyevich (Archaeological Research Unit, University of Cyprus, Nicosia, Cyprus)

The region of Protaras-Paralimni on the eastern coast of Cyprus remains an almost blank spot on the archaeological map of Cyprus. Excavations of a coastal Neolithic settlement at Nissia showed not only early habitation of the region but also its maritime character from the beginning. In spite of the rushed touristic development of the area during the past 20 to 30 years many scattered areas of pottery are still visible on the coast and under water, proving an extensive and diachronical involvement of the region in maritime activities. So far only minimal research has been done on land, mostly rescue excavations and one non-intensive survey. Underwater research consists of two surveys and one ongoing excavation. A new, intensive underwater survey was undertaken by the author at Nissia Coves between October 2016 and February 2017. It covered an area of 6500m² and revealed pottery remains dating from the Classical to the Late Ottoman period, showing a diachronical involvement of the area in maritime activities. The poster will present the results of this survey in comparison with data from previous archaeological projects in the region on land and under water, in order to provide a closer and detailed look into the poorly researched role of Protaras-Paralimni within the maritime landscape of Cyprus.

P44. An Anchorage Beyond Its Anchors: The Maritime Landscape of Petounda Anchorage, Cyprus

Lefkothea Papakosta (Archaeological Research Unit, University of Cyprus, Nicosia, Cyprus)

This poster presents the results of the underwater and terrestrial survey that took place at Cape Petounda, Cyprus, in the summer of 2016. Based on the significant number of stone anchors found around the cape during this survey (over 50), it is believed that an ancient anchorage or harbor used to exist in the area. This work initially provides a classification and comparison of these anchors to similar findings on the island. Furthermore, it aims to understand the deeper relationship between this anchorage and the maritime landscape of the surrounding area as well as the maritime map of the southern coast of Cyprus.

To overcome the limitations in dating stone anchors, the research project relied on pottery evidence and on the excavation of an Early Christian baptistery around the cape. Based on these findings, the historical framework for the activity in Petounda can be placed around Late Antiquity and Byzantine times. Trade in Cyprus flourished during these periods; therefore, a seafaring network of small-scale ports and anchorages would have been needed to facilitate the transfer of agricultural and mineral goods. This paper places the previously unexplored underwater area of Cape Petounda on Cyprus’s archaeological maritime map. It also identifies its anchorage as a potential link, along the trade route of the southern coast of Cyprus, that contributed to the economical and commercial growth of the island during that time.
P45. The Tradition of Fishing and Fishing Gear on the Island of Cyprus

*Katerina Mavromichalou (Cyprus American Archaeological Institute (CAARI), Nicosia, Cyprus)*

*Maria Michael (Independent Scholar, Nicosia, Cyprus)*

The research presented in this poster focuses on the study of fishing and fishing gear on the island of Cyprus during the eighteenth and nineteenth centuries. Cyprus is the third largest island in the eastern Mediterranean, which has a long-lived oceanographic tradition. Consequently, the relationship of its population with the sea must be very close. The sea has been explored and managed by communities for thousands of years. This is testified by various remains and finds, such as imported ceramics and other products, fish bones, fishing tools and representations in art, recovered during the course of archaeological excavations. Despite the fact that fishing equipment and related artefacts have been recovered from excavations and surveys for a long time, and that fishing still seems to be a part of daily Cypriot life, in general the study of fishing has attracted only limited attention from scholars. Consequently, the main aim of this research is to combine archaeological data with historical testimonies, oral tradition and the results of an ethnographical study in an attempt to acquire a better general understanding of the formative phases of fishing around the island during recent periods in its history. It also explores the development of fishing methods and technology, and considers how these activities influenced the daily life of the island communities.

P46. Wooden Shipbuilding in Cyprus From the Late Nineteenth to Middle Twentieth Century: Significance, Problems and Protection

*Constantinos Nicolaou (Archaeological Research Unit, University of Cyprus, Nicosia, Cyprus)*

Wooden shipbuilding in Cyprus is a craft based on traditional, pre-industrial design and construction methods, and as such it preserves elements and processes that can help us understand ancient shipbuilding as well, through an ethno-archaeological approach. During the nineteenth and early twentieth centuries, wooden ships and shipbuilding on the island mainly related to trade and less to fishing or other activities. From the mid-twentieth century onwards, as large modern steel vessels replaced pre-industrial wooden vessels, wooden shipbuilding mostly dealt with small fishing boats.

The craft of wooden shipbuilding has been almost abandoned in Cyprus for various reasons that have not been systematically studied, at least on a scholarly level. Important, direct information about wooden shipbuilding can be obtained from elderly boat builders and from the few surviving boats themselves. Thus, it is necessary now to save and protect the last examples of local traditional wooden shipbuilding and everything related to their construction and use.

The principal research questions of this project are focused on three areas: the origins of modern wooden shipbuilding on the island; the identification and classification of the main types of vessels manufactured during the twentieth century; and a comparative analysis of vessel types from Cyprus, and vessel types from the eastern Mediterranean and the Aegean.
P47. Bronze Age Harbours in the Aegean: Towards a New Approach

Eugenia Loizou (Independent Scholar, Norderstedt, Germany)

Located on the littoral, harbours are an important human creation. They are the nodal points where people and the marine environment diachronically meet. Prehistoric harbours, however, in contrast with ancient ones, leave scarce remains and have been less investigated. The poster introduces various types of evidence for Bronze Age Aegean harbours. Iconography, archaeological finds, geomorphological surveys, theoretical models and Homeric poems are briefly presented and discussed, in order to give a complete picture of the current study of Aegean harbours. The presentation also explores the old question on the necessity of their existence, and comments on the approaches that have so far been employed to detect a Bronze Age harbour.

In light of the above, a new theoretical approach to the study of the Bronze Age Aegean harbours is attempted. It is suggested that Bronze Age harbours should be examined under the notion of the dynamic seascape and considered as active cultural landscapes with sociopolitical implications. These qualities can be found in the architectural and urban development of the settlement, and especially in the structures that are consistent with an Aegean harbour-town.

P48. Late Bronze Age Harbours in Southwest Greece: Systems of Maritime Activity Through the Use of Maritime Cultural Landscape

Vasiliki Ivrou (Hellenic Institute for Marine Archaeology, Athens, Greece)

This poster considers the perception of maritime space during the Late Bronze Age in the SW Peloponnese-Kythera region and western Crete, analysing and linking issues of coastline morphology and harbour location. Drawing heavily on the concept of maritime cultural landscape, the presentation reviews the state of knowledge about the nature of coastal settlement during the Mycenaean period in the SW Peloponnese-Kythera region and West Crete and how the coastline has altered since antiquity due to geomorphological processes. The poster presents the results of a coastal and offshore (snorkelling) survey carried out along several stretches of coast in the designated area, with the aim of assessing the location of possible harbours/anchorages dating to the Late Bronze Age. These results are compared with those available for comparable harbour locations in the rest of the Aegean region dating to the Late Bronze Age period. The presentation adopts a maritime perspective, viewing the coastal littoral from the sea. It examines various parameters including natural processes on the coast and hinterland that were, and remain, vital to the connectivity of cultures through the sea during the Late Bronze Age and thereafter. The intention is to contribute to a fuller understanding of seascapes and the maritime cultural landscape in LBA SW Peloponnese-Kythera and western Crete as seen through the evidence of potential harbours, and to gain insight into how maritime space may have impacted the issue of harbour installations of that period.
P49. Ancient Harbours, Anchorages and Marine Installations Along the Mediterranean Coast of Israel – Underwater and Coastal Research

Ehud Galili (Israel Antiquities Authority; The Zinman Institute of Archaeology, University of Haifa, Haifa, Israel)

Baruch Rosen (The Zinman Institute of Archaeology, University of Haifa, Haifa, Israel)

The Levant coast has been a busy sea route for at least five millennia. The Mediterranean coast of Israel is generally straight, with no natural shelters for watercraft. The sea conditions off this coast are hostile and did not favor seafaring in ancient times. The shortage of shelters and the heavy storms challenged mariners, who developed and adopted various solutions to such difficulties. Underwater and coastal archaeological investigations carried out during the last decades have yielded numerous coastal and underwater sites and artifacts that shed light on ancient maritime activities in the region. Based on these finds, this study offers a typology of underwater and coastal archaeological sites along the Israeli coast, including ancient harbours and anchorages. It describes and discusses key issues associated with the three main built harbours (Atlit, Akko and Caesarea), as well as proto-harbours, natural anchorages, and mooring facilities. It re-evaluates the nature of Bronze Age harbours, the use of river channels as inland harbours, and the destruction of the harbour of Caesarea. It also reports the discovery of new harbour facilities at Ashkelon and Atlit.

P50. About the Meaning of Limen Kleistos During the Archaic and Classical Eras

Chiara Maria Mauro (Department of Historiographic Sciences and Techniques and Archaeology, Complutense University of Madrid, Madrid, Spain)

Despite all the scientific publications regarding ancient Graeco-Roman harbour systems that mention the expression λιμήν κλειστός (limen kleistos), the meaning of this phrase remains obscure. Although several theories have been proposed over the years, the academic world still differs on the correct interpretation of this expression. The aim of this poster consists in the re-examination of the meaning of λιμήν κλειστός, focusing analysis specifically on the Archaic-Classical epoch. The study is based on written evidence and archaeological information available today. Every citation of the phrase λιμήν κλειστός found in the text of the Periplus of Pseudo-Scylax has been considered and studied, in order to demonstrate a new possible interpretation of its meaning.
P51. River Channel Palaeogeographies of the ‘Fiume Morto’ and the Ancient Harbours of Ostia (Italy)

Hanna Hadler (Institute of Geography, Johannes Gutenberg-University Mainz, Mainz, Germany)
Peter Fischer (Institute of Geography, Johannes Gutenberg-University Mainz, Mainz, Germany)
Andreas Vött (Institute of Geography, Johannes Gutenberg-University Mainz, Mainz, Germany)
Michael Heinzelmann (Institute of Archaeology, University of Cologne, Cologne, Germany)

Ostia, the harbour of ancient Rome (Italy), is situated in the coastal area of Latium at the banks of the Tiber River. Geoarchaeological investigations were carried out at two different sites that are both associated with the ancient harbour, in order to better understand the spatio-temporal evolution of the Tiber River environment at Ostia. To the west of the archaeological site, a local depression at the southern banks of the Tiber was found to represent a lagoonal harbour basin of Roman Republic times. To the north of ancient Ostia, an abandoned meander of the Tiber River—the so-called ‘fiume morto’—served as a river harbour during the Roman Imperial period. Our study revealed different generations of harbour basins and river channel structures. We also found traces of repeated impact by high-energy wave events from the Tyrrhenian Sea. For the Fiume Morto area, we present a detailed geochronostratigraphy based on more than 60 radiocarbon ages, several age estimates of diagnostic ceramic fragments found in sediment cores, and archaeological evidence from excavations. Our results are well consistent with historical reports on the harbour history and Tiber channel evolution.

P52. The Port of Colonia Iulia Pola (Pula, Croatia) – 2013 Investigations

Marko Uhač (Department for the Protection of Cultural Heritage, Conservation Office, Ministry of Culture, Pula, Croatia)
Ida Koncani Uhač (Underwater Archaeology Collection, Archaeological Museum of Pula, Pula, Croatia)
Giulia Boetto (Aix-Marseille University, National Center for Scientific Research (CNRS), Ministry of Culture and Communication; Centre Camille Jullian, Aix-en-Provence, France)

Colonia Iulia Pola was founded at the southern tip of the Istrian peninsula in the first century BC. The city was built on a hill at the end of a naturally protected bay offering a safe place for mooring ships. A freshwater spring was located on the northern part of this deep and protected bay. This is one of the reasons why this location was recognised and used as a mooring place since the prehistoric times. Due to its geographical position, Pola played a strategic role not only within the regional trade network but also in the trans-Adriatic transportation system towards Italy (Ravenna to the west, Ancona to the south and Aquileia to the north).
Today, due to eustatic phenomena, hydrological features and human impact, part of the harbour basin of Roman Pula is located approximately 160m from the current coastline. In 2013, during a rescue archaeological survey of urban works in the area of Flacius Street, a small portion of the ancient harbour basin and the remains of two Roman lashed vessels (Pula 1 and Pula 2) were discovered and investigated. A wide range of archaeological materials (organic and non-organic) was also collected. Ceramics and amphoras can give indications about the chronology of the harbour use and its abandonment. This material also offers a glimpse of the city's involvement in inter-regional and trans-Adriatic maritime trade. Findings such as wooden and leather objects, ropes, and botanical specimens that were very well preserved in wet conditions, make it possible to better understand depositional processes of this part of the harbour and yield important information about the palaeo-environment surrounding the ancient city.

P53. Searching For the Harbour of Ancient Rhizon: Past Research and Future Perspectives

Marta Bajtler (Institute of Mediterranean and Oriental Cultures, Polish Academy of Sciences, Warsaw, Poland)
Karolina Trusz (Institute of Archaeology and Ethnology, Polish Academy of Sciences, Warsaw, Poland)

The ancient settlement of Rhizon or Risinium is located at the end of the Bay of Kotor in modern Montenegro. Rhizon was an important centre, and gave its name to the entire bay: Sinus Rhizonicus. Residential units, storerooms filled with amphoras, and pottery from the Mediterranean world, were discovered by the Polish-Montenegrin team during their excavations that began in 2001. We have information from ancient written sources about Illyrian pirates stationed here who attacked Greek colonies and Italian merchants. Modern illustrations and nineteenth century travellers’ accounts provide information about remains of building structures still visible in the sea, and places where ships moored. These descriptions of submerged buildings provided a case study for several seasons of underwater survey. Only clusters of ceramics and single stone blocks were found. It is noteworthy that no remains were found at the beginning of the twenty first century. We know that this area was severely damaged by an earthquake in 1979. The walls visible one hundred years earlier could simply have fallen apart. Nevertheless, we believe we should have been able to find some ruins. It is therefore possible that techniques used in previous underwater sonar surveys conducted in 2003-2011 were inadequate, and that the findings described above, architecture or its remains, are at present hidden beneath bottom layers composed of light silt.
Salvage excavations conducted ca. 450m north of Tel Akko have revealed makeshift construction, complete and fragmented ceramic vessels combined with field stones, as building material in the area named ‘Area R’. The largest percentage of ceramics belong to straight-shouldered Phoenician jars and Greek amphoras originating in northern or western Asia Minor. The architectural remains can be dated to between the fifth century BC and the first half of the fourth century BC.

A review of archaeological data from various excavations that have taken place in the vicinity of Akko reveals that only habitation remains dating to the end of the Persian period have been found beyond the borders of Tel Akko. However, remains of the later Persian period are presently being found within a belt of a half-km breadth on the northern and eastern sides of the tell. In addition, an ancient, active seacoast was identified in ‘Area T’ during a salvage excavation directed by Amani Abu Hamid, below the tell at its southern edge.

In excavations carried out during Moshe Dothan’s excavation project in the 1970s and 1980s, rich remains from the later Persian period, including many from the Aegean world were found, especially in ‘Area F’. This phenomenon has been corroborated by the current ‘Total Archaeology’ project directed by Ann Killebrew and Michal Artzy. Historical records describe Akko as one of the sites where the Persian army and mercenaries, especially Greeks from western Anatolia and the islands who were under Persian command. Akko was indeed a major hub in the Eastern Mediterranean trade network during that period.

The archaeological, geo-archaeological and historical evidence indicates that, between the end of the fifth century BC and the first half of the fourth century BC, an active anchorage or harbour was located southwest of the tell, while an area north of the tell was utilized for habitation by Aegean, Phoenician and possibly Cypriote mercenaries, hired by the Persian army to deal with the Egyptian revolts.