



DFG Priority Programme 1630
"Harbours from the Roman Period to the Middle Ages"



Harbours as objects of interdisciplinary research – Archaeology + History + Geosciences

Wednesday, 30.09.2015, 19:00

Opening-Lecture

More than just one harbour – The case of Ephesus

Sabine Ladstätter

Thursday 1.10.2015

Keynote Lecture Hall H – Chair: Falko Daim

9.30 – 10.00

Roman and Medieval London: 40 years of interdisciplinary harbour research

Gustav Milne

London, sitting on the Thames at the head of a tidal estuary, has been the subject of considerable redevelopment in the post-war era. As a direct consequence of that regeneration programme, its ancient harbours have been the focus of detailed archaeological, historical and geoarchaeological study since 1972 particularly on the City waterfront, in Southwark on the south bank and, to a lesser extent, in Westminster. It is now known that the period from c AD50 to AD 1550 saw major changes in the port, including periods of abandonment and relocation. There were also changes in the tidal head and in the level of mean high and mean low water, in harbour topography, bridge construction, in ship-building technology, in the economic culture and financial frameworks, in the languages spoken and materials and volumes traded.

Research has also shown the complex inter-relationships of all these themes. The early and late Roman harbours were both quite different, the former seeing major state investment. Following a period of abandonment from c AD 450-600, a new beach market developed on the Strand to the west of the old Roman City until AD900, when it too was abandoned. From c AD 900 a new beach market was established directly outside the walls of the re-occupied Londinium, and this developed into a fully-functioning and expanding merchant port by c 1200-1300.

10.00 – 10.30

An unique insight into Viking-age harbour development and activities: Hedeby harbour excavation 1979/80

Sven Kalmring

The early town of Hedeby was one of the most important trading centres of the Viking world. By means of its key position in the borderland between the Carolingian Realm respectively later German Empire and Scandinavia two traffic routes could be controlled from here: The north-south directed overland traffic route and – even more important – a portage between the North Sea and the Baltic.

The harbour excavation from 1979/80 exposed an area of more than 2,200 m² of the former harbour basin within a drained sheet pile box. Within it, next to the royal longship Hedeby wreck 1, approximately 2,000 wooden piles and 1,600 post holes from harbour facilities could be documented. Up to today the excavation has to be regarded as one of the best insights into a Viking-age harbour and its development. Little surprising its study consequently formed the very basis for the priority programme "harbours" of the German Research Foundation DFG.

Its analysis has shown that the harbour in its double function as the area for mooring ships and as the towns' market place holds central significance for the comprehension of Hedeby as such. By the enduring adaption to the changing demands of professional seafaring it safeguarded the economic basis of the emporium itself. Even though the harbour at first glance has to be considered as a maritime phenomenon, the economic development of Hedeby was directly subjected to it.

Session Keynote Lecture Hall H - Chair: Peter Ettel

11.00 – 11.30

Geoarchaeological and geomorphological studies in ancient harbours of the eastern Mediterranean – selected case studies

Andreas Vött, Claudia Finkler, Peter Fischer, Hanna Hadler, Björn R. Rübke, Vera Werner, Timo Willershäuser

During the past decade, ancient harbours have experienced increased attention from the side of Geoarchaeology and Coastal Geomorphology. Most of these harbours are silted up with sediments and often lie hundreds of meters or even kilometers distant from the modern coastline. In the Mediterranean, intense archaeological and historical investigations are being conducted in many ancient harbour sites and there is a large interest in unravelling both harbour histories and the complex interactions between man and environment as mirrored in ancient harbour deposits.

Within this historical context, a major geoarchaeological issue is to define the time span when a harbour was in use and when it was abandoned. Modern geoarchaeological research may, however, also find out which natural and/or man-made processes have played major roles in the siltation of the harbour basin. Moreover, the investigation of harbour stratigraphies gives insight in dredging activities and phases of harbour extension. Finally, modern palaeotsunami research has shown that ancient harbours are excellent geoarchives which can be used to reconstruct both magnitude and frequency of extreme tsunami landfalls for which – in many cases – also historical accounts exist.

This keynote talk will present results from geoarchaeological studies in ancient harbours in different natural contexts. The ancient harbours of Oiniadai, southern Akarnania, for example, have been strongly affected by the progradation of the Acheloos River delta. Ancient harbour installations in the Bay of Palairos-Pogonia and the Sound of Lefkada in northern Akarnania were mainly subject to siltation processes, co-seismic crustal movements and high-energy wave impacts. The harbours of Pheia, used as landing place for Olympia, Kyllini and Lechaion – lying at the western and northern coasts of the Peloponnese – show a complex palaeoenvironmental history mostly controlled by sea level fluctuations, neotectonic influences and palaeotsunami impacts.

In each and every studied case of an ancient harbour, we found a strong correlation potential between the natural development as documented by multifold geo-scientific proxies and the historical development as known from written accounts.

11.30 – 12.00

Towards a virtual research environment for ancient harbour data

Hartmut Müller, Lukas Werther, Thomas Engel, Axel Kunz

Manifold restrictions complicate cross-project and interdisciplinary harbour research. Systematic data integration could help to answer crucial questions, launch diachronic and supra-regional comparisons and develop models of harbour evolution. An interdisciplinary working group of spatial information technology and harbour experts is dealing with this task within the priority programme.

Interoperable data access is essential and guaranteed by using standardized open source Web-GIS services and technologies. External data such as extracts of the Barrington Atlas or hydrological datasets could be integrated. Further processing is possible via data integration in local GIS systems. An open-data approach ensures long-term availability and usability. A highly flexible data acquisition system based on standardized tables enables the gradual import of heterogeneous data. Copyright remains at every author. A close collaboration with the working group Terminology and many other projects ensures cross-domain interoperability.

A web-based test platform and a data acquisition structure have been developed and evaluated with the involvement of almost all trans-regional projects in the priority programme in 2014. In the next step, we will launch the platform with extended functionality and open it to the research community. We intend the platform and data pool to grow dynamically.

12.00 – 12.30

No harbours without ships, no ships without harbours – Shipwrecks as maritime cultural heritage of the Baltic Sea

Ralf Bleile

Between harbours, these junctions in communication networks, lay ships which never arrived. More than 10.000 wooden wrecks are known and preserved in the brackish water of the Baltic Sea with low oxygen, salinity and low temperature. This small and relatively young sea has connected human societies for 15.000 years. This means ships belong to our regional identity and are able to explain maritime culture in Baltic Sea colors.

Some wrecks play an important role since they were discovered, salvaged, examined or presented. They were given a second history after they have been discovered and developed into monuments of an important part of our common cultural heritage. Examples shall spotlight different circumstances and set light upon different aspects of their sentimental value. In comparison with harbours, such shipwrecks seem to be junctions for an interregional and international culture of monuments:

The so-called "Nydamboot" (Germany, Schleswig-Holstein), a wooden rowing boat laid down in a bog together with hundreds of artefacts of an army, interfered in the relation between Denmark and Germany after the excavation for a long time. The famous Viking ships from Skuldelev (Denmark) are visible today not only as original reconstructions in a modern museum, but also at sea as replicas sailing under supervision for examining living conditions on board and sailing qualities of those ships. A medieval cog was reconstructed in Wismar (Germany, Mecklenburg-Western Pomerania) using archaeological features of an exceptional wreck close to the shore of the isle of Poel. The famous warship "Wasa" (Sweden) was salvaged under the light of public and not only developed into a highlight of the museum landscape in the Baltic region, but also into a patient of conservation. An international exhibition was elaborated in Schleswig about the Swedish flagship "Prinsessan Hedvig Sofia" (Germany, Schleswig-Holstein) even though the ship is still preserved under water far away. The merchant vessel "Vrouw Maria" (Finland) seems to be a treasure, but shall never be salvaged. During the last days of the Second World War terrible catastrophes happened on the Baltic Sea in which thousands lost their lives. Wrecks like "Wilhelm Gustloff" (Poland) and "Cap Arcona" (Germany, Schleswig-Holstein) underline our responsibility.

Session - Archaeological Features I (Lecture Hall H) – Chair: Johannes Preiser-Kapeller

14.00 – 14.30

Interdisciplinary studies on early and high medieval inland harbours focusing the hubs Karlburg and Salz

Andreas Wunschel, Peter Ettel, Michael Hein, Sven Linzen, Christopher-Bastian Röttig, Michael Schneider, Lukas Werther

Archaeological features show that many early and high medieval landing sites are "natural harbours" which can be easily used by logboats or flat-bottomed boats. In contrast to complex constructions, natural landing places are much less vulnerable to hydrological and morphological changes of the river and easier to preserve. On the other hand there's a lack of archaeological remains and the question of the harbour construction is the one of the courses of the bank.

In the framework of the SPP, we identified potential harbour locations in two riverine case studies and reconstructed their integration into landscape with a specific range of methods. The analysis of LIDAR scans, aerial photos and historical maps together with large area geomagnetic SQUID measurements, drillings, surveys and excavations plays a central role for the detection of natural and anthropogenic changes.

Karlburg, located 28 km north of Würzburg, was directly connected with one of the main transportation routes of the Frankish-German Empire via the river Main. The use of this waterway for transportation is shown exemplarily by a high level of imported finds. Nevertheless, the position and structure of a harbour long remained unclear.

Previous research approaches the equalization of the medieval harbour area with a harbour basin of the 19th century. This could be confuted by geoarchaeological studies. The medieval bank – and potential landing area – is now identified over a length of about 2 km 40-100 m west of the current river.

The early medieval central place Salz at the Franconian Saale is located about 100 km (by river) north of Karlburg. Written sources report on several river travels of Charlemagne and Louis the Pious to the royal palace Salz. As a part of this complex, only the site "Mühlstatt" is situated directly on today's river course. Our investigations show that the deserted settlement areas have been situated at a privileged position on a flood-free relief height in medieval times. In contrast to the Main, the course of the river Saale is very constant in this area over centuries. So it is possible to give an insight to the medieval bank and potential harbour situation.

We will also present a comparative perspective on Karlburg and Salz in the light of recent knowledge of early and high medieval constructional solutions for inland harbours in different zones of the Frankish-German Empire from an archaeological perspective.

14.30 – 15.00

The Rhine River in the first millennium: recent research on one of Europe's leading transport axis
Steve Bödecker, Manuela Mirschenz

The Rhine River is one of Europe's leading transport routes. With the incorporation of the Rhine region into the Roman Empire a new era of urban settlements and harbor facilities along the left bank of the Rhine has begun. Most of the Roman towns and settlements along the Rhine survived into the early Middle Ages and played a major role in a European wide transport system throughout the first millennium.

Despite the extensive investigation of Roman and medieval settlements along the Rhine the system of its riverine harbor and landing infrastructure is one of the least well understood. An interdisciplinary approach within the DFG funded project has led to a wide range of new insights into the Roman and medieval transport network system and strategies to cope with one of Europe's most dynamic river landscapes.

15.00 – 15.30

Fossata Magna – a canal contribution to harbour construction in the 1st millennium AD

Lukas Werther, Lars Kröger, André Kirchner, Christoph Zielhofer, Peter Ettl, Stefanie Berg-Hobohm, Michael Schneider, Sven Linzen, Eva Leitholdt

Navigable canals are an exception in the 1st millennium AD – but not as rare as often thought. In certain periods and regions, they form important parts of the European harbour network. By means of canals, local and regional site conditions at transition zones of the transportation network have been artificially modified. The construction of canals, especially their water depths and fairway width, reflects the specific requirements regarding the accessibility of inland ports and waterways in the adjacent transport zones. These requirements significantly depend on the size of ships, which themselves are determined by the site conditions of the transport zone they were made for. Canals could thus enlighten unknown parameters of close-by harbours, waterways and shipbuilding traditions, because these parameters determined the hydro engineers' decisions for the specific shape of each canal. In our study, we present a supra-regional and diachronic comparative approach to selected artificial waterways and their contribution to harbour construction. Our case studies cover different transport zones (fluvial and maritime) and periods (Roman and medieval). We will compare selected parameters of the canals and contrast them with ship findings of the correspondent transport zones and periods. The pivotal point of our study will be the Fossa Carolina or fossatum magnum, which was constructed in 793 AD on royal initiative to bridge the main European watershed between the rivers Rhine/Main and Altmühl/Danube. We will present key aspects of our interdisciplinary fieldwork with a special emphasis on (dendro-) archaeological results on the cross section, timbering and maintenance of the fairway. Some decades earlier in the 8th century, the Kanhave canal was cut through the bottleneck of Samsø Island (Denmark) to avoid the lengthy detour around the island by ship. The utilization of this canal for seagoing ships in a maritime network will be discussed in the light of different construction parameters and natural conditions. Our oldest case study will be the Fossa Corbulonis, which was built around 50 AD by Roman military. It bridges the watershed between the rivers Waal and Maas (Netherlands) to avoid a dangerous coastal route. We will present new insights in the usability for riverine or seagoing ships and the connectivity with fluvial and maritime harbour networks.

Session – Geoarchaeology (Lecture Hall D) – Chair: Andreas Vött

14.00 – 14.30

A riverside Slavic harbour? A geoarchaeological case study from Bardy, Poland

Martina Karle, Sebastian Messal, Tina Wunderlich, Dennis Wilken

The aim of this interdisciplinary study is a systematic research of the structures of early medieval maritime emporia between Wismar Bay and the Gulf of Gdansk. In this paper we will focus on first results of geoarchaeological investigations at one of the two Polish settlements. About 15 km southeast of Kołobrzeg on the western bank of the river Parsęta the early medieval settlement complex of Bardy/Świelubie is located. The site consists of two hill-forts of the 8th – 10th century, several associated settlements and a huge barrow cemetery. The significance of the site – the most important business in the economy of this region was the

extraction of salt from the land – is clearly attested by the presence of Scandinavian settlers, which were buried on the cemetery. The site is abandoned at the end of the 9th century when the functions moved downstream to the early urban centre of Kołobrzeg. The presence of Scandinavians clearly indicates that the site of Bardy/Świelubie was easily accessible from the Baltic Sea via the river Parsęta. It is therefore very likely that landing sites for ships existed in the vicinity of the hill-forts. However, currently no structures and constructions for the landing of vessels are known, what is likely to be caused by changes of landscape within the fluvial environment. For an investigation of the settlement history of the Bardy/Świelubie site in early medieval times a reconstruction of the former landscape is necessary and required. Therefore, geophysical surveys and geological corings were conducted to obtain data which allow a preliminary reconstruction of the early medieval landscape, especially the course of the river Parsęta. In addition, evidence of archaeological traces of settlement activities could be detected and mapped.

14.30 – 15.00

Deciphering with fossils - The hidden history of the harbour island of Stralsund, Southern Baltic Sea
Thomas Daniel, Peter Frenzel, Jörg Ansorge, Manuela Schultz

When the new OZEANEUM of the Meeresmuseum Stralsund was planned about 10 years ago, archaeologists were facing a unique opportunity to examine an area that has been sealed in the 1860ies – the old harbour of the Hanseatic city Stralsund, close to the island of Ruegen. Already the preliminary reconnaissance for the basement delivered several indicators for human impact and, a special feature, preserved sediments of the Littorina-Transgression of the Baltic Sea, giving reason for detailed archaeological and micropalaeontological investigation.

During the excavation campaign in summer 2006, the remains of two wooden piers have been localized, the former Kingsbridge and Semlower Bridge. Underneath the piers, sediments of the past harbour basin and the Littorina-Transgression were preserved outstanding to date. These two sections with thirteen samples from the Kingsbridge and fifteen samples from the Semlower Bridge were the basis for a palaeoenvironmental reconstruction from the last deglaciation to the middle of the 19th century and finally for a correlation with the sections from the 2002 excavation site “Mischwasserspeicher” close to the harbour island.

The analyses of several macro- and microfossil groups, e.g. foraminifers, ostracods, bivalves, gastropods, vertebrates as well as botanical macroremains and, of course, artifacts, led to a detailed reconstruction of the environmental history within the harbour basin, which could be parallelised with the history of the old town and even single historic events. Environmental factors like salinity, the availability of oxygen, water depth, rheology and their changes with time could be deduced by examining the variation in diversity and abundance of organisms. Foraminifer taxons like *Criboelphidium albiumbilicatum*, *C. williamsoni*, *C. gunteri* and several endobenthic molluscs are references for increased water depth and storm events while the appearance of *Milliammina fusca* admits the determination of the wave basis. Trochamminid foraminifers like *Balticamina pseudomacrescens* and *Haplophragmoides manilaensis* are reliable proxies for the past sea level and several buried colonies of the soft-shell clam *Mya arenaria*, a neozoon in the Baltic Sea, indicate a mid 17th century colonization by this species. New micropalaeontological investigation, performed in 2014 and targeting the Moorteich and the Frankenteich, elucidated the development of the ponds around the historic city centre and contributed to the detection of environmental changes in the history of the World Heritage city of Stralsund.

15.00 – 15.30

Geoarchaeological investigations of North Frisian harbour sites of the 12th and 13th cent. AD
Hanna Hadler, Jürgen Newig, Claudia Finkler, Peter Fischer, Timo Willershäuser, Andreas Vött

The coastal region of North Frisia, characterized by Pleistocene Geest landscapes, Holocene fens and marshes and extensive tidal flats, is subject to constant environmental changes. From the 11th cent. AD onwards, the extensive reclamation of cultivated land by dike building resulted in major man-made changes of the so far natural coastal landscape.

Located at the interface between land and sea, harbour sites are the first to respond to coastal changes. In the early Middle Ages, North Frisia already participated in a supra-regional maritime trade network between the North Sea and the Baltic Sea. Harbour sites were mostly located further inland along the Geest fringe or on trading terps.

Except for few historical reports, cartographic depictions or archaeological observations that provide evidence of (supra-)regional maritime trade, only little is known about North Frisian harbour sites and their trading activities for the corresponding period. So far, neither the existence and development, nor the palaeogeographical context of such harbours have been investigated in detail. This is most likely due to devastating storm surges

during the high and late Middle Ages that repeatedly affected the North Frisian coastline and again turned formerly cultivated land into tidal flats. These tidal flats hold a key position for the detection and reconstruction of potential harbour sites from the high Middle Ages and their environs within the former marshland.

Based on a combined approach of geophysical, geomorphological and archaeological methods, this study therefore aims at (i) evaluating the impact of medieval storm surges along the Hever tidal channel, North Frisia, and (ii) reconstructing the historical landscape in order to (iii) identify potential harbour sites and associated settlements. We further aim at (iv) deciphering the complex interactions of man and environment in this highly dynamic landscape with respect to the evolution of different harbour sites, particularly the trading settlement of Rungholt. So far, preliminary studies in the North Frisian Wadden Sea proved excellent preservation conditions for both, cultural traces as well as traces of medieval storm surges in the surroundings of present day Hallig Südfall. Furthermore, we were able to detect sediments associated with the major storm surge in 1362 AD ("Grote Mandränke") that caused vast land losses along the North Frisian coastline and most likely destroyed the trading settlement of Rungholt.

Session – Geophysics (Lecture Hall A) – Chair: Jörg Hausmann

14.00 – 14.30

Coupling of ERT (Electrical Resistivity Tomography) and DP-EC logs (Direct push electrical conductivity) for improved geoarchaeological interpretation

Tina Wunderlich, Peter Fischer, Ercan Erkul, Hanna Hadler, Wolfgang Rabbel, Andreas Vött

Non-invasive geophysical methods are increasingly applied in geoarchaeological research commonly showing the need of data calibration based on stratigraphical information deduced from outcrops or vibracores. This is especially true for the inversion of ERT (Electrical Resistivity Tomography) data, as it is non-unique. The reliability of the inversion result can be greatly improved by the incorporation of constraints such as layer interfaces derived from vibracores or electrical resistivities from in-situ measurements. DP-EC (Direct push electrical conductivity) logs provide fluctuations in grain size in high resolution as well as highly resolved electrical conductivities. Constraints from DP-EC logs in form of layer interfaces and electrical resistivities can be coupled to the ERT inversion process minimizing the ambiguity of inversion results. This can be done locally limited around the DP hole or, if the stratigraphy is assumed to continue between the logs, over the whole ERT profile. In this case the ERT profile is capable of spatially interpolating between neighbouring DP-EC logs.

It is shown that incorporating regions with certain resistivities based on DP-EC logs exceed the advantage of using layer interfaces alone. Using layer interfaces alone might result in too high or low values of resistivity in a certain area, because a layer interface derived from vibracoring is not necessarily connected to a change in electrical resistivity. The coupling of ERT and DP as well as the needed horizontal and vertical resolution of DP logs is discussed based on synthetic and field data from different geoarchaeological archives.

14.30 – 15.00

Prospection using Rayleigh-wave Resonance Mapping: Method and Field Examples

Dennis Wilken, Tina Wunderlich, Jasmin Andersen, Wolfgang Rabbel, Bente Majchczack, Davide Zori, Sven Kalmring, Jesse Byock

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15.00 – 15.30

Magnetic prospection with SQUIDs – A basis for interdisciplinary (geo)archaeological-geophysical research
Sven Linzen, Michael Schneider, Stefanie Berg-Hobohm, Peter Ettl, Christoph Zielhofer, Lukas Werther, Andreas Wunschel, C.-B. Röttig, J.W.E. Faßbinder, C. Meyer, Wolfgang Rabbel, S. Dunkel, R. Stolz, H.-G. Meyer

Generally, the magnetic prospection is a fundamental geophysical method to reveal archaeological sites. But can the method contribute essentially and play a key role to the investigation of medieval inland harbors and settlements as well as canal structures? We enter into the question by means of the preliminary results of two interdisciplinary projects in Franconia within the framework of the SPP 1630. One is focused on the Fossa Carolina – Charlemagne's canal between the rivers Rhine/Main and Altmühl/Danube to overcome the main European watershed. A second focus is set on the potential harbor sites at Karlburg and the early medieval central place Salz, located on the rivers Main and Franconian Saale, respectively.

All sites on which we report were prospected magnetically on a large scale by means of our SQUID (Superconducting Quantum Interference Device) measurement system. The motorized, fast and high-sensitive system was used at an early stage of the projects to get data sets of the entire archaeological sites as basis for subsequent geophysical and (geo)archaeological investigation. Thus, an area of more than 120 hectares was mapped in the vicinity of the visible remains of the Fossa Carolina as well as in a greater distance. The precisely georeferenced magnetic data were used in combination with topographic information to determine a promising position for a first excavation. The combination with sediment analysis of well-positioned drill holes led to the localization of the buried canal course hundreds of meters to the north. For Karlburg and the site Salz the combined analysis of magnetic, electromagnetic and geoelectric data, LIDAR scans, aerial images and drill hole information resulted in a reconstruction of the medieval river bank and a preferential flood-free terrace situation, respectively.

In addition to the so far used two-dimensional magnetograms the SQUID system provides further information. The system records simultaneously different gradient components of the magnetic field up to the full gradient tensor as well as the precise local position. This amount of information enables us to develop inversion and three-dimensional modelling algorithms. First applications to the data of the Franconian sites will be presented. The magnetic simulations will be compared with geoelectric and seismic profiles. Perspectives of restricted or joint inversion approaches will be discussed.

Session - Archaeological Features II (Lecture Hall F) – Chair: Julia Daum

14.00 – 14.30

Report of the Working Group on Harbour Terminology
Ingo Eichfeld

Large terminological uncertainties exist in ancient and medieval port and harbour studies since the particular terms for this subject have never been clearly defined neither by archaeologists nor by historians. As a consequence, different features are referred to with similar terms, or different terms are used for comparable structures. These terminological uncertainties make harbour research very demanding and communication between researchers of different disciplines extremely difficult. It is for this reason that an interdisciplinary working group on harbour terminology was launched at the onset of the DFG priority programme 1630 "Harbours from the Roman Period to the Middle Ages".

14.30 – 15.00 The North Bay of Dor – A Roman Seafront and a 4th to 7th Century CE Anchorage
Udi Arkin Shalev, Gil Gambah, Assaf Yasur-Landau

The North Bay of Dor is a natural shelter, one of the four bays located by the ancient city. Situated on the Carmel coast 9 km north of Caesarea, Dor has a rich archaeological and textual record testifying to its maritime, ecclesial and political status. Despite this, pinpointing its actual anchorages or harbors during the Roman and Byzantine periods has remained elusive for the most part. Furthermore, movement of the city towards the east and off the tel after the Roman period may have impacted the maritime activity of the site during the Byzantine period.

In this talk we address two main issues regarding maritime activity in Roman and Byzantine Dor. The first is concerned with identifying Dor's Byzantine anchorage(s) and the degree to which their location and functionality reflect the renewed urban layout. The second is a re-examination of two key Roman structures in the North Bay. Our comprehensive underwater survey has found new evidence for the existence of an anchorage in the North Bay of Dor, operating during the 4th–7th centuries CE. Local trade patterns are indicated rather than long-range traffic. The anchorage was located outside the Byzantine city wall, which terminates on the ridge overlooking the

North Bay. The concurrent use of the North Bay and the nearby Tantura Lagoon during the 4th–7th centuries CE, as evidenced by the shipwrecks excavated there, points to a peak in the maritime activities of Dor during this time. Furthermore, the ceramic record from the North Bay is typologically similar to the finds originating from Byzantine Dor's rural hinterland, as well as from the city's southern bays and nearby Caesarea.

In addition, our renewed coastal excavations in the North Bay have examined two coastal structures formerly identified as quays belonging to a built Roman harbor. However, the existing structures at the bay may be now re-interpreted as being part of a Roman urban sea-front complex of the 1st century BCE–3rd century CE.

Overall, our results add to the ever-growing body of evidence for the city of Byzantine Dor. They are augmented by ecclesial texts centered on the diocese of Dor and the basilica found at the foot of the tel, one of the largest in Palestine at the time.

15.00 – 15.30

The warehouses of Greenland and their role for harbours - a Norse building type revisited

Natascha Mehler, Joris Coolen, Ronny Weßling

The Norse coastal settlements of Greenland were situated at good natural harbours. Contact to the wider world was vital and ships regularly travelled to Iceland, Norway, and beyond. For centuries, walrus tusks were an important export item, transported to royal manors and aristocratic centres across Northern Europe. In the early years of archaeological investigations in Greenland, that is the early 20th century, a specific building type was identified at many Norse harbour sites. On the basis of written sources, mainly Sagas, buildings of this type were named warehouses and said to be storages for the export goods such as walrus tusks. The buildings are mostly of rectangular shape and made of solid rock walls.

This paper presents the warehouses investigated during the project “Harbours in the North Atlantic, c. 800-1300 (HaNoA)”. Written evidence will be contrasted with the archaeological record and past interpretations regarding their function are scrutinized.

Session - Written and Iconographic Sources (Lecture Hall B) – Chair: Dominik Heher

14.00 – 14.30

Images and imaginations of harbour infrastructure. The case of the arched moles

Stefan Feuser

Due to the lack of monuments pictorial representations of ancient maritime scenes are frequently used to reconstruct the architectural appearance of Roman Imperial harbours. For those pictorial representations it was commonly assumed that the represented monuments can be specifically identified and assigned to particular ports, without checking the images' own value as a source. However, it is a necessity to examine in detail in which genera representations of ports occur, who were the clients and audiences, which is the value of those images as a source and which information we are able to gain about the structural facilities of ports.

The aim of this paper is to verify the images' value as a source for reconstructing the appearance of ancient Roman harbours. As an example, the paper focuses on the so-called arched mole, which occurs in numerous depictions of harbor scenes in a wide variety of genres. In those images the mole is displayed in the foreground, built into the water, and boats move through its arches. It is commonly assumed that these images depict the 372 m long mole of ancient Puteoli, resting on 15 pillars that were bridged by arches. However, in the images the appearance of the mole differs; in the numerous depictions it is combined with several kinds of buildings, boats as well as people. These details demonstrate that the images show fantastic harbour architecture rather than the harbour of Puteoli. Thus, the value as a source of these images for reconstructing ancient Roman harbours seems to be limited.

14.30 – 15.00

The Harbour as Corporate Identity of the City?

Caroline Bergen

Symbols, icons, logos - today's world is full of apparently simple pictures that establish a whole range of memories, possibilities and desires inside our minds. A good logo is recognized all around the world - an important part of the marketing concept of every successful corporation in our globalized society.

Nowadays cities take part in the global competition for money, success, customers and so they did in the Roman Imperial time. There was an powerful emperor to get privileges from, there were subsidiaries of big and small

trading companies as way for financial gain of a city. To feature a safe harbour was an obvious advantage of location in the Mediterranean world. It was only necessary to find the perfect way to present it to the inhabitants of the Imperium. One of the chosen methods was to take a feature of the harbour and to use it as component of the pictorial representation of the city - a kind of logo for the harbour or even the whole city. Different cities used different features to symbolize the importance and quality of their harbour. In this contribution we will have a look at some of the ways the harbour and its significance for the city is mirrored in the numismatic and pictorial evidence of the cities of Ephesus, Caesarea Maritima and Alexandria.

Session Archaeological Features I (Lecture Hall H) – Chair: Andreas Wunschel

16.00 – 16.30

Hamburg-Harburg the Market and harbour of a middle age small town

Philip Lüth

The small medieval town of Harburg today is part of the administrative area of Hamburg. The older city core situated between the Geest and the southern bank of the river Elbe. From the 12th century onward under the constant influence of the tides a wharf settlement evolved in the marshy terrain. By the support of the local potentates Harburg developed into a site of regional importance and at the end of the 13th century received its town charter.

From 2012 to 2014, the largest excavation in the history of Hamburg took place in this area, which brought up important results on the local urban history.

These included the localization of the port and the market of the medieval town. Both elements represent important points of culmination of the city topography and stand for trade and communication.

Furthermore a number of archaeological features in close relation with archaeobotanical and archaeozoological studies plus historical sources point to the changing environmental conditions in the lower Elbe region between the 14th and the 15th century.

With the help of all these sources it is possible to reconstruct the maritime topography of Harburg from the late Middle Ages to the early modern period.

Harburg does not represent the large and important far distance ports of trade like Lübeck, Hamburg, Bremen or London, but stands for the larger number of small and medium-sized ports in the Elbe valley. These places may be more appropriate to extend the debate on the themes of trade, ports and shipping during the late Middle Ages.

16.30 – 17.00

Measuring Monnikerede. An interdisciplinary research for a medieval outpost of Bruges

Jan Trachet, Wim De Clercq

The Zwin tidal inlet functioned as the Medieval gateway to the port of Bruges. Along the banks of this linear harbour-hub, a series of smaller landing sites soon acquired city and staple privileges. Thus, the fishing village of Monnikerede got engaged in transshipment and commerce, was integrated into international trade networks and soon transforming it into a miniature city. However, economic, geomorphological and military developments in the troubled 16th century showed that smaller landing sites were inviable without the port network in which they sprout. Consequently, they were gradually deserted and disappeared from the landscape. The research on these outports was until now focused on socio-economic functions, using predominantly written sources, whereas the topography of the sites and their harbour-related infrastructure remained largely unknown. This paper will show how we detect and assess the location, morphology and state of preservation of these deserted ports.

First, the broader port area was approached from a macro-scaled historical-geographical framework in which both historical as oblique aerial photographs and LiDAR were combined with cartographical and geological data. Then, the focus narrowed to a micro-scaled high-resolution scan of the outports themselves, starting with a full-scale geophysical survey (Electromagnetic Induction) and a comprehensive DGPS-mapped fieldwalking campaign. To meet specific site-based problems, we applied additional prospection techniques, such as UAV-mounted 3D-photogrammetry, hand-held fluxgate magnetometry, underwater survey and molehill-prospection. Furthermore, we managed to plot and visualize non-cartographic proto-cadastral documents, using retrogressive techniques. The GIS-integration of these highly detailed datasets provides us with various layers of subsoil-information at the scale of the individual Medieval allotment. The combination of these traditional and innovative techniques delivers a promising methodology for non-invasive research on Medieval (landing) sites.

17.00 – 17.30

Gammel Strand, the late medieval and early Renaissance harbour of Copenhagen. New material from the recent excavations

Stuart Whatley

The aim of this talk is to present the recent discoveries of the late medieval and renaissance harbourside of Copenhagen from the recent Metro Cityring excavations and to show and discuss why the harbour was located in this area.

Much has been written about the harbour of medieval Copenhagen, with information obtained from small archaeological watching briefs, historical records, or later summaries in the late 1800s and 1900s by scholars.

The harbour and sea born trade has always been central to the origins, habitation and later expansion of Copenhagen. A settlement called Havn is first mentioned in Knytlinga Saga in the 1043 which may be the first mentioning of Copenhagen. By 1200 Saxo Grammaticus records Copenhagen in Latin as Mercatorum portus (The merchants' harbour), in Danish as Købmændenes havn.

The location of Copenhagen, originally as an islet type port with small islands/islets and larger island of Amager on the Øresund strait was obviously chosen as a fantastic location to fish of herring and undertake and later dominate trade in the central part of the Baltic by the 1600s.

The late medieval harbourside has only been uncovered in the recent Metro Cityring excavations from 2010. Findings include a truncated, and therefore, discontinuous wooden harbour front protected by wooden posts driven in the beach in 1530s. Located directly north of the harbour front were the foundations of former buildings dated to the late 1400s and 1500s by the surrounded late medieval rubbish.

The medieval harbourside was supplanted in the 1580s by a new stone harbour built directly on top of the late medieval harbour. Important border control buildings such as the weighing house and accisehus were also built directly above earlier structures which have been dated by dendrochronology and archaeological finds. The purpose of these buildings, to regulate and control the trade, and the general area construction being evidence of the King and the merchant's efforts to maximize trade and make the area favourable to foreign traders.

Session Geoaerchaeology (Lecture Hall D) – Chair: Christoph Zielhofer

16.00 – 16.30

Understanding a Harbour Site – A Geomorphological Perspective

John Preston, Anthony Newton, Simon Mudd, Andrew Dugmore

Perhaps one of the most important aspects of a successful harbour is that of structural equilibrium. A harbour must have physical stability (or a dynamic equilibrium in the case of a beach) for boats to use it safely season to season, year on year. In the absence of a major civil engineering effort, the geomorphological setting of a harbour is a key control on its physical equilibrium (or otherwise). Should the harbour be located on a particular changeable coastline with active geomorphological processes, it may well rapidly alter to the point that it becomes unviable. Conversely, the harbour may be located on such a stable coastline that even over centennial timescales, little change in geomorphic condition occurs, therefore infrastructure can endure and many aspects of the physical environment remain predictable. Norse harbours throughout the North Atlantic show a great deal of variability in their geomorphological settings, and thus variation in physical stability over short, medium and long time scales.

How do we quantify the ability for a coastline to change, and how do we look for evidence of this? A two-fold approach can be used: site survey, and numerical modelling. Observation and understanding of the timing and spatial expression of dominant geomorphic processes, such as patterns of erosion and deposition, local energy regimes and relative sea level change, is critical to understanding the trajectories of geomorphological change along a coastline. Supporting evidence can be gathered from geomorphological mapping, archival sources, coring and an integrated programme of dating. These techniques allow both a local and regional picture of change to be established.

Numerical models, informed by well-understood principles of Earth surface processes, combined with local field data, allow various scenarios of coastline change to be explored, and the likely implications for harbour identification and use inferred. To illustrate this, we present modelled coastline changes from the island of Unst, Shetland, using the sediment dynamics model, MIKE21. These show how beach instability, known to have occurred on the island in post-Iron Age times, can be modelled to determine the likely circumstances under which beaches formed, changed or disappeared and thus the potential geomorphological drives of coastal change, harbour use and our ability to identify past harbour sites.

16.30 – 17.00

Fossils as tracers of trade connections in German Baltic Sea harbours

Peter Frenzel, Jörg Ansorge, Melanie Thomas

Remains of organisms, especially microfossils, are not only excellent proxies for environmental conditions of the past, but they may indicate trading connections as well. We present examples from excavations in the Hanseatic cities of Stralsund and Wismar at the southern Baltic Sea coast. Here we found exotic molluscs as for instance the European oyster *Ostrea edulis* derived from food waste or pilgrimage souvenirs as the shells of Saint James Pecten maximus indicating pilgrimage to Santiago de Compostela in North-western Spain and Turbo shell opercula (operculum marinus) in a late medieval pendant. Especially interesting is the finding of medieval ballast sands in the old harbour of Wismar, used for land reclamation. These sands contain an intertidal microfauna with estuarine influence deriving from the southern North Sea coast. The analysis indicates ship trade between Wismar and posts at the southern North Sea coast in the mid-15th century. Another example of North Sea or North Atlantic ballast sand use for land reclamation was discovered in the mid 18th century bastion Fährbastion in Stralsund (Ansorge 2013).

The re-use of ballast stones preserved in buildings and cobblestone streets in harbour towns was exhaustive and obviously more common than the use of sand. Some easily identifiable rocks, as for instance rhomb porphyry from the Oslo region can be recorded far outside its natural glacial distribution; examples from Stralsund, Greifswald and Wolgast are highlighted.

In pre-industrial times Northern Germany was extensively supplied with building stones and limestone for lime burning from Scandinavia; the use of Palaeozoic limestone from Gotland and Öland and Danian limestone from Sealand (DK) are well known. Investigation of mineral products and ballast material of ship wrecks and wreck sites can provide detailed information about trading routes and the amount of their sharing of the total cargo. To mention are whetstones from Norway and Sweden, millstones from Mayen (Rhineland) and Afjord (Norway), copper ore from Falun (Sweden) and even sulphur from Iceland.

We plead for more attention to exotic shells and rocks with their incorporated macro and microfossils in archaeological excavations enabling detailed palaeoenvironmental reconstructions and tracing trade connections of the past.

17.00 – 17.30

Provenance of Viking Age Ballast Flint in the North Atlantic– Geochemical source identification with LA-ICP-MS

Michael Brandl, Maria M. Martinez, Christoph Hauzenberger, Natascha Mehler, Pål Nymo

Scandinavian flint has garnered much attention in prehistoric studies concerning stone tool production, however, this study is focused on flint as ballast material. The principle goal of this research is to reconstruct economic aspects of medieval harbour management strategies such as the procurement, use, recycling and final deposition of materials used as ship ballast during the Viking Age. Stone has always been amongst the favored materials used as ship ballast in the North Atlantic due to its high specific weight. While the sources of most lithic ballast materials have been identified, the provenance of the “ballast flints” remains elusive.

Scandinavian flint is bound to Cretaceous formations in Northern Europe and occurs, e.g., in Northern Germany, Denmark, Sweden and on the British Isles, directly coinciding with the HaNoA-project study area. Most of the flint deposits are situated at the coast, and the weathered flint nodules could easily be collected from beach shores. In order to establish the provenance of archaeological ballast flints, finds from contextually significant sites together with geological comparative samples gathered in the course of systematic field surveys were petrographically, mineralogically and geochemically analysed. For this undertaking, an internationally acknowledged and approved method – in short MLA (Multi Layered Approach) – was applied. The MLA combines visual comparative studies, stereo-microscopic analyses of micro-fossil inclusions and geochemical trace element analyses using LA-ICP-MS (Laser Ablation Inductively Coupled Mass Spectrometry). Flint was formed in specific depositional contexts which provide the possibility to establish geochemical fingerprints of raw material clusters by investigating variations of trace element contents that are characteristic for such genesis environments.

For the present study, ballast flint from the Viking age Kristiansand shipwreck (Norway) has been investigated. This material represents a single-event deposition containing material from only one source, and is therefore suitable for provenance studies.

In the course of geo-archaeological surveys potential primary procurement sites as well as glacial deposits close to the shore were investigated and the collected raw materials were used as geological comparative samples. Our preliminary results produced strong indications for the origin of the Kristiansand shipwreck ballast flint. Moreover, there is legitimate reason to believe that the planned investigations will allow the characterization of

specific source areas on a large scale and afford the separation of particular deposits within the Northern European flint zone.

Session – Geophysics (Lecture Hall A) – Chair: Tina Wunderlich

16.00 – 16.30

Ping-Pong: A high resolution marine reflection seismic system for archaeological prospection in shallow waters
Dennis Wilken, Tina Wunderlich, Clemens Mohr, Detlef Schulte-Kortnack, Wolfgang Rabbel

The geophysical investigation of ancient harbours means working in the border area of waters. These areas show water depths of only a few meters and often a high salinity. Common depth resolving prospection methods (mainly electromagnetic methods like GPR/EMI) fail in these waters because of high attenuation due to the salinity. Offshore magnetic gradiometry suffers from the decrease of resolution caused by the enlarged distance between sensors floating near the water surface and targets located below the seafloor. However, hydroacoustic or reflection seismic methods offer the possibility to prospect large areas with a depth resolution of a decimeter scale.

The requirements to these systems are:

- multichannel/array acquisition to be able to cover large areas,
- low draught to be able to access shallow water areas,
- low weight to be able to access areas in difficult environments,
- easy and stable steering behavior, and
- operating source frequencies of a few kHz and thus kHz data sampling.

In the framework of the central geophysical project of the SPP 1630 a marine seismic acquisition system was developed that complies with these requirements to deal with the various underwater tasks of the SPP archaeological projects. We show the properties of this system and its imaging capabilities in terms of different case studies of the SPP 1630 dealing with e.g. landscape reconstruction and the imaging of anthropogenic structures underwater.

16.30 – 17.00

Seismic exploration of silted bays and river mouths

Wolfgang Rabbel, Dennis Wilken, Tina Wunderlich, Harald Stümpel

High erosion and sedimentation rates caused the siltation of many ancient harbors and river mouths on Mediterranean coasts since antiquity. In many cases seismic measurements enable depth mapping of the underlying basement and layered consolidated sediments. The deposited sediments can be classified to a certain extent through the propagation velocity of seismic waves, which can be determined from seismic refraction and reflection measurements. In this context seismic measurements with shear waves are highly significant because the propagation velocity of shear waves is nearly fully determined by sediment composition, grain size and cementation. In contrast to the velocity of compressional waves (“sound waves”) shear wave velocity is nearly independent of water saturation. Therefore, shear wave surveys are well suited for the lithological characterization of sediment layers. In combination with drillings shear wave seismic measurements enable the determination of geological boundary conditions, under which settlements and harbor constructions were planned and carried out in ancient times. We explain the basics of shear wave seismic exploration and show field examples illustrating the use of this method for identifying previously unknown harbors sites and for determining the structure of known harbor basins of ancient Mediterranean cities.

17.00 – 17.30

Direct push tools in the frame of geoarchaeological site investigation in floodplains and wetlands

Jörg Hausmann, Christoph Zielhofer, Robert Heymann, Ulrike Werban, Peter Dietrich

Geoarchaeological trenching techniques in floodplain and wetland environments are challenging due to the impact of groundwater inflow and highly unstable trench edges. Alternatively, classical driving core applications often come along with the contraction of organic layers and bias in height accuracies. Here, we present the application of direct push techniques for geoarchaeological studies in environments with high groundwater tables, especially when high-resolved parameterization of the near surface is of broad scientific interest.

Two of these direct push techniques, are electrical conductivity logging (EC) and the measurement of soil colors (SC) in unconsolidated sediments throughout depth. These provide proxy information about layer structure, texture and organic carbon.

Here we show that direct push techniques—yielding high-resolved information on vertical layer patterns—are a promising tool for such tasks. The speed of investigation allows for obtain a large data set by means of vertical resolution and lateral profiling. We exemplarily provide first results of a densely investigated cross-section, which is part of Charlemagne's summit canal, an early medieval hydro-engineering project bridging the Central European Watershed.

We compare the obtained high-resolved probings to core samples and discuss transfer options from multiple one-dimensional logs towards generation of two-dimensional cross-section. In this context, we recognize in situ-obtained soil colors and electrical conductivity as descriptive proxies for site characterization. Given the cost and time effectiveness of such tools, site information was grown rapidly, compared to less densely performed drillings, which require a high effort for post-analysis.

We conclude that direct push technologies, therefore, are especially promising for geoarchaeological applications in floodplain and wetland environments, owing to the broad variety of available sensors and probes, their minimally invasive nature, and the high-resolution data they provide (geophysical, geotechnical, hydrological, geochemical).

Session - Archaeological Features II (Lecture Hall F) – Chair: Lukas Werther

16.00 – 16.30

Revisiting Birka's Black Earth Harbour

Sven Kalmring, Lena Holmquist

As one of the few northern proto towns of the early medieval period Birka is one of the most important sites in Viking age archaeology. While earlier efforts were targeting of the islands vast burial grounds, its fortifications and a section of the settlement layout, the harbour as the towns' very means of existence is hardly known. Yet it was due to the harbour that rich merchants from Frisia, Denmark, Norway, the West Slavic areas, Sambia and "Scythia" attended Björkö subsequently resulting in an extraordinary accumulation of large amounts of goods and money as the written sources inform us.

Due to transgression the largest part of the former harbour basin today is laying on dry land. Already in 1969 a 50 m long and 1 m wide trial trench was dug from the Black Earth settlement area into the old harbour basin. In this section a stone foundation was encountered and the trench enhanced in 1970/71. The structure belonged to the landward foundation of an otherwise wooden jetty. However the wooden prosecution of this seemingly only moderate harbour facility could not be analyzed by means of this trench so that both dimension and dating are still somewhat uncertain.

In order to get a closer understanding of the wooden continuation of the jetty the current efforts focused on the area in front of the stone foundation only partially excavated in the 70ies. Additionally the excavations were prepared by means of geo-radar surveys in autumn. As a result the stratigraphy of the harbour basin could become revised and the harbour activities studied via the artefact spectrum. Finally a jetty post was encountered and taken in for dendrochronological analysis. While the project is run as a joint project between the Stockholm University and the Centre for Baltic and Scandinavian Archaeology also a close cooperation with the Swedish Maritime Museum is being maintained. Since the latter conducted complementary underwater surveys in the remaining part of the harbour still covered by water this opens way for an important dialogue on Birka's harbour as a whole.

16.30 – 17.00

The 11th century Schleswig waterfront - its establishment and rapid development a part of a major trading center

Felix Rösch

Schleswig, the mediaeval successor of Viking-age Hedeby, has recently moved into the focus of new investigations. One aspect is the analysis of a number of old excavations, whose features have always been connected to the harbour of Schleswig. Due to very good preservation conditions for organic material those excavations uncovered large numbers of wooden structures which have been well documented. Using GIS and database programs, these structures have now been recorded digitally and were systematically analyzed for the first time on the whole. They draw an image of a complex and rapidly developing waterfront in an age of upheaval – the transition from Late Viking Age to the High Middle Ages in the course of the 11th century.

During the 1070ies the shore of Schleswig's old town peninsula is settled systematically by plots and wooden ways. After renewing the plot boundaries several times, the shore is additionally fastened by revetments. In the late 1080ies the plots are extended into the shallow water by constructing massive dam-like structures, which continuously protrude further forward. Within two decades they dominate the whole waterfront. On those

structures buildings, fireplaces, wells and cesspits are established. In combination with the latest results on the historical water level these observations result in an interpretation that the dams did not work as landing facilities in the first case. They have rather to be understood as private multipurpose structures that reclaim land in an area of major interest. As Schleswig has been a highly frequented trading place during the High Middle Ages, whose goods traffic was to large amounts based on ships, the waterfront was one of the most attractive places in the city. Against this background the dams are the manifestation of the land-based actors of trade, establishing themselves directly in an advantageous position. Thus, the studies provide new perspectives on the topography, infrastructure and organization of high medieval waterfronts.

17.00 – 17.30

Rostock-Dierkow revisited! New investigations in the early medieval Emporia and it's harbor
Sebastian Messal, Martina Karle

The central element in the organization of the exchange of goods within the Baltic Sea region consisted of coastal settlements that specialized in trans-regional trade and crafts and were established throughout the Baltic region from the 8th century onwards. These maritime trading centres derived their significance chiefly from the existence of harbours. Archaeological investigations at these ports have been conducted only sporadically between the Bay of Lübeck and the Gulf of Gdansk. Since 2013 interdisciplinary investigations are conducted in Rostock-Dierkow which demonstrate the high potential of the site for the study of early medieval emporia in the southern Baltic Sea region and their ports. In addition to the detection of far-reaching trade relations and industrial production beyond subsistence levels, it was possible to record extensive building activities and land development measures of the late 8th and early 9th centuries. These building activities focussed on the Warnow and are indicative of a harbour area which attracted extensive construction measures for preservation or enhancement. The paper will present a new interpretation of the emporia of Rostock-Dierkow based on the re-evaluation of old and new excavations.

Session - Written and Iconographic Sources (Lecture Hall B) – Chair: Andreas Külzer

16.00 – 16.30

Auf der Suche nach Verwaltungsstrukturen der Häfen Konstantinopels (7.-11. Jh.)
Martin Marko Vucetic

Constantinople was a maritime capital for the maritime Byzantine Empire. Not only did it lie on important sea routes, its population was in great need of these for adequate day-to-day supplies. In written sources a whole row of harbours and anchorages of highly diverse magnitude are recorded. For the first time, with the spectacular discovery of the harbour of Theodosios, a metropolitan harbour has been excavated. Since the harbours played a central role in everyday life and in the operation of a functional capital on the Bosphorus, we may assume that the city had a certain administrative structure at its disposal to regulate everyday affairs. Our sources only reveal highlights of this aspect of the administration and organisation of Constantinopolitan harbours. I shall explore these administrative traces in my lecture and collate this information. Next to seals, literary testimonia (historiography, administrative records etc.) will play a more important role than they would for provincial harbours. My paper is therefore well-suited to the section on "Written and Iconographic Sources: Complementing the Material Evidence". Chronologically attention will be concentrated on the early 7th to the close of the 11th C, in accordance with the focus of my project.

16.30 – 17.00

Ports and harbours as heterotopic entities in Byzantine literary texts
Myrto Veikou

This paper will focus on the discussion of some cultural aspects of Byzantine ports and harbours through an evaluation of their representations in medieval texts. The investigation will be based on a selection of medieval hagiographical texts, letters and travellers' narrations, dating from the 4th to the 15th century. First of all, it will attempt to show that, through their fundamental and direct link with maritime travelling, Byzantine ports and harbours emerge as heterotopic entities i.e. as intermediate and "other" spaces. The notion of *heterotopias*, as first defined by Michel Foucault (1984) and further developed by later scholars, have been defined as simultaneously physical and mental spaces, which have more layers of meaning or relationships to other places than immediately meet the eye, thus, time is there experienced differently than in normal life.

Secondly, the study aims to show that these heterotopic entities serve as narrative tools in the specific contexts of their use. It will be specifically discussed how these *heterotopias* are linked to the late antique and medieval authors' complex spatiotemporal experiences of which the authors' mobility is an essential element. Thus, the examination of these heterotopic representations of Byzantine ports and harbours in medieval texts will stretch in two directions: a) considering these representations as literary spaces reflecting social reality and b) locating the ways in which these literary spaces determine the aesthetics of the texts.

As far as methodological issues are concerned, an interdisciplinary qualitative theoretical approach will be used in this investigation, because it is considered to provide promising alternatives for grappling with people's complex spatiotemporal experiences. This decision aims to acknowledge and take into consideration two different factors of social life. The first is that the places people can reach and at what time they can reach them (individual accessibility) are important determinants of their exposures to various social or environmental influences. The second factor is that the ways in which people communicate these complex spatiotemporal experiences depend on their specific intentions for communication.

17.00 – 17.30

The role of harbours in the ritual topography of Constantinople

Dominik Heher, Grigori Simeonov

Many aspects of life in Byzantine Constantinople were strongly influenced by the sea that enclosed the city on three sides. Economy and military depended heavily on maritime communication networks. Several big ports and a number of small anchorages along Constantinople's walled coastline shaped the city's skyline and facilitated both long and short distance travel.

The sea, however, also played a vital part in the ceremonial routine of the imperial court which has been largely neglected so far. It is true, many ritual obligations necessitated processions on horseback or on foot, but boats and ships were an important complementary means of transport. For example, the solemn return of the victorious emperor from war frequently began with his crossing over the Bosphorus and also when visiting monasteries and churches in the suburbs the emperor and his entourage often set sails in the imperial barges or warships. Finally, harbours played a role in the reception of foreign rulers or princesses who were to be married to members of the imperial family.

By examining the function of some of the harbours that appear frequently in written sources (Palace harbour "of the Boukoleon", Hebdomon and Golden Gate, Kosmidion, harbours of the Golden Horn) and trying to reconstruct their architectural setting our paper aims to contribute to a better understanding of the ritual topography of Constantinople.

Friday 2.10.2015

Session Archaeological Features I (Lecture Hall H) – Chair: Natascha Mehler

9:00 – 9:30

Efficient Simplicity – Roman Harbors in the Southern Levant

Paula Rut Zajac, Assaf Yasur-Landau, Gil Gambash

The Southern Levant is characterized by a shallow and disadvantageous coastline, mostly devoid of natural safe havens for sailing vessels. Phoenician harbor technology – consisting in the erection of moles constructed of double walls of ashlar headers – was employed in the area probably since the late 9th century BCE. But the introduction of Roman hydraulic concrete to the area sometime in the third quarter of the 1st c. BCE, would have offered a superior technological solution – one that would have allowed enhanced protection from the energy of the sea, and the possibility to build bigger and deeper harbors. The harbor of Sebastos at Caesarea Maritima came into being by the agency of King Herod the Great. It was the first concrete harbor ever to be seen in this area; and it remained a unicum throughout the time of its existence.

The part played by large sophisticated harbors in trade activity during the Roman period remains a debatable issue. To be sure, the revolutionizing potential of Roman hydraulic concrete and its appearance in various parts of the Mediterranean have been recognized by modern research. But also coastal seafaring (cabotage) – employing mostly small harbors and natural havens – gradually reveals itself to have been a significant player in Mediterranean economy. For the Southern Levant, modern research has always included a close focus on Herod's Sebastos. Considerably less attention has been given to other seaside localities in the area which show continuous engagement in maritime activity despite the lack of technologically advanced harbors. In fact, seen from this perspective, the Southern Coastal Levant has not yet been studied as a micro-region.

The suggested paper examines some of these less conspicuous coastal sites – such as Ashkelon, Jaffa, Akko, and Dor (hopefully presented separately at the conference by another team from our department), and explore their relationship with advanced building techniques, particularly ones employing hydraulic concrete. Ultimately, it aims to suggest that, at least in this part of the Mediterranean, sophisticated harbor technology was neither desired nor necessary to facilitate trade, and that coastal sites were capable to engage in intense maritime activity and to flourish while using basic harbor installments. This, in turn, will create a wider context, hitherto little investigated, for the harbor of Sebastos itself.

9:30 – 10:00

Elaia, the maritime satellite city of Pergamum

Stefan Feuser, Felix Pirson, Martin Seeliger

Between 2006 and 2011, Elaia, the harbor-city of ancient Pergamum, had been examined using a combined methodology including archaeological survey, building survey, geomatics, geophysics and geoarchaeology. The layout of the city and its harbours could be reconstructed together with its settlement history. The aim of this paper is to present the progressive development of the different harbours and anchorages as well as their facilities from Hellenistic to Late Roman/Early Byzantine times in a changing natural environment.

The combination of a closed harbor, a fortified harbour-front with presumable shipsheds and a beach-harbour served the need of Pergamum and the Attalids in Hellenistic times. Elaia was the commercial harbour of the Pergamenians and the military base of the Attalids where parts of their fleet was garrisoned. Apart from its relation to Pergamum, the development of Elaia largely depended on changes in the natural conditions. Those changes were mainly caused by alluvial and colluvial deposits of the river Kaikos. While the fortified harbour-front started silting-up as early as the 1st c. BC/AD, the closed harbour stayed navigable until the 4th c. AD connected to the sea via a channel built into a natural tide-way. While this closed harbour silted-up in the course of the 5th c. AD approx. 1 km south of the city several wall structure were constructed in shallow water covering an area of ca. 1150 m × 265 m. However, these were not used as further harbour installations but as a saline producing salt on local and regional scale.

10:30 - 10:30

Central Greek Coastal Installations as a reflection of Byzantine Harbour Tradition
Alkiviadis Ginalis

Central Greece and in particular Thessaly constitute not only an ideal region to gain equal information for the study of Byzantine ports, harbours and other coastal installations of the Early- to Late Byzantine periods, but also to compare independent regional and imperial central building activities. As part of archaeological fieldworks and preliminary excavations between 2012 and 2013, the speaker investigated a series of coastal sites within the entire region of Thessaly. These include both primary ports such as Demetrias, Thessalian Thebes, Almyros or Pteleos and secondary harbours such as Skiathos or Platanidia, as well as regional staple markets such as Nies or Amaliapolis. Together with detailed archaeological studies of further harbour installations throughout central Greece such as Anthedon or Larymna, a comprehensive comparison of harbour facilities and infrastructures from the Roman Imperial to the Late Byzantine periods can be set against a theoretical historical groundwork.

This comparison allows an overall picture of the history and architectural developments of harbour features and associated coastal structures, as well as general conclusions concerning hierarchies and networks of Byzantine ports.

Finally, beyond independent regional harbour traditions, the speaker makes a first attempt to present a general reflection of imperial central tendencies and transitions of harbour facilities and infrastructures from the Early- to Late Byzantine periods.

Session - Archaeological Features II (Lecture Hall D) – Chair: Ingo Eichfeld

9:00 – 9:30

The roman port of Rezé / Ratiatum (France, Loire-Atlantique) : Quays and architectures
Jimmy Mouchard, Frédéric Epaud, David Guitton

Rezé is located at the bottom of the estuary of the Loire and in south shore of the river, in front of the city of Nantes. The urban area – situated in province Aquitaine and on picton territory – occupies an important crossroads of ground, river and maritime ways and develops along the river on approximately 50 hectares in its peak at the beginning of the 11th century AD.

The excavations driven since 2005 in the district of Saint-Lupien, in the oriental extremity of the city, allowed to confirm the existence of harbour, relatively modest developments at first, then more impressive from the end of 1st century. A vast building site opens then with the construction of a thick wall of stone bank, which takes support against a break of natural inclination. From part and others of this wall, vast artificial terraces advance in the direction of the water. They are built wooden and stone, following a technique of juxtaposed boxes. For the moment, the monumental ensemble established in the contact of the Loire was recognized then studied on more than 200 m of length and until 30 m of wide. Port facilities identified with Rezé were built in facade according to the principle of the timber framing.

One of the platforms, the complete plan (21 m of facade) and the best preserved (1,30 m of rise), includes an internal armature constituted by posts, beams or longrines in oak so crossing and subdividing the area into several compartments. Spaces so bounded are then swamped with waste of mica-schist's size before being covered with a tiled floor or with a floor.

The introduced program, imposing by many aspects (surface, used quantity of materials) results inevitably from a joint town planning scheme and from a strong political will, of so much, that as is of the research, it remains possible to imagine that the roman city of Rezé, presents a monumental and harbour facade of more than a kilometer in left bank of the Loire.

9:30 – 10:00

The roman harbour system of Fossae Mariana (Gulf of Fos, South of France) : new data on the submerged structures and main tracks of a new multidisciplinary research project
Souen Fontaine, Mourad El-Amouri, Frédéric Marty, Corinne Rousse

In the Gulf of Fos, in the south coast of France lie the impressive submerged remains of a harbour system dating to the Late Roman Republican and the Roman Imperial period. The harbour complex is situated in the extremity of the presumed river channel dug by the troops of Marius to bypass the dangerous mouth of the Rhone. Mentioned as Fossis Marianis on the map of Peutinger, this major harbour complex has been for centuries one of the main harbours of north-western Mediterranean, ideally located as access point to the Rhone Valley. If the wealth, abundance and concentration of archaeological remains, leave little doubts on the importance and the

density of the port's activity during the Early Empire, the layout of Fossae Mariana, the topography of the harbour sector and the ancient settlement, the dating and the functionality of the facilities are still not well defined. Paradoxically, the harbour sector is very little studied given its archaeological and historical importance and its potential in comparative studies with contemporary large-scale harbour systems.

The underwater archaeological excavations, as well as the marine geophysical prospections undertaken since 2012 have revealed extensive facilities preserved in situ. At present, the entire Gulf of Fos and the Fossae Mariana are studied in the framework of a large-scale Research Project, conducted by a multidisciplinary team, with main objective interconnected studies between the harbour sector, the coastal settlements and the Marius Channel.

10:30 - 10:30

The harbour system of Narbo Martius (Narbonne, France) and its facilities during Antiquity

Nicolas Carayon, Simon Keay, Pascal Arnaud, Corinne Sanchez

The actual city of Narbonne in south of France was the capital of the Roman province of Gallia Narbonensis and a city-port located at the crossroad of the Via Domitia which linked Italy to Spain and the Via Aquitania which linked the Mediterranean Sea to the Atlantic Ocean. Its port, the "emporion of all Gaul" in the words of Strabo was in fact a vast system of hundreds of occupation sites organised around a huge natural water area into a local internal network.

Within the framework of the ERC funded project Rome's Mediterranean Ports – Portus Limen and thanks to a partnership with the Collective Project of Research: Les ports antiques de Narbonne (CNRS, UMR 5140 Archéologie des sociétés méditerranéennes), it has been possible to precisely define what was the harbour system of the Colonia Narbo Martius since its foundation in 118 BC until the late antiquity.

This paper aims to reconstruct the evolution of this harbour system taking into account the major transformation of the landscape, the human occupation of the area and the artificial development of the harbour activities. The recent archaeological discoveries allow new interpretations about the functioning of one of the most important Roman port of the western Mediterranean. The integration of all the data available into a GIS and into an interdisciplinary database allows visualizing the harbour system and its evolution over five centuries.

Session Geoarchaeology I (Lecture Hall A) – Chair: Steffen Schneider

9:00 – 9:30

Geoarchaeology of Magdala harbour and Tel Akko (Israel)

Christophe Morhange, Michal Artzy, Matthieu Giaime, Veronica Rossi, Giovanni Sarti

With the support of the MISTRALS-ENVIMED-GEOSISRAEL program and A*MIDEX GEOMED project, we have been able to reconstruct the palaeo-environmental evolution of two ancient harbours in Israel. Harbour geoarchaeology was mainly developed in Israel by the late Avner Raban, founding member of the RIMS multidisciplinary research unit in 1972 at Haifa University. Since these pioneering years, a series of geoarchaeological projects have focused on different ancient harbours, mainly at Caesarea, Dor, and Atlit. Paradoxically, landscape evolution of the major harbour sites of Magdala and Tel Akko have been neglected until two comprehensive multidisciplinary archaeological projects were recently started.

Recent excavations undertaken in the ancient city of Magdala, located on the western shore of the Sea of Galilee, have unearthed a harbour structure extending for more than 100 m, dating from the late Hellenistic (167-63 BC) to the middle Roman (70-270 AD) periods, with well-preserved quays and mooring stones. An integrated (geomorphological, sedimentological, micropalaeontological and archaeological) study of the sedimentary succession buried beneath the ancient harbour area reveals the harbour's main evolutionary stages, shedding new light on the natural versus anthropogenic controls on sedimentation. Three sedimentary sequences reflect the recent palaeoenvironmental evolution of Magdala. These include: 1) a pre-harbour foundation sequence; 2) a harbour sequence from the 3rd-2nd centuries BC to the first half of the 1st century AD. The substantial increase of ostracod species (*Pseudocardona albicans*) preferring calm waters and fine-grained facies point to the establishment of a protected, shallow and organic-rich setting. The increase in sodium and potassium concentrations is accompanied by the sudden appearance of *Heterocypris salina*, a brackish-tolerant species, and by the dominance of noded valves of *Cyprideis torosa*; and 3) a harbour abandonment sequence dated ca. 270-350 years AD.

Archaeological excavations at Tel Akko, east of the present city, revealed imported artifacts and evidence for maritime trade from the Middle Bronze Age (2200–1500 years BC) onwards. The findings strongly indicated that

a harbour had been developed on this site even though its exact location and associated facilities were still to be determined. Sedimentological and paleontological analyses together with ¹⁴C dating of cores provide new palaeo-environmental information allowing for the reconstruction of shoreline changes over the last 4000 years. Firstly, we propose that the southern face of the tell constituted the harbor environment, with lagoonal-marine characteristics until ca. 2800 years BP; and that the site was protected by a natural rocky breakwater and a spit which were eventually silted up and transformed into a continental marsh. This environment might have been used as a harbour by inhabitants before the archaic period. Secondly, it seems that the west side of the tell was lined by a sandy coast that had prograded offering an open anchorage until the Persian period. These results must be cross-validated by future archaeological excavations aimed at more accurately locating the ancient harbour structures.

9:30 – 10:00

Effect of The Holocene sea level change on geomorphology and geoarchaeology of ancient harbours sites in Ras El Hekma area, NW coast of Egypt

Magdy Torab, Samah Moustafa

Leuke, Hermaeis, Phoenicus or phénikountos and Pnigea are four of ancient harbours in Ras El Hekma area as a part of the NW coast of Egypt. Some geoarchaeological remains were discovered by the authors during their field surveying in the eastern side of Ras El Hekma triangle shape coastline on the NW coast of Egypt, west of Alexandria city of about 200 km., in the same location of the above ancient harbours were described by early writers.

The location of phénikountos Greek and Roman harbours have been identified with the ruins that lie on the coast in the gulf, near Bir el Gènèfis. (Fourtau, 1914, p. 108). There are twin islets, below which is the anchorage, with sufficient depth for large ships; water is to be found in a cistern in the neighboring valley. (Ball, 1942, P. 131). The geomorphological characteristics were studied for both locations but we must bear in our mind that the coastline were changed from the Roman period up to recent time by coastal erosion and other geomorphic processes in addition to the Holocene sea level change.

The study area is occupied by alternating Quaternary limestones as a part of eroded carbonate coastal ridge. Some geomorphic coastal landforms formed by The Holocene relative sea level were observed on the shoreline such as multi-level marine notches, platforms and caves in addition to some solution micro landforms formed by sea water on carbonate rocks such as solution holes, channel, pits and residual pinnacles.

The objective of current study is to define the geomorphological and geoarchaeological characteristics of some ancient harbours sites in Ras El Hekma area and to study effect of The Holocene sea level change on its geomorphology, based on detailed field geoarchaeological and geomorphological surveying, mapping and collect some sedimentary samples by coring and dating, as well as multi dates historical maps and RS images to measure erosion rate of the coastline during last century by using GIS techniques.

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10:30 - 10:30

Harbour of Elaia: Land-sea-human interactions during the last 7,500 years

Lyudmila Shumilovskikh, Martin Seeliger, Anna Pint, Stefan Feuser, Felix Pirson, Helmut Brückner

As part of the geoarchaeological research about Elaia, the harbour city of ancient Pergamum (W-Turkey), palynological studies were carried at a sediment core from the silted-up closed harbour basin of Elaia (core Ela70, 9 m long), in order to reconstruct the vegetation and environmental history. In addition to standard pollen analysis, non-pollen palynomorphs helped to detect environmental changes. An age-depth model based on 11 calibrated radiocarbon ages, starting from ~5500 BC, provides the basis for a high resolution chronostratigraphy. The lower part of the pollen diagram is characterized by high percentages of deciduous oaks and pines, suggesting the dominance of open forests close to the coring site. While visible deforestation occurred around 5,000 BC and later 3,770 – 2,300 BC, the change from oak forests to anthropogenic landscapes with olive, pistachio, walnut, and grape definitely starts around 850 BC, reaching a maximum between 170 BC and AD 180, and continued up to ~AD 800. Afterwards the landscape got reforested by pines, while salt marches developed in the surroundings of the coring site. Elaia's heyday is characterized by increased fire activity, indicated by high charcoal concentrations, and the enhanced amount of eggs of intestine parasites *Trichuris* and *Ascaris*,

suggesting the existence of canalisation in Elaia. The change of land-use activity from tree cultivation to pasture is traceable since ~AD 180. Enhanced herbivore activities (pasturing) are indicated by higher percentages of coprophilous fungal spores, such as *Sporormiella*, *Podospora*, *Sordaria* etc. High pasture pressure might have intensified soil erosion, indicated by an increased amount of mycorrhizal fungal spores of *Glomus*. The harbour construction strongly influenced the aquatic environment: foraminifers and autotrophic dinoflagellates disappear, possibly because of desalinization and/or enhanced nitrification, suggested from an increase in heterotrophic dinocysts. The occurrence of the Black Sea species *Peridinium ponticum* in the harbour environment highlights the importance of maritime traffic for species distribution.

Session - Geoarchaeology II (Lecture Hall F) – Chair: Jean-Philippe Goiran

9:00 – 9:30

Microfossil studies on harbour sediments of ancient times from the west coast of Turkey - a review
Anna Pint, Peter Frenzel, Martin Seeliger, Friederike Stock, Helmut Brückner

The complexity of the coastline is of crucial importance for the existence of harbours. On the west coast of Turkey, the well protected and deeply incised embayments provided ideal locations for harbours during antiquity. Their connection to the hinterland via rivers made these locations even more attractive. However, the enormous fluvial sediment supply led to the siltation of the harbours in relatively short times. In order to solve this problem, people dredged, extended or relocated the harbour basins. Nevertheless, most of the harbours had to be given up after a relatively short time of usage.

With invasive geoscientific methods, mainly sediment coring, the life cycle of the harbours and the evolution of the surrounding ecosystems and of the coast in general can be investigated. In addition to sedimentary and geochemical analysis, the microfaunal research is of major importance. We concentrated our studies on Ostracoda and Foraminifera, two classical groups of calcareous microfossils of 0.2 to 1 mm in size on the average. Both groups occur in large numbers in most types of marginal marine waters. Micropalaeontological studies on harbours follow the uniformitarian approach, i.e. the modern ecology of species is the base for palaeoecological reconstructions of the ancient environment. Concerning the microfossil inventory, harbours are very similar to lagoons in habitat type and ecology due to their protected position. In harbour basins, eutrophication is common, caused by the input of human waste. This is reflected by a ubiquitous faunal association with temporary deficiency in oxygen. Often, the sedimentation rate is higher than in natural lagoons. Silting up of a harbour leads to the separation from the sea followed by a freshening of the water body, similar to coastal lake, with a characteristic freshwater fauna. This marked change in the faunal composition indicates the end of the harbour activity.

As for the west coast of Turkey, the interaction of fluvial sedimentation and coastal evolution must be considered. This interaction results in the formation of different sedimentation spaces with strongly varying sedimentation rates within relatively small areas. These systems can be differentiated by the microfossil assemblages based on their salinity preferences. It is even possible to detect sea level changes, directions of sediment transport, and high energy wave events.

9:30 – 10:00

Geoarchaeology at the ancient harbour of Agrigento
Valentina Caminneci, Vincenzo Cucchiara, Giuseppe Presti

Near the mouth of the Akragas river the archaeological research suggests the existence of the ancient port of Agrigento, remembered by literary and hagiographic sources as Emporion, functioning from the 6th century BC to the 7th century AD.

We debate here about the topography of this area, not only, through the review of the findings from the archaeological excavations, to define chronological aspects, but also by observing the geological characteristics of the site.

The reconstruction of the processes of human settlement along the coast cannot be separated from the archaeological study of the coastal landscape.

The research aims to define the trend of the fluctuations in the sea level since the formation of marine terraces in this area, the variations of the coastline up to the historic age, the identification of paleosoils through a geologic survey and some laboratory tests aimed at a precise characterization of sedimentary bodies recognized on the sand dune still preserved near the river mouth and the analysis of the samples taken during the archaeological excavations, to understand flooding and silting phenomena of the coastal environment.

10:30 - 10:30

The lagoonal harbour of Portus Pisanus (N Tyrrhenian Sea, Italy): a long history of human adaptation to changing coastline

Veronica Rossi, Monica Bini, Christophe Morhange, Adriano Ribolini, Giovanni Sarti

During the last millennia human and natural processes have become increasingly intertwined, especially in the Mediterranean coastal and alluvial plains where major urban and trade centres developed since protohistoric times. Port's construction represents one of the human activities that have mostly contributed to modify coastal environments, inducing a variety of hydrodynamic and hydrochemical changes especially since Roman times (Marriner et al., 2014).

Exceptions in this common manner to plan harbours have been recognised along the N Tyrrhenian coast, where no high-impact defense works are explicitly documented by either historical sources or archaeological excavations for three main harbours developed during Etruscan-Roman times (IV-I century BC): Portus Lunae (Bini et al., 2012), Portus Pisanus and Vada Volterrana.

Roman literary sources (i.e., *Itinerarium Maritimum* 501; Rutilio Namaziano) mentioned Portus Pisanus as a flourishing commercial site within a natural protected area (called Sinus Pisanus by Tacito) characterized by Posidonia meadows and located at the foot of Leghorn hills, ca. 18.5 km south of the Pisa city. Recently, archaeological excavations undertaken close to the hills slope, 3 km inland from modern coastline, unearthed a wooden palisade, stone piers and a warehouse dated to the Roman period (Pasquinucci, 2013; Morhange et al., 2015).

However, the exact location of the lagoonal harbour basin is still controversial. Through a multidisciplinary approach (sedimentological and micropalaeontological core analyses, radiocarbon dating, geomorphological field survey, remote sensing and historical cartography), this study aims to contribute to fill this knowledge gap and shed new light on the main stages of Portus Pisanus history, in the framework of the mid-late Holocene palaeogeographic evolution of Pisa coastal plain.

Since the marine transgression peak (ca. 8000 cal yr BP), the study area was occupied by a wide lagoonal basin. This basin, recorded by a m-thick subsurface succession of soft grey clays with brackish meiofauna, persisted for several millennia and corresponds to Sinus Pisanus. The available stratigraphic data document that during Roman times the lagoon became progressively less connected to the sea and turned into a coastal lake/pond. This seaward facies shift forced the westward transferring of the Middle Ages harbour.

These results show that natural sheltered conditions, whose prolonged persistence was also favoured by the distance of the main coeval Arno River branch from the Sinus Pisanus site, made more advantageous for humans to accommodate to the shoreline changes, rather than making high-impact interventions.

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Session - Archaeological Features I (Lecture Hall H) – Chair: Ursula Warnke

11:00 – 11:30

The Roman port in Savudrija: A research program for the harbor and it's coastal landscape

Ida Koncani Uhac, Rita Auriemma

The Roman port in the bay of Savudrija (Umag, Croatia) encompasses a complex consisting of different structures, some of which are visible along the shoreline, particularly in the southern section of the small bay, between the beach line that has been washed away by the action of the waves and the natural terrace on which a campsite is currently located. This terrace that was more protruding in ancient times hides a series of wall formations hypothetically attributable to substructure works. Furthermore, excavations have been carried out in correspondence of the breakwater and inner pier. The aim was to evaluate the height of the jetty and the depth of the local bedrock, to highlight the building steps and to define the time of construction and the chronological

range of use. In addition, the researches have been aimed to contextualize this significant harbour (40.000 mq) in the port hierarchy of the Istrian coastal landscape.

The data, looking forward to further confirmations by the materials' study, allow us to speculate about the ancient coastal landscape during the Roman Age, the settlement patterns and the relationship between this port and its hinterland.

11:30 - 12:00

Roman harbours on the Tyrrhenian coast

Julia Daum

Among the ports on the Tyrrhenian coast, the best-known are Puteoli and Portus. However, there existed much smaller harbours since the Etruscan period or were established as colonies of the Roman Republic. From the second to the first century BC, there had been a phase of intensive construction activity. In the Imperial Period then, the harbours were being maintained, but no entirely new ones were built, with one exception: Centumcellae, today's Civitavecchia. Here, the emperor Trajan (98-117) built a harbour with enormous dimensions, much bigger than all the other maritime constructions along the coast. South of Rome, new harbour facilities were also built in the name of Trajan – in Terracina. Antoninus Pius (138-161) finished the work.

There are thus two harbours which were built or at least paid for by the emperor. What did that mean for the other, smaller, but well-established harbours along the coast?

The SPP-Project "Efficiency and Competition" investigates the development of the harbours between Mons Argentario in the north and Minturnae in the south during the middle phase of the Roman Empire. The research does not only focus on harbour remains, but also on the connections between harbour and hinterland as well as on economic topics. As documentation and research levels differ widely, a broad spectrum of archaeological and historical sources have been used. In addition to the maritime facilities themselves, the archaeological materials consist of amphorae, coins, remains of walls, epigraphic sources and scattered wrecks.

Ancient written sources complete the picture.

In selected examples, the presentation is going to investigate the commitment of individual Romans in the development of these harbours and to illustrate the diversity of these structures along the Tyrrhenian Coast.

12:00 – 12:30

The Adriatic communication area: functional structure of Roman imperial port cities and their facilities along the Italic and Dalmatian coasts

Julia Daum, Martina Seifert

After the establishment of the province of Dalmatia by Augustus in AD 9 and the decrease of piracy, many Italic families expanded into the port cities and the hinterland of the eastern Adriatic. In conjunction with local elites, their economic activities contributed significantly to the prosperity of the region. Favourable environmental conditions, established technological know-how and the possibility of logistical connections to terrestrial trade routes and the hinterland were just as important as regional and inter-regional political developments and trans-Adriatic family contacts in establishing an 'Adriatic communication area'.

Building on the results of our earlier work on Tyrrhenian coastal ports in the Roman Imperial period, the present project seeks to analyse and establish the relative importance of these different factors with a view to addressing the role that coastal ports in the east and west Adriatic played in regional and inter-regional trade. The starting point for assessing the economic efficiency of these ports is to study their architecture, their infrastructural integration into the remainder of the town and the use of or access to resources in the surrounding areas.

The lecture will be the first presentation of the new harbour project of the SPP, which will start in October 2015. We will show the possibilities of the economical environment of the north Adriatic basin with its hinterland and harbours.

Session - Archaeological Features II (Lecture Hall D) – Chair: Sven Kalmring

11:00 – 11:30

The port of Narbonne : five centuries of maintenance and repairs, from the second half on the 1st century BC to the first half of the 5th century AD

Corinne Sanchez, Marie-Pierre Jézégou, Patrick Andersch Goodfellow

The term Emporium was attributed to Narbonne by Diodore of Sicily, and the town was considered by Strabo to be the port of the whole of Gaul during the republican and Augustan era.

The sheltered lagoon provided a particularly favorable environment located at the intersection of maritime and land routes and at the beginning of the Gallic isthmus, the shortest route between the Mediterranean and the Atlantic with a navigable river flowing into it. In 118 BC, the area of Narbonne was selected to become the first Roman colony outside Italy and subsequently the capital of a Province that extended from the Pyrenees to the Alps. Its commercial prosperity persisted until late Antiquity as evidenced by the heavy installations and the many repairs undertaken to maintain a sufficient depth of access into the Castérou-Mandirac harbor channel. The channel was around 50 m wide and corresponded to the mouth of the Aude, which was equipped as early as the second half of the 1st century AD.

The discovery of large warehouses and many vestiges of transshipment testify to the role played by the Port La Nautique outer port, north of the lagoon, in the thirties BC. Economic and environmental considerations probably played a role in the abandonment of the site to the profit of Mandirac and Castérou in second half of the 1st century AD. The focal point of the Narbonne harbor system was thus an urban river port, of which we are beginning to discover the warehouses on the left bank of the river, and outer ports in the lagoons. The goods transported in the sea going ships were unloaded in the outer ports and then transported by tug or overland to the town and its hinterland.

The considerable work invested testifies to the public determination to maintain this important harbor system, maybe linked to the flourishing economy, evidence of which, in addition to epigraphy and literary testimonies, can also be found in the cargo of wrecks which was probably stored in the Narbonne warehouses before being loaded on ships leaving from Narbonne for re-export at interregional scale.

11:30 - 12:00

The logistic function of the Rhine-Meuse estuary in the Roman period: the harbour of Voorburg-Arentsburg (The Netherlands) as a case-study

Mark Driessen

The site of Roman Voorburg-Arentsburg – situated along the Corbulo canal between Rhine and Meuse rivers – was initially interpreted as a fleet station of the *classis germanica* by Holwerda in 1923. Later on it was reinterpreted as the Roman town Forum Hadriani, which served as the capital for the *civitas* of the Cananefati. The hand of the central Roman authority can be felt all around the coastal delta area of the Low Countries. This varies from infrastructural adjustments, building and keeping up the frontier line with all kind of military installations, to the construction of new planned towns.

The location of the recently discovered harbour of Voorburg-Arentsburg –near the North Sea coast which lacked natural harbours – and the nature and provenances of the retrieved materials fuelled the idea that this harbour was not only laid out to supply this central place of the *civitas* Cananefatium. The harbour was pivotal in the provisioning of the military in the coastal zone of the West Netherlands, but was constructed as well for supra-regional aims. Our natural coastal delta with favourable off-shore winds and currents will have stimulated not only the Roman coastal trade, but most probably also that to and from Southern and Northern Britain. Archaeological artefacts retrieved from the harbour basin can underpin such functions.

Session - Geoarchaeology I (Lecture Hall A) – Chair: Lyudmila Shumilovskikh

11:00 – 11:30

Palaeotsunami imprint of southwestern Crete (Greece) – examples from the ancient harbour of Sougia and the Palaiochora coastal plain

Vera Werner, Kalliopi Baika, Peter Fischer, Björn R. Röbke, Jack Mason, Sascha Schneider, Anastasia Tzigounaki, Aggeliki Tsigkou, Klaus Reicherter, Ioannis Papanikolaou, Andreas Vött

The southwest coast of Crete, one of the most seismically active regions in Europe, is sup-posed to have been uplifted up to 9 m within the process of the mega-earthquake that struck the eastern Mediterranean world on

July 21, 365 AD. An associated tsunami event is known to have caused thousands of fatalities and destroyed many coastal settlements and infra-structure between the Levante in the east and the Adriatic Sea in the northwest. Since then, the entire southwest coast has experienced strong erosion so that near-coast sedimentary archives showing relevant Holocene sedimentary records are rare. So far, coastal archives in this region including distinct palaeotsunami fingerprints were thus unknown.

A multi-proxy study including sedimentological, geochemical, geochronological and micro-faunal methods has been conducted to reconstruct the palaeoseismological history during the late Holocene at Sougia, within an ancient harbour basin, and around the promontory of Pal-aiochora. Detailed multi-electrode geoelectrical studies and several near-coast vibracores helped to detect promising local sedimentary archives. In addition, prominent elevated shore-lines, evidenced by notches and algal rims, have been measured with DGPS.

This study is supposed to enable a better understanding of the co-seismic movements of the southwest coast of Crete based on multi-proxy investigations of the local sedimentary record. Sedimentary archives at Sougia and Palaiochora have revealed distinct sedimentological, geochemical and geomorphological traces of high-energy flooding from the marine side most possibly related to seismic events. For example, we found a sheet of allochthonous marine sand, partly cemented, intersecting silt-dominated harbour deposits at Sougia, and high-energy erosional channels cut in the local bedrock and filled with sand and gravel near the village of Palaiochora. Specifically, we found tsunamite candidates of the 365 AD event which have not yet been identified in southwestern Crete.

11:30 - 12:00

The Alkinoos harbour geoarchive of ancient Kerkyra (Corfu Island, Greece) – palaeoenvironmental reconstructions based on a multi-proxy approach

Claudia Finkler, Peter Fischer, Kalliopi Baika, Diamanto Rigakou, Garyfalia Metallinou, Hanna Hadler, Andreas Vött

Corfu Island, located in the NW Greece in the northern Ionian Sea, is well-known for its multifaceted history as attested in various archaeological sites. Ancient Kerkyra, a prevailing naval power in antiquity, had at least two harbours created along a narrow peninsula, namely the Alkinoos harbour in the north and the Hyliaikos harbour in the west, both representing promising geoarchives. This paper presents the first detailed palaeoenvironmental analysis of sediments retrieved from the Alkinoos harbour, today silted, based on systematic geophysical subsurface investigations and vibracores. Sediments were analysed by means of geomorphological, sedimentological, geochemical, mineralogical and micropalaeontological methods. The main objectives of our study were to reconstruct palaeoenvironmental and palaeogeographical changes in and around the ancient Alkinoos harbour. So far, the harbour basin was identified solely by archaeological evidence, namely the remains of shipsheds, though it is well known by historical accounts. By this study we present – for the first time – sedimentary and micropalaeontological evidence of harbour basin sediments which yielded further information on the dimensions, structure and history of the ancient harbour.

Several vibracores were drilled in front of the ancient Alkinoos shipsheds. We found silt-dominated deposits rich in organic material and with high lead concentrations, all of which are typical of ancient harbour deposits. Geochronological data show that the harbour was in use until Late Roman to Early Byzantine times. Additionally, we encountered a conspicuous sand layer within the harbour sequence with a clear allochthonous micropalaeontological signature which we interpret as being of tsunamigenic origin.

12:00 – 12:30

Underwater and Coastal Interdisciplinary Research in the Ancient and Medieval Harbour of Kyllene/Glarentza (NW Peloponnese, Greece)

Kalliopi Baika, J. Pakkanen, D. Evangelistis, M. Geraga, G. Papatheodorou, A. Vött, H. Hadler, S. Heath, D. Christodoulou, M. Iatrou, E. Fakiris

The paper discusses methodological issues arising from the on-going geoarchaeological investigations conducted on the ancient harbour site and Crusader's port of Kyllene/Glarentza, NW Peloponnese, Greece.

Ancient harbour-city of Kyllene was one of the ports that served the sanctuary of Olympia. It was also an important naval base of the Spartan fleet in the Ionian Sea in the 5th c. BC during the Peloponnesian War. Centuries later, on the same location, developed the Medieval Crusader's port of the city of Glarentza built by the Franks in the 13th century. During the Crusaders' period, it evolved as one of the major transshipment harbours in Western Greece connected in the west with the ports of Genoa and Venice.

The Kyllene Harbour Project (2007 – 2017) is a joint project of the Finnish Institute at Athens and the Ephorate of Underwater Antiquities of the Greek Ministry of Culture; it is conducted in collaboration with the Universities of

Peloponnese, Patras, Mainz and Aix-Marseille. The interdisciplinary approach so far involves archaeological underwater and coastal topographical survey, marine geophysical investigations, coastal geomorphological prospections and underwater excavation.

The remains of the harbour installations of the medieval port are very extensive, including an inner and an outer harbour basin. Yet, the original harbour configuration is today completely altered, being partly submerged and partly silted up. Therefore, the principal objective of the research is the study of the harbour's layout and the diachronic geoarchaeological evolution of the site in order to reconstruct the maritime façade of the harbour-city (Classical to Medieval). The underwater excavation has been focusing on deciphering the different construction phases of the harbour, as well as comprehending its layout and function during its long period of use.

The interdisciplinary study so far has demonstrated the potential and limits in the use of different techniques in providing an effective methodological approach for the study of shallow-water submerged ancient ports and coastal installations in the eastern Mediterranean.

Session - Geoarchaeology II (Lecture Hall F) – Chair: Christophe Morhange

11:00 – 11:30

Geoarchaeology of the harbour of Ostia

Jean-Philippe Goiran, F. Salomon, C. Vittori, E. Pleuger, J. Christiansen, C. Oberlin, G. Boetto, P. Arnaud, I. Mazzini, L. Sadori, C. Pepe, A. Pellegrino

For the first time, in 2011, the Soprintendenza archeologica di Roma, gave the authorisation to make mechanical corings at the West of the so-called Palazzo imperiale, in order to prove the presence of the ancient harbour basin of Ostia in this sector (Goiran et al, 2012, 2014). Today, the high-resolution study of the stratigraphic sequence of Ostia basin integrate a solid serie of 17 radiocarbon datings. Three steps can be distinguished: (1) pre-harbour, (2) harbour (with 2 units: (2a and 2b) and (3) post-harbour sequence. (1) The pre-harbour step is feature by a fluvial-marine environment dated between the 9th and 8th BC. (2a) The base of the harbour sequence correspond to a quiet area in connection with both the river and the sea. It starts at the earliest in the middle of the 4th c. BC (360 BC) and is attested until no later than the end of the 3rd c. BC (205 BC). At that time the depth of the basin reached 6m below roman sea level. This unusual depth is very significant for the time and implies that seagoing vessels could access the basin. The sedimentation rate is high: 2, 6cm/ year. (2a) The upper part of the harbour sequence is marked by yellow sands brought by floods of the Tiber. The protective role of the basin decreases between 165 BC and 5 AD and depth is no more than 2.5m under the ancient sea level. Most sea-going ships cannot access it anymore. (3) The basin loses its function at the beginning of the imperial period because its depth was only 60 cm between 45BC and 25 AD and about 30cm between 80 and 230 AD. Three hiatus are observed in the stratigraphy: (h1) At -6m corresponds the digging of the basin. (h2) At -2.5m probably represents a dredging. (h3) At -0.50m corresponds a decrease in the sedimentation rate or traduce the maintenance of a structure related to a function modification of the sector. In order to compare the depths of the harbour basin of Ostia and the ancient Tiber a core sample was carried out on the southern shore of Isola Sacra. It provides a stratigraphic sequence of 11m and reveals the presence of the ancient mouth of the Tiber, dated between the 5th and 3th c. BC. A depth of 6.7m below the ancient marine biological zero is attested. It is clear that the depths of the Tiber and the harbour basin are very close. Does the basin has been dug by fitting the Tiber bed or else the mouth channel was dredged to work with the basin?

11:30 - 12:00

Coastal evolution of the Tiber delta (Italy) over the last 2 ky as recorded by the sediments of the hexagonal harbour of Trajan

Ilaria Mazzini, Valeria Ruscito, Francesca Giustini, Mauro Brillì, Massimo Spadoni, Caterina Pepe, Alessia Masi, Salomon Ferreol, Letizia Di Bella, Marco Mancini, Mario Voltaggio, Jean-Philippe Goiran and Laura Sadori

The Trajan basin nowadays consists of an enormous hexagonal basin with 357-metres sides, 3 km inland from the coastline. The artificial Trajan harbour, inaugurated in 112 AD, was part of the most important port system of the ancient Mediterranean during Roman times and was located in correspondence of the ancient coastline, north of the Tiber River mouth. The harbour was connected to the Tiber River through a system of artificial channels. The basin hosts 5 m thick fine sediments, recording the environmental evolution of this coastal area from its excavation, during the 2nd century AD, until today. Although of great historical and archaeological interest, the lake was never studied before in a geoarchaeological perspective. Several sediment cores were drilled in the centre of the Trajan Lake and micropaleontological (ostracoda, foraminifera and pollen), XRF-

geochemical and stable isotopes analyses were performed on two of them. The aim of this study is to identify the main phases of environmental evolution of the area, linked to three main factors: river regime, coastal dynamics and human impact.

Autoecological data from ostracoda and foraminifera were used to characterise the water body and to disentangle the different water inputs. Selected carbonatic shells of ostracoda (*Cyprideis torosa* and *Heterocypris salina*) and foraminifera (*Haynesina germanica* and *Ammonia tepida*) were used to perform stable isotope analyses of carbon (

Resolution Gamma-Ray Spectroscopy and Magnetic

Susceptibility analyses were performed along the bulk core. Chemical data were statistically analysed by carrying out principal component analysis. The chronological framework was based on both historical data and AMS radiocarbon dates.

The lower part of the core records a coastal lagoon environment, affected by increasing freshwater inputs through time. During the harbour phase, the freshwater inputs seem linked mostly to flood events. The subsequent post-harbour phase indicates isolation from the sea: delta progradation was the main driver for sediment inputs and low-salinity to freshwater fluctuations but human interventions played a major role. The pollen analyses well record the human interventions on the surrounding landscape. In particular, they enhance the land-reclamation and planting activities of the last centuries that led the harbour to become the large lake known today more as a resting place for migratory birds than as the remains of ancient Rome's main gateway.

12:00 – 12:30

Roman city of Pollentia (Alcúdia, Mallorca, Balearic Islands): location of the harbour under coastal changes

Matthieu Giaime, Christophe Morhange, Nick Marriner, Miguel Angel Cau, Joan J. Fornos

The coloniae of Pollentia was founded after the Roman conquest of Mallorca, led by the consul Quintus Caecilius Metellus in 123 B.C., and flourished until the end of the 3rd century AD when a fire destroyed several parts of the city. After this dramatic event it survived into the Vandal, Byzantine and the Islamic periods but in a progressive process of decline and abandonment until its complete disappearance around 1300.

Situated on the eastern facade of the island, it is the largest archaeological site of the Roman era of Mallorca. Based on the south coast of the isthmus between the bays of Pollença and Alcúdia, the city, sheltered from the prevailing northern winds, enjoyed immediate proximity to a relatively calm environment. Bio-sedimentological analyses undertaken on four cores show the gradual closure of the environment, evolving from an open lagoon environment into a semi-enclosed lagoon due to coastal processes, relative sea-level stability and sediment supply.

At the time of the foundation of the Roman colony, the shore was occupied by a semi-enclosed lagoon. Fragments of Roman amphorae and other pottery were found in this unit, reflecting the fact that this environment was contemporary with the Roman period. This navigable waterbody, have potentially been occupied as a harbour.

Session Geophysics (Lecture Hall H) – Chair: Dennis Wilken

14:00 – 14:30

Archaeological survey and marine geophysical prospection in the ancient city of Kane, Turkey

Tina Wunderlich, Ercan Erkul, Annika Fediuk, Dennis Wilken, Wolfgang Rabbel, Eric Laufer, Felix Pirson

The ancient city of Kane (near Bademli) is situated on the identically named Kane peninsula, today's Karadağ peninsula, which is located at Turkey's western coast close to ancient Pergamum. The site is a tongue of land about 150 m wide, 400 m long, up to 20 m high and flanked by two bays to the west and east. On top of the peninsula the density of ceramic finds is high on ploughed fields, but no surficial building remains can be seen, whereas ancient building structures can be found along the western and eastern brims extending into the shallow water. Archaeological and historic evidence indicate a small harbour city which existed from the Classical to the early Byzantine period.

In 2014 an archaeological survey, documentation of visible building structures, a ceramic survey, geoarchaeological studies and geophysical prospection on the water were conducted under the auspices of the Pergamum Excavation, associated with the „Portus Limen – Rome'e Mediterranean Ports“-Project which is financed by the European Research Council. For geophysical prospection in both the western and eastern bays Fluxgate gradiometers and a high-resolution reflection seismic system that are mounted to a rubber boat were used. A by-product of the reflection seismics is a bathymetric map of both bays revealing a large breakwater in the eastern part of the western bay. It forms the NW edge of a ca. 50x100 m rectangular bathymetric anomaly oriented parallel to the coastline. Its surface is covered by large stone blocks, which are clearly visible in the

seismic reflection profiles. The interior of the breakwater shows chaotic reflections and diffractions caused by the piled-up rocks. Another result is the stratigraphy inside the bay underneath the sea bottom, which allows to reconstruct the development of the bay. Marine magnetic measurements were done along the shoreline in shallow water, but the results are dominated by strong dipolar anomalies caused by surficial stones of the same material as the building structures. Thus, interpretation of the magnetic maps is difficult and can only be done in comparison with visible building structures.

14:30 – 15:00

Considering palaeogeographies in numerical tsunami simulations – a new base for geoarchaeological investigations of harbour sites in the Gulf of Kyparissia

Björn Röbbke, Andreas Vött, Timo Willershäuser, Peter Fischer, Hanna Hadler

Owing to the immediate vicinity to the subduction zone of the Hellenic Trench, the Gulf of Kyparissia (western Peloponnese) is located within the most tsunamigenic region in the Mediterranean. This is reflected by both, historical accounts and sedimentary and geomorphological field data. Field traces were detected within numerous surveys along the northern coast of the Gulf of Kyparissia during the last years and give evidence of multiple tsunami impacts in historical and prehistorical time. Furthermore, fundamental changes in the coastal landscape and topography connected with tectonics and fluvial activity are obvious from field data.

Both, tsunami impacts and topographical changes are assumed to have significantly influenced human activity in the study area in the past and thus are essential in understanding the regional geoarchaeology. Taking account of our field data and of literary information, we derived two possible palaeogeographies of the northern Gulf of Kyparissia and created corresponding digital elevation models to reproduce the former landscape conditions, which are assumed for the time of palaeotsunami landfall in the area. In a second step, we simulated various tsunami inundation scenarios in order to find wave constellations in close agreement with tsunami field traces. Focussing on the Katakolo Pass and the ancient harbour of Pheia as well as the area of (ancient) Epitalio and its presumed harbour, our numerical models prove a useful tool to reconstruct palaeotsunami events and their implications for the regional (pre-)history in the context of ancient harbour (geo-)archaeology.

15:00 – 15:30

Geophysical investigations into the Roman Harbour of Narbonne

Vivien Mathé, Guillaume Bruniaux, Adrien Camus, Julien Cavéro, Camille Faisse, Marie-Pierre Jézégou, Francois Lévêque, Corinne Sanchez

Since 2005 an interdisciplinary research project has sought to reconstitute the harbour topography of ancient Narbonne, considered as the second port of the Roman Empire in the West. From 2007, geophysical surveys have taken a large place in this cooperative work. The investigation area was delimited from aerial photographs and old maps, georeferenced and analysed into a Geographic Information System. The geophysicist team targeted the Castelou-Mandirac sector (8 km south of Narbonne), a zone of several square kilometres where aerial photographs show clear geometric traces which seemed correspond to constructions. The goal of the surveys was indeed to find evidence for harbour infrastructure associated with a channel that would have allowed the delivery of cargoes to Narbonne.

Given the surface of the investigation zone and diversity of surveyed environments, several methods were used and measurement protocols were adapted. In very humid and salty areas, along the Bages pond, electromagnetic prospecting coupled with GPS positioning proved fast and efficient. EM31 or EM38 conductivity meters were respectively used where vegetation was high or short. On areas that have low contrast in electrical conductivity, magnetic surveys (Ferex gradiometer) have proved particularly successful. All these mapping data have been advantageously supplemented by 2D electrical resistivity tomography (Terrameter LS).

Surveys have located over more than 1km long a channel about 50m wide bordered by two banks from 15 to 20m wide. These constructions are supplemented by two protective works along several hundred meters. Since 2009, tens of archaeological soundings, all located according to the results of geophysical surveys, have helped make great strides in understanding this remarkable port system.

Session Written and Iconographic Sources (Lecture Hall D) – Chair: Grigori Simeonov

14:00 – 14:30

Managing contingency in watery contexts: Roman harbour sites in Hispania

Jasmin Hettinger

In my presentation I focus on different means of managing waterlogged landscapes around Roman harbour sites on the Iberian Peninsula. The two settlements of Hispalis (Sevilla) and Ilipa (Alcalá del Río) not far from the mouth of the Baetis River (Guadalquivir) both had to manage two different kinds of flooding: marine flood tides and river inundations. The Roman state as well as local communities had to deal with these by coordinating a whole set of options, ranging from public architectural interventions to administrative solutions.

The “procurator ad ripam Baetis”, for example, did not only have to organize all the shipments of stately subsidized olive oil to Ostia and Rome. He was also responsible for the functioning of the infrastructure related to it, including the navigability of the Baetis channel by securing the river banks and avoiding the silt from blocking it. Apart from archaeological evidence, there is a bunch of inscriptions and literary accounts informing us about these efforts. Especially the epigraphical texts found in Hispalis and Rome state a close relationship between the work of the “procurator” at the Baetis and the urban oil supply of Rome. So, there was a strong interest of the Roman state in the Baetican fluvial and marine infrastructure that constantly needed to be adopted to the capital’s needs. The provincial elite for their part was mainly interested in the securing of their workshops and estates. On the one hand, their location close to the urban business area by the river banks was essential for their economic success, on the other, the permanent risk of flooding prevailed and needed to be managed.

The main concern of the presentation is, therefore, to analyse these archaeological, epigraphical and literary sources in order to learn more about municipal and stately intervention in a provincial but crucial territory in “watery context”, always oscillating between two poles:

1. Adapting human settlements and constructions to natural conditions,
2. Establishing permanent artificial order within a highly variable landscape.

14:30 – 15:00

The management of Marseilles’ Old Port in the Middle Ages through written sources: geo-engineering techniques and environmental effects on the surrounding lands

Nicolas Maughan

Since its founding 2600 years ago by Phocian people the metropolis of Marseilles (southeastern France) had always been constrained by a mountainous topography causing a compact development along hillsides over centuries. Thereby, the first port, the Old Port (named the “Vieux Port” in French), occupying the lower part of the city and characterized by a distinctive shape, was often threatened by filling up with diverse exogenous rock or sedimentary materials (especially during the LIA) but it also progressively became a permanent cesspool for all stormwater and sewage over the centuries. This place, acting as the geographic center of the city, has been not only an exchange zone for dwellers but also a sort of centralized accumulation site for sediments and for various wastes excreted by the urban metabolism. If the surrounding landscape has had an influence on the physical structure of the port (e.g. important silting due to erosion), ecological resulting conditions caused in return disturbances through the downtown area (e.g. infectious diseases) and conflicts on the coastline with local fishermen (ocean dumping of dredging muds), especially during medieval times. Consequently, the port has had a major impact on the urban dynamic, mainly the city’s sanitation issues together with the elaboration of innovative geo-engineering techniques and transfer of technologies from other countries for dredging the port’s main basin.

However, if numerous historical academic works have dealt about economic and social role of the port for all periods, engineering and hydrogeomorphological issues have scarcely been studied for the medieval period despite available written sources.

In this context, after briefly describing both the topography and the hydrogeomorphological attributes of the “Vieux Port”, we’ll present thanks to the analysis of available local sources (Municipal Archives) the main hydro-sedimentary and geotechnical constraints frequently encountered by port managers in the Middle Ages and also various technical approaches (focusing particularly on the control of terrestrial sediment fluxes and dredging technics) that engineers have tried to implement to decrease the port’s main basin sedimentation rate or even to increase its depth.

Then, we will see what kind of informations can be given by these sources about environmental and sanitary consequences induced by these management actions on the conterminous lands and the coastline, over a period of 1000 years.

15:00 – 15:30

The smallest harbours thinkable... - Ferry stations as a case study for workaday life at southern German rivers
Lars Kröger

It is nearly impossible to understand the daily routine at a medieval river harbour only through the archaeological evidence. Similarly, an examination of written sources produced by the highly profane and ecclesiastical authorities can only prove us with a glimpse into the practical life of people involved with river transportation. In fact the best and most detailed information is contained in the local community regulations which monitored and advised the inhabitants.

During the last four years, research focused on ferry stations at the rivers Main and Neckar in southern Germany was carried out (funded by the German Research Foundation). It has been shown that the local ferryman did not only have the duty to transport people and goods from one side of the river to the other, but also were in charge of controlling the local trade, preparation of landing places and other obligations. They sometimes had the privilege to run a special ship to bring local people once or twice a week to the surrounding larger markets to sell or buy goods. All these rights have been part of a fief, which was granted by a lord and controlled by his representative in the village.

Expectedly, permanent quarrels arose, which resulted in the generation of sources such as Weisthümer and tenant memorandums, starting mostly from the 14th century. This source material demonstrates that the regulations did not change a lot until the end of the 18th century, so it is justified to make assumptions for earlier periods. These hypotheses are supported by a huge quantity of archaeological finds of early and high mediaeval logboats, which were parts of the ferryboats.

The aim of the presentation is to showcase daily harbour life not at supra-regional centers, but rather the local river based trade which is often outside the focus of archaeological sources.

Session Archaeological Features I (Lecture Hall A) – Chair: Joris Coolen

14:00 – 14:30

Two ancient harbours on the Adriatic Sea: natural elements and anthropogenic infrastructures at Cala Incina and Torre Santa Sabina (Puglia, Italy)

Antonella Antonazzo, Marina Maria Serena Nuovo

Puglia was known as Regio II Apulia et Calabria during Roman times and is located along the southern-western Adriatic coast. The littoral is characterized mainly by the presence of low rocky beaches and small bays, locally called cale. Most of the bays were originally palaeoriver mouths, flooded by the sea during earlier geological times. There are not many big natural ports, the only exception is the port of Brindisi, which was of great importance from antiquity till modern times. Despite the lack of big harbours, the coast has a series of small natural ports, many of which were provided with fresh water. They were excellent landing places for short distance trades and coastal navigation, but probably used as anchorages for long-distance journeys too. The bays are usually well protected from the predominant winds blowing mainly from S, SE and E. For this reason many of the ports are not provided with extra anthropogenic features like breakwaters.

The aim of this paper is to present and discuss the case-studies of two harbours - Cala Incina and Torre Santa Sabina - which had not anthropogenic structures due to their excellent natural characteristics.

Cala Incina is located 4 km south of Monopoli and it is a narrow and elongated bay, almost 300 m long and 50 m wide. It was originally part of lama Incina, a palaeoriver almost 10 km long, that had deeply incised the soft bedrock and that had formed a small canyon. The bay offered a good mooring because it has a depth between 5 and 15 m and it has fresh water springs which today are a few meters below the sea level. The bay was not protected by anthropogenic structures because it was already naturally well protected from the winds. Small terraces were cut along the banks for loading and unloading and used as docks. The ports has been in use for centuries, as it demonstrated by finds discovered on the seabed during underwater surveys.

Because of its location and natural features Torre Santa Sabina bay (30km north of Brindisi) played a strategic role in the Adriatic trade over the centuries, but it had no anthropogenic structures.

The importance of the harbour from the Middle Bronze Age to the Middle Ages is demonstrated by significant underwater finds that include the remains of cargoes and the wooden hulls of at least 5 vessels.

In the Archaic period (TSS3) the site was a minor, but lively, harbour connected with Κάββινα (a Messapian settlement destroyed by Taras in the 5th c. BC) and used as subsidiary stop along the coastal route from Aegean, Greek and Illyrian coasts towards the northern Adriatic Sea.

The harbour's activity increased in the Late Republican period (TSS4) because of its proximity to Brundisium, the important via Traiana's network and the productive sites of Apani and Giancola. At this time it became an

auxiliary harbour for ships which sailed up the eastern Adriatic coast and descended to the safe harbour of Brindisi.

In the second half of the 1st c. BC, use of the harbour declined as local production decreased. It continued to be used as a subsidiary harbour for the hinterland on a drastically reduced scale.

14:30 – 15:00

Multidisciplinary investigation at the ancient harbour of St. Cataldo (Lecce, South Italy): new data for understanding a long maritime history. The Portus Lupiae Project

C. Alfonso, C.M. Amici, R. Auriemma, L. Calcagnile, G. Ceraudo, A. Cossa, L.M. Foresi, M. Jackson, S. Margiotta, A. Quarta, G. Quarta, Mariangela Sammarco

A multidisciplinary research investigation has been undertaken to describe a massive monumental pier located at St. Cataldo, the main coastal harbour of the Roman town of Lupiae, modern Lecce in southern Italy. The pier is dated back by literary sources (Pausania 6.19.9) to the era of Emperor Adrian and the archival documents provide detailed descriptions of the ancient structure up to the XVI century. In previous studies, the visible remains of the ancient structure located on the shore just south of the lighthouse were partly cleared and documented. In 2014, an international team of experts organized by the University of Lecce continued an investigation of the coastal area and the waters off the Bay of St. Cataldo to further describe the construction of the pier and its historical context. The investigation integrated aerial surveys with oblique aerial images, a GPR survey, 3D reconstruction, studies of building materials, underwater excavations and carbon-14 analysis to describe the ancient structures. These indicate an original length of ~150 m, whereas the present surveyed length on the shore is ~60 m. The pier was reduced in size in 1901, and the ancient material partially re-used in the construction of a twentieth-century breakwater that was directly founded on the earlier structure, and is still preserved in shallow water.

Studies of planktonic foraminifera and chrono-stratigraphical analysis has been performed, supporting a clear identification of the geological origin of limestone blocks. The mortars of conglomeratic concretes have a lime-based cementitious matrix, which incorporates relict lime clasts and abundant sedimentary sand grains, and encloses larger clasts of ceramic fragments, sedimentary rock fragments, and very occasional yellowish gray pumice fragments. This mortar is very different from Roman maritime mortars of the western Italian coast, which have a lime mortar dominated by pumiceous volcanic ash, or pozzolana, from the Campi Flegrei volcanic district. Underwater researches revealed the existence of submerged foundations ~20 m long made by limestone block. Wooden posts in a nearby rubble jetty have been dated with calibrated carbon-14 ages at 1280-1400 AD. These could be associated with medieval rebuilding of the pier, commissioned by the Queen Maria d'Enghien in the first half of the XV century, as described by literary sources.

15:00 – 15:30

New approaches to the study of the harbour of Tarraco: archaeological and literary research (III B.C. - VIII. A.D.)

Ada Lasheras, Patricia Terrado

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Session Archaeological Features II (Lecture Hall F) – Chair: Manuela Mirschenz

14:00 – 14:30

Traders, farmer, sailors: Newly discovered trading sites of the 1st millennium AD at the southern Elbe estuary
Ingo Eichfeld, Daniel Nösler

Several previously unknown settlement sites of the 1st millennium AD were discovered on the southern shore of the Elbe estuary by metal detector prospection and conventional surveys conducted by the archaeological service of the county of Stade (Lower Saxony, Northern Germany). The sites are located in the archaeologically largely unexplored region of northern Kehdingen on levees of former tidal creeks, which offered direct access to the river Elbe and thus to the North Sea long-distance trading network. Findings suggest that the settlements were at least temporarily geared towards trade and crafts and connected to cross-regional communication routes. Among these sites, the settlement of Freiburg-Landesbrück stands out not only due to its size of approximately 10 hectares, but also due its particularly high find density of so far more than 900 metal objects dating between the 2nd/3rd and the 10th/11th centuries AD. The site is therefore of great importance for the study of the economic and social importance of maritime settlements and harbours along the North Sea coast, which are in the focus of the project "Medieval North Sea harbours" funded by the Priority Programme 1630 of the German Research Council (<http://www.spp-haefen.de/de/die-projekte/nordseekueste/>). In the course of this project, geomagnetic, pedological and archaeological investigations were carried out in order to gain insights into the paleogeography, the structure and the preservation conditions of the settlement. The paper presents the current state of research and discusses the functional role of the sites both in the local settlement hierarchy and the cross-regional trading structures.

14:30 – 15:00

Harbours in the Bremen Basin at the first millennium A.D.
Gerson H. Jeute

The Bremen Basin comprises three natural environments: geest, sand dune and marshland. In them are located nearly 100 sites of the 1st millennium A.D. which were linked to the regional transport network of the inland navigation between the river Weser and the coast of the North Sea. By the help and cooperation of geophysical prospections the sites and theirs surroundings were be examined for traces of harbours, landing sites or berths. The results were inserted in an environmental history study of the Bremen Basin. Finally this will enable statements about the usage of branch streams in the Lower and Middle Weser region as channels of communication, distribution and supply.

15:00 – 15:30

Viking Age trading sites on the North-Frisian island of Föhr
Bente Sven Majchczack

During the last decade, several Viking Age settlement sites (8th- 11th century) have been located on the North-Frisian island of Föhr (Germany) using aerial photography and a combination of geophysical prospection methods, such as geomagnetics, ground penetrating radar and geoelectrics. The Viking Age sites are located on the southern edge of the high pleistocene core of the island, overlooking the low marshlands as well as the beaches. Access to the North Sea is provided through tidal creeks. Two of these sites at Witsum and Goting show a distinctive settlement pattern dominated by pit-houses. Excavations of pit houses revealed traces of craft activities such as smithery and textile production. Numerous finds of imported goods from the West-Frisia, the Frankish empire and Scandinavia indicate a strong connection to the cross-regional trade routes along the North Sea coasts. These maritime trading sites are embedded in a substantial Viking Age settlement landscape with rural settlements, several richly outfitted burial sites and the impressive ramparts of the Borgsumburg, which most likely served as a Danish military fort to control the coastal area of North Frisia. Both sites in Witsum and Goting have been included in the project "Medieval North Sea harbours" funded by the Priority Programme 1630 of the German Research Council (<http://www.spp-haefen.de/de/die-projekte/nordseekueste/>). The paper presents the current state of research of the archaeological, geophysical and pedological investigations conducted by the project and discusses the structure and function of the settlements, their position within the

macroregional settlement landscape and their connections with the North Sea communication and trade networks.

Plenum Session (Lecture Hall H) – Chair: Claus von Carnap-Bornheim

16:00 – 16:30

Introducing the fetch method for the investigation of harbours in the North Atlantic

Marianne Nitter

An important criterion for a good harbour is protection against various weather and wind situations. Harbours consist of many possible landing places and each landing place is exposed to different wind directions due to topographic conditions that produce different fetches. In the project “Harbours in the North Atlantic, c. 800-1300 (HaNoA)” the fetch method has been applied in various harbours in Norway, Faroe, Shetland and Iceland and it is used as a tool to predict the harbour's vulnerability and to evaluate the quality of the different landing-places within a harbour basin. The method has proven to be very useful, to explain why archaeological sites along the coast are rare in some areas, but numerous in others.

In order to assess the landing places it is important to include wind statistics that provide information about the most frequently occurring wind directions. However, it is important to be aware that the wind direction and force are modified by the topography and landscape elements. The maximum significant wave height has been calculated/estimated for the different wind directions and divided into wind sectors using the fetch method on different possible landing places in each harbour, in order to determine the best landing place.

For each landing place, all wind sectors have been summed up and expressed in degrees. This information, together with wind statistics from the nearest weather station is very important in the overall assessment of the harbours and the various landing places within.

16:30 – 17:00

Connecting harbours. A comparison of traffic networks across ancient and medieval Europe

Johannes Preiser-Kapeller, Lukas Werther

It is evident that every harbour installation or landing site has to be interpreted in its embedding in the surrounding settlement as well as regards its connectivity to other sites in its immediate and wider hinterland and “foreland”¹, both via shipping routes (maritime or inland) or terrestrial routes. Concepts and technical tools of network theory enable us to survey, visualise and analyse such connections in order to re-construct or model traffic systems on the local, regional or “global” level. Positions of centrality or intermediation within such networks can be identified for a single site (or installations such as canals²) respectively clusters of places. With appropriate data, also the temporal and spatial dynamics of webs of connectivity can be analysed for different time slices; this may also allow for inferences on the complex interplay between the development of a single place and its relative significance within these networks.

Based on evidence from three projects of the Priority Programme 1630 (*Fossa Carolina, Inland harbours in the Frankish-German Empire* and *Byzantine harbours on the Balkan coasts*) we will present possibilities to apply these methods on archaeological and on written evidence as well as to combine data from various sources into network models. The combination of case studies on various spatial scales as well as from regions of inland and maritime navigation (Central Europe respectively the Seas around the Balkans) will allow for the identification of structural similarities respectively difference between pre-modern traffic systems across Europe. The contribution is also designed as a pioneer study for the further adaption of tools of network analysis as instrument for the connection and comparison of data across the projects of the Priority Programme 1630.

17:00 – 17:30

Final Discussion

¹ On these termini cf. J. Preiser-Kapeller, Harbours and Maritime Mobility: Networks and Entanglements, in: J. Preiser-Kapeller/F. Daim (eds.), Harbours and Maritime Networks as Complex Adaptive Systems (*RGZM – Tagungen 23 = Interdisziplinäre Forschungen zu den Häfen von der Römischen Kaiserzeit bis zum Mittelalter in Europa 2*). Mainz 2015, 119-139.

² Cf. P. Ettl/F. Daim/S. Berg-Hobohm/L. Werther/C. Zielhofer (eds.), Großbaustelle 793 - Das Kanalprojekt Karls des Großen zwischen Rhein und Donau (*Mosaiksteine – Forschungen am Römisch-Germanischen Zentralmuseum 11*). Mainz 2014.