

ÉCOLE D'ÉTE / SUMMER SCHOOL

Exploitation des ressources et mise en valeur du territoire
 au 1er millénaire de notre ère :
 Nouvelles méthodes en archéobotanique, archéométrie, modélisation

Land use and exploitation of natural resources in the 1st millennium AD -
 New methods in archaeobotany, archaeometry and modelling



Programme & Abstracts' book

Poreč/Parenzo – Tar-Vabriga/Torre-Abrega – Crikvenica, Croatia
 25th-30th June 2018



ORGANISERS

C. Rousse (Aix Marseille University, CNRS, CCJ)

Chr. Vaschalde (LabEx Archimède, ASM -ISEM)

A. Konestra (Institut za arheologiju - IARH)

SCIENTIFIC COMMITTEE

G. Benčić (Zavičajni muzej Poreštine)

M.-B. Carre (Aix Marseille University, CNRS, CCJ)

A. Konestra (IARH)

G. Lipovac Vrkljan (IARH)

S. Mauné (CNRS, University of Montpellier 3, ASM)

R. Matijašić (University of Pula, CIRLA),

C. Rousse (Aix Marseille University, CNRS, CCJ)

N. Rovira (University of Montpellier 3, CNRS, ASM),

F. Tassaux (University of Bordeaux Montaigne, Ausonius),

Chr. Vaschalde (LabEx Archimède, ASM-ISEM).

MAJOR SUPPORTERS

LabexMed - Aix Marseille University - Centre Camille Jullian - UMR 7299

LabEx Archimède - Archéologie des Sociétés Méditerranéennes - UMR 5140

Institut za arheologiju - IARH - Project RED: Roman economy in Dalmatia (HRZZ, IP-11-2013-3973)

Zavičajni muzej Poreštine / Museo del territorio parentino

Ecole française de Rome

Ministère de l'Europe et des Affaires étrangères

A*MIDEX - *Water Traces* project

Općina Tar-Vabriga - Torre-Abrega/Comune di Tar-Vabriga - Torre-Abrega

Tourist board Tar-Vabriga - Torre-Abrega

Comunità degli Italiani "Giovanni Palma" di Torre

Crikvenica Municipal Museum

PRACTICAL INFORMATION

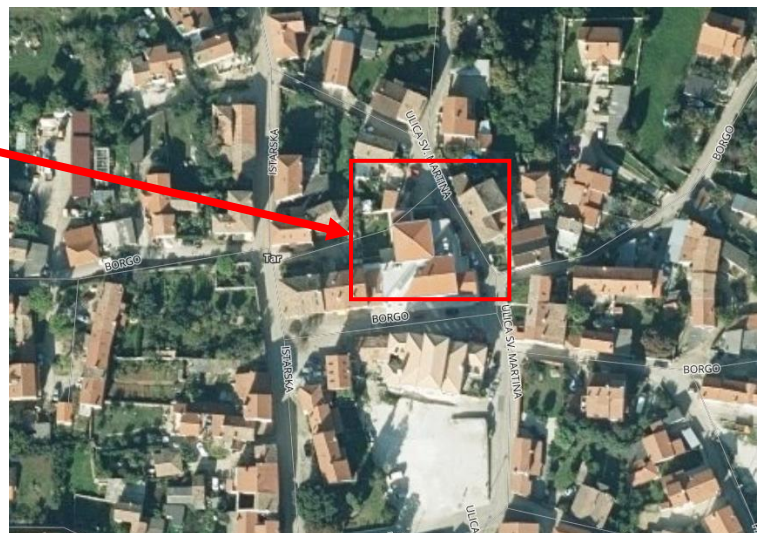
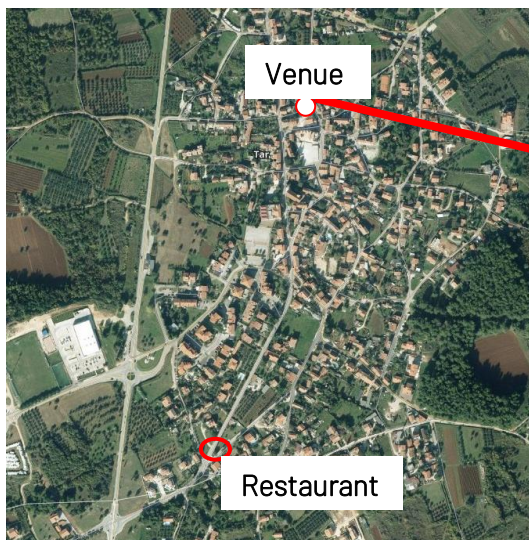
- **Timing:** lectures - 30 min; PhD presentations - 20 min; discussions will follow each set of contributions
- Field visits and practical workshops will be organized in the late afternoon
- For the *Composing time in archaeology: Initiation to chronological modelling* workshop, participants are encouraged to bring their own laptops and datasets
- At Tar/Torre and Crikvenica all venues can be reached on foot; for field visits and the move to Crikvenica, transport will be organised
- On Thursday **28th June** evening, the Museum of the Poreč territory will organise a tour of Poreč and a reception in the Lapidarium of the Museum
- On the **29th - 30th June 2018** the Summer School will move to **Crikvenica** for an experimental kiln firing at the site of the pottery workshop of *Ad Turres*. The opening of the experimental kiln on the **30th of June** will mark the end of the Summer School

ENGLISH WOULD BE THE PREFERRED LANGUAGE FOR PRESENTATIONS AND LECTURES TO ALLOW A BETTER UNDERSTANDING BETWEEN ALL PARTICIPANTS

VENUE AT TAR:

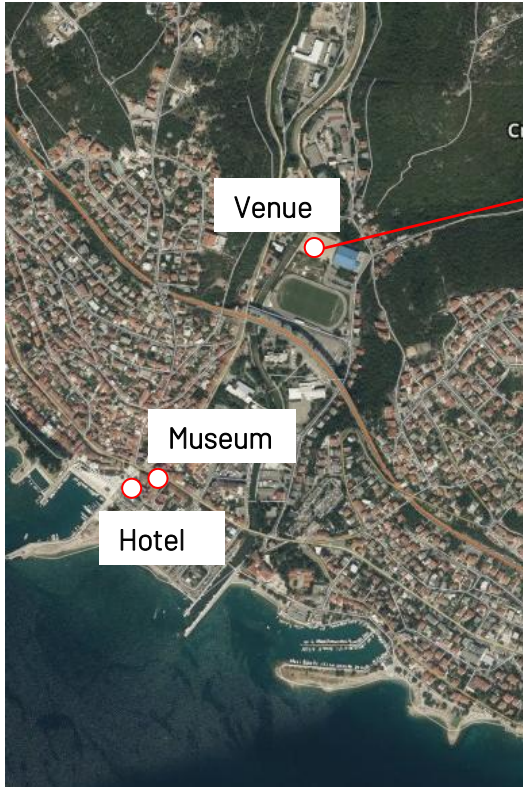
Lectures and presentations will be hosted in the conference room of the Italian Community in Tar/Torre, 5 S. Martino street (entrance from Borgo street)

Lunches/Dinners are organised at "Tri kantuna" restaurant (1 Istarska street).



VENUE AT CRIKVENICA:

Most activities will take place at the location of the pottery workshop site ("Igralište" site, Kotorska street). All movements are possible on foot.



PROGRAMME

MONDAY, 25TH JUNE 2018

Welcome and Presentation of the Summer School

9.00 Welcome

G. Benčić – Tar-Vabriga / Torre-Abrega Municipality

E. Uljančić – Zavičajni muzej Poreštine / Museum of the Poreč territory

A. Konestra, C. Rouse, C. Vaschalde – Welcome by the organizers and main partners

9.20 – 9.50 Introduction to the Summer School

G. Benčić, D. Munda (Museum of the Poreč Territory), M.-B. Carre (AMU, CNRS, CCJ), A. Konestra (IARH), C. Rouse (AMU, CNRS, CCJ)

Loron / Santa Marina, Busuja and Stancija Blek: Presentation of the interdisciplinary research on the territory of Tar/Torre

SESSION 1 : Vegetal economy

Morning - Lectures

Session Chair – G. Benčić

10.00 – 10.30 **F. Guibal** – *Wood identification and dendrochronological analysis of the Busuja fish pond*

10.30 – 11.00 **E. Goršić** – *Dendrochronology in archaeology*

11.00 – 11.40 Discussion/Questions; Break

11.40 – 12.10 **N. Rovira** – *Plant products and culture contact: the exemple of fruits in the north-western Mediterranean during the 1st millenium BC and the early Roman times*

12.10 – 12.40 **V. Glavaš** – *Difficult karstic landscapes on the Velebit mountain: research methods and results*

12.40 – 14.00 Discussion/Questions; Lunch break (1 hour)

Afternoon - Presentations

Session Chairs – N. Rovira, E. Goršić

14.00–14.20 **M. Tillier** – *Archaeobotanical evidence of economic plants in coastal Croatia during Roman times*

14.20 – 14.40 **M. Murredu** – *Wild and domesticated plants exploitation in Sardegna during Phoenician and Punic period 8th-3rd century BC*

- 14.40 – 15.00 **A. Ferreira Dominguez** – *Studies of the wood of ancient shipwrecks and structures of the Adriatic Sea and South-eastern Europe: contribution to the study of the local shipbuilding traditions*
- 15.00 – 15.40 Discussion/Questions; Break
- 15.40 – 16.00 **A. Barbir** – *Grave goods as evidence for ritual and trade in the early Roman period graves from Ilok-Dvor knezova Iločkih, eastern Croatia*
- 16.00 – 16.20 **Y. Boulmis** – *Land-use and exploitation of natural resources in Maurétania Caesariensis under the Roman Empire (1st c. BC – 5th c. AD)*
- 16.20 – 16.40 Discussion/Questions;

EVENING EVENT

- 17.30 – 19.00 Visit to the archaeological sites of Loron and Santa Marina
- 20.30 Dinner

TUESDAY, 26TH JUNE 2018

SESSION 2 : Craft, fuel and production

Morning - Lectures and Presentations

Session Chair – M.-B. Carre

- 09.30 – 10.00 **C. Rouse, C. Vaschalde, C. Benčić, D. Munda** – *Archaeological and anthracological approaches of the workshop complex of Loron: new insights into the amphorae kilns*
- 10.00 – 10.30 **G. Lipovac Vrkljan, A. Konestra** – *Project RED - Defining pottery production in Roman Dalmatia: workshops, resources' exploitation and technological choices*
- 10.30 – 11.10 Discussion/Questions; Break
- 11.10 – 11.40 **S. Mauné** – *Bilan, enjeux et perspectives du programme OLEiculture et production d'amphores en Turdétanie Romaine (Bassin moyen du Guadalquivir, province romaine de Bétique, (I^{er} s. av.-III^e s. ap. J.-C.))*
- 11.40 – 12.00 **I. Gonzales Tobar** – *New Insights into oil amphorae workshops of Conventus Cordubensis. Results of the Land Surveys in the Gualdaquir Valley and excavation of El Mohino amphorae workshop*
- 12.00 – 14.00 Discussion/Questions; Lunch break (1 hour)

Afternoon - Presentations

Session Chairs – A. Konestra, C. Rouse

- 14.00 – 14.20 **L. La Rosa** – *Firing pottery: assessing the environmental impact of terra sigillata production*
- 14.20 – 14.40 **L. Cavassa** – *Pottery production in Pompeii during the 79 AD*
- 14.40 – 15.00 **V. Lauras** – *Potters' workshops and the exploitation of natural resources during Roman times in the low valley of the Peyne: New perspectives on research*
- 15.00 – 15.40 Discussion/Questions; Break
- 15.40 – 16.00 **I. Valent** – *The topography of archaeological sites with smelting characteristics on the territory of the River Drava Basin*
- 16.00 – 16.20 **M. Pawłowicz** – *Une production de pâtes sombres à Fréjus (Var)? : les fours de potiers situés sous la domus de la Plate-Forme*
- 16.20 – 16.40 **T. Berden** – *Crafts of Nauportus*

16.40 – 17.00 Discussion/Questions;

EVENING EVENT

18.00 – 19.00 Practical workshop on the pottery production of
Loron (Y. Marion, C. Rouse)

20.30 Dinner

WEDNESDAY, 27TH JUNE 2018

SESSION 3 : Land resources and Archaeometry

Morning –Lectures and Presentations

Session Chairs – R. Matijašić, P. Lanos

- 09.30 – 10.00 **F. Tassaux** – *Approaches to the study of territories in Roman Istria, between traditional methods and archaeometry*
- 10.00 – 10.30 **P. Machut** – *Production strategies and procurement of clay raw materials: the case of Loron (1st-3rd c. AD)*
- 10.30 – 11.10 **Discussion/Questions; Break**
- 11.10 – 11.40 **C. Morhange** – *Geoarchaeology of ancient Mediterranean harbours*
- 11.40 – 12.10 **S. Faivre** – *Relative Sea-Level Change along the Northern Adriatic during the Late Holocene*
- 12.10 – 12.30 **A. Teklehimanot Araya** – *Paleoenvironmental reconstruction of Caraburun shoreline: a geoarchaeological approach*
- 12.30 – 14.00 **Discussion/Questions; Lunch break (1 hour)**

Afternoon – Lectures and Presentations

Session Chairs: S. Mauné, S. Faivre

- 14.00 – 14.30 **V. Ollivier** – *Geomorphology and water management, a diachronic view*
- 14.30 – 14.50 **Ph. Bromlet** – *Provenance studies of materials (building stones, mortars) - presentation of Pierresud database*
- 14.50 – 15.10 **Y. Rezkallah** – *A multidisciplinary approach to the study of the ancient quarries of Djelfaoune, in the area of the ancient city of Thamugadi (Algeria)*
- 15.10 – 15.50 **Discussion/Questions; Break**
- 16.50 – 16.10 **K. Mijić** – *Roman ceramics as a grave goods*
- 16.10 – 16.30 **C. Caillaux** – *Productions and uses of pitch in Antiquity: crossed contributions of archaeological data and chemical analysis*
- 16.30 – 16.50 **Discussion/Questions;**

EVENING EVENT

17.30 - 19.00

Visit to the archaeological sites of Stancija Blek and Busuja
(practical workshop *in situ* to observe the biological relative
sea-level indicators - in swimsuit)

20.30

Dinner

THURSDAY, 28TH JUNE 2018

SESSION 4 : LAND RESOURCES AND MODELLING

Morning - Lectures and Presentations

Chairman : F. Tassaux

- 10.00 – 10.30 **R. Matijašić** – *ArchaeoCulTour - A project aimed at studying the archaeological landscape of Vrsar / Orsera*
- 10.30 – 10.50 **S. Popović** – *ArchaeoCulTour project - First results of LiDAR data interpretation and mapping in GIS*
- 10.50-11.30 Discussion/Questions; Break
- 11.30 – 11.50 **G. Ciucci** – *Modelling for archaeological research and heritage promotion. The case study of the villa maritima of Saint-Cyr-sur-Mer (Var, France)*
- 11.50 – 12.10 **O. Tiago-Seoane** – *Roman amphorae kilns in the Western Mediterranean (2nd century BC - 5th century AD): new reflections on the contributions of archaeometry and modelling*
- 12.10 – 14.00 Discussion/Questions; Lunch break (1 hour)

Afternoon Lecture and Practical workshop

- 14.00 – 14.30 **Ph. Lanos** – *Composing time in archaeology: Initiation to chronological modelling*
- 14.30 – 15.00 Discussion/Questions; Break
- 15.00 – 16.30 **Ph. Lanos, C. Vaschalde** – *Practical workshop with ChronoModel*

EVENING EVENT

- 17.30 Visit to the town of Poreč . Reception at the Lapidarium – Museum of the Poreč territory

The Summer School moves to Crikvenica (2 hours trip, departure from Tar at 8.30)

- 29th June 2018

Morning: filling of the kiln with ceramic objects. Starting firing of the kiln

- Open air exhibition on the site of the pottery workshop in Crikvenica (ancient *Ad Turres*)

Lunch at the Hotel

Afternoon:

- Crikvenica's products: review of the typology of the products
- Visit to the Badanj fortress: visit of the monument, view on the Vinodol and of the clay deposits of Slani potok

Evening: reception organised by the Crikvenica municipal Museum

All day: firing of the kiln with temperatures and firing progress monitoring

- 30th June 2018

Morning: opening of the kiln and review of the fired objects - End of the summer school

ABSTRACTS

Wood identification and dendrochronological analysis of the Busuja fish pond

GUIBAL Frédéric

IMBE - Mediterranean Institute for Biodiversity and Ecology Europôle Arbois, Aix-Marseille Univ,
CNRS, Aix-en-Provence, France

Dendrochronology or tree-ring dating uses the annual pattern of radial growth shown by most tree species in temperate regions. Each year trees put on a ring under the bark. Ring-width depends on various factors among which climatic factors determine whether the ring is wide or narrow. Within restricted geographical areas, trees of the same species growing at the same time show similar ring-width patterns. The fundamental process of synchronizing two ring-width patterns is known as cross dating. Comparison of the ring patterns between different wood pieces makes it possible to evidence the trees grew at the same time; comparison of the ring patterns from a timber of unknown date to those of an absolutely dated chronology (reference chronology) makes it possible to assign the date of formation of each ring on the sample and to date the felling date of the tree.

The anatomical and dendrochronological study of the wooden structures excavated in the Busuja fish pond (Istria, Croatia) started in 2012 after the discovery of the waterlogged wooden remains of a well-preserved floor in several basins of the fish pond. From this date, the discovery of other timber remains provided the opportunity to sample adequately the fish pond for wood anatomy identification and dendrochronological studies. The goals of these studies were to point out which tree species were used for timber construction and to date the felling of the trees which were used to produce the timber.

The lecture will provide an overview of the more significant results which have emerged from wood identification and dendrochronological study. Tree species identified will be discussed in terms of wood origin. Major obstacles that hinder tree-rings study will be outlined.

*Dendrochronology in archaeology***GORŠIĆ Ernest**

Faculty of Forestry, University of Zagreb, Croatia

Dendrochronology or tree ring dating is a discipline that is widely used in Dendroarchaeology. The need for precise calendar dating of wooden artefacts is of great importance for archaeologists. In comparison to radiocarbon dating method which enables the sample to be dated in the range of +/-50 years dendrochronology is the only discipline which can date the wooden sample in the exact calendar year. The basis for dendrochronological dating is existence of reference chronologies. Building a reference chronology starts with taking samples from living trees, comparing them and if they match adding them to master chronology. The process of deciding if tree rings match is made in two steps: visual and statistical. Further chronology extension into the past is made by adding samples taken from old wooden houses, bridges and similar. In the end material from archaeological sites is needed to extend the master chronology further into the past. In that process several important factors have to be present. First, a tree species has to be abundant. Many samples are needed to get valid data. The second factor is the number of tree rings present in the sample. Trees that can reach age of 200 or more years are preferred. In the end trees should respond to environmental changes by changing tree ring width or structure.

Plant products and culture contact: the example of fruits in the north-western Mediterranean during the 1st millennium BC and the early Roman times

ROVIRA Nuria

Université Paul Valéry-Montpellier 3, ASM UMR 5140, France

Since the Late Neolithic, several fruit trees are grown in the Mediterranean along with cereals and pulses, but to our knowledge they are few. Among the most important are the olive tree (*Olea europaea*), the vine (*Vitis vinifera*), the fig tree (*Ficus carica*) and, in the East, the date palm (*Phoenix dactylifera*). The first millennium BC will thus see the development of viticulture and olive growing, as well as the specialization of certain Mediterranean regions, from the Iron Age, in these productions with the aim, above all, of obtaining derived products (wine and olive oil) for many socio-cultural practices and trade. Then, especially around the change of era and during the High Roman Empire, arboriculture will soar and become one of the distinctive signs of a new agricultural system and new economic and cultural practices.

We propose in this course to trace the history of the main fruit species in the North-West Mediterranean from the point of view of their native status and / or introduction, their uses and their evolution in this new and complex Roman socio-economic system. Our approach is going to be mainly based on the analyses of seed and fruit remains. We will also discuss current archaeobotanical methods, both sampling and taxonomic identification, that we can set up on archaeological sites and archaeobotanical remains to try to extract as much information as possible from the seed and fruit assemblages.

Difficult karstic landscapes on the Velebit mountain: research methods and results

GLAVAŠ Vedrana

Department of Archaeology, University of Zadar, Croatia

The Velebit Mountain spreads along the Adriatic sea between Senj in the North West and the Zrmanja river in the South East. Velebit is a Dinaric Mountain consisting mostly of carbonate rocks. Main characteristic of its sea slopes are scarce resources and aridity, which affected land use and settlement positions during prehistory. Although the Velebit Mt. is a very hard area to live in, people have made great efforts during the past to shape the landscape in order to survive. The karstic nature of the Velebit Mountain with its unique micro morphological traits, impedes prehistoric cultural landscape research and makes it difficult to detect and study the sites. In this talk we will present land use research methods in the difficult landscapes of the Velebit Mt., as well as new results.

Plant products and culture contact: the exemple of fruits in the north-western Mediterranean during the 1st millenium BC and the early Roman times

TILLIER Margaux

Université de Montpellier Paul Valéry 3, ASM-ISEM, France

This presentation aims to expose the archeobotanical results from nine Roman archaeological sites located in coastal Croatia. This synthesis is based on published data and new results acquired during my PhD work.

The archeobotanical studies were carried out on diversified contexts: ports, villae, towns and a hill fort. The study of waterlogged samples (from ports and villae) allows registering a wider spectrum of economic plants (both cultivated and wild) than dry sediments, where only charred plant remains are preserved. Waterlogged contexts are a major source of palaeoeconomic and palaeoenvironmental information, providing new insights into diet, plant processing activities, local cultivation and trade. The most frequently recorded taxa are cereals, grapevine, fig tree, olive tree, stone pine and walnut tree. Some plants are just consumed and others locally introduced and grown during Roman times, such as peach tree, melon/cucumber, coriander, bottle gourd and cherry tree.

Olive stones fragmentation and anatomical diversity of grapevine (pips, pedicels and aborted berries) suggests that olive oil and wine making are current in several sites (Caska and Veli Brijun). Other archaeological findings such as presses, pottery workshops (amphorae), iconography (funeral altar of Volusius Hermes) and ancient written sources, underline a regional specialization in olive oil production and probably wine production. Trade of plant foodstuffs over long-distances is illustrated by the finding of sebesten fruits (*Cordia myxa*) in Pula and Zaton, imported for consumption or medicinal purposes. It highlights the role of these urban ports in the Mediterranean trade network and perhaps the privileged access to exotic goods for urban elites. Finally, the recording of numerous remains of cypress, mainly from Caska, allows identifying local presence of this symbolic tree in Dalmatia at least since the 1st-2nd c. AD.

*Wild and domesticated plants exploitation in Sardegna during Phoenician and Punic period
8th-3rd century BC*

MUREDDU Maria

Università degli Studi di Cagliari, Italy

The project aims to study the plant macroremains found in Sardinian archaeological sites dating approximately from the 8th to the 3rd century BC, a period which Sardinia is characterised by the presence of the Phoenician and Punic culture. The finds come specifically from coastal waterlogged sites related to Phoenician and Punic settlements, allowing either to study the commercial aspects, in the case of finds coming from possible harbours or anchorages areas.

The carpological remains are taken in particular consideration. From one side the seeds are identified with the stereomicroscope analyses thanks to modern reference collections. A more in-depth investigations is done on the seeds of some species thanks to computer image analysis, especially on *Vitis vinifera*, *Olea europea*, *Ficus carica*, to study the state of domestication of this plants at the period, and the wild plant *Sarcopoterium spinosum*, used in Antiquity on commercial ships to protect the cargo, in the hope to find hints on commercial routes.

The study will give information about local plant exploitation in Sardinia during the Phoenician and Punic period, the state of domestication of some plants, the introduction of allochthonous species and varieties, and also of derived products, and the commercial routes involving the Island.

Grave goods as evidence for ritual and trade in the early Roman period graves from Ilok-Dvor knezova Iločkih, eastern Croatia

BARBIR Antonela

Institute of Archaeology, Zagreb, Croatia

Archaeobotanical studies of funerary offerings can give us important insights into funerary rituals in the past, but also into possible trade routes between different regions. The archaeobotanical study presented here concerns the Gallo-Roman cremation graves from Ilok-dvor knezova Iločkih, located in the easternmost part of Croatia. The cemetery at Ilok contains 6 cremation burials, dated to the early 1st century A.D., all of which contain botanical material. Plant taxa identified in the sample contain cereals, pulses and fruits. The most abundant are *Triticum* (hulled wheat), *Hordeum* (hulled barley), *Lens* (lentil), but also different species of fruits (grapevine, plums, cherries, figs, apple/pear, elder). All cereals and lentils are carbonized, suggesting they are deliberately or unintentionally burned, possibly as a part of the funeral pyre. Poor preservation of the sample can also be a result of cooking. Other fruits in the sample are calcified, suggesting samples were dried or fresh at the time of disposal. The fig tree seldom produces ripe fruit in northeastern Croatia, and must therefore be considered as dried import transported from the Mediterranean area. Figs originated in different regions and their cost value could have been extremely variable. Most of the edible plants found in the graves, such as barley, wheat, lentil, grape and plum were commonly used, and most of them are of local origin. Analysis of plant remains from cremation burials allows an insight into ritual and economic aspects of the Gallo-Roman times.

Studies of the wood of ancient shipwrecks and structures of the Adriatic Sea and South-eastern Europe: contribution to the study of the local shipbuilding traditions

FERREIRA DOMINGUEZ Alba

Aix Marseille Univ, CNRS, CCJ, Aix-en-Provence, France – Ecole Française de Rome, France

My doctoral research is focused on the study of the wooden remains belonging to some vessels and other structures (harbour structures, fish ponds) dated from the Bronze Age to the Late Antiquity discovered in Croatia, in marine environment (Istria and Dalmatia) as well as in inland waters (Kupa river). This study includes xylological analyses in order to identify the wooden taxa, dendromorphological analyses to recognize which parts of the trees were used, and dendrochronological analyses to date the felling of the trees in which the constructions were built. My doctoral research combines Nautical and Maritime Archaeology and Archaeometry in order to better understand the patterns of the use of wood resources in Antiquity within some different regions of Croatia.

The goals of my PhD research are multiple. First of all, this research will contribute to the study of each archaeological site and, in particular, to the study of the structures of the ancient vessels discovered in Caska (Dalmatia), in Istria and in the Kupa river, providing a strong basis for their chronological assessment. Secondly, this research will permit to study the processes of selection of the trees in relationship with the qualities of their wood and also in relationship with the use within the ship's structures. Thirdly, this research will help us defining potential supply areas also in connection with the problem of the wood transport and wood storage. Finally, it will be possible also to draw hypotheses on ancient forest landscapes of the areas interested by my research.

I hope also that this research would be an occasion to collaborate with Croatian, Slovenian and Italian specialists in order to implement the dendrochronological database of this region and to increase probability to obtain significant cross-correlations between sites.

Land-use and exploitation of natural resources in Maurétania Caesariensis under the Roman Empire (1st c. BC – 5th c. AD)

BOULMIS Yacine

Université de Montpellier Paul Valéry 3, ASM, France

This communication has for objective to present the land use and the exploitation of natural resources in Maurétania Caesariensis, through two examples, the arboriculture and the transformation of the products of the sea. These two files offer a new prism through which it is possible to apprehend the evolution of the rural space and his organisation.

The economy of Roman Africa owes its development to the agriculture, and contrary to the preconceived ideas, it takes shape well before the Roman domination. However, the integration of the Roman agronomic techniques to the autochthonous techniques already enriched by the Punic influence probably allowed the diversification of the agricultural practices and the modes of exploitation of the ground. This can be supported by the example of presses, plentiful in Caesarian, and among which the multiplicity of forms and types testifies of a technological diversity of the systems of pressing.

Besides, the visible domination of the agriculture should not mask another important practice of the African economic life, the exploitation of the halieutic resources. Effectively, the region, widely influenced by the Punic culture, mastered the practices of transformation of the maritime products as evidenced by the numerous vestiges discovered on the coast of the Caesarian. The number of these vestiges could increase considerably by multiplying the systematic prospecting, which have to be made by taking into account environmental specificities (estuaries, zones of swamp...) the latter being particularly important, as illustrated by Hispanic and Lusitanian examples.

To approach the proposed theme, this communication would open at first by an examination and clarification of the state of this question in the Maghreb. Then, the files of the exploitation of the shrubby and halieutic resources will be handled by exposing the new archaeological data collected these last two years within the framework of my thesis.

New insights into the amphorae kilns of the ceramic workshop of Loron (Tar-Vabriga Torre Abrega, Croatia). An archaeological and anthracological approach

ROUSSE Corine

Aix Marseille Univ, CNRS, CCJ, Aix-en-Provence, France

VASCHALDE Christophe

ASM-ISEM, LabEx Archimède, France

BENČIĆ Gaetano

MUNDA Davor

Zavičajni muzej Poreštine Croatia

The workshop of Loron (Tar-Vabriga, Croatia) corresponds to an out of standard complex of pottery production, known as the property of senators and emperors. Built on the seashore around 10 AD, on the territory of the colony of *Parentium* (Poreč), it was mainly dedicated to the large-scale production of Dressel 6B oil amphorae, intended for exportation towards Northern Italy and the Danubian *limes*. The dimensions of the complex and the volume of its production rank among the largest *figlinae* of the North Adriatic region. The workshop also produced a large variety of common wares, some wine amphorae (Dressel 2/4 and « a fondo piatto »), fine wares in terra sigillata (10-40 A.D.) as well as construction materials. The archaeological data show that the workshop had been flourishing from the beginning of the 1st c. until the end of the 4th century.

Thanks to the stamps on the Dressel 6B amphorae, we know some of the famous owners of Loron, as the founder Sisenna Statilius Taurus, cos. 16 A.D., who was the son of the great Statilius, a companion of Emperor Augustus ; then, Calvia Crispinilla, well known for her belonging to Nero's circle ; finally the emperors, from Domitian to Hadrian. Since 1994, the excavations led by an international team have also revealed the great planned organization of the potter workshop with kilns and warehouses, arranged around a vast central courtyard.

From 2012 onwards, a new international scientific program has focused on the exploitation of natural resources, especially fuel to supply the high yield kilns. The methodological approach is based on archaeological and bioarchaeological data (anthracology and dendrometry). The recent excavation of one of the amphoras kiln (2017), perfectly preserved, with a set of intact carbonized logs of wood discovered in the *praefurnium*, can yet precise the management of the fuel and the functioning of the kilns in the last phase of activity of the complex. The lecture will present the first results of the bio-archaeological approach, which show that the amphorae production is based on a rational management of forest, and a sustainable land investment.

Project RED - Defining pottery production in Roman Dalmatia: workshops, resources' exploitation and technological choices

LIPOVAC VRKLJAN Goranka
KONESTRA Ana
Institute of Archaeology, Zagreb, Croatia

In recent years a number of pottery workshops and seemingly isolated kilns have been discovered in the coastal area and island of ancient *Dalmatia*, with a concentration in its northern part, ancient *Liburnia*. The range of their products spans from amphorae to ceramic building materials, proving that pottery production did indeed occur in the region in Roman times, a fact often hypothesized but previously difficult to prove.

The location, layout and product's characterization of each identified workshop will be examined, as well as their relationship with the distribution network and the wider territory.

As a programme of archaeometric research has been established within the project RED (HRZZ, IP-11-2013-3973) in order to, firstly, assess and characterize local production, and then tackle the technological and production aspects of each workshop, a short overview of the setting up of RED's archaeometric programme will be described including sampling strategies, analytical methods used and main questions asked, with a brief outline of the shortcomings and problems faced by the researchers in each phase of the work.

While findings are still being interpreted, preliminary results will be presented in order to assess whether the archaeological questions have been answered, what are the results' implications and how can we utilize the data gathered in a wider archaeological and ecological interpretation.

Bilan, enjeux et perspectives du programme OLEiculture et production d'amphores en Turdétanie Romaine (Bassin moyen du Guadalquivir, province romaine de Bétique, (I^{er} s. av.- III^e s. ap. J.-C.)

OLEASTRO Project (Guadalquivir Basin, Betica, 1st-3rd c. AD) : overview and emerging issues

MAUNÉ Stéphane

ASM UMR 5140, LabEx Archimède, France

Les objectifs scientifiques du programme OLEASTRO, qui succède au programme triennal PAEBR (2013-2015) du LabEx Archimède, consacré à la vallée du Genil, sont multiples et concernent la problématique générale des interactions entre les activités économiques et l'évolution de l'environnement. Il s'agit d'appréhender sur la longue durée, à partir du cas spécifique de l'industrie potière de la vallée du Guadalquivir (province de Bétique) quelles ont été les stratégies de développement mises au point pour répondre aux stimulis d'une économie spéculative florissante liée en grande partie à la production et à la diffusion vers Hispalis (Séville) de l'huile d'olive contenue dans les amphores Dr. 20. L'huile a assurée pendant toute l'époque romaine, avec d'autres produits agricoles et les minerais, l'enrichissement des classes dominantes locales, selon un processus bien mis en évidence par F. Jacques, G. Chic Garcia et F. des Boscs notamment.

Nous partons du postulat que cette activité a pu exercer une très forte pression sur le milieu en raison de son intensité – on se trouve ici en présence de la plus forte densité d'ateliers connue dans l'Empire romain – et de son amplitude chronologique. Comment a été assuré l'approvisionnement en combustible de cet immense agrégat d'ateliers que l'on peut qualifier, pour la plupart, d'industriels ? Quelles sont les réponses techniques apportées par les producteurs d'amphores à la demande toujours croissante de conteneurs ? Comment étaient organisés ces centres de production ? Existait-il une forme de rationalité des outils de production et de leur organisation destinée à maîtriser les effets de cette activité sur l'environnement ? Quels étaient les liens entre huileries et ateliers d'amphores ? Quelles étaient les variétés d'olive à huile produite et peut-on discerner une évolution des types choisis en fonction de leur productivité ?

Autant de questions auxquelles voudrait répondre ce projet grâce à la mise en place, sur un territoire atelier où ont été localisés plus de cent centres de productions, d'un protocole de travail rigoureux et de recherches pluridisciplinaires. Le travail de recherche s'organise, en parallèle, dans les deux conventus de la basse vallée du Guadalquivir : celui de Hispalis/ Séville situé entre Palma del Rio et Séville ; celui de Cordoba qui se trouve à l'amont de Palma del Rio et remonte jusqu'à l'agglomération de Cordoue. Comme le conventus d'Astigi/Ecija, les deux conventus d'Hispalis et de Cordoba correspondent à des zones possédant une juridiction propre et exercent sur le commerce des Dr. 20, un contrôle attesté sur les marques peintes sur Dr. 20. Ces trois zones de production semblent avoir leurs propres spécificités et l'un des objectifs d'OLEASTRO est justement de confronter et d'analyser les résultats obtenus dans ces trois zones de production d'amphores.

A partir des méthodologies mises en place lors du programme PAEBR (LabEx Archimède, 2013/2015), on se propose de dresser un inventaire argumenté et détaillé de l'ensemble des ateliers d'amphores Dr. 20 et d'huileries situés sur les berges du Guadalquivir, à partir de campagnes de prospections de surface, de campagnes de survol par drone et de prospections magnétiques ciblées sur quelques ateliers. On procédera également à la fouille d'ateliers et l'on

poursuivra le travail de datation archéomagnétique des fours dégagés. Sur les ateliers fouillés, l'accent sera mis sur la collecte de données paléoenvironnementales bien datées afin d'établir des comparaisons avec les résultats de Las Delicias, fouillé en 2013/2015

New Insights into oil amphorae workshops of Conventus Cordubensis. Results of the Land Surveys in the Guadalquivir Valley and excavation of El Mohino amphorae workshop

GONZÁLEZ TOBAR Iván

Université de Montpellier Paul Valéry 3, ASM, France

The amphorae region production of Corduba, capital of conventus and capital Baetican Province, has benefited in recent years, in the OLEASTRO program, of a major contribution of data. The four pedestrian surveys carried out between 2016 and 2017 made it possible to inventory about a hundred Roman sites, of which 38 are oil amphora workshops, 11 of which are completely unpublished. It has thus been possible to add some new producers to the productive panorama of Betic, as well as to locate the officinae of more than fifty producers already known on the consumption centers, but whose places of production in Betic were unknown. Following a limited selection of the best preserved sites, a geomagnetic prospecting campaign carried out in collaboration with the University of La Rochelle, made it possible to locate exactly fifteen kilns kept in the selected workshops. Finally, in January 2018, an archaeological excavation made it possible to test the potential of one of the workshops surveyed, in addition to being one of the oldest workshops in the Guadalquivir Valley, the El Mohino workshop. Located in Palma del Río, in the region of Cordoba (Andalusia, Spain), he has delivered the remains of two large buildings, each including four amphora ovens. They've been dated between the 1st and the beginning of the 2nd century. ap. BC and they've produced oil and wine amphorae. Its size, its early abandonment and its excellent state of conservation make this complex a particularly interesting case study which illuminates the development of oil amphora production at the end of the Julio-Claudian era, in the Guadalquivir.

Pottery production in Pompeii during the 79 AD

CAVASSA Laetitia

Aix Marseille Univ, CNRS, CCJ, Aix-en-Provence, France - EHESS, France

This presentation is aiming to provide an overview of our knowledge about the pottery production in Pompeii at the precise moment of the destruction of the city. To start with, we will study the two workshops already known today to make a transversal study of the situation. In fact, currently, we know two atelier in Pompeii which were in activity during the 79.

The first one, discovered during the 19th century, is located out of the city, in the Porta Ercolano sector, around the via dei sepolcri. It is a particular workshop, build in a portic. The second one was discovered during the middle of the 20th century. It is located in the city, near Porta Nocera and was installed in a domus. The parallel study of the two ateliers, together with the results of the recent excavations (the internal organization, the productions, the analysis of the clay, fuel...), provides a good overview of the pottery production in Pompeii at the end of the 1st century AD, and will offer new data.

Firing pottery: assessing the environmental impact of terra sigillata production

LA ROSA Lorenza

University of Oslo, Department of Archaeology, Conservation and
History, Norway

During late-republic and early empire terra sigillata ware was a mass product; at first crafted in Italy, its export assumed an extraordinary dimension for quantity and diffusion. This paper discusses the relationship between production and environment through archaeological and epigraphic information, environmental and archeometric data. The massive use of wood necessary for the sophisticated firing procedure might have conditioned the location of the workshops and thus, if favourable environmental conditions were important to establish and maintain a production site, changed conditions, due to exploitation of forests, could have played a role in productivity drops, and possibly in delocalization of manufactures.

Potters' workshops and the exploitation of natural resources during Roman times in the low valley of the Peyne: New perspectives on research

LAURAS Vincent

Université de Montpellier Paul Valéry 3, ASM, France

Located in the Narbonne area, about twenty kilometers to the east of the ancient city of Baeterrae, the area of the lower valley of the Peyne has enjoyed intense and dynamic research, for the last thirty years. On this micro territory not larger than 50 square kilometers, archaeological excavations and prospections have succeeded one another and allowed the catalogue of Roman era sites to expand. Around 80 sites including villae, potteries, and various sites have been established. To deal with this complex subject, it seems interesting and appropriate to ask in what socio-economic and "ecological" context these institutions and their occupants evolved from the second century BC. During all antiquity, is observed, in fact, the installation of a whole series of rural habitats, most likely attracted to the region by the agricultural and silvicultural potentialities of this zone.

The plain called "Neffiès" is watered by a skein of small streams, fed by many perennial sources, and lined with limestone or volcanic reliefs. It is therefore very fertile and promotes the establishment of agriculture in the rich alluvial lands, with viticulture encouraged on more stony landforms. There are many indications of handicrafts, particularly ceramics, posing the question about the exploitation of natural resources. In this valley, the challenge of understanding this problem is twofold. Indeed, the high valley is made up of steep reliefs, unusable for agriculture but extremely rich in wood; rich agricultural lands occupy, for their part, the lower valley. The latest surveys carried out on the ground in January 2018 have brought new elements to the understanding of the exploitation of the territory as well as for its organization. Indeed, about fifteen new sites have been characterized, including a new potter's workshop: the Lande II. This latest discovery allows us to know that eight workshops of potter's and tile makers existed, revealing the density of the occupation and the exploitation of this rich zone. The data gathered over the last thirty years can be put in perspective with the recent studies that have been the subject of anthracological analyzes as on the Embournière workshop, hitherto unpublished for our research zone.

The discovery and excavation of this potteries in 2017 allowed us to obtain relevant information on the installation of structures built near a stream and on the exploitation of natural resources. It would therefore be interesting to compare these results with the data collected in surveys on potteries, even if this collection remains limited. Only an archaeological operation would have a solid basis of comparison. We think that the unpublished research on the potteries of the Lande II, not contemporary with Embournière, could help bring elements of an answer to the organization of the plain at different times: the Lande II for the change of era and Embournière for the High Empire.

The topography of archaeological sites with smelting characteristics on the territory of the River Drava Basin

VALENT Ivan

Muzej grada Koprivnice, Croatia

During extensive systematic field surveys conducted on the territory of the River Drava Basin during the past forty years numerous sites with traces of metallurgical characteristics have been recognised. These characteristics primarily relate to the existence of smelting or metallurgical slag, parts of furnaces and nozzles which indicate that some sort of metallurgical activity occurred within the questioned settlement.

Over the past several years archaeological interest for the metallurgical workshops stepped up and several trial archaeological campaigns, were undertaken. The results of these research proved the existence of smelting workshops on the territory of the River Drava Basin in Late Antiquity and Early Medieval period, where as surface finds of ceramics collected with pieces of smelting slag, from dozens of other sites, indicate their existence from late Iron age to Modern period.

Based on these preliminary results a research project sponsored by the Croatian Science Foundation, Production of Iron Along the Drava River During Antiquity and Middle Ages: Creation and Transfer of Knowledge, Technology and Commodities, was initiated. One of the main parts of the project is the topography of sites with smelting characteristics whose position and functioning depended on the possibilities of extracting and preparing the bog iron ore which was used as a raw material in the production of iron on the territory of the River Drava Basin. Due to the fact that the existence of the bog iron ore in soils depends on natural characteristics and changes in pedology, geology and hydrology of the environment it is crucial to understand the positions of these sites in order to understand and reconstruct the landscape and the cyclic changes that occurred in it which allowed the extraction of the bog iron ore from late Iron age to Modern period.

Une production de pâtes sombres à Fréjus (Var)? : les fours de potiers situés sous la domus de la Plate-Forme

*Common ware production in Frejus (Forum Iulii, Var – France)
New insights into the early kilns on the la Plate-Forme site*

PAWLOWICZ Marie

Aix Marseille Univ, CNRS, CCJ, Aix-en-Provence, France

Le site de la Plate-Forme, situé dans l'angle sud-est de la ville antique de Fréjus (Var), est occupé par une vaste domus construite au début du 1^{er} siècle apr. J.-C. En 1961 et 1963, l'archéologue P.-A Février a effectué un certain nombre de sondages sous les sols de ce bâtiment afin de dater les remblais ayant servi à l'installation de ses fondations. À cette occasion, au moins deux fours de potiers ont été découverts, l'un circulaire et l'autre quadrangulaire, témoignant d'une occupation antérieure de la zone et de sa fonction artisanale. La ville concentre une importante activité potière au 1^{er} siècle, dont les ateliers produisent essentiellement des amphores et des communes à pâte claire. Cependant, P.-A Février avait identifié sur ce site une production de céramiques à pâte grise ou sombre, information inédite à l'époque.

La reprise de la documentation de fouille et l'étude du matériel céramique, dans le cadre d'un master 2 réalisé cette année, permettent d'apporter tout un lot de nouvelles problématiques sur ces fours qui comptent parmi les plus anciens de la cité connus à ce jour. Premièrement leur datation et leur chronologie. Deuxièmement leurs fonctionnements car nous avons affaire à deux architectures complètement différentes. Troisièmement, leurs productions dont les formes, inspirées du répertoire italique, sont bien connues à Fréjus mais dont la pâte ne semble pas encore bien identifiée. Enfin leur réinsertion dans la topographie urbaine à un moment où la ville était au début de son expansion.

Crafts of Nauportus

BERDEN Tina

Research Centre of the Slovenian Academy of Sciences and Arts, Institute of
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Nauportus (present-day Vrhnika) is located in central Slovenia, at the sources of the navigable River Ljubljanica and near the important trade route connecting the Apennine peninsula with the central Danubian region. The Romans founded the settlement there in the first half of the 1st century BC. It was a vicus in the territory of Aquileia. A fortified market place with large storage buildings and a river port was constructed in the Augustan period and used for supplying the legions in Illyricum. Nauportus lost its strategical importance in the 1st century AD and remained a small settlement along the route Aquileia -Emona.

The 2005 excavation was located in the settlement area near the main Roman road and it revealed the architecture and layers from the end of the 1st century BC till the end of the 4th century AD. Wooden and stone buildings were excavated with the remains of pavements, drainage channels and wells. A large amount of archaeological artefacts was found as well as the well-preserved organic residues.

The remains of lead labels provide evidence for trade of food products and plants, as well as for existence of the local textile industry. The semi-finished bronze products and slags indicate the existence of metallurgical activities.

The large quantities of kitchen ware originate presumably from the local and regional pottery workshops. In the absence of workshop remains in Nauportus there is a question how to recognize and determine the local and regional productions and distinguish them from the imported ware.

The approach of territories in Roman Istria, between traditional methods and archaeometry

TASSAUX Francis

Université Bordeaux Montaigne, Institut Ausonius, France

- 1 - Showing first the achievements made through a mingling of archaeology and textual sources, lapidary epigraphy and instrumentum inscriptum (stamps and graffitis on tiles, bricks, amphorae and pottery)- the privileged case of Istria.
- 2 - Comparing them to the new horizons opened by the disciplines of earth and life as well as the methods and tools of archaeometry: the first contributions, prospects and interrogations.
- 3 - Underlining the growing importance of the new tools in cartography, for the historical reflection on the one hand, and on the other hand for the diffusion of the results.

*Production strategies and procurement of clay raw materials: the case of Loron (1st-3rd c. AD)***MACHUT Pierre**

Université Bordeaux Montaigne, CNRS, IRAMAT-CRP2A, France

Ancient amphorae are frequently considered on the basis of their status as proxies for ancient trade patterns rather than through their production. However, these containers remain above all manufactured objects, often in very large quantities, for a precise and generally one-time use. Although the archaeological remains of the workshops and especially the abundant ceramic finds testify to the extent of the organisation of production and the quantities produced, these hardly make it possible to reconstruct the strategies implemented at every stage of manufacture, particularly with regard to the collection and preparation of raw materials. These aspects are however fundamental to the understanding of the exploitation of natural resources by the potters of Antiquity and their relation with the territory within which they are established. From the 1st to the 3rd century, the territory of Istria was a prominent area for olive oil production, exported in so-called Dressel 6B amphorae towards northern Italy and the Danube. The production of these containers was carried out by a number of workshops located along the Istrian coast. The main ones, Fažana and Loron, were distinguished by their exceptional size and the fact that they were initially private aristocratic properties, before they entered the imperial domain at the end of the 1st century. In a geological context where resources suitable for large-scale pottery production are scarce in the immediate vicinity of the workshops, the management of the collection of raw materials and their processing into a material of the required quality and properties call for an in-depth study.

By combining in an integrated approach new archaeometrical data from analyses of Loron amphorae and local clay sediments with the accumulated knowledge from an archaeological research project carried out since the 1990s, this presentation will seek to provide answers to these questions, focusing on evolutions over three centuries of activity in the workshop.

Geoarchaeology of ancient Mediterranean harbours

MORHANGE Christophe

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Although much has been written on the subject of ancient Mediterranean harbours, the relatively new area of harbour geoarchaeology remains dispersed in the geoscience and archaeological literature. Over a decade of research has amassed rich and varied datasets of anthropogenically forced coastal evolution, with a remarkable number of between-site analogies. This new research field also shows the rich potential of geoscience to reconcile important archaeological questions. The aim of this presentation is to (1) discuss how ancient harbours have come to be preserved in the geological record; (2) expound the basic principles and palaeoenvironmental tools underpinning ancient harbour geoarchaeology; (3) outline some of the most significant research advances made; and (4) discuss a new chrono-stratigraphic model applicable to harbour sequences. Examples will be taken from the Adriatic sea.

Relative Sea-Level Change along the Northern Adriatic during the Late Holocene

FAIVRE Sanja

University of Zagreb, Faculty of Science, Croatia

The late Holocene is the most intensively studied period in palaeo-sea-level research. This research increased during last two decades along the eastern Adriatic as well. Sea level curves are obtained by using various methods and are based on different markers which are often combined. Those are primarily archaeological coastal remains as well as geomorphological and sedimentological markers. However, most of the methods used till now do not provide enough precision. As the studying period is short the error bars are often too large. In order to provide more precision and better accuracy of sea-level curves the latest research along the eastern Adriatic has been centred on algal rims as sea-level markers. Fossil bio-constructions on rocky coast have proven to be precise sea-level indicators in microtidal environments. Algal rims formed by alga *Lithophyllum byssoides* (Lamarck) Foslie allow us to study the relative sea level change with much more consistency and accuracy. Under favourable conditions *Lithophyllum byssoides* build reef like bioconstructions just above the biological mean sea-level which can be ¹⁴C dated. Algal rims from different locations in the Northern Adriatic have been analysed. The obtained ¹⁴C ages of algal carbonate samples have been further corrected for the marine radiocarbon reservoir effect. The obtained relative sea-level curve starts in the 5th century when the relative sea level was -70 ± 10 cm below the recent mean sea level what confirms our previous findings obtained combining geomorphological and archaeological markers. We have also established a close link between relative sea-level change and periods of rapid climate changes during the last 1.5 ka.

This research was supported by the Croatian Science Foundation (project no. HRZZ-IP-11-2013-1623, *Reconstruction of the Quaternary environment in Croatia using isotope methods - REQUENCRIM*).

Paleoenvironmental reconstruction of Caraburun shoreline: a geoarchaeological approach

TEKLEHIMANOT ARAYA Awet

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Located between the undelimited borders of Istros and Orgamè, Caraburun is an archaic settlement in the southern Danube delta with an occupation period beginning in the mid-6th c. BC (Dupont et al. 2016). Although the absolute chronology is not known yet, the archaeological from the site indicate its co-existence with the neighbouring archaic Greek colonies of Istros and Orgamè on the western Black Sea coast. However, while researches have been carried out in these two major sites (Vespremeanu et al. 2012; Bony et al. 2015), the case of Caraburun has been overlooked and there is nothing regarding questions of harbour environment and evolution of the shoreline to explain the anthropogenic and natural processes that affected/ had impact in the settlement. Hence a geoarchaeological approach is needed to better understand the paleoenvironmental evolution coastal zone in Caraburun's area. This research looks at the paleoenvironmental reconstruction of the shoreline based on multi-proxy analysis of 3 cores collected from area surrounding the site. It will analyze granulometry, fossil micro-fauna (mainly ostracods) supported by ^{14}C (AMS) dates with the aim to resolve the following questions: 1) Shoreline dynamism? 2) Its connection with Istros and Orgamè ?

Geomorphology and water management, a diachronic view

OLLIVIER Vincent

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Water management is often linked through time to local and/or regional hydrogeomorphic conditions. Water supply, flooding protection, river diversion, settlement location also evolved following the hydrogeologic and climatic changes. In addition, due to the sensitivity of some environmental conditions, the use of water resources by ancient populations have sometimes destabilized the morphosedimentary balance of the exploited systems (river, karst, calcareous tufa, etc.). Using geomorphological approach, diachronic and various examples in and around the Mediterranean will be presented to illustrate and expand the enriching debate about the relationship between water management and environmental constraints evolution.

Provenance studies of materials (building stones, mortars) - presentation of Pierresud database

BROMBLET Philippe

CICRP -Centre interdisciplinaire de conservation et de restauration du patrimoine,
Marseille, France

Provenance studies are more and more required to find out the nature and origin of constitutive materials of archaeological sites. Various analyses are carried out to characterize the material and its properties such as mineralogy, petrography, petrophysic, isotopic compositions... The results are usually compared to reference samples already characterized whose origins are well known. In some cases, the source of the original material is not known and investigations in the field are required to locate the ancient extraction and production sites. They are no longer in use from a long time, may be very well hidden in an apparently natural landscape and can show only very scarce marks of exploitation. The methodology used will be presented and illustrated by several case studies concerning marble and alabaster sculptures, building stones, mortars and renders.

"Pierre Sud" which is a database coupled to a geographic information system (GIS) dedicated to building and ornamental stones, quarries and monuments of the South-East of France will be also presented.

A multidisciplinary approach to the study of the ancient quarries of Djelfaoune, in the area of the ancient city of Thamugadi (Algeria)

REZKALLAH Younes

Université Paris 1 Panthéon-Sorbonne, ArScAn, France

The subject deals with the unpublished quarries of Djelfaoune, located in the immediate vicinity of ancient city of Thamugadi (Timgad in Algeria), which supplied most of the sandstone building materials used in the construction of the monuments. The study highlights the relationship between an ancient city and the natural resources in its region from the second century AD. J. - C. A multidisciplinary approach was privileged to deal in an innovative way this subject, the methods of archeology, archaeometry, geology and geomatics were then solicited.

This leads first to the identification and the listing of new quarries and extraction sites, whose data were subsequently integrated and spatialised in a GIS. Then, thanks to the petrography we were able to identify correctly the origin of the most used lithotype in the building. Finally, this approach allowed us to understand the role of the geological features of rock outcrop (stratigraphic layout of the banks, their thickness, lithological quality, etc.) and the technical characteristics (abundance and extraction facilities) in the choice of the place of the foundation. In the current state of knowledge, the archaeological potential of the Djelfaoune quarries is estimated at more than 5 ha on a potential area of 137 ha. Ten sites of extraction were clearly identified during two field survey campaigns. Complementary archaeometric analyzes (XRD, spectroscopy, etc.), new techniques (3D, photogrammetry, predictive models, etc.) and new tools (webGIS) are envisaged in future to better apprehend all the questions related to the study of this relationship between an ancient city and its territory. This study also aims to promote and to protect this unknown and endangered heritage sites.

Roman ceramics as a grave goods

MIJIĆ Krešimir
University of Zadar, Croatia

I will present one part of my doctorate thesis which is roman pottery as a grave good. In my thesis I will process material found during the protective archaeological research of the Garden-Relja site 2005-2006 in which 119 roman graves were found. Most of the material found during those excavations is still unpublished. It includes burying in ceramic urns, stone urns and burying the dead in graves covered by taegule. In the presentation I will focus my attention on those graves and their material. Material will be typologically processed and categorized. The ceramic material from the settlements will be compared with ceramics found in the graves of the ancient necropolis of Zadar. I will use interdisciplinary approach to ceramics in which way it is possible to get best view of roman pottery in Zadar.

Productions and uses of pitch in Antiquity: crossed contributions of archaeological data and chemical analysis

CAILLAUD Christophe

Université de Montpellier Paul Valéry 3, ASM, LabEx Archimède France – Université d'Avignon, France

The pitch, resulting from the transformation of resinous trees by pyrolysis, is undoubtedly the most widespread vegetable substance in all sectors of ancient daily life. The multiple domains of application of the pitch make this product a real panacea used to waterproof the amphorae, the wineskins, the barrels, to treat wine, for caulking ships, for the treatment of architectural woods, for medicine, for veterinary care... Many areas of the northern Mediterranean (Greece, Italy, Spain and Gaul) are identified as areas of production and exportation of the pitch through archaeological evidences or through Greek and Roman literary sources.

In Roman Gaul, the southern and eastern fringes of the Massif Central and the Landes coast are two major centers of the development of the pitch in the first and second century AD which are linked to the development of viticulture in Narbonnaise and Aquitaine. The dissertation of E. Loir on "l'Industrie de la Résine dans les Causses à l'Époque Gallo-Romaine", published in 1940, remains the first scientific reference on the discovery and study of the pitch production units in Lozère and Aveyron. Since then, recent researches have revealed the considerable number of pitch manufacturing sites which is estimated at several hundred.

This research project has a multidisciplinary vocation whose aim is to synthesize and renewing the knowledge on the production and use of the pitch by bringing new archaeological data and also unpublished biomolecular chemical analysis and archaeometric analysis. The main objectives of this study will be to characterise the organisation of this proto-industrial production at a regional level and to determine the contours of its integration into a globalized Roman economy.

ArchaeoCulTour - A project aimed at studying the archaeological landscape of Vrsar / Orsera

MATIJAŠIĆ Robert

Juraj Dobrila University of Pula, Faculty of Humanities,
CIRLA, Croatia

The project, financed by the Croatian Science Foundation, the Municipality of Vrsar-Orsera, the Tourist Office and "Maistra" a tourist firm, is centred on mapping and documenting the archaeological heritage of a territory north of the Lim Bay, around 29 km². Most of the area is covered with dense Mediterranean macchia and it has been scanned with ALS. We are now analyzing the images and surveying the most interesting spots, in order to understand the most important features.

The most significant features are prehistoric hilltop settlements, mounds, Roman centuriation lines and post-Roman field boundaries, quarries and natural pits and caves.

The aim is to form a comprehensive catalogue of sites and features, elaborate the data in view of their preservation needs and presentation potential, and compose guidelines for the definition of landscape character and use of historic landscape in planning for the future, mainly in tourism, which is the area's most important economic activity.

First results in the use of LiDAR and GIS for the territory of Vrsar (project ArchaeoCulTour)

POPOVIĆ Sara

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CIRLA, Croatia

The objective of the ArchaeoCulTour project is to investigate the archaeological heritage and assess the potential for its implementation in sustainable development of cultural tourism of Vrsar municipality. A substantial part of this 40 sq km area is covered with dense forest and for that reason LiDAR data gave us priceless information which enabled future research planning. Interpretation of this data-set resulted in detecting more than 8 km of previously unknown roman land division lines, one previously unknown prehistoric hillfort, as well as caves and rock shelters. All these different archaeological features were mapped in GIS and the database was supplemented for ones which were documented during our first field reconnaissance. This also enabled us to define locations for first excavations which were conducted in May.

Apart from mapping archaeological features in GIS, broad-brush characterization of the landscape was made in order to understand where can we expect a better state of preservation of the remains. At the same time we can reconstruct land uses and spatial organization of different historic periods.

***Modelling for archaeological research and heritage promotion. The case study of the villa
maritima of Saint-Cyr-sur-Mer (Var, France)***

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The archaeological site of Saint-Cyr-sur-Mer has been known since the middle of the 18th century. For a long time, it was wrongly identified as Tauroeis. Remains still visible today are part of a *villa maritima*, dating back to the beginning of the 1st century AD. In spite of the interest of the monument, the site was never excavated, nor are there scientific publications about it. The study we propose is mainly based on visible structures: in the archaeological part we develop an analysis of the construction techniques, as well as an analysis of the stratigraphic relationships. Based on this, we identify the solutions adopted, and the architectural typologies of the villa. The analysis of the construction techniques relies upon a database (USM), a photographic file and a photogrammetric work – according to a methodology already followed in our PhD thesis. The 3D-modelling of the structures enables to study the monument in its complexity – in particular in its three-dimensionality – without creating abstract typo-chronological models that might lead to erroneous conclusions.

As a result, the analysis allowed for a first archaeological interpretation of the complex, thus representing the basis for the reconstruction of the elevations of the villa. It also provided essential means for verifying the feasibility of the reconstruction hypotheses and for the development of the site. Indeed, the 3D-modeling projection through augmented reality – employing 3D-glasses – allows visitors to have a concrete idea of the archaeologists' work, and to immediately understand the history of the site. In addition, the 3D-modeling of objects coming from the excavation, or preserved in the museum, gives the possibility to a virtual, real-time "manipulation", by directly relating to it. This process changes completely the relationship between the visitor and the visited site.

Roman amphorae kilns in the Western Mediterranean (2nd century BC - 5th century AD): new reflections on the contributions of archaeometry and modelling

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Over the last twenty years, interest in amphorae kilns has intensified, yet most studies focus on describing them as architectural structures rather than what they are, complex technological constructions. No research has yet been conducted on the issue of calorific capacity, which in our opinion is a fundamental data for the knowledge of the history of techniques. Indeed, the various architectural choices were probably also dictated by technological considerations. A multidisciplinary approach based on archaeometric modelling, spatial and chronological, is essential for the study of these pre-industrial structures. The modelling applied to the study of furnaces is more and more used these last decades to restore their architecture and the modalities of the amphorae loading. Some examples will illustrate how new computer methods such as 3D make it possible to apprehend the issues related to the superior architecture of furnaces (laboratory) and production capacity. Finally, the main problematic of the thesis concerns the calorific yield of Roman amphorae furnaces. In what way could the archaeometric modelling answer the different problematics specific to kilns? The ambition of this work is to establish a new methodology for furnace study, based on multidisciplinary collaborative work (archaeometry, anthracology, and modelling). The reflection on a calculation method, by means of archaeometric modelling, will focus on determining the thermal efficiency of a kiln, and the impact of its internal architecture and construction materials implemented, on the circulation of the heat.

Composing time in archaeology: Initiation to chronological modelling

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Bayesian statistical analysis of chronological data has developed considerably in the field of archaeology since the 1990s. This development responds to the considerable increase in dating data that can no longer be treated manually. The success of this modeling approach relies on the ability to incorporate multiple sources of widely varying data and knowledge into complex models, and the ability to account for sources of variability and uncertainty in dating. The inferences and predictions produced by this modeling are expressed in a probabilistic form allowing a quantified analysis of the chronology.

The "big data" effect linked to a growing production of dating data by laboratories and the complexity of excavation contexts or cultural ensembles require the availability of tools for inference of essential parameters for the understanding of chronological processes in archaeology and history. The mastery of these tools is essential for archaeologists who want to extract from these masses of data information both relevant and the most accurate possible.

This workshop will present the tools to analyze the chronological data (laboratory datings, archaeological artefacts, texts, sedimentary archives) through the new software ChronoModel (<https://chronomodel.com/>). The fundamental principles of Bayesian reasoning which allows the modeling of chronological data will be introduced. Emphasis will be placed on the practical implementation of these principles in ChronoModel from concrete archaeological examples.

The objective of this workshop is to learn how to:

1. build chronological models from archaeological observations (Events, Phases, stratigraphies, successions)
2. Calibrate the data and take into account the uncertainties
3. Analyze temporal scenarios based on models and uncertainties.

Participants are recommended to bring their own laptop and their own data set.

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