The Greeks and Romans in the Black Sea and the Importance of the Pontic Region for the Graeco-Roman World (7th century BC-5th century AD): 20 Years On (1997-2017)

Proceedings of the Sixth International Congress on Black Sea Antiquities (Constanța – 18-22 September 2017)

edited by

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Dedicated to Prof. Sir John Boardman to celebrate his exceptional achievements and his 90th birthday

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Contents

Opening Lectures

Section 1
Foundation of Greek Colonies and the Character of Greek Colonisation; their Relationship with Pontic and Near Eastern Local Populations

Section 2

Pontus and Athens; Pontic Art; Religion; Navigation and Trade; Pontic Kingdoms

Section 3

Later Republic and Early Empire in Pontus and the Relationship with the Local Population; Art; Religion; Navigation and Trade

Section 4
New Excavations and Projects

Section 5
Varia

Coastal Geoarchaeology of the Danube Delta. Results from Halmyris, Enisala and Istros*

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Abstract

This paper presents the preliminary results of the AMIDEX-GEOMED and COFUND geoarchaeological projects investigating the Danube Delta. It is based on cores drilled in this area in 2015 and 2017, as well as on geophysical and archaeological investigations. Our research focuses on the human settlement dynamics in the Danube Delta in relation to the evolution of the geomorphological context from the Neolithic up to the Middle Ages via a multidisciplinary approach. By analysing palaeo-ecological proxies we can see how, since the Neolithic, human activity is an operating factor in shaping the landscape. The multi-proxy research allows us to highlight the importance of geo-climatic factors in influencing the strategy of ancient societies (agriculture, trade, harbour location...) and also on their capacity to adapt to a dynamic environment.

Geographical setting

Since *ca.* 9000 BP,[1] the Black Sea has been reconnected to the Mediterranean, hence their water bodies respond synchronously to glacio-eustatic changes.[2] In the context of sea level stabilisation since *ca.* 6000 BP,[3] geomorphic and climatic phenomena such as deltaic progradation, floods, storms, etc. have severely impacted the coastal system, and along with human activity have had a strong influence on the deltaic environment. Understanding these climatic and geomorphological processes will enhance our understanding of the Danube Delta's evolution and the adaptive responses of different societies to these changes (Figure 1). Interaction of various factors, such as climate, soil erosion, land-use, sediment supply, crustal movements (tectonics and isostasy), waves and currents systems control, in the main, the fluvial and coastal geomorphology of a delta and its related features.[4]

The Danube Delta is the second largest in Europe, after the Volga Delta. It is a unique ecological hotspot, being Europe's largest wetland and reed bed, and since 1991 it has been included on UNESCO's World Heritage List. Its aquatic environment is characterised by various ecosystems, such as freshwater bodies, *limans* and numerous lakes and bays, as well as a large number of brackish water ecosystems. The mosaic-like morphology that we see today, defined in the western part of the Delta by a flat area of fluvial and lagoonal origin, with a series of levees and, in the south-eastern part, by the presence of marine sand bars and coastal dunes, reflects a complex long-term evolutionary process. The formation and development of the Danube Delta represent a source of scientific debate since the beginning of the 20th century, covering a wide range of issues, such as space configuration, the existence and evolution of

* This project received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement no. 713750. Also, it was carried out with the financial support of the Regional Council of Provence-Alpes-Côte d'Azur and with the financial support of A*MIDEX (n° ANR- 11-IDEX-0001-02), funded by the Investissements d'Avenir project of the French Government, managed by the French National Research Agency (ANR). Support was also provided by the Institut Universitaire de France, through the project 'Geoarchaeology of Ancient Harbours' (headed by C. Morhange). We thank the Eccorev federation and the sedimentology laboratory of the CEREGE (D. Delanghe, CEREGE) for the funding of the binocular microscope Leica MZ125. We are thankful to Andrei Asăndulesei, Cristian Micu and Alin-Mihu Pintilie from ARHEOINVEST, Iași University, for the geophysical investigations. Also, we thank the University of Bucharest for the support during the archaeological excavation at Istros from June 2017. The archaeological excavation was funded from OT-MED project 'Geoarchaeology of the ancient harbour of Histria (Danube Delta, Romania)'. We would like to thank for help during the fieldwork: Emmanuel Gandouin, Vincent Olivier, Majid Shah-Hosseini, Marius Streinu, Sabin Rotaru, Florin Zăinescu, Adrian Vladu, Liliana Croitoru and Laurențiu Țuțuianu. Warm thanks from C.M. and A.B. for logistics to Geta.

1 Soulet *et al.* 2011.

2 Brückner, Kelterbaum *et al.* 2010.

3 Stanley and Warne 1994; Giosan *et al.* 2006; Brückner, Kelterbaum *et al.* 2010.

4 Vespremeanu-Stroe *et al.* 2017a; 2017b; Anthony 2009.

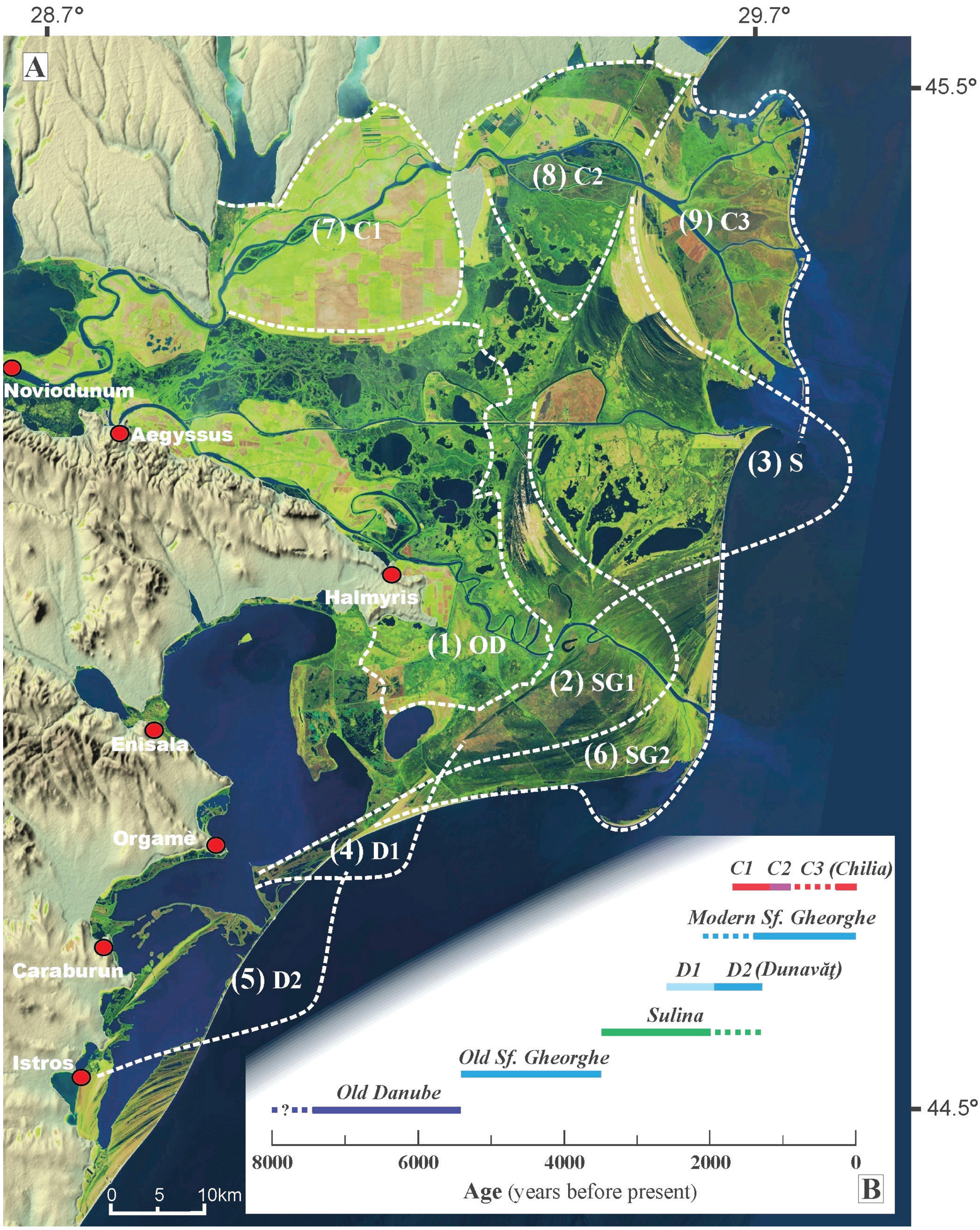

Figure 1: Geomorphological map of the Danube Delta with the studied archaeological sites. The pointed line marks the Danube Delta lobes (including bayhead, lacustrine and open-coast lobes) at their maximum extension: SG1 – Old St. George; S – Sulina; D1 – Old Dunavăţ; D2 – New Dunavăţ; SG2 – Modern St George; C1 – Chilia 1; C2 – Chilia 2; C3 – Chilia 3. The numbers express their chronological succession (after Vespremeanu-Stroe *et al.* 2017b).

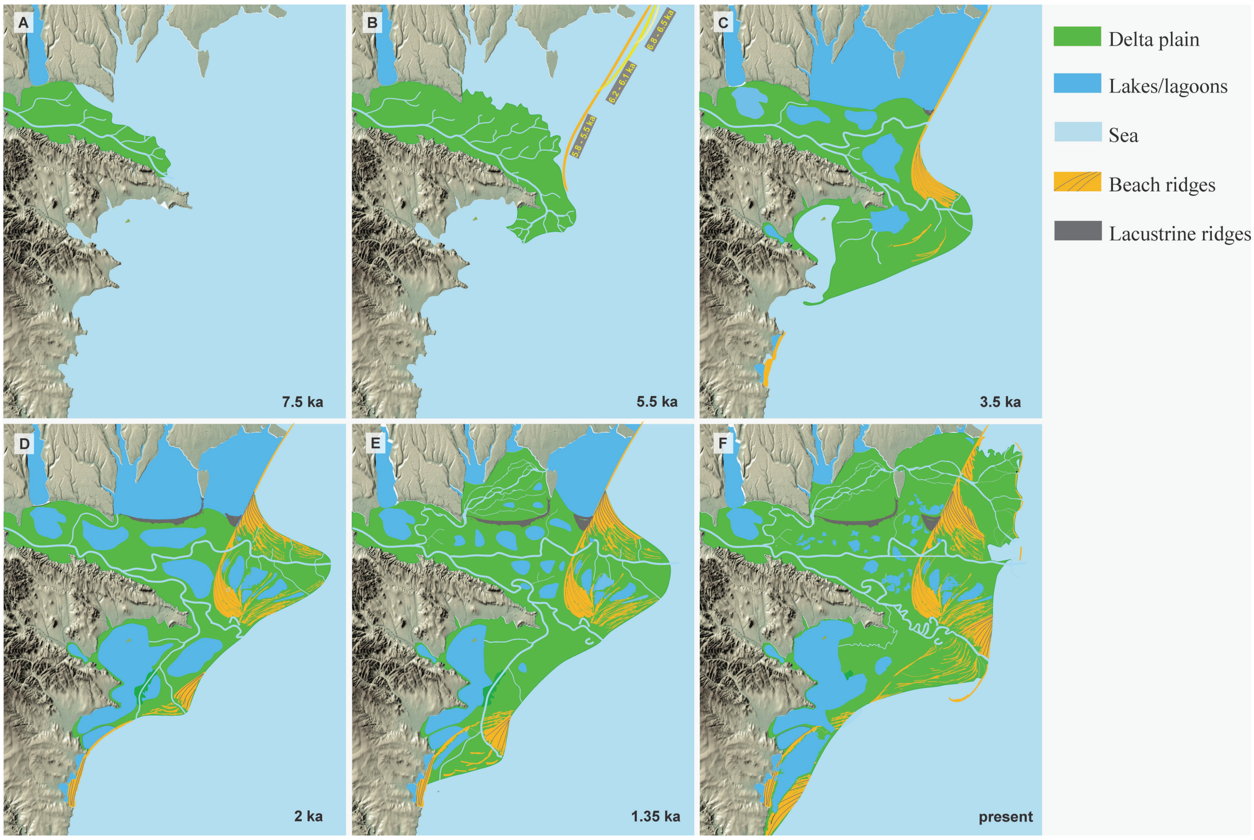

Figure 2: Evolutionary stages of the Danube Delta
(after Vespremeanu-Stroe *et al.* 2017a).

spits and barriers, the variability in time and space of the distributaries and the lobes, etc.[5] However, since Antipa,[6] scholars haves agreed that Danube Delta is composed by two distinct units: a western fluvial delta and a south-eastern maritime delta, separated by the Jibreni-Caraorman barrier. Excepting the problems of geomorphological evolution, another issue is related to the chronology. The first to propose an absolute chronology for the Danube Delta was Panin in 1983,[7] followed by Giosan *et al.* in 2006, who bring a chronology for the maritime unit.[8]

Recent work by Vespremeanu-Stroe *et al.* minutely reconstructed the evolution of the delta, giving new insights into its chronology and development (Figure 2). For the fluvial delta, the authors determined two phases: i) the period between 8000/7500 BP and 5500 BP, which consists of a bayhead delta front advancing into the Danube Bay, followed by ii) a later phase of fluvial aggradation (*ca.* 4000 BP-present), with the emergence and southward elongation of the initial spit (first coastal barrier: Jibrieni-Letea-Caraorman) starting around 6700-6500 BP and ending towards 5800 BP.[9] The maritime unit developed east of the initial spit when the Danube mouths entered under a stronger influence of waves and nearshore currents, since *ca.* 6000-5500 BP, creating a landscape dominated by open-coast deltaic lobes.[10]

Geoarchaeological Research in the Danube Delta: State of the Art

Tracking the evolution of the Danube Delta is crucial in the context in which this landform was inhabited constantly since the Neolithic period. The spatial distribution of human settlements, reflected in their internal development as well as in their rise and decline, is an indicator not only of the delta's morphogenesis, but also for these area's constraints and potentialities. The fluvial and deltaic sediments are rich archives (bio-indicators, macro-remains, artefacts, etc.) that, corroborated with archaeological data, allow the reconstruction of landscape history. Starting with the foundation of the first Greek colonies (Istros/Histria and Orgame) in this area, the Danube Delta become a hotspot for the circulation of both goods and ideas and thereby, it played a major role in shaping what we call today Balkanic culture. This multidisciplinary study aims to highlight the role of the constraints and the potentialities into the development of the ancient human fluvial and coastal settlements located in such a changing and challenging environment as the Danube Delta.

The study of the relationships between ancient societies and their coastal environment has long been fragmentary in the Black Sea area and mainly in the Danube Delta. In recent

5 Vespremeanu-Stroe *et al.* 2017a, 524-26.
6 Antipa 1914.
7 The ages given by Panin for the beginning of the Danube Delta are 11,700 BP-9800 BP, in Panin *et al.* 1983.
8 Giosan *et al.* 2006 date the formation of the Danube Delta around 5200 BP, some 5000 years later than proposed by Panin.
9 Vespremeanu-Stroe *et al.* 2017a, 526-34.
10 Vespremeanu-Stroe *et al.* 2017a, 534-45; 2017b.

years, interdisciplinary and international research teams have started to focus on the geoarchaeological study in the deltaic area, most of the investigations being concentrated on archaeological sites from the Neo-Eneolithic period in Tulcea county.[11] For the Graeco-Roman period, two sites constituted the subject of this research: Orgame[12] and Istros.[13] The only multidisciplinary project of pan-deltaic scope was DELTARCH, 'The Archaeology of the Ancient and Medieval Danube Delta: Modelling Environmental and Historical Change',[14] between 2011 and 2015, based at Alexandru Ioan Cuza University in Iași.

In this general context, a new collaboration started in 2015 between France, Italy and Romania in the framework of the AMIDEX-GEOMED project, 'Geoarchaeology of Mediterranean deltaic environments. A comparative approach including: Turia (Spain), Birgi (Italy), Danube (Romania), Akko (Israel) and Kuban (Russia)', collaboration which continues now under the scheme of the COFUND-DOC2AMU doctoral project 'Environmental Change and Geoarchaeology of the Danube Delta since 6000 years'. The planned research is based on a multidisciplinary approach, including archaeological, historical, geographical, geomorphological and bio-sedimentological data as well as modelling and 3D reconstruction of the delta's human occupation in respect of its geomorphological evolution between the Neolithic and the Middle Ages. Our methodology has been used and developed over two decades.[15] The project presented here integrates sedimentary archives from coastal areas with the archaeological context. Comparative analysis will allow us to cross-examine the economic, social and food supply strategies of the ancient societies that inhabited the Danube Delta in relation to their degree of technical development, hence bring to the fore their adaptability in particularly mobile and changing environments. The stratigraphic sequences in the coastal sedimentary archives comprise, in many places, a clearly identified anthropogenic signature, notably in ancient harbour basins, some of which underwent rapid silting up due to high sediment inputs generated by new agricultural and urban practices since the Bronze Age, inducing, in some cases, successive downstream harbour relocation. Increasing human influence has been, in turn, a dominant driver of change in sediment supply, strongly modulating deltaic development. Human activities in the last 6000 years have determined a transition from a strongly nature-dominated to an increasingly human-dominated environment.[16]

In the context of the relative sea level stabilisation around 6000 years ago, the supply of fluvial sediment has been the key agent in mediating human occupation in deltas in general. Understanding and reconstructing the sediment supply's continuity in space and time is rather challenging in light of the involved geomorphological processes: erosion, distributaries' oscillation, lobe-switching, etc.[17] Settlement pattern is a key for a better understanding of these natural processes, as human occupation translates shoreline changes as well as the dynamics of the natural phenomena that have affected the coastline.

Methodology

Deciphering the interdependent relationships between nature and culture begs a multidisciplinary and comparative approach involving archaeology, history, geography, geomorphology and geology. We have combined fieldwork and laboratory research. Our fieldwork is based on coring campaigns, geophysical investigations and archaeological excavations, which are of a paramount importance for obtaining an extensive dataset for our research. For the laboratory work, different type of analyses are performed: every core's sedimentary content, more precisely the granulometry and texture, is analysed. The biological content (micro- and macro-faunal assemblages) is carefully studied the better to define the palaeo-environments; pollen analyses are also performed in order to identify the palaeo-climate and the vegetation cover. Also, analysis of stable isotopes of lead is carried out in order to discriminate more exactly the anthropogenic signature in ancient harbour contexts. The chronological framework is based on radiocarbon dates obtained from the Poznan Laboratory (Poland), CIRCE Laboratory (Italy) and RoAMS Laboratory (Romania).

All these raw data are corroborated with information from archaeological and historical sources (primary sources, inscriptions, etc.), as well as with data from aerial photographs and satellite images, for modelling the diachronic human occupation in rapport with the evolutionary stages of the Danube Delta. The sites taken into account for our research are, from upstream to downstream, Noviodunum, Aegyssus, Halmyris, Enisala, Orgame, Karaburun and Istros. Thus, we shall obtain new local and regional maps, which will translate the geomorphological and as well anthropogenic transformation of the Danube Delta.

In the present paper we render the preliminary results from three of the aforementioned sites: Halmyris, Enisala and Istros.

Halmyris

Halmyris is located on top of low-lying relict cliffs – the Dunavăț promontory – of the ancient Holocene Danube ria and faces the St George arm (Figure 3a), the oldest branch that has had an uninterrupted flow over the last 8000/7500 years.[18] The present-day St George mouth is located approximately 40 km east of Halmyris.

[11] Carozza *et al.* 2010; 2012.
[12] The research was conducted in the framework of ANR-Pont Euxin. The geoarchaeological research was led by Christophe Morhange and its results are presented in Bony, Baralis *et al.* 2013; Bony, Morhange *et al.* 2015.
[13] Hanganu 2012; Preoteasa *et al.* 2012; 2013; Vespremeanu-Stroe *et al.* 2013; http://histria.geo.unibuc.ro.
[14] Romanescu 2013; Romanescu *et al.* 2015; www.deltarch.uaic.ro.
[15] For example, the investigations conducted in Marseilles by Morhange (1994; Hesnard 2004; Morhange, Laborel and Hesnard 2001); Miletus (Brückner, Müllenhoff *et al.* 2006; Müllenhoff, Herda and Brückner 2009; Brückner, Herda *et al.* 2014.); Ephesus (Kraft *et al.* 1999; Stöck *et al.* 2013; Steskal 2014; Delile *et al.* 2015); Tyre (Marriner, Morhange *et al.* 2005; Marriner and Morhange 2006; Marriner 2007; Carayon *et al.* 2011); Orgamè (Bony, Baralis *et al.* 2013); Akko/Acre (Morhange, Giaime *et al.* 2016); Morhange, Marriner and Carayon 2016; Morhange, Marriner *et al.* 2016; Marriner, Morhange *et al.* 2017.
[16] Berger and Guilaine 2009.
[17] For further details, Bird 2000, 331-47; Vespremeanu-Stroe *et al.* 2017a, 521-29; Anthony 2017, 37-41.
[18] Vespremeanu-Stroe *et al.* 2017a, 533.

The oldest traces of occupation are dated to the 4th century BC, when the Getae settled on the site of the future fort. Notwithstanding this, the oldest pottery fragment discovered on the site dates back to the 6th century BC, typologically pertaining to the Middle Style II bowl of Oriental style.[19] The first archaeological layer corresponds to the period of the 4th-3rd centuries BC, while the second one corresponds to the dwelling level dated to the 2nd-1st century BC and can possibly be related to a *dava*, a fortified Getic settlement. Regarding the settlement type, scholars suggest that pre-Roman Halmyris could also have been an *emporion*, integrated in the *chora* of Istros or, more probably, in that of Orgame.[20] This hypothesis is based on the toponymy (Halmyris is possibly a Greek name, related to the ancient homonymic gulf, which could mean salt water)[21] and on the Greek pottery discovered (especially amphorae from Chios, Chersonesus and Thassos). Even though the proposal of a Greek foundation in which the Getae mixed with the Greek element is plausible, there is not sufficient archaeological data unequivocally to support it.

During the Early Roman period (1st-3rd century AD), Halmyris played a significant strategic role. Initially an earth fortification (last quarter of the 1st century AD), Halmyris was rebuilt in stone during the 2nd century AD as a fort. The newly built fort had an important role in controlling the last segment of the Danubian *limes*, overseeing the territory between Aegyssus (Tulcea) and the mouth of the St George arm.[22]

The most important discoveries dating from this period are eight inscriptions in which a *vicus classicorum* is mentioned.[23] The date of the inscriptions (2nd-3rd century AD) suggests that in this period, near to the *castrum* a civil settlement was founded by the discharged mariners of the *Classis Flavia Moesia.*[24]

The last phase of occupation covers the interval between the last quarter of the 3rd century AD and the third or fourth decades of the 7th century AD.[25] During the Late Roman period, the military character of Halmyris was mixed with civilian dwellings, given the appearance of constructions such as *thermae*. Regarding the harbour, Zosimos (4. 10) informs us that Halmyris was a point of transfer from large maritime vessels to fluvial ones. Moreover, considering the conflicts with the barbarians during the 5th century AD, archaeologists take into account the possibility of the fort also having a military harbour.[26] The abandonment of the fort during the first half of the 7th century AD has several aspects. First of all, the change in the composition of the population, attested by the Slavic pottery, indicates a phase of socio-political instability,[27] something that is characteristic of the entirety of Scythia Minor during this period.[28] This instability is also perceivable in the decline of urban life, for, at this time, the habitat consists of dugouts built of *spolia* from previous structures.[29] As we will see below, we can link these factors with the geomorphological and hydrological changes which took place during the 7th century AD.

The Palaeo-environmental Evolution and the Question of the Harbour

Our research at Halmyris is focused on two main issues: the evolution of the landscape and the identification of possible harbour structures. The core which offered the best insights is HA III, with a length of 575 cm and which is located 100 m in front of the fort's northern gate (Figure 3a, b).

The bio-sedimentlogical analyses of core HAIII shows five main environments which translate a classic progradational sequence dominated by a marine environment at the base of the core, superposed by fluvial sediments. Starting with the 5th millennium BC, the fluvial progradation led to the development of a floodplain characterised by an amphibious environment, as shown by the organic peat layers recorded in the core and dated between 5210 ± 40 cal BP and 3920 ± 35 cal BP.[30] The ages of *ca.* 6100-5400 cal BP which define the contact between the fluvial muds and the basal peat layers for all three cores (HA I-HA III) are in good agreement with the recent reconstruction of delta plain formation, which indicates that *ca.* 6000-5500 years ago the deltaic coastline (via the St George arm) advanced beyond the Dunavăț Promontory reaching the open sea and marking the initiation of the first open-coast lobe.

At the top of the peat layer, we identified a sedimentary sequence consistent with a relatively calm freshwater body. The ostracods from this layer attests the presence of slow moving waters coherent with a calm channel between 2400 cal BC and 600 cal AD, that gently flowed in front of the northern gate of the ancient city.[31] The water depth of this channel was estimated at *ca.* 175 and 195 ± 10 cm b.s.l.[32] The information obtained from the study of core HA III is sustained by the data offered by core HA I, on which the analysis of chironomids (insects, Diptera) was performed.[33] The identified species confirm the presence of a secondary channel of the Danube.[34]

The first pollen analyses carried out at low resolution on the Halmyris core HA II, between 60 and 840 cm depth, indicate a diversified thermophilous forest with a mixed oak forest (*Quercus, Corylus*) associated with *Carpinus* and *Ostrya*. Coniferous forest is also present (*Picea, Pinus, Abies*). These species are associated with a riparian vegetation with alder and willow. The assemblages show a very woody landscape, with very few herbaceous plants and few elements indicating agricultural practices, which were based mainly on cereal cultivation.

The palaeo-environmental analysis allows us to affirm the presence of a shallow fluvial channel in the northern part of

[19] Suceveanu and Angelescu 1988; Zahariade and Karavas 2015.
[20] Zahariade 1991; Suceveanu *et al.* 2003; Zahariade and Karavas 2015.
[21] For the toponymic discussion, see also Suceveanu and Zahariade 1987; Suceveanu *et al.* 2003; Zahariade and Alexandrescu 2011; Zahariade and Karavas 2015.
[22] Suceveanu *et al.* 2003.
[23] Suceveanu and Zahariade 1986; *L'Année Épigraphique* (1988), 987; Zahariade and Alexandrescu 2011, 29-30, no. 6; Matei-Popescu 2016, 217-20,
[24] Zahariade and Alexandrescu 2011, 36-38.
[25] Suceveanu *et al.* 2003.
[26] Suceveanu *et al.* 2003.
[27] Zahariade and Phelps 2002; Suceveanu *et al.* 2003
[28] Suceveanu and Barnea 1991.
[29] Zahariade and Karavas 2015.
[30] Giaime 2016.
[31] Giaime 2016; Vespremeanu-Stroe *et al.* 2017a; 2017b.
[32] Giaime 2016.
[33] Magne 2016.
[34] Gandouin *et al.* 2006; Magne 2016; Giaime 2016.

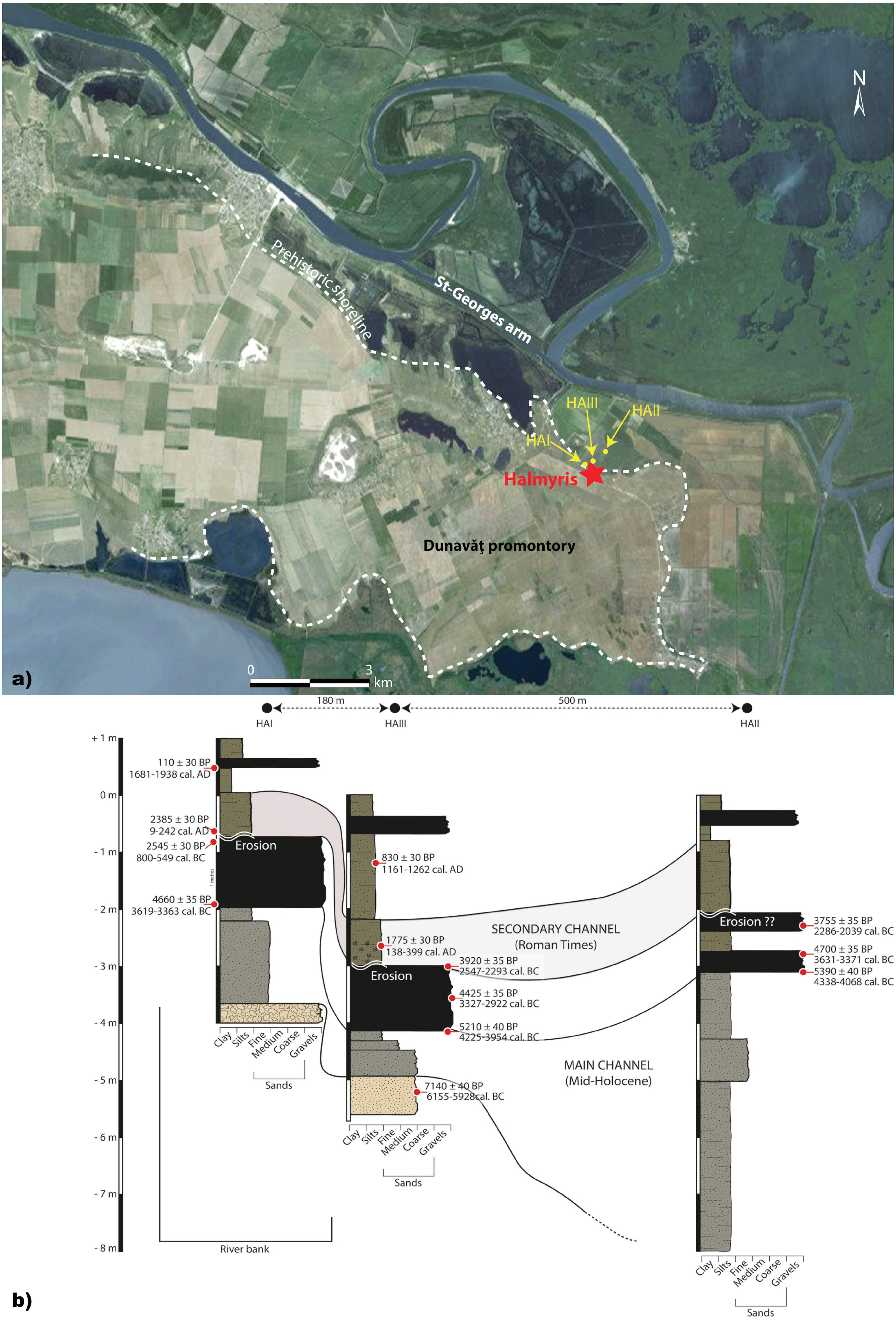

Figure 3: a) Position of Halmyris Fortress on the Dunavăţ promontory and the position of the cores; b) The stratigraphy of the cores with the secondary channel unit emphasised (after Giaime 2016).

Figure 4: Trace of the palaeo-meander as seen from Google Earth. In this secondary channel of the St George arm, the harbour structures could have been installed.

the site (Figure 4), as postulated by archaeologists before.[35] We might assume that during the Roman period (1st-7th centuries AD) the channel could have been used such as a port-canal. At present, no archaeological structure related to the harbour has been discovered, but human intervention in order to maintain the channel's navigability could be conjectured from the chronological inversions recorded in unit E, core HA III.[36] The harbour's confinement due to the disconnection between the secondary channel and the main channel of the St George is contemporaneous with the abandonment of Halmyris during the 7th century AD. Nevertheless, the question of whether the harbour's closure led to the city's abandonment or if the harbour was abandoned because it was no longer used is unclear.

Enisala

Enisala is a village in Tulcea county, located in the northern Dobrudja between the Babadag and Razelm lakes, on whose territory a large volume of archaeological remains from the Neolithic to the Middle Ages have been identified (Figure 5). Considering the density of this material, we positioned core EN I so that the bio-sedimentological data could be correlated with the entire area between the actual village of Enisala and the mediaeval fortress (Figure 5). By contrast with Halmyris, Enisala is located on the proximal margin of the Danube Delta and this site has experienced huge landscape coastal metamorphosis from rocky cliffs to leaky lagoon.

The area has been inhabited ever since the Neolithic period: there are traces of dwelling dated to the Neolithic, Bronze Age, Iron Age (one of the largest Getic necropoleis near a Getic settlement), a Roman village probably called a *vicus Novus*, two Romano-Byzantine fortifications and a well-preserved mediaeval fortress.[37] The mediaeval fortress, which was founded by the Byzantines and Genoese at the end of the 13th-beginning of the 14th century under the name of Heraklea, was an important harbour in the commercial network of the Black Sea. During the reign of Mircea the Elder (1386-1418) it was included in Wallachia's defensive system and was later conquered by the Ottomans, who renamed it Yeni-Sala. The fortress was abandoned during the 16th century.

The Metamorphosis of the Landscape

Considering the high density of archaeological evidence within this area, we will present it briefly in direct relationship with the metamorphosis of the landscape.

Core EN I is located approximately 1 km north-west of the mediaeval fortress. The stratigraphic sequence measures 15 m long and based on our bio-sedimentological analysis registers six stages of environmental transformation, from 6102 ± 33 cal BP to 391 ± 26 cal BP. The first environmental shift is registered around 6102 ± 33 years BP, when the shallow bay identified at the base of our core (between 15 m and 11 m below soil level), became a brackish lagoon (Figure 6). These findings are in general agreement with an independent recent study which, based on multi-proxy analyses, attests that during the Early

35 Suceveanu *et al.* 2003.
36 Giaime 2016.
37 Babeş 1971; Baraschi and Cantacuzino 1976; Ailincăi *et al.* 2011.

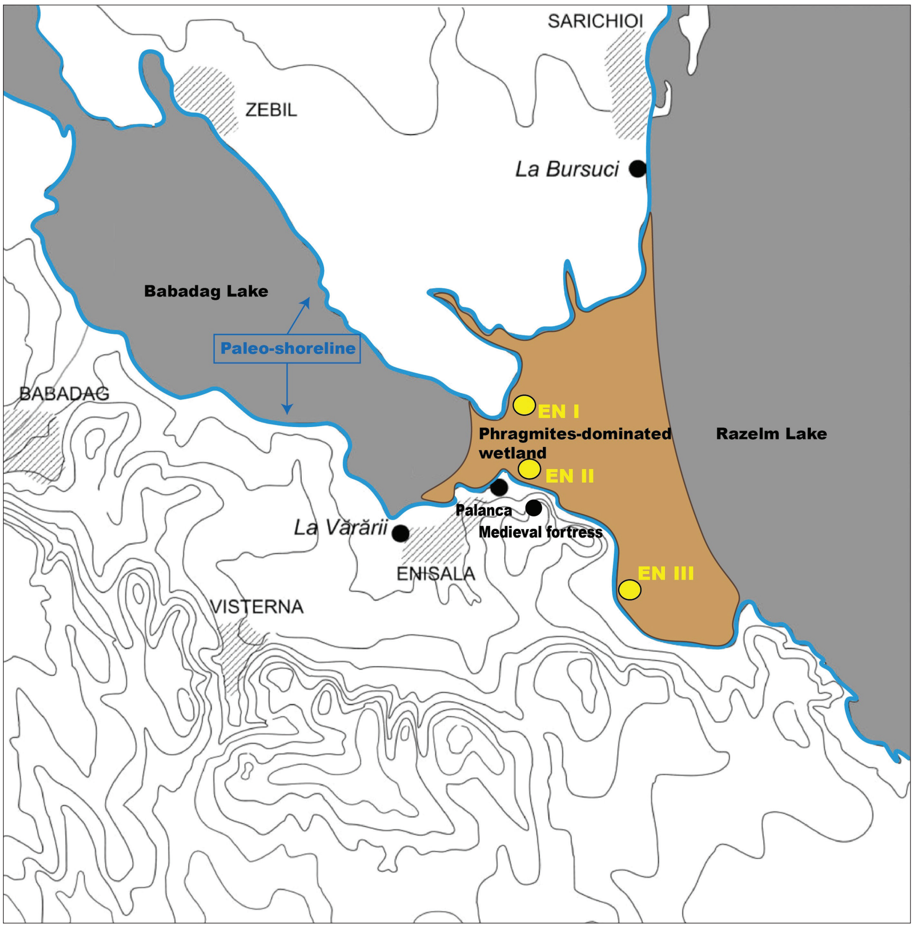

Figure 5: The main Eneolitic sites in Enisala area and the position of the cores (modified after Mihail *et al.* 2012).

Neolithic the first human settlements developed near the Telița-Taița floodplain, which gradually became flooded and turned into brackish marsh and lakes (8000-7500 years ago) in response to the rise in the water table forced by relative sea level rise. Soon after, during 7500-6000 BP interval, the area was transformed into a fully developed marine bay, which is also confirmed by our bio-sedimentological analysis carried on core EN I.

In this milieu, the Neolithic population of Gumelnița culture[38] settled in the Enisala area. In respect to the position of our core, we have many archaeological spots, but the most important is the one called La Palancă. It is situated approximatively 1.5 km north-east of the village, on the contact zone between the Razelm and Babadag lakes, at the foot of the Gras Hill where the mediaeval fortress was built. Even though the site was noticed in 1947[39] and archaeological investigations were conducted in 1979[40] and during the 2000s,[41] there is little data regarding the Late Neolithic habitation in this area. The research revealed only one archaeological layer specific to the habitation level. The scattered data led the researchers to the hypothesis that the Late Neolithic habitation at Enisala covers a very short timespan.[42]

The fact that close to this spot other Late Neolithic traces were discovered, more precisely at La Vărării (approximately 500 m south-west of La Palancă) and La Bursuci (approximately 4.5 km north of La Palancă), is an indicator of dynamic human activity during this epoch (Figure 5). The main question regarding the Late Neolithic habitations is whether the archaeological traces were poorly preserved because of recent human activity (for example, clay extraction, agriculture, draining, etc.) or are we dealing with some environmental or societal stress that impeached a more powerful human development during Late Neolithic?

An important fluvial activity considering the freshwater ostracod fauna and dated between 5742 ± 34 cal BP – 4799 ± 30 cal BP marks the partial confinement of the lagoon (Figure 6).

The restricted lagoon, formed around 4799 ± 30 cal BP would slowly evolve into a wetland and persist as such up to the Middle Ages (Figure 6). The Bronze Age at Enisala is poorly represented, as generally all over the Dobrudja.[43] For the Early and Middle Bronze Age we do not have any discoveries; the first material evidence is dated during the Late Bronze Age, when Coslogeni culture emerges around 14th century BC.[44] As for the Late Neolithic period, the question regarding the extent and frequency of archaeological discoveries dated

[38] The main culture of the Dobrudja region during Late Neolithic, which covers the second half of the 5th millennium to the beginning of the 4th millennium BC.
[39] Ailincăi and Constantinescu 2008.
[40] Lăzurcă and Mănucu-Adameșteanu 1980.
[41] Jugănaru *et al.* 2004; 2005; 2006; 2007; Mihail *et al* 2012.
[42] Mihail *et al.* 2012.
[43] Morintz 1972; Lăzărucă 1972; Roman 1986; Irimia 2003; Dobrinescu 2005.
[44] Morintz and Angelescu 1970.

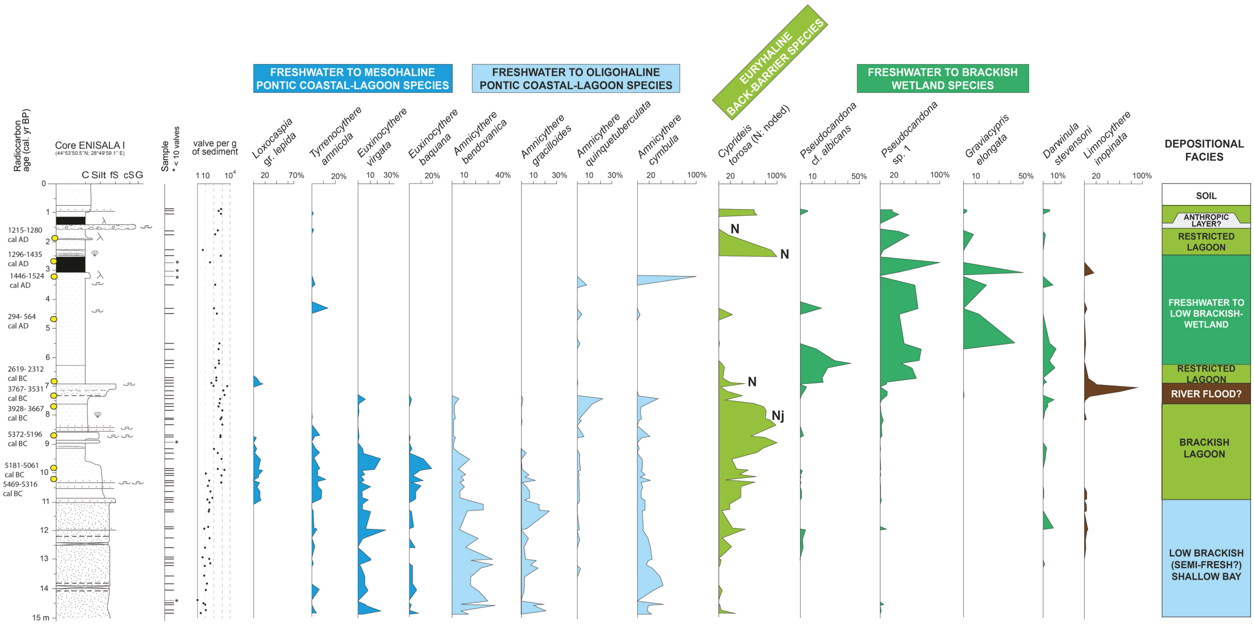

Figure 6: Palaeo-environmental evolution at Enisala based on ostracod fauna and depositional facies (core EN I).

during the Late Bronze Age remains open.[45] Archaeological remains from Iron Age are more numerous. For the first phase of this period (Babadag culture, 10th century BC-second half of the 7th century BC), the discoveries are concentrated at La Palancă and on the hill where the mediaeval fortress is located. During the second phase (6th/5th century BC-2nd century BC), the majority of archaeological discoveries are of Getic origin. Along with this autochthonous material, we find also Greek artefacts, unsurprising considering the proximity of cities such as Orgame and Istros. One of the most important vestiges of this period is the necropolis, dated to the 4th-3th century BC, being one of the biggest Getic necropoleis with its architecture and rituals directly influenced by Orgame's necropolis.[46]

Therefore, at La Palancă there is a remarkable uninterrupted period of dwelling since Late Neolithic, with a hiatus during the Early and Middle Bronze Age, while the Getic dwelling settled over the Late Bronze one.

During the Early Roman period (1st-4th century AD), traces of habitation (a large quantity of Roman pottery on the soil surface) were identified at La Bisericuță site and in the centre of the actual village, as well as at La Palancă.[47] For the Late Roman period (4th-6th century AD), we have a fortress on a small promontory on the shores of Babadag lake, north-east of the village (La Peşteră site).[48] In the proximity of the fortress, there is a necropolis dating from the same period.

Until the construction in 1969 of the road between Enisala and Sarichioi, at La Palancă (500 m north-east of La Peșteră) there was a small fortress (*castellum*), with the dimensions 35 x 40 m, with *fossa* and *vallum*, also Late Roman in date.[49] Today some traces of it are visible.[50]

An important discussion concerning Enisala during the Roman period is if it was the location of a *vicus Novus*. In the 19th century, an inscription dated in the 3th century AD and mentioning *vico Nov(us)* was discovered at Babadag (7 km north-west of Enisala). Since then, whether the Roman village was located at Enisala or at Babadag has been debated, considering that there are many instances of inscriptions not discovered in their original place. In support of Enisala, A. Barnea underlines the toponymic continuity: *vicus Nov(us)* – Novώ – Novoe Selo – Yeni Sale – Enisala.[51] G. Nuțu, in an article from 2009, argues that even though this hypothesis is very attractive, we cannot ignore the hiatus between the inscription's date and the foundation of Yeni Sale (13th century AD).[52]

The last transformation of the environment is dated to 565±52 cal BP (Figure 6, core EN I), respectively to 460 cal BP, when the abundant sediment supply derived from massive deforestation and intensive land-use in the Middle Ages finally led to the clogging of the lacustrine area between the Babdag and Razelm lakes and the recent installation of *Phragmites Australis* marsh through which artificial navigation channels are preserved.[53] The equivalent age of 1420-1560 cal AD,[54] correspondents to the last phase of the mediaeval fortress. The former conditions (lagoon) could have been one of the factors encouraging the Genoese to erect here a fortress and a harbour, considering that accessibility to the

[45] For the discussion concerning the demographic issue during Bronze Age mainly in southern Romania, but also in the Dobrudja region, see Schuster 2011. The author emphasises not only the geographic-climatic influence, but also the nomadic way of life, as well as an unequal repartition of contemporary research.
[46] Lungu 2010.
[47] Stănică *et al.* 2005-06.
[48] Iacob *et al.* 2006.
[49] Nuțu 2009, 124.
[50] In Ștefan 1977. On an aerial photograph from 1969 there are still visible the traces of a defensive wall: Nuțu 2009.
[51] Barnea 1998.
[52] Nuțu 2009.
[53] Preoteasa *et al.* 2019.
[54] Vespremeanu-Stroe *et al.* 2013; 2017b.

open sea was of paramount importance for a commercial and maritime society such as theirs. Also, the poor traces of human occupation from previous periods, especially from the Graeco-Roman period when to the north we have the Roman fortress of Halmyris and to the south the Greek city of Orgame, could indicate that the constraints of the environment hindered a more extensive development of human occupation.

Important information about the landscape's transformation comes from mediaeval written sources regarding maritime and fluvial transport in the Danube Delta. Even though the Genoese preferred to use *bastarda*, a narrow galley with high decks, in the Danube Delta they used *ciguti*, a hybrid type of cargo ship.[55] Moreover, at Killia, also a Genoese fortress built on the Chilia branch, another type of ship was used: *pamfyloi*, a round-hulled vessel that served to ferry war machines and horses, oar- and sail-powered (between 130 and 160 oarsmen).[56] The fact that the Genoese used small and round-hulled vessel in this area is an indicator of a shallow but navigable water column.

Istros/Histria

The ancient city of Istros is located on the southern margin of the Razelm-Sinoe lagoon system close by the southern limit of the Danube Delta. This area is defined by the coexistence of distinct geomorphological units, namely two major beach ridge plains (Saele, where Istros is located, and Chituc), sandy barriers (Lupilor) and shallow lakes (Sinoe on the east, Istria and Nuntași on the west) interconnected by natural and artificial channels. The main sedimentary input came from the St George's branch, via the Dunavăț (Peuce) channel which, before its canalisation in 1912, represented a secondary distributary.[57]

The intense coastal progradation (14-20 m/year) of the Istros region associated with a local high discharge of the Dunavăț branch and with the New Dunavăț lobe development (2000-1300 years BP), along with the longshore currents, led to the rapid formation (10-15 m/year: 1000-720 cal BP) of the eastern unit of Saele beach ridge plain, with a maximum length of 9.5 km and a width of 3 km.

The older unit, Saele West, is OSL dated to 5000-2730 cal BP[58] and connects the green schist palaeo-island (where Istros' Acropolis is located) to the continent. The existence of this coastal plain before the foundation of the city by the Milesians in the second half of the 7th century BC is supported by geomorphological evidence[59] as well as by archaeological data, as we can see from the dwelling structures dated to the Archaic period (end of 7th-5th century BC), which are built directly on the sand on the Western Plateau.[60]

The continuous occupation of almost 1300 years, which can be grouped into five main archaeological periods, has been the subject of numerous studies and monographs[61] and, therefore, it will not constitute a topic of the present paper.

Environmental Changes and the Question of the Location of the Harbour Basin(s)

Since the beginning of research at Istros, the issue of landscape transformation and the identification of the harbour were topics of debate. From archaeologists to geographers and geoarchaeologists, different reconstructions were proposed,[62] none of them unanimously accepted. Identifying the ancient harbour basins is of paramount importance from a palaeo-environmental point of view, as we can clearly delimitate the palaeo-shorelines, but also for the question of coastal progradation: this geomorphological process implies a 'race to the sea' of Istros' harbour(s).

Up to the present, our research at Istros is the first with an integrated approach, as we have managed to corroborate three different methods of investigation: long continuous cores and bio-sedimentological analysis, geophysical survey, and archaeological excavation.

After the first campaign in 2015, in 2017 we undertook 25 more cores (Figure 7a, b), having altogether 29. Based on bio-sedimentological analysis from 2015[63] and on the stratigraphical and sedimentological observations made in the field, we proposed a preliminary palaeo-environmental reconstruction and a possible location for the harbour basins (Figure 8). During the Archaic period, we might have a first phase anchorage on a pocket beach, open to the Black Sea, most probably located south from the green schist island, considering the main direction of the storm waves (north-easterly) on the western Pontic coast and the prevalence of northern winds.[64] Nevertheless, in core HIS XXIII, located in the north-western corner of the island, we identified a stratigraphic sequence quite similar to that identified to the south (cores HIS V, HIS VI, HIS VII), so the possibility of another anchorage spot on the northern side of the island should not be ruled out. A harbour basin could also have been located in the north-western part of the site in the so-called Sărătură spot.

Another important question raised after our field observations is related to the communication between the two nuclei of habitation: the Acropolis (palaeo-island) and the Western Plateau (Old Saele BRP). As we remarked, with the presence of a body of water to the south as well to the north, we attempted to find the route of circulation between the two nuclei. Hence, we took two cores (HIS X and HIS XX) in the more auspicious area, a ridge that forms the northern limit of the Sărătură Basin (Figure 9a), whence communication could have been made and we discovered a completely different sedimentological sequence from the other cores. This led us to the hypothesis of the existence of a dam or causeway linking the two urban nuclei. With the

[55] Atanasiu 2006.
[56] Atanasiu 2006.
[57] Antipa 1914; Hanganu 2012, 24; Vespremeanu-Stroe *et al.* 2013, 248.
[58] Hanganu 2012; Preoteasa *et al.* 2013; Vespremeanu-Stroe *et al.* 2013.
[59] Hanganu 2012; Preoteasa *et al.* 2013; Vespremeanu-Stroe *et al.* 2013; Bivolaru 2016.
[60] Dimitriu 1966, 27-37.
[61] For the history of research, see Angelescu and Avram 2014.
[62] Moisil 1909; Pârvan 1915; 1916; Lambrino 1938; Condurachi 1954; Canarache 1956; Bleahu 1963; Coteț 1966; Adameșteanu 1967; Alexandrescu 1970; Ștefan 1987; Bounegru 1988; Höckmann, Peschel and Woehl 1996-98; Dabîca 2011; Hanganu 2012; Preoteasa *et al.* 2013; Vespremeanu-Stroe *et al.* 2013.
[63] Bivolaru 2016.
[64] Dinu *et al.* 2013; Zăinescu *et al.* 2017.

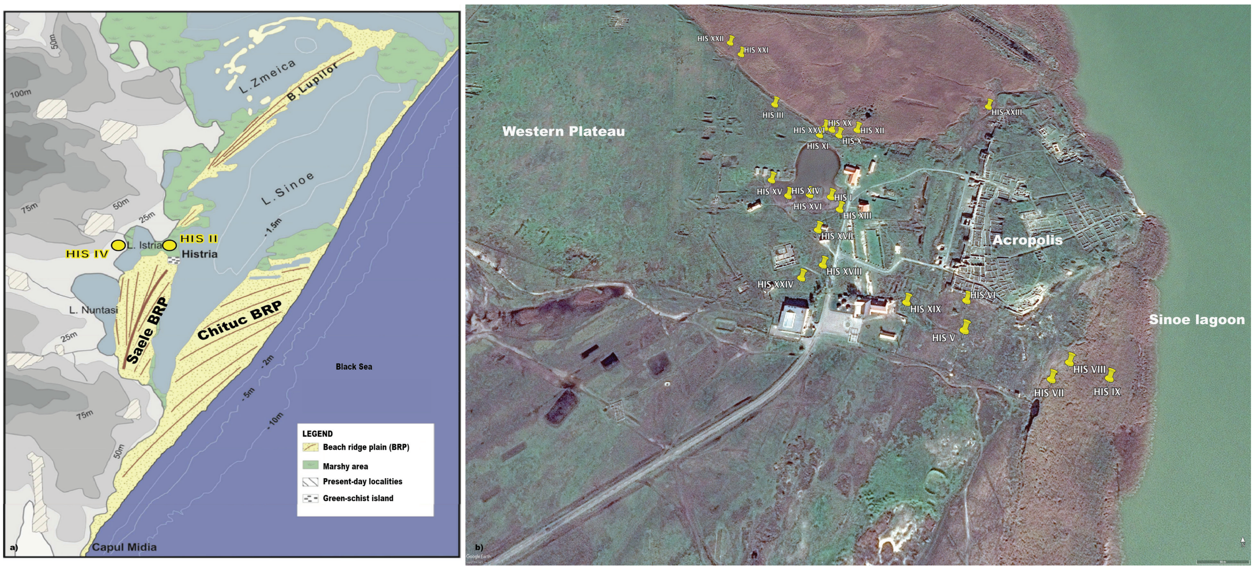

Figure 7: a) Geomorphological map of Istros region (modified after Hanganu 2012, 24) with the position of cores HIS II and HIS IV; b) The position of the cores on the archaeological site.

Figure 8: Proposition of reconstruction of the harbour basins at Istros, based on the stratigraphic observations made during the fieldwork. This hypothesis will be tested by our further bio-sedimentological and geochemical analyses (UAV photography: A. Asăndulesei).

help of a team from ARHEOINVEST, led by Dr Asăndulesei, geophysical investigations (GPR and ERT) were effectuated along the dam/causeway area (Figure 9b). By comparing the geophysical data with the stratigraphy obtained from the cores, we decided to start an archaeological excavation for checking the functionality of the area. Therefore, a trench was excavated: 17 m long orientated north to south (perpendicular on the ridge) with a width of 2 m and a depth of 1.8 m (Figure 10). We discovered three superposed archaeological structures with a north-west to south-east orientation and fashioned just on the western side. Based on the archaeological material, these cam be dated between the Hellenistic period (4th century BC) and the Early Roman (1st century AD). We did not find any archaeological material from the Late Roman period. This is an important indication, as we can deduce that the area was by then no longer useful for some reason or another (economic, environmental?). The use of these structures is still unclear: the small width of the trench has inhibited interpretation. Nevertheless, we took a core (HIS XXVII) inside the trench and another one (HIS XXVIII) at its northern limit in order to see if the dwelling continues under these structures, and we found

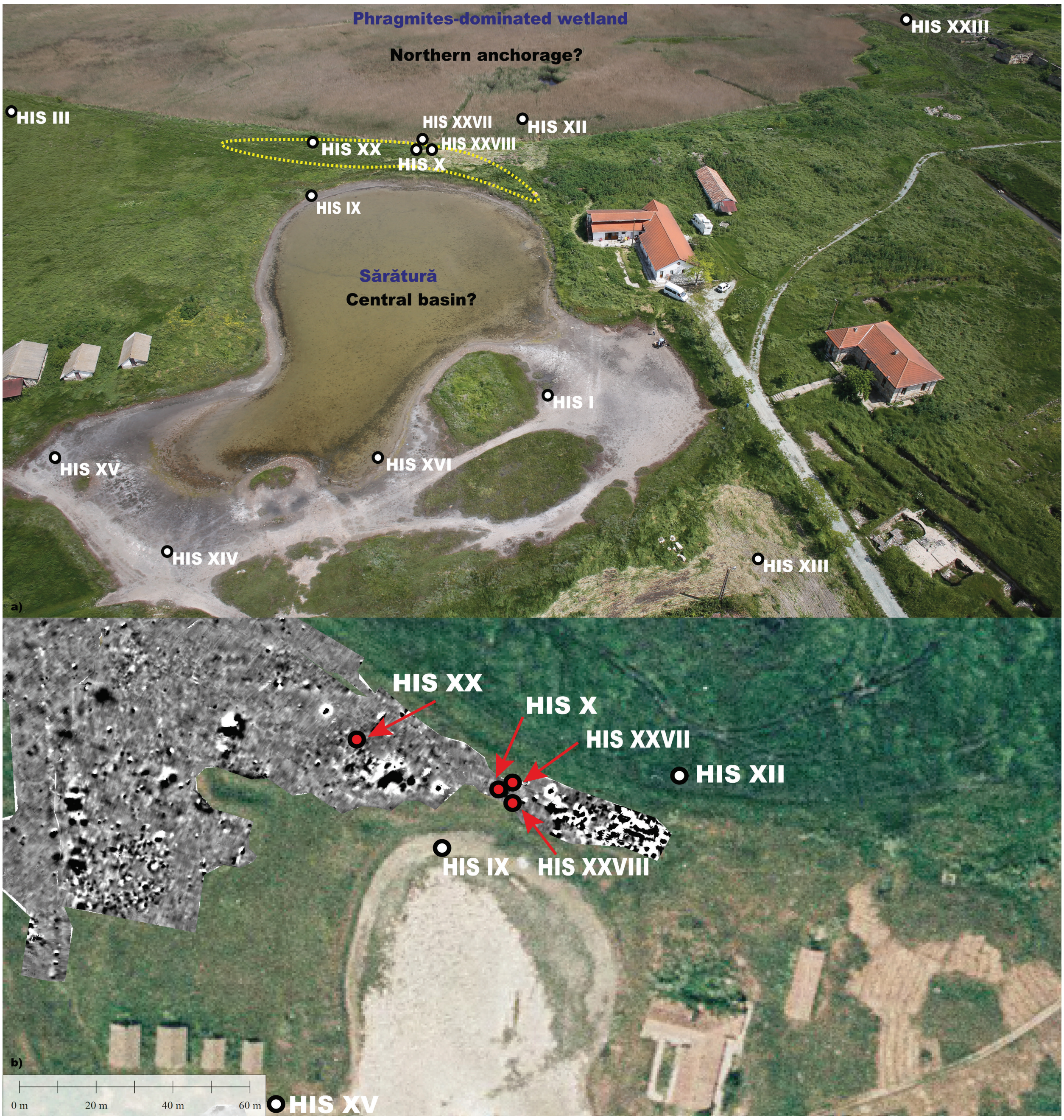

Figure 9: a) Sărătură spot with the position of the cores; the ridge is punctuated in yellow.
b) Geophysical investigations (electromagnetism) on the ridge and Western Plateau
(© A. Asăndulesei).

archaeological material[65] for another metre. The continuation of this excavation in future years is of fundamental importance, as it can test the working hypothesis presented above.

Questions and perspectives

As one can observe, a multidisciplinary approach is relevant in archaeological research in coastal areas from at least two points of view: (1) by corroborating historical, bio-sedimentological and geophysical data, etc., we are better able to contextualise the archaeological record in a coastal environment; (2) we can examine the economic, social and spatial strategies of these societies in relation to their degree of technical development and hence bring to the fore their adaptability in particularly mobile and changing environments.

Although some preliminary responses were offered by our research, there are still many questions that need to be answered at. An important factor that needs to be taken into account by readers of this paper is the stage of our research. Considering that we took a rather impressive number of cores during the 2017 campaign, more results will be revealed in

[65] The pottery sherds identified in the cores are impossible to determine due to the fact that they are just atypical fragments, thus a chronology could not be established.

Figure 10: Archaeological excavations on the ridge. We can easily remark the same north-west to south-east orientation of the three structures.

the near future, not just for the sites presented here, but also at a regional scale, for the entire Danube Delta.

Considering the sites, for Halmyris, one of the topics is the trajectory of the palaeo-channel, another is the existence or not of some artificial harbour structures (quays or docks) along the palaeo-riverbanks. The palaeo-ecological study of core HA II will improve evidence of higher resolution changes in eco- and agrosystems. For the palaeo-environmental question, another core was instituted in order to reinforce our results; for the archaeological question, geophysical and archaeological investigations are wanted to determine clearly the existence of a harbour setting.

In the proximal margin of the Delta, in Enisala, we obtained a local-scale palaeo-environmental image in which the anthropogenic impact is hardly sizable. Hence, two other cores were undertaken in the marshy area at the base of the La Palancă site and at the base of Grass Hill, where the mediaeval fortress is located, to obtain a more discriminating picture of the human impact on the environment. Also, a comparison with a core located 1.2 km west of EN I is about to be finalised, towards a comparative approach of landscape metamorphosis, as this other core is situated further inland than EN 1.

For Istros, our preliminary hypothesis presented here will be toughened by bio-sedimentological analysis, as well as by a more robust chronology. As mentioned before, the archaeological excavation needs to be continued, on a larger surface, to offer a more elaborate interpretation.

At a regional scale, the questions of where, when and how ancient societies transformed their deltaic environment form the basis of our research – and how, conversely, this environment restrained or favoured the evolution of these societies. In this respect, we long to distinguish the spatial extent and frequency of these changes by investigating the aforementioned archaeological sites, located in key positions, that may hold new insights into how the history and geomorphological environment of coastal civilisations were interconnected during the Holocene, in the context of deltaic zones.

Archaeological site	Lab code	Sample nº	Depth (cm)	Material	Conventional Age BP	Age cal. BP (2σ)	Age cal. BC/AD (2σ)	Marine reservoir age (Siani et al. 2000)
Halmyris	Poz-79628	HAI(55-60)	55-60	Peat	110(30)	12 - 269 BP	1681-1938 AD	
Halmyris	Poz-79629	HAI(157-163)	157-163	Plan remains	900(30)	740-911 BP	1039 - 1210 AD	
Halmyris	Poz-79163	HAI(157-163)	157-163	Marine shell (*Cerastoderma glaucum*)	2385(30)	1708 - 1941 BP	9 - 242 AD	498(41)
Halmyris	Poz-79630	HAI(170-175)	170-175	Peat	2545(30)	2498 - 2749 BP	800 - 549 BC	
Halmyris	Poz-79631	HAI(295-300)	295-300	Peat	4660(30)	5315 - 5467 BP	3518 - 3366 BC	
Halmyris	Poz-83374	HAII(225-230)	225-230	Peat	3775(35)	3498 - 3701 BP	2288 - 2039 BC	
Halmyris	Poz-83375	HAII(276-280)	276-280	Charcoal	4700(35)	5320 - 5580 BP	3631 - 3371 BC	
Halmyris	Poz-83376	HAII(310-313)	310-313	Charcoal	5390(40)	6017 - 6287 BP	4338 - 4068 BC	
Halmyris	Poz-81693	HAIII(60-63)	60-63	Peat	1230(30)	1069 - 1261 BP	689 - 802 AD	
Halmyris	Poz-79633	HAIII(120-125)	120-125	Plant remains	830(30)	688 - 789 BP	1161 - 1262 AD	
Halmyris	Poz-81694	HAIII(245-250)	245-250	Organic sediment	1930(30)	1820 - 1946 BP	4 - 130 AD	
Halmyris	Poz-79655	HAIII(270-275)	270-275	Charcoal	1775(30)	1611 - 1812 BP	138 - 339 AD	
Halmyris	Poz-81695	HAIII(275-280)	275-280	Charcoal	2585(35)	2510 - 1770 BP	821 - 561 BC	
Halmyris	Poz-79656	HAIII(300-305)	300-305	Charcoal	3920(35)	4242 - 4496 BP	2547 - 2293 AD	
Halmyris	Poz-79657	HAIII(355-360)	355-360	Peat	4425(35)	4871 - 5276 BP	3327 - 2922 BC	
Halmyris	Poz-81696	HAIII(405-410)	405-410	Peat	5210(40)	5903 - 6174 BP	4225 - 3954	
Halmyris	Poz-79659	HAIII(470-480)	470-480	Organic material	5125(35)	5749 - 5939 BP	3990 - 3800 BC	
Halmyris	Poz-79164	HAIII(530-540)	530-540	Freshwater shell (*Dreissena polymorpha*)	7170(40)	7877 - 8104 BP	6155 - 5928 BC	498(41)
Enisala	RoAMS-519.67	EN_I_195	195	Typha	776(28)	525 - 636 BP	1314 - 1425 AD	
Enisala	RoAMS-518.67	EN_I_245-240	245-240	Marine shell (*Cerastoderma glaucum*)	391(26)	139 - 227 BP	1723 - 1811 AD	Not applicable
Enisala	RoAMS-517.67	EN_I_320	320	Vegetal remains	379(27)	427 - 504 BP	1446 - 1523 AD	
Enisala	RoAMS-616.67	EN_I_460-455	460-455	Marine shell (*Cerastoderma glaucum* and fragments)	2473(27)	1928 - 2120 BP	171 BC - 22 AD	498(41)
Enisala	RoAMS-515.67	EN_I_695-690	695-690	Marine shell (*Cerastoderma glaucum* and fragments)	4799(30)	4852 - 5043 BP	3094 - 2903 BC	498(41)
Enisala	RoAMS-514.67	EN_I_740	740	Marine shell (*Cerastoderma glaucum* and fragments)	5742(31)	5984 - 6195 BP	4246 - 4035 BC	498(41)
Enisala	RoAMS-513.67	EN_I_775-770	775-770	Marine shell (*Cerastoderma glaucum* and fragments)	5872(34)	6172 - 6307 BP	4358 - 4223 BC	498(41)
Enisala	DSH7733_SH	EN_I_870-875	870-875	Marine shell (*Cerastoderma glaucum*)	6280(56)	6493 - 6795 BP	4846 - 4544 BC	498(41)
Enisala	RoAMS-512.67	EN_I_990-985	990-985	Charcoal	6216(33)	6781 - 6972 BP	5023 - 4832 BC	
Enisala	RoAMS-511.67	EN_I_1010-1005	1010-1005	Charcoal	6392(33)	6996 - 7212 BP	5263 - 5047 BC	
Enisala	RoAMS-510.67	EN_I_1050-1045	1050-1045	Charcoal	6102(34)	6658 - 6807 BP	4858 - 4709 BC	
Istros	RoAMS-526.67	HIS I_156-155	156-155	Wood	5653(33)	6391 - 6498 BP	4549 - 4442 BC	
Istros	RoAMS-525.67	HIS I_168-158	168-158	Charcoal	2969(29)	3056 - 3227 BP	1278 - 1107 BC	
Istros	Poz-78016	HIS-I-2 168-169	168-169	Organic matter	4230(35)	4800- 4860 BP	2911 - 2851 BC	
Istros	RoAMS-524.67	HIS I_492-490	492-490	Wood	7045(34)	7826 - 7958 BP	6003 - 5873 BC	
Istros	Poz-78019	HIS-I-4 496-500	496-500	Organic matter	3745(35)	3984 - 4162 BP	2213 - 2035 BC	
Istros	Poz-78020	HIS-I-5 563-567	563-567	Organic matter	9520(50)	10659 - 10902 BP	8953 - 8710 BC	
Istros	RoAMS-523.67	HIS I_577-567	577-567	vegetal remains	4331(32)	4842 - 4970 BP	3021 - 2893 BC	
Istros	Poz-78021	HIS-I-6(1) 640-650	640-650	Organic matter	3820(35)	4141 - 4300 BP	2351 - 2192 BC	
Istros	Poz-78333	HIS-I-6(2) 640-650	640-650	Marine shell	3110(30)	2139 - 2428 BP	479 - 190 BC	498(41)
Istros	RoAMS-522.67	HIS-I-660-650	660-650	Wood	4706(32)	5322 - 5419 BP	3470 - 3373 BC	
Istros	Poz-78334	HIS-II-2 100-123	100-123	Marine shell (*Abra alba*)	3780(30)	2947 - 3264 BP	1315 - 998 BC	498(41)
Istros	Poz-78335	HIS-II-2 180-190	180-190	Marine shell (*Abra alba*)	4305(35)	3600 - 3898 BP	1949 - 1651 BC	498(41)
Istros	Poz-78337	HIS-II-3 260-280	260-280	Marine shell (*Abra alba*)	4015(30)	3290 - 3543 BP	1594 - 1341 BC	498(41)
Istros	Poz-78338	HIS-II-3 370-380	370-380	Marine shell (*Abra alba*)	3585(30)	2741 - 2988 BP	1039 - 792 BC	498(41)
Istros	Poz-78022	HIS-III-2 190-200	190-200	Organic matter	2305(30)	2306 - 2357 BP	408 - 357 BC	
Istros	Poz-78023	HIS-III-3 316	316	Organic matter	2150(30)	2039 - 2183 BP	234 - 90 BC	
Istros	Poz-78025	HIS-III-3 355-365	355-365	Organic matter	2250(30)	2156 - 2267 BP	318 - 207 BC	
Istros	RoAMS-528.67	HIS III_355-365	365-355	Wood	2196(28)	2140 - 2312 BP	363 - 191 BC	

Table 1: Radiocarbon determinations and calibrations.

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