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The nEU-Med project: Vetricella, an Early Medieval royal property on Tuscany's Mediterranean

edited by
Giovanna Bianchi, Richard Hodges

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The nEU-Med project: Vetricella, an Early Medieval royal property on Tuscany's Mediterranean

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All'Insegna del Giglio

Cover: Aerial view of excavations at Vetricella (Scarlino, GR) (photo nEU-Med project).

Unless otherwise specified, all photos are by the authors of the individual articles.

Italian to English translation

Alexander Agostini for contributions:

Introduction by G. Bianchi, R. Hodges

The stratigraphic sequence at the site of Vetricella (8th-13th centuries): a revised interpretation by L. Marasco, A. Briano

The coins from the excavations of Vetricella. Notes on the issues of Berengar I by the mint at Pavia by A. Rovelli

The Medieval coins from Vetricella: the stratigraphic context by C. Cicali, L. Marasco

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Rural public courts for an economic history of the Kingdom of Italy (10th and 11th centuries): an archaeological survey by G. Bianchi

Virna Pigolotti for contributions:

Archaeological and geochemical surveys in the Pecora Valley: the first results by L. Dallai, I. Carli, V. Volpi

Simonetta Ceglia for contributions:

Single fired glazed ceramics and colature rosse *from the site of Vetricella (Scarlino, Grosseto): typological study and first thermoluminescence analysis (TL)* by A. Briano

The coarse, fine and selezionata *wares from the site of Vetricella (Scarlino, Grosseto): a comparative analysis of two contexts* by L. Russo

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The Knots and the Nets: Fisc, Rural Estates and Cities in the Written Sources (Northern Italy, c. 800-1000) by A. Fiore

English to Italian translation

Simonetta Ceglia for contributions:

The blue and bluish green glass sherds, decorated with opaque white glass strands, discovered at Vetricella (Scarlino, Grosseto): analytical study by B. Gratuze

Defining the archaeology of Bloch's first Feudal Age. Implications of Vetricella Phases I and II for the making of Medieval Italy (8th-9th centuries) by R. Hodges

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Italian abstracts

* * *

Pierluigi Pieruccini, Davide Susini***

THE HOLOCENE SEDIMENTARY RECORD AND THE LANDSCAPE EVOLUTION ALONG THE COASTAL PLAINS OF THE PECORA AND CORNIA RIVERS (SOUTHERN TUSCANY, ITALY): PRELIMINARY RESULTS AND FUTURE PERSPECTIVES

1. INTRODUCTION

The Holocene landscape evolution of the coastal plains around Mediterranean is a key issue in order to assess the relative influence of sea-level rise (isostasy, tectonics etc.) and climate and human-induced changes on the inland landscape (Mazzini *et al.* 1999; Carboni *et al.* 2002; Rossi *et al.* 2011). Moreover, the assessment of the depositional environments and their changes through time and space provides important proxy data about site formation processes in the archaeological record as well as information about settlement strategies and environmental exploitation (Bini *et al.* 2006; Carmona González, Pérez Ballester 2011). This is the case of the coastal plains of the Pecora and Cornia rivers (*fig*. 1) where research activities of the ERC Project nEU-Med (Bianchi, Hodges 2018) have been focussed. The presence of early Medieval settlements in both areas raised the question of the character of the physical environments at a mid- to large-scale around the sites, including the hydrography and the extent of the lagoon and related surface processes. In fact, Vetricella is located at the transition between the alluvial and the coastal plain of Pecora river basin (Marasco 2009), while Carlappiano (Dallai 2018) lies on the coastal dune belt that marks the coastline progradation during the Holocene in the Cornia basin.

Based on this premise, in this paper we present the preliminary results of a coring campaign carried out in the two coastal plains *(fig*. 1), mostly dealing with sedimentary facies and chronology. Due to the long chronological intervals under discussion, greater effort was initially devoted to investigating the upper part of the stratigraphy and its chronology. However, the sedimentary analysis extended to the whole stratigraphy, although supported by less geochronological data. These are also the first long- record data regarding the assessment of the evolution of the Late Holocene (Meghalayan, cfr. Walker *et al.* 2018; IUGS 2019) physical palaeoenvironments along the northern Mediterranean, although two decades ago core analyses in the Cornia area were undertaken with an emphasis on the Last Glacial-Interglacial cycle (Amorosi *et al.* 2004). Further investigations regarding biological (pollen, charcoals, ostracods, foraminifera, fish etc.) and geochemical (TIC/TOC, pH, electrical conductivity, P etc.) proxies are currently ongoing.

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2. MATERIALS AND METHODS

The location of the cores followed a detailed geomorphological survey and mapping (*fig*. 1) carried out by traditional fieldwork, high-detailed Digital Terrain Model derived by LIDAR available from the Regione Toscana Environmental Agency (http://www.regione.toscana.it/web/geoblog/-/opengeodata), classified to a 10 cm resolution and geo-referenced on historical maps. In the latter, the boundaries of the so-called lagoons and swamps of the beginning of the 19th century (Catasto Leopoldino, 1821, www502.regione.toscana.it/geoscopio/castore.html) were taken into consideration in order to fit some of the cores with the most recently preserved lagoon environments in the area. Undisturbed sediment cores were collected using a drilling machine equipped with a hydraulic piston and a 1 m-long cylindrical corer with a 101 mm-diameter cutting shoe. Drillings were performed by GAMMA GeoServizi company. Respectively, 8 and 4 cores were drilled in the Cornia and Pecora coastal plains. The depth of the cores spans between 6 and 10 m according to the type of sediments and the chronological interval under examination. The drilling system and the sedimentological characteristics allowed the recovery of about 90% of the undisturbed sediments. Cores were preliminarily studied in the field and subsequently moved to the lab at the Department of Physical Sciences, Earth and Environment, University of Siena, for cleaning and detailed description and documentation. Facies analysis took into account texture, colour, fabric and sedimentary structures, biological rests (plants, charcoal, molluscs etc.) and pedological features (organic matter, carbonates, iron, redox etc.). Selected samples (charcoal, charred material, humic matter etc.) were also collected for radiocarbon dating (Beta Analytic) and for biological proxies such as pollen (University of Modena-Reggio Emilia-Italy), ostracods (CNR, Rome-Italy), foraminifera (University of Turin-Italy) and geochemical proxies (University of Siena – Italy; Umeå University-Sweden). The obtained stratigraphic logs (*fig*. 2) were used for correlation and description of the chronological and spatial changes of the depositional environment and related dynamics.

3. GEOGRAPHIC AND GEOMORPHOLOGICAL SETTING

The drainage basins of the Cornia and Pecora rivers extend from the inland Colline Metallifere to the coastal plain between Piombino to the north and Follonica to the

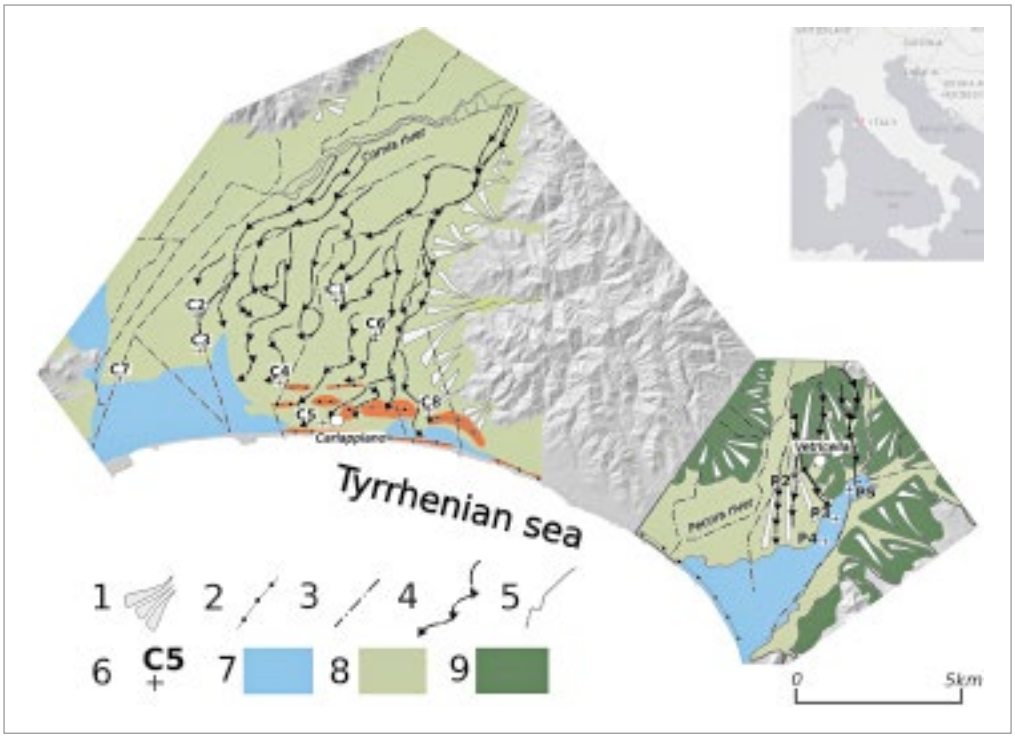

fig. 1 – Geomorphological scheme of the two investigated areas: 1. Alluvial fan; 2. beach dune ridge; 3. artificial channel; 4. palaeochannel; 5. artificial levees; 6. cores; 7. wetlands reclaimed after XIX cent.; 8. Late Holocene alluvial plain; 9. Late Pleistocene alluvial deposits.

south (*fig*. 1). The coastal plains are separated by the "Parco di Montioni" ridge that is the watershed between the Cornia river to the NW and the Pecora river to the SE.

The Cornia river is approximately 50 km long and its drainage basin covers about 350 km sq. The proximal and medial reach of the catchment is characterised by a deep valley and steep tributaries, whilst the coastal plain opens at c. 11 km from the present-day shoreline for about 10 km in width in the distal portion. The plain is also characterised by the presence of several palaeochannels showing a shift of the channel belt from E to NW (Censini *et al.* 1991) after reclamation works made in the 19th century. In the coastal sector two distinct palaeo-lagoons can be observed, features that are also shown in the Catasto Leopoldino (*fig*. 1).

The Pecora river is about 21 km long and the drainage basin covers approximately 250 km sq. The proximal part of the basin is characterised by wide karst features such as karst depressions, active and unactive karst springs, and *calcareous tufa* terrace systems. Most of the tributaries of Pecora river come from the right and are characterised by deep valleys although with flat terraced narrow valley bottoms. The coastal plain opens at c. 6 km from the present-day coastline and widen up to 5 km in the distal part. According to the Catasto Leopoldino, in this area an open lagoon was present only in the southeastern part, directly opening to the sea, whereas a locally densely vegetated swamp extended up to 4 km inland (Londi *et al.* 2007). The present-day surface hydrology of this sector is mainly related to the reclamation works during the last two centuries. Nevertheless, human induced reclamation activities during the Early Middle Ages, affecting the *calcareous tufa* environments in the upper reach of the Pecora valley, have also been detected (Pieruccini *et al.* 2018). The coastal dune belt is today poorly preserved due to the anthropic impact on the coastline.

4. RESULTS

4.1 Facies analysis

The description of the sedimentary facies is reported in *tab*. 1. Each facies code and corresponding stratigraphical interval is also represented in *fig*. 2.

4.2 Chronology

A total of 29 radiocarbon ages were performed on charcoal and organic matter. 21 dates were obtained from the Cornia cores and 8 from the Pecora cores. Sampling for aging was concentrated in the upper parts of the cores due to their relationships with the main goal of nEU-MED project. However, the overall chronology spans the Early Holocene up to the Late Holocene, encompassing all the described sedimentary facies except for the gravelly channels (*fig*. 2).

The ages considered for each single core were lacking chronological inversions except for 2 refused dates, due to their exceptionally old age (Late Pleistocene) and probably related to re-working and run-off processes. The radiocarbon dates are summarized in *tab*. 2 where CAL ages are reported and grouped according to the chronostratigraphic interval with particular emphasis for the periods falling within the scope of the nEU-Med Project.

5. DISCUSSION

The observed sedimentary successions along both coastal plains indicate a regressive trend, from lagoon to swampy and floodplain environments. The same trend is recorded along the Tyrrhenian coast to the north and to the south of the studied area, at the mouth of the main rivers (i.e. Arno, Rossi *et al.* 2011; Ombrone, Bellotti *et al.* 2004; Volturno,

Facies	Description	Interpretation
	Lagoon	
L1	Pale grey to dark grey clays, massive or thinly laminated with abundant brackish shells (*Cerastoderma*) and marine shell fragments as well as macro-charcoal fragments. Rare thin beds of fine sands and silts.	Inner low-energy lagoon.
L2	Dark grey massive or bioturbated silty clays, with abundant wood and charred or poorly decomposed plant fragments. Common centimeters-thick fine sands beds.	Vegetated lagoon shores.
L3	Thin to thick yellowish to pale brown well sorted sandy layers and fine gravels with abundant marine and brackish fragmented molluscs fauna, interbedded with pale grey silty and clayey beds.	High-energy lagoon with marine wash over.
	Swamps	
S1	Grey to very dark grey massive to weakly laminated clays, rich in fibrous organic matter with abundant plants and charcoals remains. No marine or lagoon molluscs have been observed.	Organic dominated swamp
S2	Pale yellowish grey massive to weakly laminated and bioturbated silty clays, with common redox features and carbonates nodules, rare charcoals, no plant or molluscs remains.	Shallow to deep non-vegetated inner swamps
	Floodplain	
F1	Brown to pale yellowish silts, clays and sands, massive to thickly laminated, locally bioturbated. Abundant redox features, secondary Fe/Mn and carbonates precipitation. The colour changes according to the abundance of organic matter. The facies is characterised by decimetres-thick intervals with fining upward trend, from darker and sandy-silty thicker laminae to lighter, massive clays with concentration of carbonate features. Rare fine charcoal.	Distal poorly drained alluvial plain
F2	Alternances of yellowish to pale brown thickly laminated silts and sands and massive dark clayey-silts. Common redox features.	Periodically flooded alluvial plain
F3	Pale grey to greyish yellow massive or weakly laminated silty clays. Abundant Fe/Mn precipitation and common red-ox features. Rare secondary carbonate precipitation. No plant remains or charcoal have been observed.	Flooded alluvial plain
	Channel	
C	Channel lag made of loose poorly sorted fine- to coarse-grained angular to subrounded gravels with sandy matrix and thin sandy layers and rare silty beds.	Fluvial Channel
	Palaeosoil	
P	Yellowish to reddish clays and silts with rare thick sandy laminae. The sedimentary structures are weakly preserved.	Subaerial exposure

tab. 1 – Sedimentary facies and associated depositional envritonment.

Amorosi *et al.* 2013) as well as in some lagoon systems (e.g. Orbetello, Mazzini *et al.* 1999).

5.1 Cornia coastal plain

The cores drilled in the more distal areas from those depicting the Catasto Leopoldino lagoon boundaries (Cornia 1, 2, 6; *figg*. 1-2) show a continuous deposition of coarser-grained floodplain facies alternating with finer grained swampy environments up to the Middle Ages. The changing environments include also the occasional presence of gravelly channel facies depending upon the shifting of the channel belt within the coastal plain as demonstrated by the geomorphological analysis. On the other hand, the chronology of these cores is problematic due to the lack of suitable materials for dating which prevented further investigations so far (*tab*. 2). Cornia 8 was drilled close to the barrier beach dunes system in the easternmost part of the coastline, next to the mouth of the so-called Corniaccia river. In this case, the sedimentary succession reveals the presence of c. 3 m thick coarse-grained gravelly channel lag opening to the lagoon located to the south in the main inter-dunal depression. The chronology of the overlying low-energy floodplain facies indicates that at least since the second millennium BC this sector of the Cornia coastal plain was already emerged and not affected by lagoon sedimentation.

Evidence of the lagoon environment linked to Medieval period, between the 6th and the 9th centuries AD, occurs only in Cornia 3 core, drilled at the boundary with the Catasto Leopoldino lagoon, thus indicating a limited oscillating lagoon environment in the westernmost sector of the area. This is also supported by the lagoon facies observed in Cornia 7 core, located in a similar position and dated to the 2nd-3rd centuries AD. In this case, the floodplain environment is recorded for the 4th-6th centuries AD, thus suggesting the seaward regression of the lagoon. Towards the inland, Cornia 4 core confirmed the existence of a floodplain since the 2nd-3rd centuries AD. The same environment can be observed in Cornia 5 core, the outermost core to be drilled in the main interdunal depression. This core indicates that in this very distal part of the landscape the lagoonal environment was already filled by floodplain sediments starting from the third millennium BC. Thus, both cores highlight an early onset of the subdivision of the two main lagoonal systems located to the west and to the east as shown on the Catasto Leopoldino. Fully and continuous lagoon environments are recorded only in the external sectors and below the present-day sea-level, down to 6 m. From a general viewpoint, the Cornia cores show that the extension of the lagoon during Medieval period was already similar to the 19th century AD circumstances (as in the Catasto Leopoldino). The outer area was characterized by low-energy flooded and swampy environments, whilst floodplain sedimentation was already dominant in the inner sector following the distribution of the sedimentary load of the palaeo-Cornia channels shifting within the coastal plain although concentrated in the easternmost sector (Corniaccia river).

5.2 Pecora coastal plain

Due to the proximity to Vetricella site, the cores were located across the landscape from an inner position (Pecora 2, alluvial plain) to a distal position (Pecora 3, 4, 5) (*fig*. 1). Pecora 2 is located on an almost flat alluvial fan fed by the Pecora river before its definitive artificial diversion in its present-day position, occurred at the beginning of the 19th

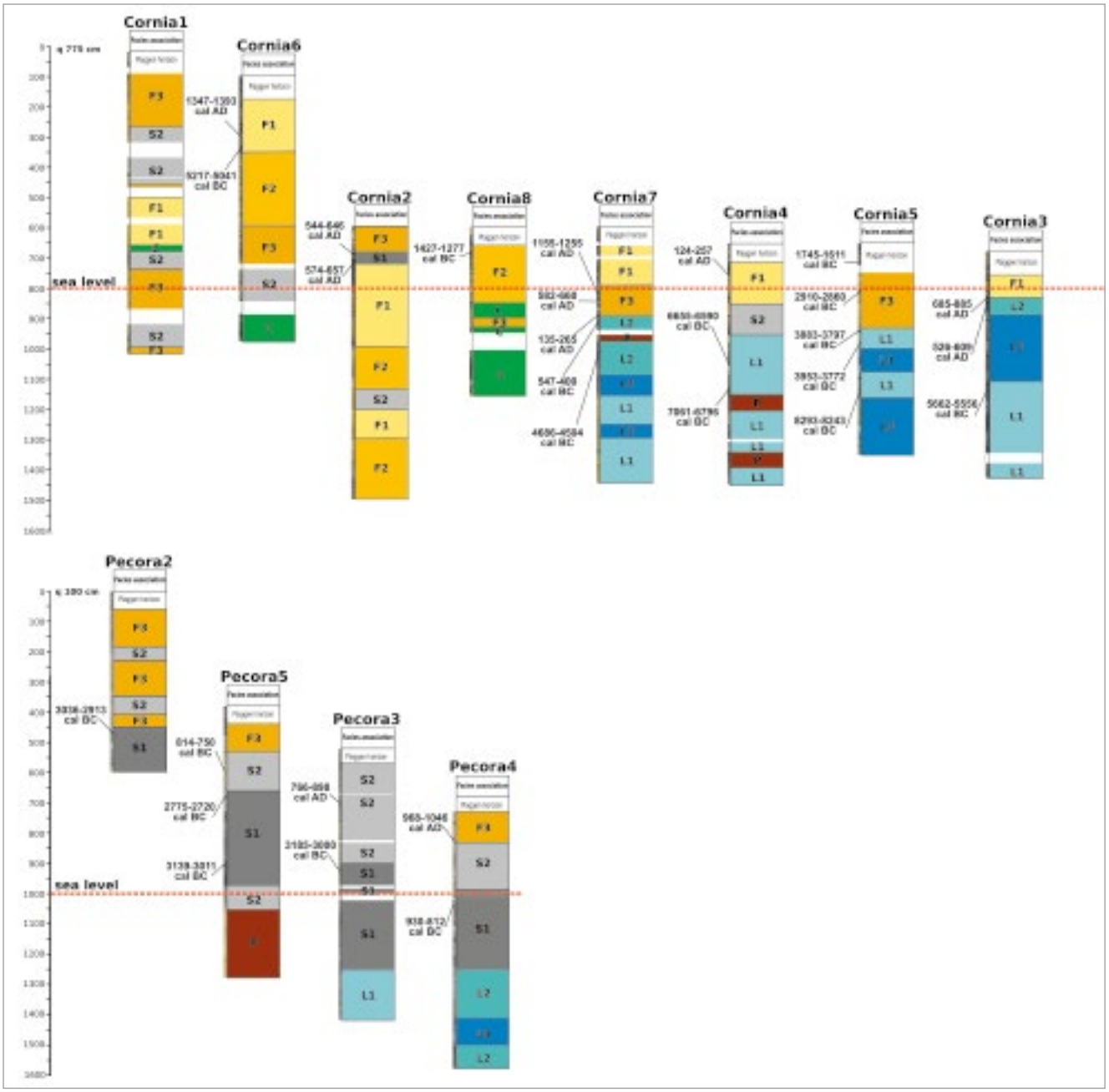

fig. 2 – Stratigraphical scheme of the cores with indication of the facies association and associated depositional environments.

century AD (Londi *et al.* 2007). Moreover, strong Medieval depositional phases are also recorded (Pieruccini *et al.* 2018). Facies analysis (*fig*. 2) revealed the presence of organic dominated swamp environment from the fourth to third millennia BC (*tab*. 2) followed by alternating flooded alluvial plain and shallow swamps environments. Despite the lack of ^{14}C dates for the younger sediments, part of the sedimentation may be correlated to the inland Medieval land reclamation, following sedimentation in the distal reach of the Pecora river. A similar chronology for the same sedimentary facies is recorded in Pecora 5 and 3. In Pecora 4, the outermost, the persistence of the same environment is dated to the first millennium BC. In Pecora 5 the depositional environments change toward shallower and less vegetated swamps and finally to fully floodplain environments since the 8th-7th centuries BC, possibly due to the more proximal position and the influence of runoff and fluvial depositional processes. The same trend is observable in Pecora 3 and 4 up to the 8th-9th centuries AD, thus suggesting the presence of shallow to deep non-vegetated swamps in a position proximal to Vetricella. Lagoonal facies are recognised only below the present-day sea-level and in the outermost cores, whereas in the Pecora 5 palaeosoil formation and in particular lagoonal sediments suggest this part of the landscape underwent an oscillation of the water-table with long-lasting phases of emersion. The chronology of the sedimentary facies changes indicates the progressive seaward retreat of the lagoon and fully swampy environments.

	Cal Ages	Cornia 6	Cornia 2	Cornia 8	Cornia 7	Cornia 4	Cornia 5	Cornia 3	Pecora 2	Pecora 5	Pecora 3	Pecora 4
Late Holocene	XI-XIV AD	1347-1393 AD 5,2 m asl			1155-1255 AD -0,3 m asl							
	X-XI AD											968-1046 AD 1,7 m asl
	VII-IX AD							685-885 AD -0,2 m asl			766-898 AD 3 m asl	
	VI-VII AD		544-646 AD 1,1 m asl 574-657 AD 0,9 m asl		582-660 AD -0,4 m asl			526-609 AD -0,3 m asl				
	550 BC–250 AD				135-265 AD -0,8 m asl 547-400 BC -1,1 m asl	124-257 AD 0,5 m asl						
	1000-750 BC									814-750 BC 3,8 m asl		930-812 BC -0,3 m asl
	2000-1200 BC			1427-1277 BC 1,1 m asl			1745-1611 BC 0,7 m asl					
Middle Holocene	4000-2700 BC						2910-2860 BC -0,1 m asl 3883-3797 BC -1,3 m asl 3953-3772 BC -1,8 m asl		3036-2913 BC 5,3 m asl	2775-2720 BC 3 m asl 3139-3011 BC 0,8 m asl	3185-3000 BC 0,7 m asl	
	6000-5000 BC	5217-5041 BC 4,7 m asl			4686-4504 BC -2,1 m asl			5662-5556 BC -3,2 m asl				
Early Holocene	7100-6500 BC					6655-6590 BC -2,4 m asl 7061-6796 BC -3,2 m asl						
	8300–8000 BC						8293-8243 BC -3,4 m asl					

tab. 2 – Chronological scheme. Each date are reported with the related depth and facies association in accordance to *fig*. 2.

6. CONCLUSIONS

In the framework of the Holocene sea-level eustatic rise, geoarchaeological analysis of the Cornia and Pecora cores reveals the surface processes and the distribution of different environments across the coastal plains during antiquity, with a major emphasis occurring in the Middle Ages. The study shows a general regressive trend of the coastal lagoonal environments indicated by the vertical stacking of swamp and alluvial deposits in the lagoonal facies. This highlights consequently the progressive reduction of the lagoon and its opening onto the sea, and the seaward progradation of swampy and floodplain environments up to the definitive emersion of the whole landscape.

In the Cornia coastal area the Medieval landscape was characterised by a lagoon extension similar to that shown on the Catasto Leopoldino, although with minor oscillations along the shores. Moreover, the lagoon widens in the western sector whereas in the eastern sector it was restricted to a small area bounded by remnants of the beach barrier belts. In the same area, prevailing alluvial sedimentation indicates the presence of the main palaeo-Cornia (Corniaccia) mouth. The overall chronology and stratigraphy of the Cornia cores are consistent with the geomorphological analysis showing the shifting of the Cornia river to the west by means of a dense network of palaeochannels redistributing the sediments coming from slope erosion in the inner parts of the valley. However, the sedimentary facies indicate the presence of a

complex system of environments related to distal low-energy alluvial plain, with the co-existence of a poorly drained coastal floodplain with its changing and shifting swamps.

In the Pecora valley the stratigraphic successions in the cores revealed the same regressive trend although the lagoonal sediments are recognizable only at depth and attributable to the Early-Middle Holocene. In this context, facies analysis depicts a different environment to that shown by the Catasto Leopoldino. Nevertheless, stable swampy environments lasted up until Medieval times and co-existed with the settlement at Vetricella, characterised by dense vegetation and shallow-to-deep open non-vegetated swamps. The alluvial environments provided very thin cover on top of the stratigraphic successions except for the area close to Vetricella, where deeper and stable wetlands had disappeared earlier and poorly drained floodplain environments dominated, as indicated by the recent analysis of the Pecora river palaeochannel upstream (Pieruccini *et al.* 2018).

The stratigraphy obtained by the cores provides a unique insight into the Holocene evolution of coastal areas along the northern Mediterranean as well as the relationships that existed between Medieval settlements and their landscapes. The sediments are currently undergoing further investigations (pollen, charcoal, geochemistry, ostracoda, foraminifera and fishes) in order to assess a more detailed palaeonvironmental evolution and highlight vegetation changes, land use and climate, ecology of swamps and lagoon and palaeohydrological regimes.

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Italian abstract

IL RECORD SEDIMENTARIO OLOCENICO E L'EVOLUZIONE DEL PAESAGGIO LUNGO LE PIANURE COSTIERE DEI FIUMI PECORA E CORNIA (TOSCANA MERIDIONALE, ITALIA): RISULTATI PRELIMINARI E PROSPETTIVE FUTURE

Nelle fasi iniziali del progetto nEU-Med (ERC grant agreement No. 670792) l'attenzione della ricerca archeologica e storica si è concentrata prevalentemente su due siti archeologici: Vetricella (tratto distale della Valle del Pecora) e Carlappiano (pianura costiera della valle del Cornia) (*fig*.1). Carlappiano si trova lungo uno dei cordoni dunali che costituiscono il sistema di dune e marca l'avanzamento della linea di costa durante l'Olocene. Vetricella si trova sulla porzione distale di una conoide alluvionale antica (Pieruccini *et al.* 2018) in prossimità della transizione alla pianura costiera. La caratteristica comune ai due siti è quella di trovarsi in un ambiente prossimo a un sistema lagunare e/o palustre che caratterizzava entrambi i settori fino in tempi molto recenti (la bonifica definitiva dell'area di Scarlino è avvenuta negli anni '50 del XX secolo, Londi *et al.* 2007). La presenza di aree umide in aree anche molto interne rispetto alla costa è testimoniata ulteriormente dalla cartografia del Catasto Leopoldino della prima metà del XIX secolo (Catasto Leopoldino, 1821 www502.regione.toscana.it/geoscopio/castore.html) e da altri documenti cartografici risalenti ai secoli precedenti (Londi *et al.* 2007).

La principale questione archeologica riguardava le caratteristiche del paesaggio all'intorno degli insediamenti medievali, ovvero presenza o meno di aree umide o lagunari che consentissero uno scambio diretto con il settore costiero, l'estensione di tali aree umide e le relazioni con i processi lungo i settori marginali e i versanti circostanti. Per indagare l'evoluzione del paesaggio fisico e biologico e determinare la successione degli eventi è stata quindi eseguita una campagna di sondaggi profondi ubicati all'interno o lungo i settori marginali dell'estensione delle aree umide riportate nel Catasto Leopoldino o in settori scelti sulla base delle indagini geomorfologiche (es. presenza di paleoalvei ecc.) (*fig*. 1). Lo scopo dei carotaggi è quello di integrare lo studio sedimentologico/stratigrafico dei sedimenti con analisi sui proxies biologici, ad es. analisi vegetazionali (pollini, carboni), paleoidrologia e paleoambiente delle lagune e delle aree umide (molluschi, foraminiferi, ostracodi, pesci) e analisi geochimiche (TIC/TOC, conducibilità elettrica, pH, fosfati ecc.). Infine, la cronologia dell'evoluzione sedimentaria dell'area è stata indagata attraverso 22 datazioni al radiocarbonio realizzate su carboni o materia organica del sedimento. In questo lavoro presentiamo i risultati preliminari delle analisi sulle stratigrafie, le principali caratteristiche di facies sedimentaria e la cronologia delle loro variazioni in relazione alle problematiche archeologiche discusse sopra.

Le carote indisturbate di sedimenti sono state ottenute utilizzando un pistone idraulico con carotiere cilindrico da 101 mm di diametro. Sono state realizzate 12 carote continue (Cornia 1-8 e Pecora 2-4) lunghe da 5 a 10 m. Il sistema di perforazione e le caratteristiche dei sedimenti (prevalentemente siltoso-argillosi o siltoso-sabbiosi) hanno consentito il recupero di circa il 90% di sedimenti indisturbati (*fig*. 2).

Le singole facies sedimentarie sono state distinte sulla base della tessitura, del colore, della presenza di strutture sedimentarie, di resti biologici (piante, carboni, macrofossili), di figure associate a precipitazione di $CaCO_3$ e Fe/Mn, forme di ossidoriduzione e accumulo di materia organica. Sono stati quindi eseguiti i log stratigrafici dove alle caratteristiche sopradescritte vengono rappresentate anche le associazioni di facies che permettono l'individuazione dell'ambiente sedimentario principale e la profondità dei livelli datati.

Le principali associazioni di facies individuate sono (*tab*. 1):

Laguna: argille da chiare a scure, massive o debolmente laminate, bioturbate, con abbondanti molluschi salmastri e marini, sia interi sia in frammenti, foraminiferi, localmente abbondante materia organica, e locali intercalazioni sabbiose associate ad abbondanti resti di gusci di molluschi. Si possono distinguere:

L1. Laguna interna a bassa energia – argille massive o sottilmente laminate con sottili livelli sabbiosi e siltosi, bioturbate con abbondante malacofauna salmastra, frammenti di molluschi marini, carboni comuni, assenza di resti vegetali.

L2. Margini vegetati della laguna – argille grigio scure e nerastre, massive o bioturbate, aumento di spessore e frequenza di livelli siltosi e sabbiosi, abbondante accumulo di materia organica parzialmente decomposta, scarsa malacofauna salmastra.

L3. Laguna esterna ad alta energia – sabbie medio-grossolane e ghiaie fini in livelli da spessi a sottili con abbondanti frammenti di gusci, sottili intercalazioni di argille massive chiare, assenza di resti vegetali.

Palude: argille, argille siltose e silts da massive a debolmente laminate, da chiare a scure. Si possono distinguere:

S1. Paludi densamente vegetate – argille grigio scure e nerastre, massive o debolmente laminate, ricche di materia organica fibrosa, con abbondanti resti vegetali e carboni. Assenza di malacofauna salmastra.

S2. Paludi da poco a molto profonde non vegetate – silts e argille da chiare a grigio scure, massivi o debolmente laminati, bioturbati, abbondanti figure di ossidoriduzione, precipitazione di carbonati, scarsi carboni, assenza di resti vegetali.

Pianura alluvionale: alternanze di silts, sabbie e argille con abbondanti figure di ossidoriduzione e precipitazione di Fe/Mn e carbonati. Si possono distinguere:

F1. Pianura alluvionale distale poco drenata – alternanza di silts e sabbie brune e giallastre, massive o con lamine

spesse, localmente bioturbate. Sottili livelli argillosi scuri massivi. Presenza di intervalli decimetrici tipicamente fining-upward, da spesse lamine sabbioso-siltose scure a argille e silts massivi chiari con abbondante concentrazione di carbonati secondari.

F2. Pianura alluvionale periodicamente sommersa – alternanza di silts e sabbie giallastre o bruno chiare, in lamine spesse, e argille siltose scure massive, presenza di comuni figure di ossidoriduzione.

F3. Pianura alluvionale sommersa – argille siltose da grigio chiare a grigio giallastre, massive o debolmente laminate. Assenza di resti vegetali e carboni, abbondanti figure di precipitazione di Fe/Mn e ossidoriduzione, scarse figure di precipitazione di carbonati secondari.

Canale

C. Canale fluviale – alternanze spesse decine di centimetri di ghiaie da fini a grossolane subangolose e subarrotondate e sabbie da fini a grossolane con sottili livelli siltosi.

Paleosuolo

P. Paleosuolo – Argille e silts debolmente laminate, con rare lamine sabbiose, di colore dal giallo all'arancione tipiche di processi pedogenetici su superfici emerse esposte all'alterazione.

Nel complesso, le stratigrafie (*fig*. 2) mostrano una generale tendenza dal basso verso l'alto alla trasformazione degli ambienti sedimentari da lagunari a palustri e infine a schiettamente continentali con l'istaurarsi di ambienti di pianura alluvionale distale interessata da fenomeni di ruscellamento o locale ristagno idrico. Questa tendenza è legata all'arrivo di sempre maggiori quantità di sedimenti da terra provenienti da diffusi fenomeni di erosione del suolo (Pieruccini *et al.* 2018) e, per quanto riguarda gli ultimi 2 secoli, dalle opere di bonifica per colmata del territorio (Londi *et al.* 2007).

Nel settore inerente al Fiume Cornia le cronologie ottenute suggeriscono come gli ambienti sedimentari fossero in stretto legame con la posizione e la presenza di paleoalvei del Cornia o Corniaccia (Cornia 6, 8), mentre gli ambienti schiettamente lagunari inizino la loro contrazione già a partire dall'epoca romana. (Cornia 4, 7). Per contro, le cronologie medievali suggeriscono l'esistenza di ambienti lagunari (Cornia 3) solamente in aree molto prossime a quelle già individuate come tali nel Catasto Leopoldino, mentre nella pianura prospiciente erano già installati ambienti di pianura alluvionale distale (Cornia 6) e di stagni o paludi legati alle variazioni spaziali delle dinamiche fluviali.

Nel settore inerente al Fiume Pecora, invece, le cronologie ottenute evidenziano che gli ambienti lagunari con evidenze di scambio con il mare erano localizzati in posizione più interna rispetto alla linea di costa attuale, mentre gli ambienti marginali erano caratterizzati da abbondante vegetazione. Quest'ultimi evidenziano una progressiva contrazione in favore dell'instaurarsi di ambienti di stagni da poco a molto profondi non vegetati. In riferimento alle cronologie medievali ottenute, è possibile osservare come gli ambienti schiettamente lagunari (Pecora 3, 4) fossero già localizzati verso la costa, a più di 1 km Sud/Sud-Ovest rispetto all'insediamento di Vetricella.

Complessivamente, l'analisi stratigrafica delle carote ottenute ha permesso finora di ottenere una visione importante dell'evoluzione olocenica delle aree costiere del Mediterraneo settentrionale in forte relazione con gli insediamenti medievali e *land use* del territorio. Le indagini paleoambientali sopradescritte, già in corso, aiuteranno a delineare una visione più dettagliata degli ambienti fisici e biologici che hanno caratterizzato quest'area in epoca storica.

The nEU-Med project is part of the Horizon 2020 programme, in the ERC Advanced project category. It began in October 2015 and the University of Siena is the host institution of the project.
The project is focussed upon two Tuscan riverine corridors leading from the Gulf of Follonica in the Tyrrhenian Sea to the Colline Metallifere. It aims to document and analyze the form and timeframe of economic growth in this part of the Mediterranean, which took place between the 7th and the 12thc. Central to this is an understanding of the processes of change in human settlements, in the natural and farming landscapes in relation to the exploitation of resources, and in the implementation of differing political strategies.
This volume presents the multi-disciplinary research focussed upon the key site of the project, Vetricella, and its territory. Vetricella is thought to be the site of Valli, a royal property in the Tuscan march. It is the only Early Medieval property to be extensively studied in Italy. Located on Italy's Tyrrhenian coast, the archaeology and history of this site provide new insights on estate management, metal production and wider Mediterranean relations in the later first millennium. Apart from reports on the archaeology, the finds from excavations and environmental studies, three essays consider the wider European historical and archaeological context of Vetricella. Future monographs will feature studies by members of the project team on aspects of Vetricella, its finds and territory.

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