SALT AND POWER

EARLY STATES • ROME AND RESOURCE CONTROL

A four-year archaeological project based at the Groningen Institute of Archaeology

1.11.2021 – 31.10.2025

rijksuniversiteit groningen

NWO

INTRODUCTION

Salt is indispensable to society, past and present. Human and animal health depend on this resource, as did preservation of food in the past. Salt was the only means available to preserve and trade foodstuffs essential for the first large towns with thousands of citizens. For Italy's early city-states, control over salt resources was crucial. In Italy, apart from rare rock salt deposits, the only source of salt is the sea (Fig. 1).

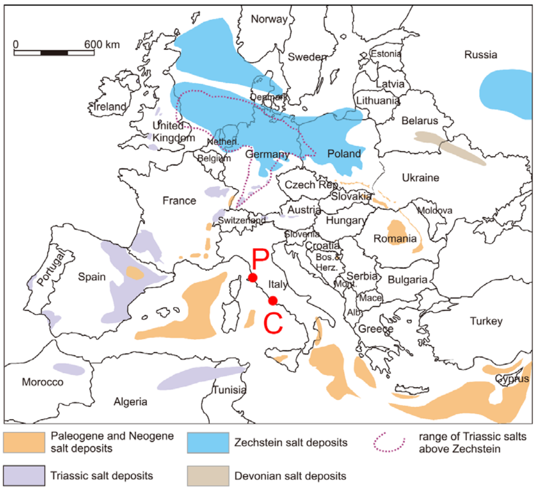

Figure 1 - Major salt deposits of Europe. Early salt production sites mentioned in the text: P: Puntone; C: Caprolace; after Harding 2014

RESEARCH QUESTION AND PROBLEM DESCRIPTION

Control of the salterns in the Tiber delta was important for Rome's rise to power (Liv. I, 15,5; Dion. Hal. II, 55,5-6; Plut., *Rom*. 25,4), however, physical evidence is totally lacking. When were salterns first established and how was salt produced before their installation? How did salt production keep pace with the rising population of the early states in Central Italy, in particular Rome and how was it secured? We will investigate these questions with an up-to-date methodology to contribute with a historically important case study to the global archaeological and anthropological debate on salt-making and resource control in the context of prehistoric and early state societies. We focus on detecting scale increase in the production of salt that, we assume occurred in Central Italy in the formative phase of the city-states between the Final Bronze to Early Iron Age around 1000 BCE. Recently, the applicant and his team discovered the origins and chaîne opératoire of two early salt production sites at two sites along the Tyrrhenian coast (Fig. 1). In the Pontine plain, south of Rome, the team investigated a Bronze Age settlement in the Caprolace lagoon (Alessandri et al., 2019) revealing its involvement in salt production. Evidence consisted of remains of an industry known as briquetage. This implies preparing and boiling a solution of seawater in special reddish ceramic jars to obtain solid salt, as described in

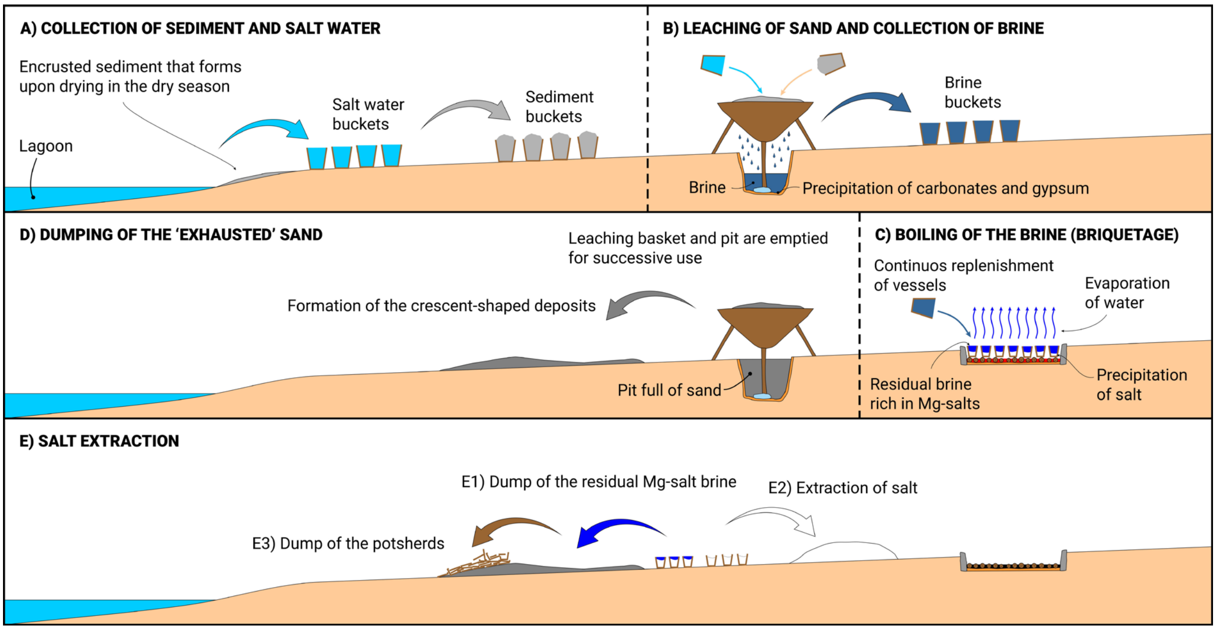

Figure 2 - The reconstructed chaîne opératoire for the salt production processes in the Puntone site; from Sevink et al. 2020

ethnographical sources and archaeologically attested in prehistoric contexts elsewhere in Europe (Harding, 2013; Weller and Brigand, 2015). Jar had to be broken to extract salt, hence briquetage sites have huge potsherd dumps.

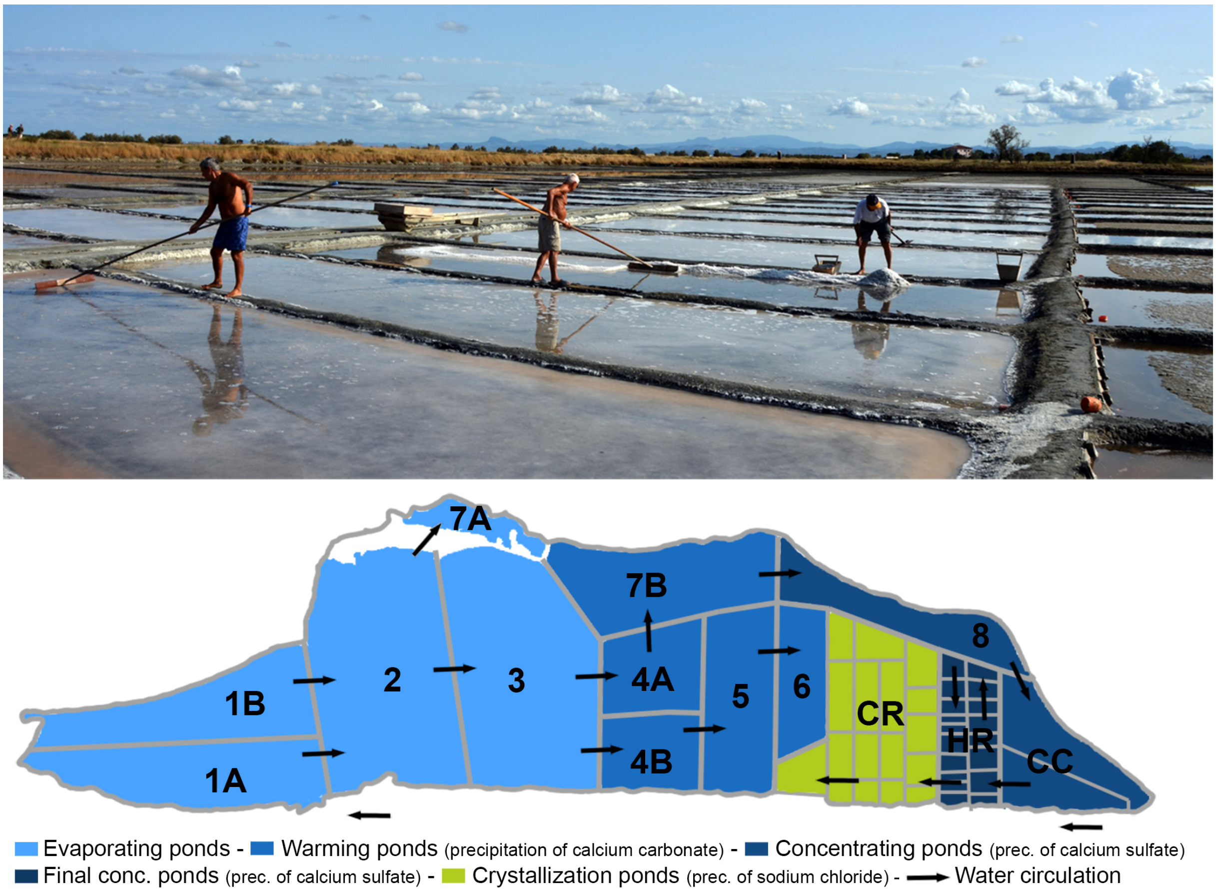

Figure 3 – Above, the saltern of Cervia (Italy). Below, the water circulation in the Cabo de Gata saltern (Spain). The precipitation of salts differs among successive ponds (data from Castro-Nogueira et al., 1997; López et al., 2010)

The Caprolace ceramic evidence suggests salt production was linked to food conservation (probably fish) and that salt and salted commodities were traded and consumed inland. In the Final Bronze Age/Iron Age Puntone site, in Tuscany, the team recovered similar evidence and reconstructed the chaîne opératoire (Sevink et al., 2020) (fig. 2). Understanding salt production techniques gives insight in labour organization, time investment and thus scale of production, which can be linked to contemporary settlement organization. Our reconstruction was achieved by combining geophysical techniques, archaeological excavations, functional artefact study and chemical analyses of soils and artefacts. This novel methodology now allows us to explore ethnographically known protohistoric briquetage and, importantly, detect historically known salt production in salterns, a more efficient production mode using series of ponds for salt precipitation that arose in the context of early urbanization (fig. 3 for contemporary salterns). Understanding this transition from relatively small-scale and labour-intensive briquetage to large scale production in salterns is at the heart of our research into scale increase and state control of salt production during early state formation.

CURRENTLY AVAILABLE EVIDENCE AND RESEARCH HYPOTHESES

Along the Tyrrhenian coast of Latium Vetus and Etruria multiple sites with dumps of reddish jars are archaeologically attested (fig. 4). These can be tentatively linked to the briquetage technique (Pacciarelli, 2010; Alessandri, 2013; Belardelli, 2013). In Etruria, their appearance is contemporary with the birth of the early states of Tarquinia, Cerveteri and Veio (10th century BCE). In *Latium Vetus*, their chronology spans from the Middle Bronze Age (17th c. BCE) to the Archaic period (6th c. BCE). Evidence about the introduction of the saltern production mode comes from the Maccarese lagoon, north of Tiber's mouth. Here hydraulic structures of a saltern, (first half of the 1st century CE) were attested (Grossi et al., 2015). However, palynological data point at increased salinity already around 2600 calBP (end of 7th century BCE), caused by artificial opening the lagoon to let in seawater (Di Rita et al., 2010). The southern

Figure 4 – Etruria and Latium Vetus*. Early States and salt production sites in the Bronze Age and Iron Age. Known salterns in Roman times. Targeted excavation sites: 1, La Frasca; 2, Grottini; 3, Greppa della Macchiozza; 4, Saracca; 5, Fosso Moscarello; 6, La Cotarda*

saltern, controlled by Rome according to the ancient sources, has not been identified yet, but a similar increase in salinity was detected in pollen records from the Ostia lagoon (700-600 BCE) due to its opening (Bellotti et al., 2011). The current evidence for briquetage and salterns led us to formulate the following hypotheses on the relationship between scale increase in salt production and early state formation in Central Italy (fig. 4);

(1) The "reddish jar sites" were early salt production (briquetage) and/or food preservation sites;
(2) Briquetage sites in time became part of the political network of the inland emerging Early States;
(3) Early States required a scale increase in production because of their rising populations. This led to a proliferation of briquetage sites towards the end of the Bronze age/start of the Early Iron Age;
(4) Not able to keep salt production in pace with the increasing salt demand of the expanding population, Early States created salterns to upscale production. This required geopolitical control as mentioned in historical sources.

PROPOSED METHODOLOGY AND HYPOTHESIS TESTING

To test our hypotheses, we will employ geophysical, chemical and archaeological methods to study both the briquetage and saltern production modes in their environmental and geographical context. Below we elaborate on the goals (fig. 5).

HYPOTHESIS (1) - The "reddish jar sites" were early salt production (briquetage) and/or food preservation sites

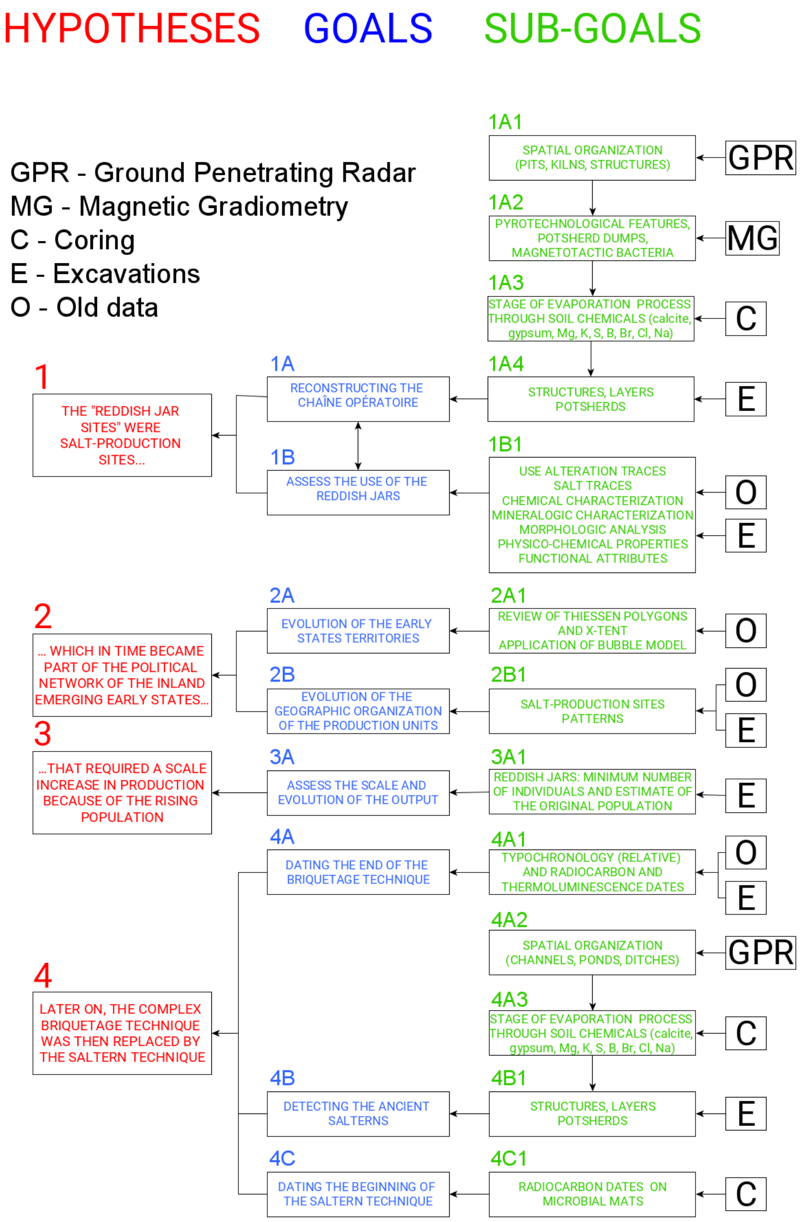

Figure 5 - The research strategy: hypotheses, goals, sub-goals and methods

Goal 1A: Reconstruct the chaîne opératoire of briquetage

Any attempt to derive salt (NaCl, halite) from seawater by evaporation (briquetage or salterns) goes through the same steps (Weller, 2015): A) Concentration, an initial enrichment to produce brine, B) Crystallization, artificial (fire) or natural (sun) evaporation process and, if needed, C) Conditioning (moulding) and D) Packaging. During the evaporation process, salts precipitate in this order: calcium carbonate (calcite), calcium sulphate (gypsum), sodium chloride (halite) and finally magnesium sulphate and other salts, referred to in the literature as 'bitterns'. They give a strong bitter taste to the mixture and to obtain a good-tasting salt one needs to get rid of the bitterns. Archaeological features linked to each of these steps can be identified through a combination of data captured by Magnetic Gradiometry (**MG**) and Ground Penetrating Radar (**GPR**), which allow the identification of spatial structures, of which the nature and function can be checked by Coring Surveys (**C**) and Archaeological Excavations (**E**). We plan to apply in sequential order:

1. **Ground Penetrating Radar**. Using **GPR** (Conyers, 2018) we will identify specific features characteristic of the briquetage technique: the pits used for Concentration, the kiln structures (usually of stones) used in the Crystallization phase and other involved structures (settlement features, huts, fences).

2. **Magnetic Gradiometry**. **MG** surveys are instrumental to detect pyrotechnological features. Kilns used in briquetage and resulting dumps of pottery sherds produce high amplitudes and dipole characteristics (fig. 6). For salterns, intracellular ferromagnetic magnetite and/or greigite magnetosomes have been described, produced by magnetotactic bacteria that live in hypersaline aquatic environments (Bazylinski and Lefèvre, 2013). We will attempt to find a relation between the occurrence of magnetotactic bacteria and degree of salinity to interpret the MG surveys (but see Lin et al., 2012).
3. **Coring**. Following the **GPR** and **MG** surveys we will do coring to obtain soil samples to chemically characterize the soil. We will check for anomalous concentrations of Magnesium (Mg), Potassium (K), Sulfur (S) and Boron (B), which characterise the residual liquor discharged after the harvesting of the salt (NaCl). We will check for the presence in features of calcite and gypsum, which both characterise the CONCENTRATION step. We expect a gradual increase in the concentrations of Boron (B) and Bromine (Br) during the different stages of evaporation (fig. 3).
4. **Excavation**. Following the results of the **GPR**, **MG** and **C**, we will collect additional evidence about the detected features and structures through excavation.

Goal 1B: **Assess the use of the reddish jars**

To assess the use of the reddish jars we will use a combination of data from use-alteration traces, vessel content (salt?) and functional and physical characteristics. Diagnostic potsherds from excavations and existing collections will be analysed (fig. 5).

A first screening will be done using a **pXRF** (portable X-Ray Fluorescence, Frahm and Doonan, 2013; Donais and George, 2018) chosen for its rapidity, non-destructive analysis and in situ application. The range of elements that a pXRF can detect being limited, more powerful analytic techniques will be used on a selection of potsherds. We will then establish a classification based on stylistic attributes and chemical fingerprints and select sub-samples based on types. The chosen potsherds will be further processed to study:

Figure 6 - The magnetic anomalies in the Puntone area and their interpretation (Sevink et al. 2020)

1. **Use alteration traces**. This concerns surface use alteration traces like internal and exterior carbonization and sooting patterns, which can provide direct evidence for contact with open fire. Ceramic attritions (Skibo, 2015) will be recorded with optical microscopy. Among the non-abrasive attritional processes, the presence of spalls might be of particular interest since they can form during fermentation processes (Skibo and Blinman, 2008);
2. **Salt traces**? A SEM-EDS (Scanning Electron Microscopy/Energy Dispersive Spectroscopy) will be used to characterise qualitative and semi-quantitative chemical properties of the potsherds. In recent research, the focus has been on the penetration of Na and Cl into the walls of potsherds as a proxy for the presence of ancient salt traces. But since Na and Cl are highly mobile elements easily leached by infiltrating water, this

method is not reliable. Moreover, in coastal areas, salt spray constitutes a potential cause of relatively high Cl and Na. We suggest to use Boron (B) and eventually Bromine (Br) as proxies for seawater used in the production processes. Boron is far more common in seawater than in a terrestrial environment and is less sensitive to leaching and salt spray (Sevink et al., 2020); Bromine is also mostly present in seawater and is characteristic of saline environments at times reaching very high concentrations (Dolphin et al., 2013; Moreno et al., 2017);

3. **Chemical characterization**. We propose to complement the **SEM-EDS** with **ICP-MS** analysis (Inductively Coupled Plasma – Mass Spectrometry) to improve the chemical characterization of the samples (Pollard and Heron, 2017). SEM-EDS is capable of performing analyses of selected point locations, but does not give absolute quantities and has poor sensitivity to trace elements lighter than Na. ICP-MS is a bulk analysis method, unable to trace trendlines across the potsherd walls, but has a much greater sensitivity to trace elements and gives absolute quantities. We will pay particular attention to the presence of sulphate which is less mobile than NaCl and is a proxy for the evaporation process due to the gypsum (sulphate mineral) precipitation from the seawater;
4. **Mineralogical characterization**. The petrographic and mineralogic characteristics of the selected samples will be described using a **PLM** (Polarizing Light Microscope) (Stoltman, 2015; Hunt and Bishop, 2016) according to the recording system already proposed by Orton and Hughes (Orton and Hughes, 2013, pp. 275–285).
5. **Physicochemical properties**. The combination of the results from point 3 and 4 will reveal the physicochemical properties of the reddish jars.
6. **Functional attributes**. To study the steps of C) CONDITIONING (moulding) and D) PACKAGING the capacity, stability, accessibility and transportability will be evaluated through technical considerations and parallels with already published ethnographic data (Orton and Hughes, 2013).

Interpretations of the inferred use (Rice, 1996) of the jars will be made on the basis of these results and the interpretation of production structures both published and found in our planned new excavations. Results will be used to enhance our understanding of the chaîne opératoire.

HYPOTHESIS (2) – Briquetage sites in time became part of the political network of the inland emerging Early States

Goal 2A: the evolution of the early state territories
To reconstruct the political network in which the briquetage sites functioned, we review the existing literature about the reconstruction of the territories of the Early States. Several scholars studied this issue with different spatial but synchronic models, borrowed from geography, such as Thiessen polygons (Barbaro, 2010; Fulminante, 2014) and X-Tent (Redhouse and Stoddart, 2011). We opt for a diachronic model (Alessandri, 2016), linking chronological phases in complex time-space models (Bubble Model) to trace the evolution of the settled landscape before and after the birth of the Early States embedding the salt production sites in the latter's territories.

Goal 2B: check the evolution of the geographic organization of the production units
To study the labour organization of salt production, we focus on the distribution and density of briquetage sites over the landscape. An even distribution of production units would point to a production geared at local demand while aggregated specialists, with few production units randomly distributed in the landscape, can be interpreted as evidence for regional or interregional exchange (Costin, 2005). Based on previous research, we envisage this transition to have occurred at the end of the Bronze age in the period of the formation of the early states (Alessandri et al. 2019). We use a model that describes the transition from seasonal household production to workshops in times of increased economic demand (Nijboer, 1998).

HYPOTHESIS (3) - Early states required a scale increase in production because of their rising populations. This led to a proliferation of briquetage sites towards the end of the Bronze age/start of the Early Iron Age.

Goal 3A: assess the scale and evolution of the output
We will use collected potsherds from the excavations to infer change(s) in the output scale (Orton and Hughes, 2013; Banning, 2020) and link the evidence for change in the output scale to concentration of specialised sites established

during early state formation (Late Bronze Age /start of the Early Iron Age). We compare the composition of assemblages using MNI (Minimum Number of Individuals) to reconstruct the amount of salt produced, calculating the volume of the jars (Rodriguez and Hastorf, 2013) and the original pottery population based on the brokenness and completeness of the samples (Felgate et al., 2013).

HYPOTHESIS (4) Not able to keep salt production in pace with the increasing salt demand of the expanding population, Early States created salterns to upscale production. This required firm geopolitical control, as mentioned in historical sources.

Goal 4A: dating the end of the briquetage technique

The only radiocarbon dates available from briquetage sites come from Pelliccione in the Pontine Plain and fall into the Late Bronze Age (Attema, 2004). However, reddish jars typologically dated to the VII century BCE have been found at Nettuno, south of Rome (Alessandri, 2013). To assess the relative chronology of the last evidence of the briquetage technique both north and south of the Tiber we will use the data from literature and the newly collected ceramics from the excavations. Absolute dates will be obtained by radiocarbon (organic) and thermoluminescence (pottery) (Aitken, 1985; Feathers, 2009).

Goal 4B: detecting ancient salterns

As mentioned (Goal 1A), salt production through evaporation of brine always follows the same steps and the methods used to reconstruct the chaîne opératoire of the briquetage sites can also be used to detect the presence of ancient salterns. We employ both **GPR** and **MG** to detect terrain adaptations, dug-out ponds and water channels transporting seawater or brine. Coring campaigns (**C**) will be conducted to chemically characterise detected ponds, analyse the concentration of Boron (B) and Bromine (Br) expecting their gradual increase in successive ponds and detect the presence of the bitterns in the final stage of the process. Test pits will be dug to double-check our interpretations.

Goal 4C: dating the beginning of the saltern mode of production

Importantly, we want to date the earliest evidence of salterns. In the literature, the beginnings of the Ostia and Veio salterns are dated around the 7th and 6th centuries BCE. While corroborated by the artificial increase in salinity of the lagoons, the salterns themselves have not yet been physically attested and dated. Study of the Puntone site (fig. 5) revealed that brine pits and associated sediments contain organic matter of largely microbial origin (Sevink et al., 2020), which is suited for absolute dating of phases in the salt production process. The same holds for salterns in which microbial mats form, the remains of which can be used to date the ponds. Combining C14 with thermoluminescence dating of collected ceramics will give a reliable chronological framework for the salterns.

SITES AND LANDSCAPE ZONES TARGETED FOR EXCAVATION AND CORING SURVEYS (see for workplan section B6).

We will obtain permits to carry out archaeological excavations and geophysical prospections on known briquetage sites and in areas where we expect to find hard evidence for the existence of ancient salterns (see workplan). Briquetage sites we will target are the following (fig. 4): La Frasca and Greppa della Macchiozza in south Etruria (alternative, Grottini) and Saracca and Fosso Moscarello, in *Latium Vetus* (alternative, La Cotarda). Landscape zones with salterns would be(fig. 4); 1) salterns that historically belonged to the Early State of Veio but were taken over by Rome (near present-day Maccarese in the Tiber delta; 2) salterns possibly belonging to the Early Sate of Tarquinia (north of the Tiber, in South Etruria; 3) The saltern near Ostia, belonging to ancient Rome.

FEASIBILITY

1. **Desktop studies**. An up-to-date geodatabase of Bronze Age and Iron Age settlements in Etruria and *Latium Vetus* is available at the Groningen Institute of Archaeology, together with a comprehensive set of old topographical maps of *Latium Vetus* (1850, 1930) rendering the pre-industrial landscape in detail (1:5000). Where possible, existing reconstructions of the ancient landscape will be used (e.g. in the case of *Latium Vetus* Alessandri, 2013; van Gorp and Sevink, 2019).

2. **Fieldwork**. For the **GPR** and **MG**, we will collaborate with Eastern Atlas GmbH & CoKG, Berlin, who performed the geophysical surveys at Puntone. The interpretation will be done by geophysicist B. Ullrich (Eastern Atlas) in collaboration with physical geographer and mineralogist prof. J. Sevink (Amsterdam University, IBED), the main applicant, PI and post-doc (to be contracted). The coring campaign (**C**) will be supervised by the post-doc researcher.
3. **Permits for fieldwork**. On account of their institutional, academic and local networks the main applicant and PI see no obstacles to obtain permits for the planned fieldwork activities. Both main applicant and PI have a long track record of permits granted for archaeological work and analyses in Lazio, Etruria and Rome (since the late 1980s).
4. **Archaeometry**. We already received permits from the relevant authorities for analysing 873 diagnostic potsherds out of 937 held in the old collections from briquetage sites. An agreement made with La Sapienza University of Rome, will give access to equipment for the assignment of physicochemical properties and use-alteration traces. The analyses will be performed under the supervision of prof. G. Sottili (La Sapienza, Earth Science Department) and prof. J. Sevink.

INNOVATION

Our proposal is innovative as regards its ground-breaking interdisciplinary methodology and its link between the natural sciences and humanities. Studying salt and salt-related issues in pre and protohistory has always been extremely difficult due to the lack of a reliable research strategy to detect its presence in the archaeological record. This has led to an underestimation of salt's paramount role in the food economy of the ancient world. In our project we propose to merge the traditional archaeological methods (chrono-typology, use alteration traces, functional and morphological analyses) with advanced physicochemical analytical techniques to investigate the very origins of its industrial procurement reconstructing modes and scales over time. In particular, we propose to use Magnesium (Mg), Boron (B) and Bromine (Br) as proxies for the use of seawater and the steps that were needed to obtain crystallized salt in both the briquetage and saltern mode of production. Novel is the use of a combination of non-invasive geophysical techniques (GPR, MG), targeted coring survey and soil chemistry to enhance our understanding of buried structures and to detect debris layers linked to salt procurement activities. Finally, our main goal to investigate the relationship between resources that are essential to mankind and the economic demand for them in the context of evolving Early States and resource control is at the cutting edge of the natural sciences and humanities.

URGENCY

Some of the known salt production sites have already disappeared or are at risk of doing so due to the high urbanization pressure and strong marine erosion to which the whole coastal stretch of Latium is subjected (Ferretti et al., 2003). Marine erosion is caused by an ongoing decrease in sediment supply by the dammed rivers, by the reduced mobility of the sediment because of the constructions of structures protruding into the sea (docks, harbours etc) and by the continuous sea-level rise. In the coastal area north of Civitavecchia, the sites of La Mattonara (fig. 7), Torre Chiaruccia and Malpasso have been almost completely destroyed by building activities. Along the coast south of Rome, some of the many salt production sites earlier found in exposed (eroded) profiles have in the course of two decades disappeared, like the briquetage site of Pelliccione, excavated by the applicant in 2000/01 (Attema, 2004). A

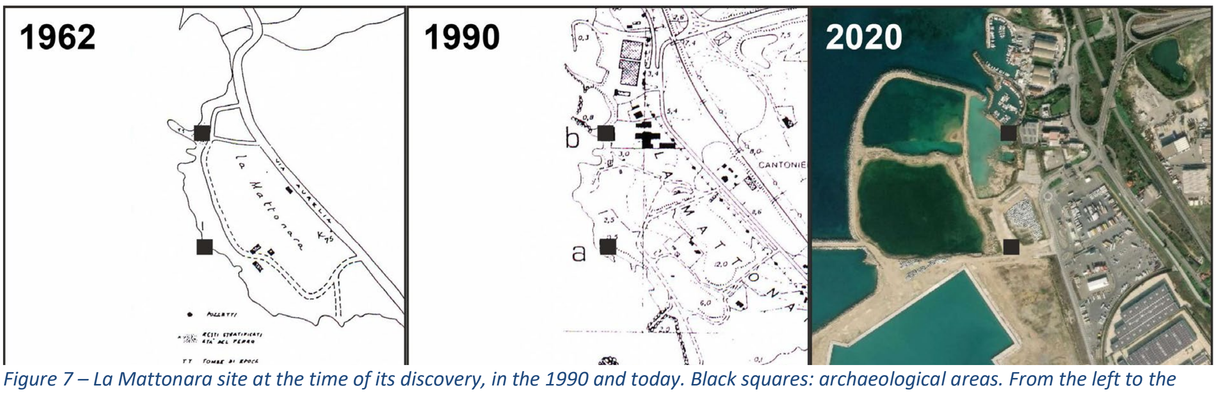

Figure 7 – La Mattonara site at the time of its discovery, in the 1990 and today. Black squares: archaeological areas. From the left to the right: from Pascucci 1998, excerpt from Carta Tecnica Regionale del Lazio and aerial photo from ESRI

detailed geomorphological study of this coastal area showed that the shoreline moved inland about 100m in the last 4000 years (Land, 2000).

Project team composition

Main applicant

Title, first name, surname	**Affiliation**	**Role**
Prof. dr. Peter A. J. Attema	Groningen Institute of Archaeology (Rijksuniversiteit Groningen)	Project Supervisor - leading author of project - synthesis and organizer of the exhibition (both with Principle Investigator)

Other team members

Title, first name, surname	**Affiliation**	**Role**
Dr. Luca Alessandri	Groningen Institute of Archaeology (Rijksuniversiteit Groningen)	Principle Investigator - coordinator of field and laboratory activities - organises, supervises and reports on excavation campaigns and archaeometric analyses - responsible for institutional and scientific reporting - (co) author of scientific articles - leading author (with project supervisor) of project synthesis - co-organizer of exhibition
Geologist with geophysical training	To be contracted	Post-doc - organises, supervises and reports on geophysical and coring campaigns - coordinates analyses of soil samples - (co) author of scientific articles
Prof. Jan Sevink	Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam	Advisor coring campaigns, geophysical surveys and archaeometric analyses
Prof. G. Sottili	La Sapienza University of Rome	Supervisor archaeometric analyses
Prof. M. Rolfo	University of Rome Tor Vergata	Collaboration in excavation
Prof. F. di Gennaro	Former prof. of Ancient Italian Cultures at the University of Cassino	Advisor Bronze Age and Iron Age of southern Etruria
Prof. A. Mandolesi	University of Turin	Advisor Bronze Age and Iron Age of southern Etruria
Dr. M. F. Gravina	University of Rome Tor Vergata	Advisor on modern saline environments and salterns
Dr. Olivier Weller	CNRS - Université Paris 1-Panthéon-Sorbonne	Advisor ancient European salt-production
Dr. Clarissa Belardelli	Istituto Italiano Preistoria e Protostoria	Advisor Bronze Age and Iron Age briquetage sites of southern Etruria

References

Aitken, M.J., 1985. Thermoluminescence dating: Past progress and future trends. Nuclear Tracks and Radiation Measurements (1982) 10, 3–6. doi:https://doi.org/10.1016/0735-245X(85)90003-1

Alessandri, L., 2013. Latium Vetus in the Bronze Age and Early Iron Age / Il Latium Vetus nell'età del Bronzo e nella prima età del Ferro. BAR International Series, 2565, Oxford.

Alessandri, L., 2016. Exploring territories: Bubble Model and Minimum Number of Contemporary Settlements: A case study from Etruria and Latium Vetus from the Early Bronze Age to the Early Iron Age. Origini XXXVII, 173–197.

Alessandri, L., Achino, K.F., Attema, P.A.J., Novaes Nascimento, M. de, Gatta, M., Rolfo, M.F., Sevink, J., Sottili, G., Gorp, W. van, 2019. Salt or fish (or salted fish)? The Bronze Age specialised sites along the Tyrrhenian coast of Central Italy: New insights from Caprolace settlement. PLOS ONE 14.

Attema, P.A.J., 2004. Zoutwinning aan de Tyrrheense kust in bronstijd Italië. Tijdschrift voor Mediterrane Archeologie XXXI, 3–11.

Banning, E.B., 2020. Counting Things: Abundance and Other Quantitative Measures BT - The Archaeologist's Laboratory: The Analysis of Archaeological Evidence. In: Banning, E.B. (Ed.), . Springer International Publishing, Cham, pp. 105–128. doi:10.1007/978-3-030-47992-3_7

Barbaro, B., 2010. Insediamenti, aree funerarie ed entità territoriali in Etruria meridionale nel Bronzo finale. Firenze.

Bazylinski, D.., Lefèvre, C.T., 2013. Magnetotactic Bacteria from Extreme Environments. Life 3, 295–307. doi:10.3390/life3020295

Belardelli, C., 2013. Coastal and underwater Late Urnfield sites in South Etruria. Skyllis 1, 5–17.

Bellotti, P., Calderoni, G., Rita, F. Di, D'Orefice, M., D'Amico, C., Esu, D., Magri, D., Martinez, M.P., Tortora, P., Valeri, P., 2011. The Tiber river delta plain (central Italy): Coastal evolution and implications for the ancient Ostia Roman settlement. The Holocene. doi:10.1177/0959683611400464

Cambi, F., Citter, C., Cristoferi, D., Silva, M. De, Guarducci, A., Macchi, G., Pizziolo, G., Sarti, L., Vanni, E., Volante, N., Zagli, A., 2015. A cross-disciplinary approach to the study of Transhumance as territorial identity factor in a long term perspective: the TraTTo project - Southern Tuscany paths and pasturages from Prehistory to the Modern Age. Review of Historical Geography and Toponomastics X, 85–98.

Castro-Nogueira, H., Lopez-Carrique, E., Aguilera, P.A., 1997. Salt production in salt pans: a model of sustainable development. Transactions on Ecology and the Environment 16, 73–81.

Cifani, G., 2016. The fortifications of archaic Rome: social and political significance. In: Frederiksen, R., Müth, S., Schneider, P.I., Schnelle, M. (Eds.), Focus on Fortifications, New Research on Fortifications in the Ancient Mediterranean and the Near East. Oxbow Books, pp. 82–93.

Conyers, L.B., 2018. Ground-penetrating Radar and Magnetometry for Buried Landscape Analysis. Springer International Publishing. doi:10.1007/978-3-319-70890-4

Costin, C.L., 2005. Craft Production. In: Maschner, H.D., Chippendale, C. (Eds.), Handbook of Methods in Archaeology. AltaMira Press, pp. 1032–1105.

Di Rita, F., Celant, A., Magri, D., 2010. Holocene environmental instability in the wetland north of the Tiber delta (Rome, Italy): sea-lake-man interactions. Journal of Paleolimnology 44, 51–67.

Dolphin, A.E., Naftel, S.J., Nelson, A.J., Martin, R.R., White, C.D., 2013. Bromine in teeth and bone as an indicator of marine diet. Journal of Archaeological Science 40, 1778–1786. doi:https://doi.org/10.1016/j.jas.2012.11.020

Donais, M.K., George, D.B., 2018. X-ray fluorescence spectrometry and its applications to archaeology : an illustrated guide. Momentum Press, New York.

Feathers, J.K., 2009. Problems of Ceramic Chronology in the Southeast: Does Shell-Tempered Pottery Appear Earlier than We Think? American Antiquity 74, 113–142. doi:10.2307/25470541

Felgate, M.W., Bickler, S.H., Murrell, P.R., 2013. Estimating parent population of pottery vessels from a sample of fragments: a case study from inter-tidal surface collections, Roviana Lagoon, Solomon Islands. Journal of Archaeological Science 40, 1319–1328. doi:https://doi.org/10.1016/j.jas.2012.09.009

Ferretti, O., Barsanti, M., Delbono, I., Furia, S., 2003. Elementi di gestione costiera. Parte seconda. Erosione costiera. Lo stato dei litorali italiani.

Frahm, E., Doonan, R.C.P., 2013. The technological versus methodological revolution of portable XRF in archaeology. Journal of Archaeological Science 40, 1425–1434. doi:https://doi.org/10.1016/j.jas.2012.10.013

Fulminante, F., 2014. The Urbanisation of Rome and Latium Vetus: From the Bronze Age to the Archaic Era. Cambridge.

Giovannini, A., 1985. Le sel et la fortune de Rome. Athenaeum 63, 373–386.
Gorp, W. van, Sevink, J., 2019. Distal deposits of the Avellino eruption as a marker for the detailed reconstruction of the Early Bronze Age depositional environment in the Agro Pontino and Fondi Basin (Lazio, Italy). Quaternary International 499B, 245–257. doi:https://doi.org/10.1016/j.quaint.2018.03.017
Grossi, M.C., Sivilli, S., Arnoldus-Huyzendveld, A., Facciolo, A., Rinaldi, M.L., Ruggeri, D., Morelli, C., 2015. A complex relationship between human and natural landscape: a multidisciplinary approach to the study of the roman saltworks in “Le Vignole - Interporto” (Maccarese, Fiumicino - Roma. In: Archaeology of Salt. Approaching an Invisible Past. pp. 83–101.
Harding, A., 2013. Salt in Prehistoric Europe. Sidestone, Leiden.
Harding, A., 2014. The prehistoric exploitation of salt in Europe. Geological Quarterly 58, 591--596
Hin, S., 2013. Counting Romans. In: Hin, S. (Ed.), The Demography of Roman Italy: Population Dynamics in an Ancient Conquest Society 201 BCE–14 CE. Cambridge University Press, Cambridge, pp. 261–297. doi:DOI: 10.1017/CBO9780511782305.011
Hunt, A., Bishop, G., 2016. Statistical Modeling for Ceramic Analysis.
Land, 2000. Indagine paleoambientale del litorale compreso tra Anzio e Torre Astura.
Lin, W., Wang, Y., Li, B., Pan, Y., 2012. A biogeographic distribution of magnetotactic bacteria influenced by salinity. The ISME Journal 6, 475–479. doi:10.1038/ismej.2011.112
López, E., Aguilera, P.A., Schmitz, M.F., Castro, H., Pineda, F.D., 2010. Selection of ecological indicators for the conservation, management and monitoring of Mediterranean coastal salinas. Environmental Monitoring and Assessment 166, 241–256. doi:10.1007/s10661-009-0998-2
Moreno, J., Fatela, F., Leorri, E., Moreno, F., Freitas, M.C., Valente, T., Araújo, M.F., Gómez-Navarro, J.J., Guise, L., Blake, W.H., 2017. Bromine soil/sediment enrichment in tidal salt marshes as a potential indicator of climate changes driven by solar activity: New insights from W coast Portuguese estuaries. Science of The Total Environment 580, 324–338. doi:https://doi.org/10.1016/j.scitotenv.2016.11.130
Nijboer, A.J., 1998. From household production to workshops: archaeological evidence for economic transformations, pre-monetary exchange and urbanisation in central Italy from 800 to 400 BC. RUG, Dept. of Archaeology, Groningen.
Orton, C., Hughes, M., 2013. Pottery in Archaeology, 2nd ed, Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge. doi:DOI: 10.1017/CBO9780511920066
Pacciarelli, M., 2010. Forme di complessità sociale nelle comunità protourbane dell’Etruria meridionale. In: Fontaine, P. (Ed.), L’Etrurie et l’Ombrie Avant Rome. Cité et Territoire. pp. 17–33.
Parsons, J.R., 2001. The Last Saltmakers of Nexquipayac, Mexico: An Archaeological Ethnography. Museum of Anthropology, University of Michigan, Ann Arbor, Michigan.
Pascucci, P., 1998. L'insediamento costiero della prima età del ferro de "La Mattonara" (Civitavecchia). Archeologia Classica 50, pp. 69-115
Pollard, M., Heron, C., 2017. Archaeological Chemistry.
Redhouse, D.I., Stoddart, S., 2011. Mapping Etruscan State Formation. In: State Formation in Italy and Greece. Questioning the Neoevolutionist Paradigm. pp. 162–178.
Rice, P.M., 1996. Recent ceramic analysis: 1. Function, style, and origins. Journal of Archaeological Research 4, 133–163. doi:10.1007/BF02229184
Rodriguez, E.C., Hastorf, C.A., 2013. Calculating ceramic vessel volume: an assessment of methods. Antiquity 87, 1182–1190. doi:DOI: 10.1017/S0003598X00049942
Sevink, J., Neef, W. De, Alessandri, L., Hall, R. van, Ullrich, B., Attema, P.A.J., 2020. Protohistoric briquetage at Puntone (Tuscany, Italy): principles and processes of an industry, based on the leaching of saline lagoonal sediments. Geoarchaeology. doi:10.1002/gea.21820
Skibo, J.M., 2015. Pottery Use-Alteration Analysis. In: Marreiros, J.M., Gibaja Bao, J.F., Ferreira Bicho, N. (Eds.), Use-Wear and Residue Analysis in Archaeology. Springer International Publishing, Cham, pp. 189–198.
Skibo, J.M., Blinman, E., 2008. Exploring the origins of pottery on the Colorado plateau. In: People and Things. Springer, New York, pp. 37–52. doi:10.1007/978-0-387-76527-3_3
Stoltman, J.B., 2015. Ceramic petrography and Hopewell interaction. The University of Alabama Press, Tuscaloosa.
Waksman, Y., 2016. Provenance Studies: Productions and Compositional Groups. In: Hunt, A. (Ed.), The Oxford Handbook of Archaeological Ceramic Analysis. Oxford University Press. doi:10.1093/oxfordhb/9780199681532.013.10
Weller, O., 2015. First salt making in Europe: an overview from Neolithic times. Documenta Praehistorica 42
Weller, O., Brigand, R. (Eds.), 2015. Archaeology of Salt: approaching an invisible past.