ARCHAEOLOGY OF SALT

APPROACHING AN INVISIBLE PAST

EDITED BY

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Contents

First salt making in Europe: a global overview from Neolithic times

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Abstract. This paper deals with the origin of salt production and discusses different approaches ranging from technology, ethnoarchaeology and paleoenvironmental studies to chemical analyses. Starting from the current research on the Neolithic exploitation of salt in Europe, we examine the types and nature of the salt resources (sea water, salt springs, soil or rock), the diversity of archaeological evidence as forms of salt working. We also scrutinize the types of production for these early forms of salt exploitation, with or without the use of crudely-fired clay vessels (*briquetage*). Finally, we contextualize the socio-economic dimensions and highlight both the diversity of salt products, as well as their characteristics, which go well beyond dietary roles.

Keywords. Salt production, Neolithic, Europe, methodology, archaeological evidence.

Résumé. Cet article traite de l'origine de la production de sel et aborde différentes approches allant de la technologie, l'ethnoarchéologie, les études paléoenvironnementales aux analyses chimiques. A partir des recherches actuelles sur l'exploitation néolithique du sel en Europe, nous examinons les types et la nature des ressources en sel (eau de mer, source salée, sol ou sel gemme), la diversité des indices archéologiques comme les formes d'exploitation. Nous examinons également les types de production pour ces premières formes d'exploitation du sel, avec ou sans utilisation de terre cuite (*briquetage*). Pour finir, nous cherchons à mieux définir les dimensions socio-économiques de ces productions ainsi la diversité des sels produits qui dépassent de loin le seul rôle alimentaire.

Mots clés. Production de sel, Néolithique, Europe, méthodologie, indices archéologiques.

If today salt is an ordinary good, a practically inexhaustible substance, both alimentary and industrial, this hasn't been the case in countless pre-industrial societies. It is at least since the Neolithic that European agropastoral societies have sought to extract it from its natural sources, or more precisely since the 6th millennium BC. Nowadays we likely associate the exploitation of salt with coastal salt marshes. Yet a great share of the production still comes from artificial heating of brine or simply from the extraction of rock salt. If regular table salt, or sodium chloride, seems an inexhaustible natural commodity, neither its geographic distribution, nor its physical forms are uniform. Salt is found in either solid (rocks, outcrops, earths, sands, plants) or liquid form (sea or spring waters, bodily fluids). Furthermore, it is present in highly variable concentrations, ranging from a few grams for blood or urine, to almost 200 g/l for certain salt springs or enclosed seas, attaining an average of 30 g/l for oceanic waters. It crystallizes at concentrations of around 330 grams per litre of water.

Faced with this disparity in concentration and distribution, humanity resorted to a wide assortment of extraction techniques. Nonetheless, apart from the exploitation of rock salt, salt extraction most often consists, in some cases after the lixiviation of a salty solid, of processing a liquid by subjecting it to a natural (solar salt) or artificial (ignigenous salt) evaporation process, until crystallisation is achieved (see Gouletquer and Weller, in this volume, fig. 1). The grained salt obtained can be then used as such or packaged as hard blocks of standardised shapes and weights. In this form, it can be preserved or readily transported and then traded over long distances.

The diversity of methods observed across the world seem intimately linked to the environmental contexts and the type of saliferous resources exploited; it also mirrors the quality of the sought product (type of salts, salted ashes, grained salt, or salt blocks), and to the specificities of the demand and of the social context (Gouletquer *et al.* 1994).

The issue of origins

If archaeologists and scholars have examined the ancient mines or the abundant debris of fired clay (briquetage) from after the Iron Age up to the 18th century, research on the origins of salt exploitation, harking to the Early Neolithic, has not yet even commenced. At a first glance, one can easily understand why, in the absence of the very object of research, the issue of salt exploitation remained poorly addressed for the prehistoric period. However, if nothing has remained of the product, the archaeological realities around salt exploitation have been ascertained in the field with the help of various types of evidences, which inform us non-vicariously of the techniques employed (catchments, pottery or charcoal accumulations), or more indirectly of their impact on the environment, the territorial organisation, or the circulation of goods.

Besides the discussion on the archaeological remains themselves, it is the general question of the function of salt which emerges. Indeed, how can we explain the appearance of this new exploitation of the natural environment? What were

the reasons for which the simple occasional collecting from a furrowed rock or from the edge of a salt spring were not sufficient anymore to these early Neolithic salt-producing communities, which now set themselves to separate the salt from its natural support (water, rocks, soils or plants) and, as such, to produce a hard, transportable and shaped salt? While many researchers have turned to biology and psychology to answer this question, others have looked for answers in ethnographic investigations. Indeed, does the biological hypotheses, according to which salt was an essential nutritional element within the new Neolithic alimentary diet, suffices to explain its exploitation?

In order to confront the hypotheses of the nutritionists with the archaeological realities, and to characterise the production of salt and its socio-economic implications, it is necessary to develop a pluridisciplinary approach and to multiply the ethnographic, historical, environmental, archaeometric, and experimental observations. It was therefore necessary to make use of several methods that, conjoined, can shed light on the archaeological realities. By illustrating our set goal with various case studies from across Europe, we seek to tackle the issue of salt exploitation from the methodological standpoint of different approaches that may be incurred, and of the elements that so far seem diagnostic. Also, we will see how the study of known or newly brought to light vestiges and of relative archaeological contexts can allow a reconsideration of the diversity of functions performed by salt, in which alimentation is not necessary the cornerstone.

Archaeological evidences

Whether or not one adheres to the biological argument, prehistorians have only recently considered other possible functions of salt in these early agricultural societies. Yet we know that the scarcity of exploitable natural resources meant that at specific times in history salt played an important economic and social role, prior to being bestowed with the multiple day-to-day applications we are now fully aware of (preservative, adjuvant for the dairy industry, tanning agent, metallurgy of precious metals, dye-fixing, medication…). Moreover, it has long been held that – just like with the production techniques of the Iron Age – salt exploitation was dependent just on the identification of vestiges or fired-clay structures collectively known as briquetage. Today, the variety of forms of exploitation recognised by both ethnography and archaeology (Alexianu *et al.* eds. 2011; Cassen *et al*. 2008; Cassen and Weller 2013; Fíguls and Weller 2007; Harding 2013; Hocquet *et al*. 2001; Monah *et al*. 2007; Nikolov and Bacvarov 2012; Pétrequin *et al*. 2001; Weller 2002; Weller *et al*. 2008) allows us to return to the issue of the function of certain material remains, and to advance new hypotheses on the place of this irreplaceable substance also in the domestic, technical and socio-economic spheres.

The directly-observable material remains of prehistoric salt production can sometimes be found in the form of wooden catchments or fittings, but most often it consists of accumulations of fired clay (or briquetage) comprising debris from ancient heating installations and fragments of salt pans, accumulations of charcoal and ashes, unearthed structures, or, in the case of rock salt exploitation, of stone

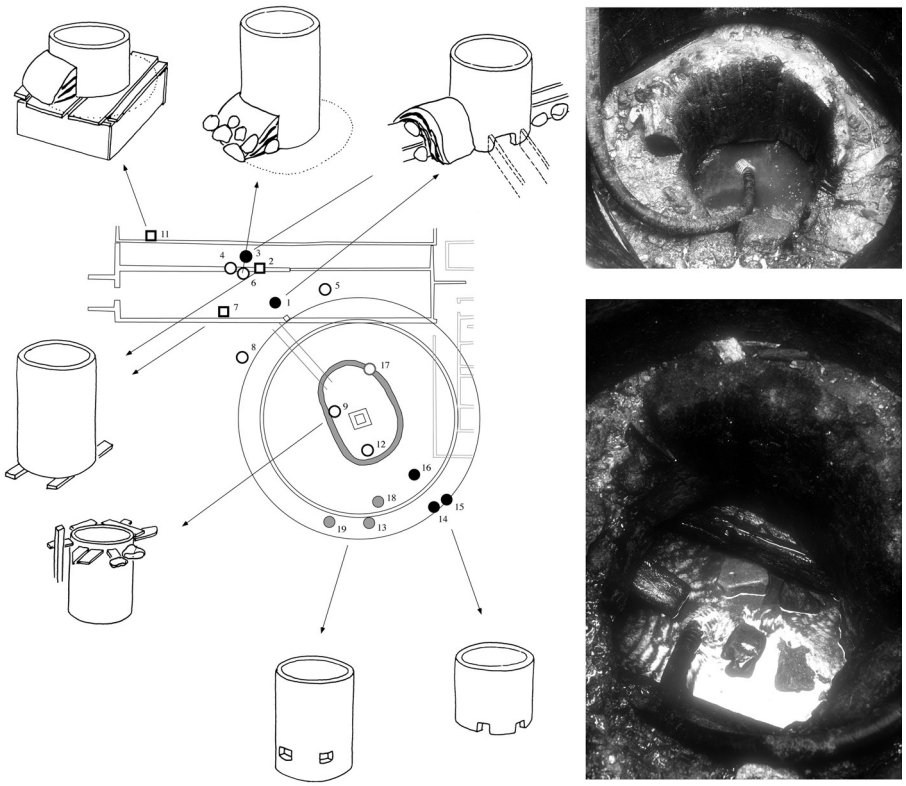

Figure 1. Neolithic wooden wells from Fontaines Salées, Saint-Père-sous-Vézelay, Yonne, France (drawing P. Pétrequin and photos O. Weller).

tools. We should note that no such remains are known at present for salt marshes, and that such inventions should be placed to the Roman period (not the Middle Ages), as shown by the excavations from Vigo in Portugal (Castro Carrera 2008).

Spring catchment and fittings

The construction of catchment systems and retention basins around the salt springs is difficult to ascertain in cases of heavy erosion or rapid sedimentation. However, French examples such as the spring from Moriez in the Alps, where researchers unearthed the frame of an ancient wattle dated to around 5600 BC (Morin *et al.* 2008), or that from Grozon in the Jura, where the salt workers erected a true horseshoe-shaped bulwark for protecting the spring (Pétrequin *et al.* 2001), suggest that the search for such structures should continue.

In the past, many wooden structures were observed during works of rehabilitation or for capturing the salt springs, but their dating is often problematic (missing elements, brief remarks at the moment of discovery…). The most eloquent are the 19 oak trunks from Fontaines Salées in Saint-Père-sous-Vézelay (Yonne, France) (fig. 1), formerly attributed to the onset of the Iron Age and nowadays re-examined and dated dendrochronologically to the 23rd century BC, that is to say contemporary with the Bell Beaker culture (Bernard *et al.* 2008).

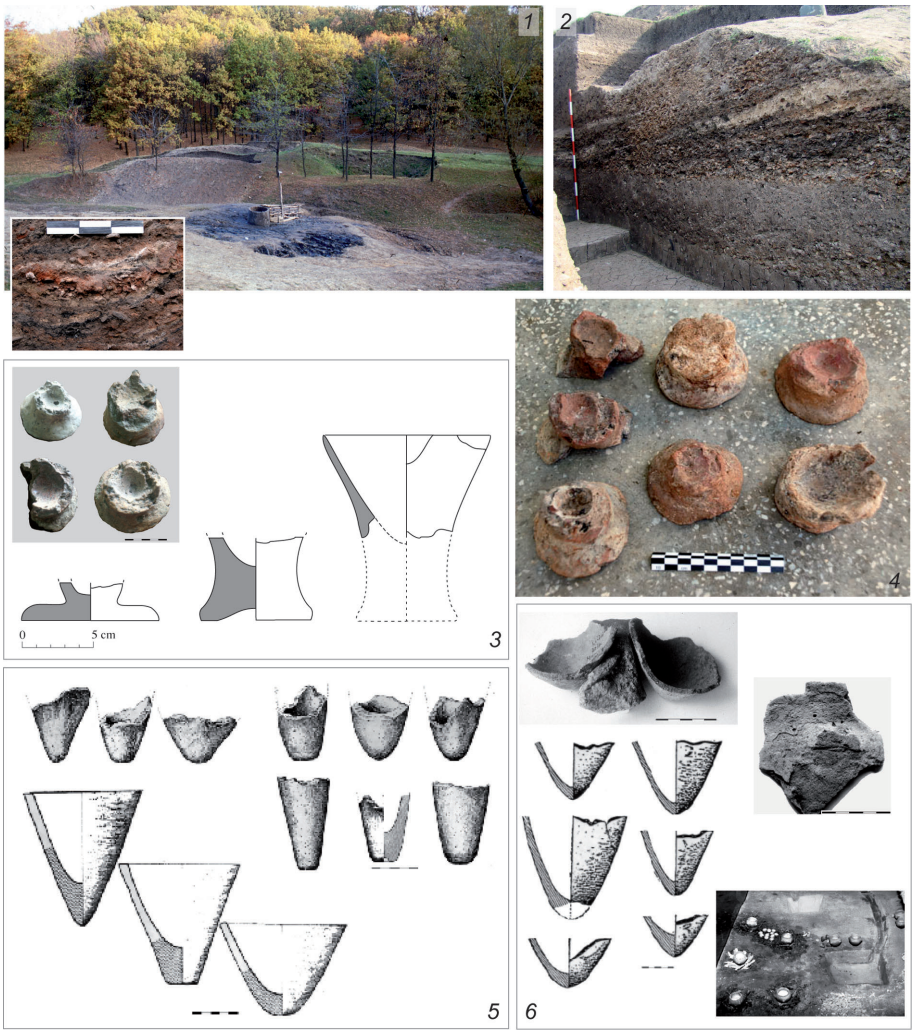

Figure 2. Evidences of salt exploitation in Central and Eastern Europe between the 5th and 4th millenniums BC: 1- accumulation of firewood places from the Early Neolithic at Lunca-Poiana Slatinei (Romania); 2- Succession of archaeological layers extremely rich in pottery from the Precucuteni and Cucuteni cultures at Ţolici-Hălăbutoaia (Romania); 3, 4- Briquetage from the Cucuteni culture (Lunca and Ţolici, Romania); 5- Briquetage from the Vinča culture (Tuzla, Bosnia-Herzegovina); 6- Briquetage with an element of a stove, corroded ceramic and model from Barycz VII (Poland) (photos and drawings O. Weller except drawings 5- Benac 1978 and 6- Jodłowski 1977).

Fired-clay vessels (or Briquetage)

The exploitation of salt during the Neolithic and Chalcolithic seems to have been in some cases particularly dynamic, on account of the considerable quantities of fragments of ceramic moulds accumulated around certain salt springs, sometimes associated with combustion structures or residues (Weller 2002a). This is the case with salt springs from Little Poland, Bosnia-Herzegovina, Romanian Moldavia

Figure 3. Chalcolithic salt moulds accumulation in Solnitsata, Provadija, Bulgaria (photos O. Weller).

(fig. 2, 2-6), or, more recently, Bulgaria (fig. 3), all exploited using fired-clay moulds, during the middle of the 5th millennium BC (Weller 2012). Around 3000 BC, on the Atlantic coast, it is the enclosures around the Poitevin Marsh in France which produce a very large quantity of briquetage (Ard and Weller 2012), while in Germany the salt springs from Halle furnish the first fired-clay moulds.

This specific ceramic ware, in all instances abundant and clearly distinct from the domestic pottery, displays the same general characteristics: clay of local provenance, numerous inclusions sometimes taking a quite large share of the paste, abundant tempering (sand, plant matter, grog, *etc.*), open shape, crude fashioning from a clay lump or from coils, finger or plant imprints, traces of wickerwork on the bottom; the edges and the outer walls are not finished but the interior is neatly smoothed. Fragmentation is nonetheless significant, due to their deliberate breaking for extracting the salt cakes. Across different producing sites, the vessels' bottoms, sometimes complete, constitute in some cases the majority of the ceramic harvest; the edges adhere to the salt cakes and can serve to trace the distribution paths.

These salt moulds thus serve both as moulds and crystallizers. If for some their function still remains at the level of hypothesis (Cassen *et al.* 2012), we were able to confirm it, for others, through a series of chemical analyses based on the assay of the element chlorine (Weller 2002a; Weller and Ard, forthcoming). Basically, the levels of chlorine in the salt moulds are 2 to 20 times higher than in domestic contexts. These values are greater still, as the meteoric waters infiltration is lower.

The use of ceramic moulds of practically identical shapes and volumes by each cultural group attests to the commitment to produce and package the salt according to a predefined shape, compact and easy to transport. The production is not aimed at simply producing salt, but salt cakes of a standardised quality, size and weight. The salt cake thus becomes a social object, an identity marker of the producers. In this form, it will circulate conveniently, be divided without losing its use value, and be stored for many years.

It is Central and Eastern Europe which in the early-middle Chalcolithic, specifically the middle of the 5th millennium BC, develops the crystallisation and moulding of salt in vessels of fired clay (Weller 2012). The appearance of these chemical techniques alongside the first copper objects, similarly casted, betray a new conception of the properties of matter, of making visible and manipulable a substance that is initially invisible. Nonetheless, with the exception of a fragment of a furnace discovered in Little Poland, there are no known genuine combustion structures from this era, and Western Europe had to wait the Bronze Age to first produce such structures, and then the Iron Age for saltworks in the true meaning of the word.

The charcoal accumulations

It was for a long time thought that in the absence of fired clay (ceramics, supports, accessories and fragments of furnaces or kilns), we could not demonstrate the exploitation of salt. However, there are other techniques of salt production, which do not necessitate the use of fired clay or kilns. The ethnographic studies conducted in New Guinea (Pétrequin *et al*. 2001; see Gouletquer and Weller in this volume) and their archaeological work in eastern France (Franche-Comté) revealed methods of exploitation that do not require the use of fired clay or furnaces, but other techniques involving the use of vegetal matter as raw material and produce considerable quantities of charcoal and ashes (Pétrequin and Weller 2008). Finding ancient accumulations of charcoal around the salt springs or littoral marshes thus becomes a new challenge for the research on ancient forms of salt production.

To have an image, if not for the production of salt, at least for the approximate volume of charcoal and waste on the river, the case of Salins-les-Bains (Jura) is exemplary: the charcoal from the production of salt during the 18th century is visible in the alluvial deposits to a distance of up to 10 km downstream from the saltworks; with respect to the charcoal produced during the Neolithic dated to around 3000 BC, it is still present in large quantities in the clogged meanders 7 km downstream of the salt exploitation area.

Over thousands of years, it is therefore a massive quantity of fuel that has been consumed in order to produce salt. For instance, the longitudinal section of the Grozon basin (Jura) across 400 m has revealed carbonaceous layers over 7 m thick, dated to between the early 4th millennium BC and the Roman period (fig. 4). The end of the exploitation during the Gallo-Roman era is marked by the entrenchment of the Romans around the salt springs (or the coastal marshes, respectively) presumably to put a halt to the Gallic exploitation and to sell their own Mediterranean salt.

As for the paleoenvironmental approaches, the palynologic and anthracologic analyses represent the most promising research directions. By studying the sedimentary sequences spread across the depressions near or immediately downstream of the salt exploitation points, it is possible to trace the management of the fuel and the history of deforesting (Dufraisse and Gauthier 2002). It is particularly possible to differentiate the deforesting for agricultural purposes (where the pollen of certain crops are well represented) and deforestation associated

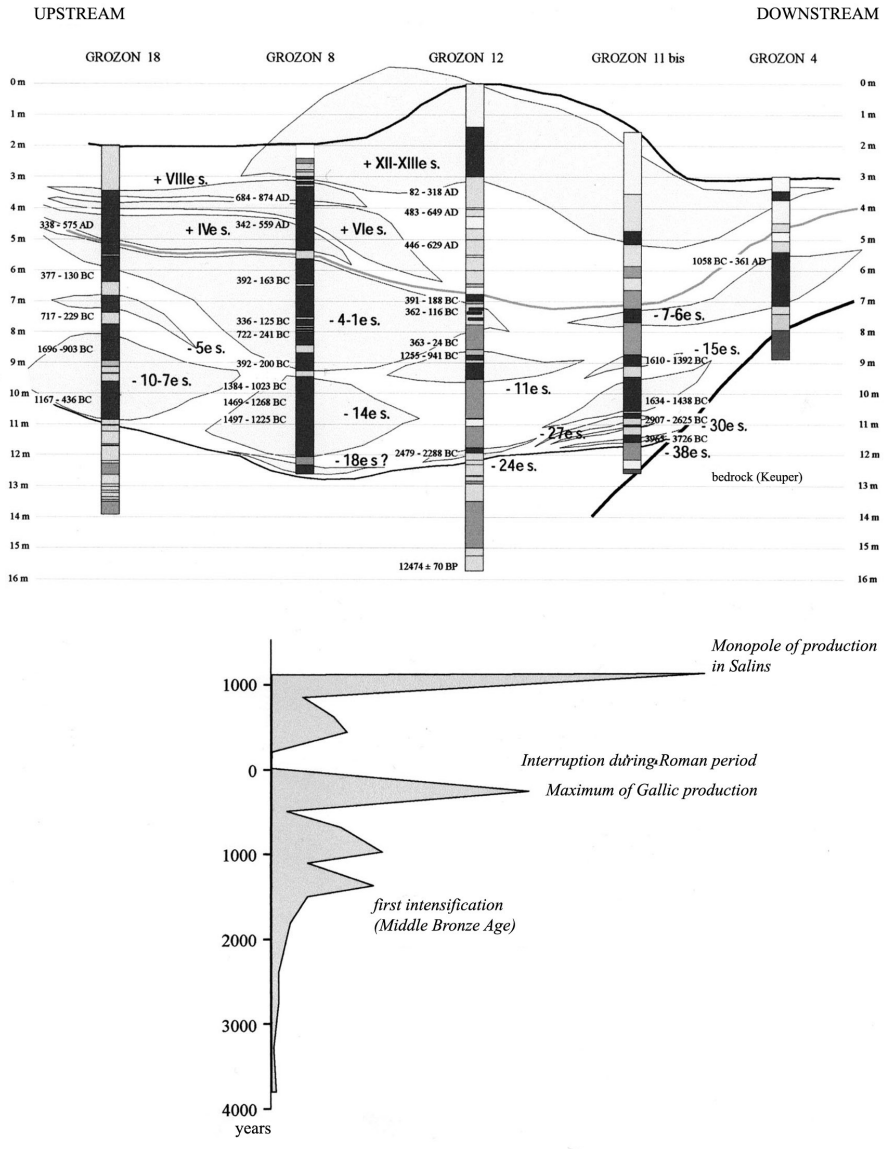

Figure 4. Salt exploitation in Grozon (Jura, France): Longitudinal stratigraphic cut of the Grozon basin (400 m) based on drill cores and dated by radiocarbon. The depression was created after the underlying salt-rock was dissolved (top). Schematic chronological evolution of the charcoal sediments volume related to salt exploitation (bottom) (drawings P. Pétrequin).

only with the exploitation of salt, in the case of the spring located at that moment outside of the permanent settlement and cultivated land. But the accuracy of the pollen diagrams is directly affected by the quality of the preserved pollen and the recording of the chronological sequences; this means that the marshes and depressions with wet environments should be the prime targets of core boring and sample collecting.

With respect to the exploitation techniques, in light of our own ethnographic study in the Indonesian New Guinea (see Gouletquer and Weller in this volume), following a re-examination of the ancient sources (foremost Pliny, Tacitus and Varro) and a series of life-size experiments (Pétrequin and Weller 2008), the extraction of salt without recipients is today better known for the Middle Neolithic of eastern France, and similarly proved for the Early Neolithic of Romania (fig. 2, 1) (Weller and Dumitroaia 2005; Weller *et al.* 2008). They involve the direct spill of the saline water over an incandescent pyre covered by a vegetal blanket meant to slow down the falling water. The saline water gets concentrated along the running path, just like in the techniques used in the gradual-evaporation salt factories of 16th-19th century Germany and eastern France; in contact with the incandescent embers, the salt crystallizes instantly. The small salt crystals are subsequently recovered from the ash and cinders, and packaged in a form that still eludes us.

The exploitation structures and buildings

Always built in the immediate proximity and view of the salt springs, according to the ethnographic data, the buildings and structures for exploitation are still largely unknown. Examples include the saltworks from Little Poland (pits, ditches and foundation post holes from the site of Barycz VII), the pits from Provadija in Bulgaria (Nikolov ed. 2008), or the Neolithic pits from Sandun (Loire-Atlantique, France), justly interpreted (Cassen *et al.* 2008) as pits for filtering salty sand and collecting brine, just like the pre-Hispanic vestiges from Mexico (fig. 5) (Liot 2000), or the Gallic sites from northern France (Edeine 1970). In the case of Sandun, it is therefore the real functions of the site considered so far as marsh-edge settlement that must be reconsidered. S. Cassen also invites us to readdress the functions of the different structures unearthed in several sites presumed to be settlements from France and Italy, or the so-called *Cultura de los silos de Baja Andalucía* for which he proposes to be reinterpreted as places for producing salt foremost by washing very fine sand. Intriguing hypotheses which must be tested in the field.

The first Neolithic mining tools

The only salt mountain in Western Europe is found in Cardona in Catalonia, at about 80 km northwest of Barcelona. This varicoloured *Muntanya de Sal* reaches more than 140 m in height. Despite the abundant research on the Neolithic burials of the region in the early 20th century and the discovery of numerous stone tools around this landform, the hypothesis of a Neolithic exploitation of this remarkable outcrop was hastily abandoned after the 1930s. After that moment, this region from the foothills of the Pyrenees remained outside of the large research endeavours and archaeological campaign concentrated along the Catalan shoreline.

However, starting from a series of chance findings gathered since the start of the last century by prospectors, farmers or workers from this salt mine, we were able to study several hundred stone tools represented by hammers, reused axes, pestles, and bushhammers (Weller 2002b; Fíguls *et al.* 2013). Their technological analysis showed that the Neolithic workers were using mining tools (usually stone axes

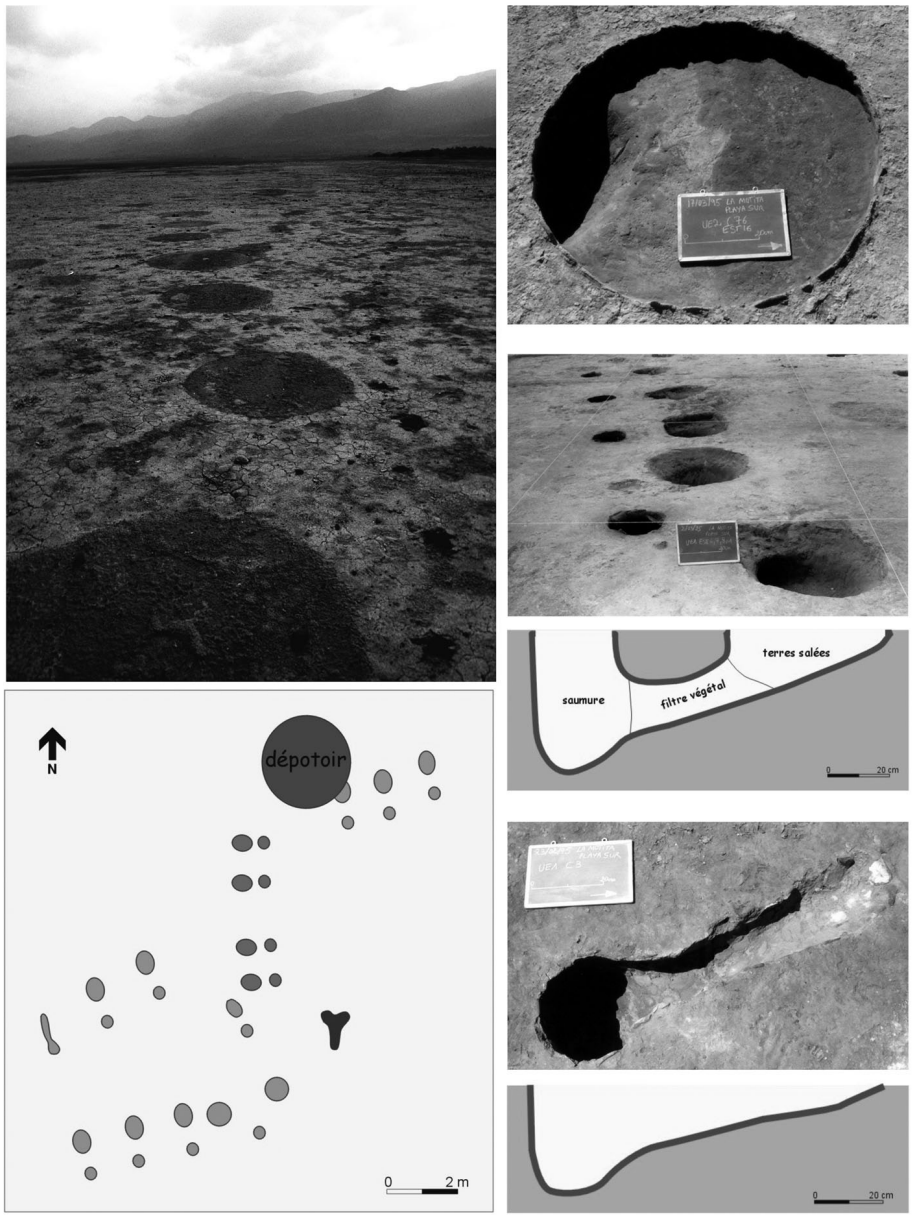

Figure 5. Pits for leaching salty soils, with watertight facing, simple, double or multiple from the Pre-Hispanic salt production centre on the edge of the Sayula basin (Jalisco, Mexico) (photos O. Weller-left and C. Liot-right, drawings C. Liot).

reused) associated with the exploitation of rock salt in the form of an open quarry. The salt blocks extracted from the outcrop were transported to the surrounding settlements in order to be transformed using mortars, and probably regularised, into blocks of salt of standard shapes and weights.

The socio-economic implications

Discerning the economic and social aftermath of the production and trade of salt consists firstly in the identification, in the vicinity of the salt springs, of the specific concentrations of settlements, and therefore of a population (Brigand and Weller 2013; *id.* in this volume), or of valuables in the form of deposits (Harding 2013), of imported goods or of spectacular graves. But this is where interpretation is most difficult, particularly since the ethnographic model of chieftain/leader societies specific to the highlands of the Indonesian New Guinea is only one among many other examples of ways in which a society can be structured. Here there are no buried treasures, no graves of momentarily prominent individuals, simply because the forms of power are transmitted equally through exchange and redistribution of wealth. Other ethnoarchaeological models should be tested before attempting to characterise social behaviours founded on social inequality, for instance like those which around the middle of the 5th millennium BC engendered the monumental tombs from the Gulf of Morbihan (France), a particularly suitable area for the exploitation of salt (Gouletquer and Weller 2002; Cassen *et al.* 2012).

On the question of the type of organisation and a conceivable specialisation of the crystallised salt production by the Neolithic groups from northern Catalonia (Weller and Fíguls 2013), the great portion of tools reused and fashioned from fractured polished axes, their distribution in an area of more than 20 km around the salt deposit, their low degree of technical development, and foremost the plausible absence of any major fortified control settlement, all suggest an open exploitation, not one reserved for a single small group of local specialists. However, the relative richness of the graves of this group in goods imported from the coast (variscite pearls from Gavà, the largest ever known, bracelets and pearls from shells, blond flint imported from Haute-Provence) suggests an elevated position of salt within a wider regional exchange network.

We may also mention the tight spatial correlation observed in Germany between the salt springs and the distribution of greenstone long alpine axes, which demonstrate that salt could have played a key role in the acquisition of these wealth and ceremonial objects (Weller 2002a). The age of the exploitation of these highly saline springs remains nonetheless to be established, only fired-clay remains used since the late Neolithic have been subject of studies.

In any case, throughout Western Europe during the 5th millennium BC, certain saliferous resources, be they inner-continental or coastal, appear to act as hubs capable of "drawing" into their networks these large polished alpine axes with attached social value, while in Carpathian-Balkan Europe, the first copper and gold objects likely integrated such networks. It is thus necessary to turn decisively towards a political geography of salt.

Depending on the nature of the salt exploitation and the modes of occupation of territories rich in saliferous resources, this production was occasional, regular or heavily invested, and also modulated by the different uses and functions of the product. These different organisations responded to the different uses of the salt, varying according to the social context, and salt most definitely did not have the same value irrespective of the time and place. The circulation paths, the exchange

networks, and the social context are from this point of view the determining factors.

If the prevailing hypotheses on the function of salt during the Neolithic are primarily biological ones, in line with the ubiquitous adage "Salt is essential to humans", the substance further acquired other uses, more recently established: preserving foods, dairy making, fixing dyes, hide processing, *etc.* However, the existence of idiosyncratic configurations of spatial organisation around the saliferous resources opens the door for other hypotheses besides the strictly utilitarian or functionalist explanations so far sanctioned by prehistorians. The diversity of functions played by salt in contemporary traditional societies shows that its status cannot be reduced to that of a simple household and nutritional chemical substance, especially because during the 5th millennium BC it was the focus of a massive technical and economic investment, as evidenced by its forging into cakes in Central and South-eastern Europe.

The appearance of the first Neolithic moulds means that salt, in the form of salt cakes, became a standardised item, dividable, transportable and storable, or, briefly said, a socialised good, an identity marker, capable of enabling long-distance exchange networks. Besides its role in human and animal alimentation, salt could have played, in certain contexts, the role of exchange good as a form of durable storage of a substance that is unique in terms of its qualities, of the areas suitable for its exploitation, and of its technical and economic charge.

We also notice that this intensification of exploitations of moulded salt in Central and South-eastern Europe coincides with periods of expansion of major groups such as the Lengyel (Poland), Vinča (former Yugoslavia), Cucuteni (Romania), or Hamangia (Bulgaria) cultures. The salt cakes could have been one of the means by which the social tensions generated by these population movements were defused. However, they were not necessarily used by all the expanding groups during this period of intensification of social relations, and were not routinely involved in all the processes of social regulation. It was just one possible form of storing wealth, one of the ways of taking part in the exchange.

As for the present, we are moving towards a European-wide geography of techniques of salt production (fig. 6), in which the technical investments, the economic and social status of this activity, but also the accompanying mental and social representations, can be pinpointed. It remains to define more precisely the forms of exploitation used in certain areas particularly suitable for extraction, for which only indirect evidence are available, but where the socio-economic contexts suggest a remarkable production (the lagoon areas of Morbihan, the highly saline springs from Halle/Salle and Bad Nauheim in Germany, the salt springs and saline lagoons from inner Spain…).

This study on an eminently soluble object is just the beginning, and future research should prioritise not only to search for undiscovered traces of exploitation (salt moulds, ceramics for boiling, filtration or storing structures, wooden catchment fittings, accumulations of ashes and charcoal, extraction implements and tools…), but should also seek to characterise the social behaviours of the groups that manipulated this substance and the historical processes that were engendered by them.

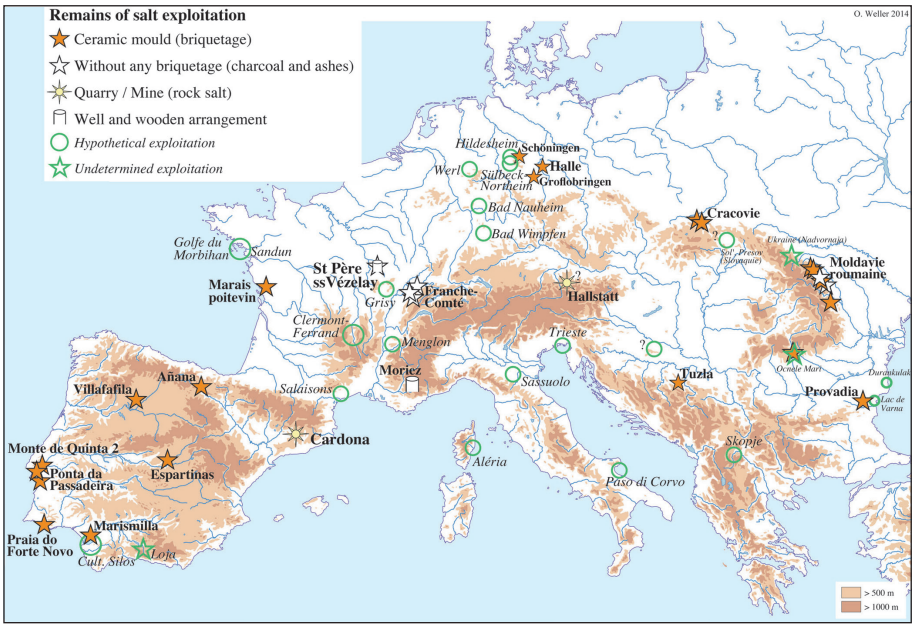

Figure 6. An European assessment for the Neolithic and Chalcolithic periods (6000-2300 BC): the various archaeological evidences for salt production (drawing O. Weller).

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