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The Present Stage of the Researches regarding Prehistoric Salt Production in the Carpatho-Danubian Region

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Rezumat

În ultimii ani cercetările cu privire la sarea preistorică în spaţiul Carpato - Danubian au cunoscut progrese importante.

Cea mai timpurie dovadă a producţiei de sare a fost descoperită în Subcarpaţii Moldovei, în siturile Lunca-Poiana Slatinei şi Ţolici–Hălăbutoaia, într-un context aparţinând culturii Starcevo-Criş (6050-5500 î.Hr.) ambele aceste situri sunt amplasate aproape de izvoare de apă sărată şi prezintă depozite de cenuşă şi ceramică fragmentată. Nu au fost descoperite dovezi explicite ale producţiei de sare, dar ambele situri sunt considerate ca fiind locuri în care oamenii evaporau apa sărată sezonier.

Recent în Bulgaria nord-estică, lângă oraşul Provadia, deasupra unui depozit imens de apă sărată, în situl Provadia-Solnitsata, aparţinând culturii Karanovo III-IV (cca. 5400-5000 î.Hr.) au fost cercetate dovezi de evaporare a apei sărate. Se crede că pe parcursul neoliticului târziu evaporarea în Provadia-Solnitsata se făcea în vase ceramice, în cuptoare speciale, în acest mod obţinându-se calupuri de sare recristalizată. S-a sugerat că aceste calupuri de sare erau produse pentru comerţ.

În Subcarpaţii Moldovei au fost cercetate mai multe situri aparţinând culturii Cucuteni (Lunca-Poiana Slatinei, Ţolici-Hălăbutoaia şi altele). Aceste situri relevă o tehnologie de evaporare a apei sărate, în aşa-numitele „brichetaje”. *Se crede că produsul final al acestei tehnologii erau calupuri de sare recristalizată în formă de con. Cu certitudine, aceste calupuri erau produse pentru schimb.*

Pentru Epoca Bronzului cele mai importante dovezi de exploatare a sării au fost descoperite în Transilvania nord-estică (Băile Figa, Săsarm - Valea Slatinei şi Caila - La Sărătură). Până în momentul actual doar la Băile Figa au fost desfăşurate săpături arheologice sistematice. Acest sit prezintă multe urme de structuri de lemn în asociere cu unelte de minerit, troace de lemn, scări de lemn şi alte obiecte folosite în exploatarea minieră a sării. Unii cercetători consideră că aceste troace erau folosite pentru exploatarea sării cu ajutorul apei, însă dovezile în acest sens nu sunt suficiente. Majoritatea uneltelor din lemn şi a instalaţiilor descoperite la Băile Figa datează, conform analizelor C^{14}, din Epoca Bronzului (între 1620 şi 975 cal. B.C.)

În ciuda dovezilor arheologice bogate de producere a sării descoperite în regiunea Carpato-Danubiană, tehnologiile de producere a sării nu pot fi reconstituite în întregime. Până în momentul de faţă, cunoştinţele noastre asupra modului de extragere şi de prelucrare a sării sunt foarte vagi. Nu există indicii sigure cu privire la caracterul, scopul şi amploarea producţiei de sare în preistorie. În aceste condiţii, interpretările referitoare la schimbul de sare pe scară largă, rolul producţiei de sare în societăţile preistorice din sud-estul Europei, par premature. Priorităţile în cercetarea sării preistorice trebuie să se concentreze asupra reconstituirii (prin cercetări mai detaliate, analize chimice, experimente) tehnologiilor preistorice de producţie a sării, precum şi asupra evaluării amplorii şi a caracterului acesteia.

In the past years, the archaeological researches regarding salt production on the territory of Romania and Bulgaria knew notable progress. On the one hand, the researches on the territory of sub-Carpathian Moldavia were continued, intensified and extended[1], the researches in Transylvania[2] and Bulgaria[3] were begun, and the earlier findings from Maramureş and Transylvania were re-evaluated[4]. On the other hand, the methodological level of research improved significantly, especially thanks to the co-operation with the scholars from France and Great Britain. At the same time the ethno-archaeological researches were intensified and extended in Moldavia[5] and Transylvania[6], and archaeological experiments began to play more important role[7]. Romanian leaders of prehistoric salt researches organised in Romania two international conferences on salt exploitation (Piatra-Neamţ 2004 and Iaşi 2008). One of the important events related to these researches was the itinerary exhibition *The Salt, Time and Man* (Sfântu Gheorhe, Sibiu, Alba Julia, Cluj-Napoca, Sighetul Marmaţiei and Bistriţa, 2006 – 2008) accompanied by the catalogue containing several studies regarding the ancient salt production in Romania[8].

In this article I will try to evaluate the present stage of research. On one hand, it is important to see to what extent the above researches contributed to a better understanding of prehistoric technologies of salt production and of its role in prehistoric societies. On the other hand, this evaluation aims to identify the most important priorities of further researches.

Neolithic

The earliest evidence for salt production in the Carpatho-Danubian region dates from Neolithic period. So far there are known three Neolithic sites in the region with the traces of salt production. It was believed until recently that the most ancient evidence of salt production in whole Europe was the Starčevo-Criş deposit from Solca-Slatina Mare site, Suceava county[9], but the recent excavation in this site showed that there is no Starčevo-Criş evidence[10]. The Starčevo-Criş and Band Linear deposits which scholars relate to the early Neolithic salt production was discovered in the sites Lunca-Poiana Slatinei[11] and Ţolici-Hălăbutoaia, both of them in the Neamţ County[12]. These sites were presented as being places of seasonal salt production[13]. To support this interpretation the authors put forward the existence of brine springs in both sites, the lack of any indications of long-term habitation within these sites, the existence of many traces of intense burnings (ashes, charcoal and fireplaces) which, according to the authors, resulted from brine evaporation by pouring it straight on the burning woods[14], such a possibility being demonstrated by experiments[15]. It is also believed that both of these sites do not provide proper conditions for agriculture, what is considered as one more argument in favour of the interpretation of these sites as being places of salt production. All these arguments are important, but they are not sufficient as long as in these sites no direct traces of the proceedings related exclusively to salt production (arranging of brine springs, brine evaporation etc.) were discovered. In this situation the only sure interpretation of these deposits is that the brine springs of sub-Carpathian Moldavia have drawn people ever since the early Neolithic period. Otherwise we would be tempted to interpret every archaeological traces found near the brine springs as the proofs of salt production. A more nuanced interpretation of the Neolithic deposits in these sites should be one of the major tasks for the future researches.

The late Neolithic evidence for salt production comes from the Provadia-Solnitsata site situated in north-eastern Bulgaria, near the Provadia town, at about 30 km west from Varna, above the only rock salt deposit in Bulgaria (Mirovskoto). This rock salt deposit appears at 12 – 20 m in depth, and it is covered by a huge brine bag; its salt concentration is of 250 – 280 grams per litre. The Provadia-Solnitsata site was researched in 2005–2007[16]. There were discovered many traces of brine evaporation within this site, in the Karanovo III-IV culture context. The salt evaporation technology, as the Bulgarian researchers reconstructed it, consisted in boiling the brine in ceramic bowls of 5.5 to 35.5 litres in volume, in the ovens made within multi-functional buildings. The bowls were made of porous fabric; they had thin walls and wide open mouth. These features facilitated the brine evaporation (through the wide opening and through the walls' pores). The use of these bowls for boiling brine was proved by the results of chemical investigations that identified in the sherds coming from these vessels chlorine, potassium and magnesium[17]. As a matter of fact, the use of big ceramic containers made of porous fabric was attested in many other archaeological sites related to brine evaporation, in England for example[18]. The bowls full of brine were put in big hot ovens and after the boiling, according to the researchers, it resulted the ingots of re-crystallised salt. It is believed that these ingots of re-crystallised salt were used as a means of trade.

No doubt, the Neolithic evidence of salt production from Provadia-Solnitsata site is one of the most important in the whole Europe, and it is one of the earliest in the world, its age being established between 5400 and 5000 BC[19]. The interpretation according to which salt produced in Provadia-Solnitsata was destined for wide territories of Bulgaria[20] seems highly plausible, as it was shown that except the western coast of the Black Sea and the Provadia area, Bulgaria is salt-poor[21]. At the same time, it seems quite surprising how the authors reconstruct the final product of brine boiling as the ingots of re-crystallised salt[22] without verifying such a possibility by experiments.

In contrast with Neolithic and Eneolithic salt production sites from Moldavia, the researches in Provadia-Solnitsata revealed many other crafts besides salt production, as well as a long-term habitation.

Eneolithic

The most consistent and expressive evidence for salt production during Eneolithic period was discovered in central and northern sub-Carpathian Moldavia in several Cucuteni culture sites (A2 and mainly B stages). The most important of them are: Solca-Slatina Mare and Cacica in Suceava county, Lunca-Poiana Slatinei, Lunca-Oglinzi Băi and Ţolici-Hălăbutoaia in Neamţ county, Cucuieţi-Slatina Veche in Bacău county. All these sites are situated nearby some brine springs. The Eneolithic deposits in these sites are much more consistent as compared to the Neolithic ones. Alike Neolithic deposits, in Eneolithic ones, sometimes in spite of the researches' vastness (Lunca-Poiana Slatinei), no traces of long-term habitation were discovered.

The Cucutenian archaeological deposits are made of ash, charcoal and many fireplaces mixed with rich pottery and other artifacts. In all these sites, except the Cucuieţi-Slatina Veche one, there is a plenty of sherds coming from small ceramic cone-shaped vessels with massive bottoms – the so called *briquetage**. It should be pointed out that this kind of pottery is totally absent in the Cucuteni sites situated out of the brine sources areas. Therefore, the association between briquetage and the brine springs is obvious. Moreover, on the occasion of the first discovery of the briquetage (at Solca-Slatina Mare), Nicolae Ursulescu observed their similarity with the briquetage from Wielicka – an Eneolithic site belonging to the Lengyel culture, near Krakow, already proved at that time as being related to brine evaporation[23].

The discoveries that followed the publication of the materials from Solca-Slatina Mare, especially that from Lunca – Poiana Slatinei, contributed very much to gathering the data that allowed the interpretation of these sites as brine exploitation places. As to the reconstruction of salt evaporation technology in these sites, the opinions are different. After some authors, the brine was directly boiled in briquetage, the saltmakers adding gradually in the briquetage brine instead of the evaporated water, so as in the end there were obtained solid cone-shaped salt cakes[24]. According to another hypothesis, the brine was first boiled in large vessels up to its transformation into a viscous high concentrated mass. Then this mass was poured in briquetage. The briquetage were then put in places with high temperature (probably on hot hearths or on embers), so that the viscose mass transformed gradually in cakes of re-crystallised salt[25].

In order to extract the cakes of re-crystallised salt the brichetage must have been broken. That is why, until now no intact briquetage was found, but only fragments, out of which the easiest to recognise are the ones from the bottoms. Unfortunately, the above reconstruction of the salt cake making was not experimentally confirmed. The experiments by which people tried to produce salt cake by boiling brine in briquetage were performed in the Cucuteni-Cetăţuie site[26]. It seems that these experiments were not really adequate: they were performed out of the area with brine sources, the briquetage were done without reconstructing the eneolithic technology of their production etc.). These experiments demonstrated that salt cakes can not be obtained by boiling brine in briquetage on open fire. In doing so, the experimenters obtained just a small amount of common salt deposited on the inner side of the walls of the briquetage. On the other hand, when the briquetage were exposed for a long time on fire they cracked. Obviously, the experiments must be repeated in better conditions, preferably in the sites where the briquetage were found. First of all the composition of fabric and the technology of modelling of briquetage must be reconstructed. The experimental boiling of brine in large pots would be recommended in order to increase the salt concentration of brine, before finalising the process in briquetage. Taking into account the high frequency of „Cucuteni C" type pottery in the Eneolithic sites with briquetage[27], it would be useful to verify the possibility to boil brine in them. At least at first sight, this category of pottery seems to gather the necessary conditions for boiling brine: the shell in its fabric must have increased its resistance at high temperature,

***** In Romanian literature a narrow meaning of the word "*briquetage*" is being used (deriving from the French therm *"briquetage"*); it is used to identify the small vessels in which salt was obtained from brine (**Monah 2008**, p. 16, nota 1). In the western archaeological literature, the word *"briquetage"* has a much wider meaning: agglomerations of burnt clay and ashes (**Gouletquer 1974**) or *"the term briquetage is taken to mean not only the ceramic equipment (troughs, supports, clips, etc.), but also the fragmented debris of hearths/ovens, used in the processing of sea salt"* (**Lane, Morris 2001**, p. 8).

and the porous fabric could facilitate the evaporation of water through the walls of pots, not only through the opening, which might have contributed to the acceleration of evaporation and to the economy of wood put on fire. At the same time, the chemical investigations are necessary in order to find the chemical traces of brine evaporation in the walls of the pots, as it was done in England[28] and at Provadia-Solnitsata[29].

Anyway, it seems highly plausible that the final product of brine evaporation involving briquetage was the re-crystallised, cone-shaped, round-headed cake of salt, by some appreciations having the weight of about 1.5 kg[30]. The ethnographic researches performed on the territory of Moldavia and Transylvania show that the villagers who use the brine from the springs rarely re-crystallise it. When they do it by boiling brine in pots on fire, they obtain just common salt that during the boiling process is gradually deposited on the inner walls of the boiling pots. The villagers are never interested in obtaining cakes of re-crystallised salt. Most of the times, they use directly the brine for cooking, for conserving the vegetables, cheese and meat, as well as for watering hay etc.; sometimes, especially at the country weddings in Transylvania, they put on the table small bottles with brine instead of salt cellars. Therefore, it seems highly unlikely that the production of salt cakes in the briquetage has been destined for own use.

Therefore the hypothesis according to which the salt cakes re-crystallised in briquetage were used to supply the settlements situated far from the brine evaporation sites seem to be plausible. For now, it is difficult to specify the distances to which the salt cakes produced in briquetage were transported. It should be mentioned, in this respect, the assumption of John Chapman and Biserka Gaydarska that the salt from sub-Carpathian Moldavia supplied not only the neighbouring Cucutenian settlements (for example the large Poduri-Dealul Ghindaru settlement), but also the mega-sites from the area of Tripolye culture[31]. The above mentioned hypothesis was recently contested by showing that Dniepr area is salt-rich and that in this conditions Tripolye culture people did not necessarily need the Carpathian salt[33]. The arguments of Magda Mircea and Marius Alexianu are quite important, but it probably must be taken into account that the salt of the Lower Dniepr area, being of marine origin, is bitter because of the high proportion of iodine in its composition. That is why animals do not like it.

There are known some ethnographic examples of long-distance movement of salt ingots, for example in Papua New Guinea[33]. It should be admitted that salt ingots could be used within Cucuteni-Tripolye culture as the means of exchange, as many historical and ethnographical examples suggest[34]. Of course, such a possibility must be verified. One of the research topics in this respect could be the briquetage seriation as it concerns their shapes and volumes, to see whether the salt cakes were done by some volume standards (in order to be easily countable in trade). In this sense a thorough examination of the fragmented pottery might contribute to a more precise and thorough reconstruction of briquetage as compared to that done twenty years ago[35].

Regarding the definition of the character of the Eneolithic sites of the Lunca-Poiana Slatinei type as being specialised exclusively in salt exploitation, there persists a question which I can not answer as long as it is believed that these sites were specialised only in brine evaporation: why in all the sites with briquetage almost the complete range of Cucutenian pottery, including the painted one, is represented? It probably means that besides brine evaporation other activities also took place within these sites. Definitely, this issue has to be one of the major topics of future researches.

It also should be mentioned that the Cucutenian sites with briquetage are concentrated only in north-western sub-Carpathian Moldavia (Suceava and Neamţ Counties). The above area lacks in rock salt sources accessible to nonindustrial exploitation (the outcrops of rock salt on the surface and the rock salt deposits on small depth). On the other hand, south from this area, along the eastern and south-eastern slopes of the Oriental Carpathians (Bacău, Vrancea and Buzău counties) and then along the southern slope of the Southern Carpathians (Prahova and Dâmboviţa Counties and further on in sub-Carpathian Oltenia), the rock salt appears frequently on the surface and at small depths. In Transylvania and Maramureş, which are rich in rock salt deposits on the surface and at small depth, no briquetage were found as well. All these mean that the briquetage were not produced in the areas where the access

to rock salt was easy. We also observe that the briquetage are concentrated only on the eastern periphery of the Carpathian salt province. Moreover, within the Cucuteni area the briquetage are concentrated in the area exposed to the wide salt-poor territories (the northern half of eastern Moldavia east from Siret, central and northern Bessarabia, forest-steppe Ukraine up to the Dniepr river, meaning broadly the territories covered by the Cucuteni-Tripolye area. This circumstance suggests that the salt cakes produced in briquetage were destined to the Cucuteni-Tripolye communities. As it was already shown, this hypothesis was expressed before[36].

An important role in the research concerning brine exploitation by the Cucuteni culture people could have the researches begun recently at Cucuieţi-Slatina Veche[37], as here, in the Cucuteni layer, predominantly with the materials characteristic to A2 stage, no briquetage were found.

The direct Eneolithic proofs of salt exploitation in north-eastern Bulgaria, at Provadia-Solnitsata, were not found yet. Nevertheless, starting from circumstantial observations, the Bulgarian scholars believe that during middle Eneolithic (Hamangia IV culture, 4.600 – 4.500 BC), and then during late Eneolithic (Varna culture, 4.400 – 4.200 BC), salt production was a main activity within the Provadia-Solnitsata settlement. They believe that the remarkable richness of this site and its complex fortification system (the earliest one of this type in whole south-eastern Europe) were determined by the fact that at that time the Provadia site supplied the salt for most of Thracia which, by Vasil Nikolov's estimations, needed in that period about 500 tons of salt annually[38]. We must, probably, expect that future researches will gather direct data regarding salt exploitation at Provadia-Solnitsata during Eneolithic period. Taking into account the fact that in that period the copper mining was practiced on the territory of Bulgaria (Ai Bunar/Mečki Klade-nets), we can also expect the discovery of some Eneolitic salt mines in the Provadia area.

Bronze Age

The Early Bronze Age indications of possible salt exploitation come from north-eastern Transylvania, where in two salt sites: Băile Figa and Săsarm – Valea Slatinei, close to the brine springs, the groupings of Early Bronze Age pottery were discovered. The possible Middle Bronze Age evidence of brine exploitation in the Carpatho-Danubian area comes from the Trzcinicec-Komariv culture sites Loeva (sub-Carpathian Ukraine), Lunca – Poiana Slatinii and Cucuieţi – Slatina Veche (sub-Carpathian Moldavia). In Loeva and Lunca – Poiana Slatinii, the salt exploitation will also continue during Late Bronze Age and at the beginning of the First Iron Age. There are also several Middle and Late Bronze Age findings with traces of salt mining in the northern half of Transylvania (Băile Figa, Săsarm – Valea Slatinei, Caila – Sărătura, Valea Florilor, Ocna Dej) and in northern Maramureş (Valea Regilor).

The *Loeva* site is situated close to some brine springs. The researches carried out here by Larisa Ivanivna Krušelnicka showed that there were rich Bronze Age archaeological deposits made of ashes and charcoal and fire places, together with Trzciniec-Komariv, Noua and Gava–Holigrad pottery[39]. At the same time, a rectangular-shaped wooden structure, made of horizontal timbers, was discovered in this site, being attributed to the Gava-Holigrad culture. It was interpreted as a brine decantation shaft. Unfortunately, a series of details (geologic context, C_{14} dating of the wooden structure etc.) neccessary for a more certain interpretation of this site are unknown. The Bronze Age and First Iron Age archaeological deposits at Lunca – Poiana Slatinei are very much similar to those from Loeva, with the specification that the Early Iron Age evidence from Lunca belong to the Chişinău-Corlăteni culture, followed by the Canlia type deposits[40]. The deposits from Cucuieţi – Slatina Veche mainly include materials characteristic to the Trzciniec-Komariv culture and a few Wietenberg and Monteoru type ceramic fragments[41]. The Bronze Age deposits in these sites are interpreted as being the traces of the activites related to brine evaporation. For now, the archaeological materials from these sites were mainly approached from the pottery typology point of view, its cultural belonging and chronology. Obviously, there is a need for a series of detailed investigations dealing with archaeological contexts, artifacts and ecofacts, particularly from the perspective of salt exploitation methods' reconstruction.

Much more expressive evidence of the Bronze Age salt exploitation was discovered

in northern Maramureş (Valea Regilor) and Transylvania (Valea Florilor, Băile Figa, Săsarm – Valea Slatinei, Caila – Sărătură şi Ocna Dej).

Valea Regilor (Northern Maramureş, at present Zakarpatska oblast', Ukraine, about 30 km north-east from Solotvino town). In 1817, during the drainage works in one of the salt mines, at the depth of about 13 m, the grotto was discovered (9.5 m long and 3.8 m wide). In its southern part there was found another grotto (its diameter was of 13 m and its heght was of 4.7 m) filled up with clay and mud[42]. In this grotto there were found several objects. The most special of them was a trough, hollowed out in a tree trunck, with one end closed and one end open. The bottom of the trough, was perforated on its median line with a row of square-shaped vents. In these vents wooden axially perforated pegs were inserted. In the axial orifices of some pegs twisted cord was inserted. Besides the trough in the mine there were also discovered a wooden ladder, a wooden hammer, a few lateral beams from the wooden ladders (?) perforated at equal distances (about 0.5 m); two wooden palettes, a thick and long rope made of jute (by V. Wollmann) or of tree bark (by C. Kacso); a rock salt block with wide holes realised with the help of water jets (?). Near this mine, in 1846 and 1847 there were also discovered two salt mines with the walls armed with massive wooden beams.

Valea Florilor (Transylvania, between Cluj and Câmpia Turzii, near Valea Florilor railway station). In 1938, during the works of the station extension, the workers found a few abandoned salt mines. One of them had round walls boarded with wattle and it was about 10 m deep. On the bottom of this mine, at about 8-10 m depth, in the salty clay layer several objects were found[43]: a trough hollowed out in a tree trunk, with both ends closed, about 2 m long, with a row of vents made on the median line of its bottom, in which there were inserted axially perforated pegs; 3 wooden shovels; one wooden sledge hammer; one simple lever; one lever with one of the ends hook-shaped; two wooden bats with one thickened end; a stone quern of *„Dacian type"*. In the nearby mines there were also discovered several fragments from other two or three troughs. Relying on the *„Dacian type"* quern, Maxim dated these objects in the Second Iron Age[44]. This dating was also accepted by other scholars[45]. However, in 2005, some trough fragments were dated by C_{14} method. On this base all objects from Valea Florilor were dated between 1420 and 990 BC cal, 96% probability[46].

Băile Figa (north-eastern Transylvania, Bistriţa-Năsăud county, Beclean town). The site is situated over a rock salt deposit, in the valley of a brine stream „Pârâul Sărat" (salty stream). It was discovered in 1977 by the geologist I. Chintăuan who observed in the stream riverbed many traces of wooden structures and a wooden trough[47]. In 2005 – 2008, there were carried out systematic reseraches[48]. It was established that on a surface of about 500 x 300 m, on both sides of the stream there are many timber structures. The over 50 timber samples dated by C_{14} method showed that these structures belong to different periods. The earliest wooden piece dates about 3000 cal BC; most of the pieces and structures date about 1620 – 1500 cal BC, 1050 – 975 cal BC and about 1005 – 915 cal BC. Several C_{14} data place some of the structures and wooden objects in the Second Iron Age (about 250 cal BC), and others in the Post-Roman period (about 330 – 540 cal AD). Within the site a lot of Early Bronze Age pottery as well as some isolated Neo-Eneolithic ceramic fragments were found.

The researched wooden structures often are destroyed by subsequent exploitations, although some of them were very well preserved. Therefore, in the northern part of the site there appeared fences made of split poles and planks dating to the period of 1050 – 975 cal BC. A grouping of wooden structures (19 x 21 m) made of wattle fences propped up on vertical poles stuck in the ground and dating about 1005 – 915 cal BC was uncovered here as well. In the middle of this grouping there was a room with wattle walls (10 x 2,5 m), with the shape of 3 opened and joined circles, covered by massive beams and hazel tree twigs. From north and east this grouping was delimited by an arch-shaped wattle fence. The traces of constructions researched in the northern part of the site overlap a pit; in its infill there are many Early Bronze Age sherds (possibly contemporary with a fragment of processed wood, found alongside, dated by C_{14} about 3020 – 2925 cal BC).

Most of the artifacts were found out of their original context and date mainly from Middle-Late Bronze Age. The discovered objects (mining stone tools, wooden ladders, wooden sledge hammers and others) highly suggest mining works. Out of the most important objects, four troughs should be mentioned, discovered in the southern half of the site, in two places, in pairs. Two of them, discovered at the southern end of the site were dated between 1620 and 1500 cal BC (95% probability); one of the two troughs discovered in the central-southern part of the site dates about 1000 cal BC. Roughly, the troughs from Băile Figa are similar to the troughs found at Valea Florilor and Valea Regilor.

In 2006 – 2008, on the territory of the Bistriţa-Năsăud county, at 10-13 km from Băile Figa, there were also discovered and examined two sites similar to the Băile Figa site: *Săsarm – Valea Slatinei* and *Caila – Sărătură*. Both of them are situated nearby some rock salt deposits. In both of them the wooden structures (similar with that from Băile Figa) were mainly observed in the riverbeds of the brine streams. At Caila – Sărătură a wooden trough was also discovered, similar to that from Băile Figa, as well as Bronze Age pottery[49]. At Săsarm – Valea Slatinei, nearby a salt water spring, there were discovered traces of some deepened complexes as well; their infill was made of ash, wattle and daub and charcoal, as well as a plenty of Early Bronze Age ceramic fragments[50].

Ocna Dej (northern Transylvania, Cluj county, about 25 km west from Beclean). Here, in an abandoned salt mine, two wooden pieces were discovered: a channel and a trough with one end closed and one end opened, with a row of vents made on the median line of its bottom[51].

As it was observed, the points in which troughs were discovered are concentrated in the northern half of Transylvania (Valea Florilor, Ocna Dej, Băile Figa, Caila), and in northern Maramureş (Valea Regilor). Chronologically, they cover the period between about 1.620 and about 990 BC. In three cases (Valea Florilor, Ocna Dej, Valea Regilor), the troughs were found in salt mines and in two cases (Băile Figa and Caila) – in brine streams, over the rock salt deposits, among the rests of timber structures, that probably are the traces of mine galleries. Therefore it is quite possible that the troughs at Băile Figa and Caila also to have come from salt mines. In most of the cases, except Ocna Dej, the troughs were associated with other objects that were used in salt mining (wooden shovels, wooden sledge hammers, wooden ladders, jute rope, stone mining tools etc.). At Ocna Dej the trough was discovered together with a wooden channel, and the one at Valea Regilor together with a salt block having round holes made, as it seems, by water jets. It should also be observed that sometimes more than one trough was found: at Băile Figa 4 troughs (two pairs of troughs in two places), at Valea Florilor – 3 or 4 troughs discovered in three (?) mines.

Regarding the typology of the troughs, one can observe that beyond the similarities they show some particularities. First, some troughs have both ends closed (Valea Florilor), while others have one end closed and one end open (Valea Regilor, Băile Figa, Ocna Dej). Second, some troughs have the exterior of the bottom straightened (flattened) by carving, while others have the exterior of the bottom unworked (naturally rounded). Some troughs have cut channels around their bodies at their ends, certainly in order to fix the ties with which the troughs were suspended. As a matter of fact, at Băile Figa such ties (twisted twigs) wrapped up the bodies of the troughs discovered at the southern end of the site. It should also be observed that the Valea Regilor trough had at its upper margin (at the rim) a triangular-shaped cut, that probably served as a place to introduce a wooden channel, through which the water was brought in the trough. Finally, sometimes in the vents of the pegs twisted cords were found (at all the troughs from Băile Figa and at that from Valea Regilor). In one case (Băile Figa) the vent of the peg was obturated by a needle-shaped wooden wedge wrapped up with wooden fibre.

All these suggest, first of all, that the troughs were used in salt mining. Recently, V. Wollman and H. Ciugudean reiterated E. Presig's hypothesis according to which the troughs were used to cut the salt blocks by water jets[52]. Relying on this hypothesis and taking into account the above observations, one can imagine the technology of salt mining that was carried out with the help of these troughs. There were chosen places in which the rock salt was close to the surface.

First of all, in these places, relatively large vertical pits were dug until the deposit of rock salt was reached. The walls of these pits were armed by poles, planks and/or wattle. Then, in some cases lateral galleries were dug. When the deposit was reached, the troughs were installed (suspended?) in chain and on different levels, as the schematic draw presented by V. Wollmann suggests[53]. The troughs on the upper levels must have had one of the ends open, therefore having the role of channels. The last trough from this chain must have had both ends closed (as that from Valea Florilor). After that, by wooden channels, water was introduced in the first trough. Trough the open end, water fell into the trough beneath it and so on, until water reached the last trough. Therefore water fell from trough to trough in cascade. Probably the water flow was adjusted in such way as in the last trough it reached as much water as it was needed in order to pierce the massive and not to flow over. After the water fall from trough to trough was provided, by opening the pegs' vents thin jets of water fell on the rock salt massif. These jets dug the holes in the rock salt massif. After these vents became large and deep enough, the pegs were taken out so as water jets got stronger and in this way the holes making accelerated. At some point, after the water accumulated in the holes of the rock salt massif diminished its penetrating power, the trough's vents were closed until the salt dissolved and the holes got wider.

Until experiments will be carried out, it is rather difficult to estimate how long the water absorption that filled up the holes in the rock salt massif lasted. Anyway, taking into account the rock salt's hardness, this process must have taken a long time. From this point of view, as V. Wollmann underlines, the most convincing piece seems to have been the rock salt block at Valea Regilor with wide and deep holes disposed in strait range and at equal distances. After the holes perforated the rock salt deep enough, the blocks of salt were detached by hitting, probably using stone mining tools.

Although the reconstruction of the salt mining process presented here seems plausible, it should be noted that for now it remains only one of possible hypotheses. As a matter of fact, the discoverer of the Băile Figa site considers the troughs as being installations used for brine evaporation[54]. On the one hand, there are necessary new data, and on the other hand, the experiments are also required.

Some conclusions

From the above presentation of the evidence of prehistoric salt production in the Carpatho-Danubian area, it can be easily observed that in the last years it significantly developed. With all these, the reconstruction of the extraction and processing methods, administration, trade and use of salt in the prehistory remains to a great extent uncertain. From this point of view, the research is still at the beginning. In what concerns the interpretations regarding the economic, social, demographic and cultural implications of salt works, they still have not exceeded the stage of more or less ingenious hypotheses.

The most obvious gap of the researches is that many of the salt-rich territories (the south of sub-Carpathian Moldavia, Walachia and Oltenia, as well as central and southern Transylvania) did not provide direct archaeological evidence of salt production. At the same time, there is no direct evidence of salt production from the transition period from Eneolithic to Bronze Age and for the most part of the Early Bronze Age.

Regarding the known evidence, beyond the field researches, there are required a few research projects. Related to the two points of Starčevo-Criş culture, the most important issue is the specification of the archaeological deposits from there: how they formed, in what seasons were occupied and how long the occupations lasted. The performing of micro-stratigraphic researches, the investigation of ecofacts and the precise dating of some occupation sequences in these sites would probably be more important than the extension of the diggings. It would also be highly recommended a more thorough research of the ceramic material, both from technological and typological points of view. There is also necessary a chemical investigation of the pottery in order to grasp the traces of brine boiling. As to the Neolithic evidence of salt production at Provadia – Solnitsata, the experimental check of the interpretation according to which the salt ingots were obtained by boiling the brine in the ceramic bowls is required. At the same time the seriation of these bowls by volumes would be extremely important, in order to see whether

some easily accountable weight patterns were respected or not.

Regarding the Eneolithic period, the most exciting research project could be the reconstruction up to the smallest details of the technology by which the salt cakes were obtained in briquetage. In this way, the course pottery must be investigated thoroughly, especially the C type one. This investigation should include the technological, typological, chemical and experimental aspects. In what concerns the briquetage, after four decades since they were first discovered, we should know how and what they were made of, what forms and volumes they had. Finally, the experiments must be resumed, in what concerns the course pottery as well as the briquetage (reconstructed properly). In this way, the credible reconstruction of the final product of this technology may be realised. At the same time, alike in the case of the two Starčevo-Criş sites, there are necessary researches in order to understand properly the character of the archaeological deposits.

Maybe one of the most fascinating research topics regarding the brine exploitation in sub-Carpathian Moldavia during Eneolithic is the scale of these exploitations. How much and in how long time the re-crystallised salt was produced in every site.

In what concerns the Eneolithic deposits at Provadia – Solnitsata, it should be looked for some mine traces in the surroundings, obviously if there are portions where the brine bag does not cover the rock salt deposit.

In the case of the Bronze Age evidence in sub-Carpathian Moldavia, the observations made in relation to the Starčevo-Criş sites are valid. In the case of Loeva site though, the only thing that could bring to light the situation from that site should be the re-starting of the excavations. Professor Anthony F. Harding and I visited this site in July of 2008 and we have seen that the site may be researched, but unfortunately the archaeologists in Ukraine have not yet manifested their interest in this respect. Maybe, as it happened already in Transylvania, Anthony F. Harding will manage to stimulate these researches in Ukraine too.

Beyond the existence of some important materials in what concerns salt production in Transylvania and Maramureş, it must be specified that for now only one site begun to be researched by systematic excavations (Băile Figa). There are also discovered a few similar sites (the most relevant of them are Săsarm – Valea Slatinei and Caila – Sărătură in Bistriţa-Năsăud County and Sânpaul in Harghita County). Unlike Moldavia, the researches in Transylvania are making the first steps. In what concerns Maramureş, for now, beyond the re-evaluation of the earlier discoveries that was carried out in the past years by Carol Kacso and Volker Wollmann, on both sides of the Tisa River the situation still stagnates.

The priorities of the researche in Transylvania are related firstly to the protection of the Băile Figa site. In what concerns the other sites from the area, they must be protected and preserved for future researches. For now, there are no possibilities to carry out researches in several sites at the same time. The difficulty of the researches from Băile Figa is related not only to the fact that the works are performed in mud and water, but mainly because the successive exploitations on the same place, often distroyed the prior ones. For now, the only area in which the complexes are almost entirely preserved is in the northern part of the site where the Late Bronze Age evidence is concentrated. In these conditions, more C_{14} dates are necessary. At the same time, the Băile Figa site offers a rare chance for this part of Europe for dendro-chronological researches. They were started by Tomasz Ważny (Cornell University), but their results, without dendro-chronological scale, valid for Transylvania have a still relative value. In this way, it is necessary the combination between dendro-chronology and C_{14} method, which might generate chronological references in absolute values for the dendro-chronological method.

Obviously, at Băile Figa there are necessary experiments with the troughs. But first of all, their original archaeological context must be retraced, which cannot be accomplished without the continuation of the diggings.

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I tried to avoid as much as possible the discussions concerning cultural, economic, social

and demographic implications of salt exploitation in the Carpatho-Danubian region. These aspects have been approached for several times, often with contradictory conclusions. In my opinion these discussions seem to be premature as long as the uncertainty concerning the methods and the scale of the salt production persists.

At the end, it should be pointed out that the above observations are aimed to contribute to the development of the future researches.

Valeriu Cavruc

Note - *Notes*

1. **Monah, Dumitroaia 2007**; **Monah 2008**
2. **Chapman, Gaydarska 2007**; **Nikolov 2008**
3. **Chiricescu, Buzea 2005**; **Cavruc, Harding 2008**; **Buzea, Deák 2008**
4. **Wollman, Ciugudean 2005**; **Kakcso 2006**
5. **Alexianu et alii 2007**; **Monah et alii 2008**; **Chiricescu, Buzea 2005**; **Buzea, Deák 2008**
6. **Bodi 2007**
7. **Cavruc, Chiricescu 2006**
8. **Monah 2008**, p. 14
9. **Nikolov 2008**, p. 47, 339
10. **Ursulescu 1977**
11. **Nicola et alii 2007**
12. **Dumitroaia 1994**
13. **Dumitroaia et alii 2008**
14. **Dumitroaia et alii 2008**, p. 221
15. **Monah 2002**
16. **Bodi 2007**
17. **Nikolov 2008**
18. **Stoyanova 2008**; **Nikolov 2008**, p. 74
19. **Lane, Morris 2001**
20. **Nikolov 2008**, p. 47, 339
21. **Nikolov 2008**, p. 74
22. **Gaydarska, Chapmam 2007**
23. **Ursulescu 1977**
24. **Andronic 1989**
25. **Cavruc, Dumitroaia 2006**
26. **Bodi 2007**
27. **Munteanu, Garvăn, 2008**
28. **Lane, Morris 2001**, p. 470-471
29. **Nikolov 2008**, p. 74
30. **Andronic 1989**, p. 176
31. **Chapman, Gaydarska 2003**
32. **Mircea, Alexianu 2007**
33. **Pétrequin et alii 2001**
34. **Lane, Morris 2001**, p. 6; **Ciobanu 2002**, p. 26
35. **Andronic 1989**
36. **Chapman, Gaydarska 2003**
37. **Munteanu et alii 2007**
38. **Nikolov 2008**, p. 339
39. **Krušelnicka 1993**
40. **Dumitroaia 2000**
41. **Munteanu 2007**, p. 65 – 67
42. **Wollmann 1996**, p. 246 – 247; **Rustoiu 2005**, p. 354, 364, fig. 7; **Wollmann, Ciugudean 2005**, p. 99; **Kacso 2006**, p. 97, 109, nota 6; **Cavruc et alii 2006**, p. 43, 49; **Lukacs 2006**, p. 13-15, 143
43. **Maxim 1971**
44. **Maxim 1971**, p. 457-463
45. **Wollmann 1996**, p. 246; **Iaroslavschi 1997**, p. 45-47; **Rustoiu 2005**
46. **Wollmann, Ciugudean 2005**, p. 101
47. **Chintăuan, Russu 1988**
48. **Cavruc, Harding 2008**
49. **Cavruc, Harding 2008**, p. 172
50. **Cavruc, Harding 2006**, p. 70-72; **Cavruc, Chiricescu 2006**, p. 2009; **Cavruc, Harding 2008**, p. 172
51. **Mureşan 1964**
52. **Wollmann, Ciugudean 2005**, p. 99
53. **Wollmann 1996**, Pl. CVII-CVIII
54. **Chintăuan 2005**

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