The Exploitation of Salt in the Prehistory of Moldavia, Romania

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Introduction: Salt, its Exploitation and the Salt Trade

The discovery of salt as a tasty, useful and therefore valuable substance lies hidden in deep prehistory. It may be imagined that both gatherers seeking different kinds of plant communities, as well as hunters following their prey to favoured grazing places, could have encountered natural salt licks or springs at an early date in the Palaeolithic. Coastal settlement also may well have led to the appreciation of salt-water as a useful source of salt. Such places may also have been discovered during reconnaissance for lithic raw material sources or in general exploration of the landscape. Experimentation with salt would have led to the discovery of its three main beneficial properties: (1) a flavouring in cooking; (2) a medium of preservation and (3) a way of improving human and animal physiology and therefore health and condition. The third advantage may well have taken longer to understand, but comparison between the taste, size and general condition of wild animals feeding on salt pastures with those who did not may eventually have been explained with reference to salt.

Although these assumptions about the Palaeolithic use of salt cannot as yet be adequately documented, the intimate knowledge of gatherer-hunter communities with their landscapes would suggest the high probability of an early discovery and use of salt (cf. 300,000 years of the use of ochres as pigments: Schmandt-Besserat 1980). In the Mesolithic period, more intensive settlement of the Eurasian coastal zones increased the likelihood of the use of sea-salt, perhaps to preserve sea-fish. An increase in salinity in the Litorina Sea exploited by later Mesolithic groups of shell-collectors in Southern Scandinavia has been postulated as a factor causing major economic dislocations (Zvelebil and Rowley-Conwy 1984) but ignored as a beneficial factor in facilitating salt production. The likelihood of increased sedentism in the late Mesolithic (Karsten and Knarrstrom in press) may also have led to a stronger interest in conserving foodstuffs for longer periods. But it is with the Neolithic period in Europe that the first clear evidence is found of the collection of salt by mining, boiling of saline spring-water and the use of salt-pans. Several factors may be suggested to account for this increased demand. An important demographic factor is the increased aggregation of both people and domesticated stock in a wider range of landscapes. The wider range of plant-based foods may also have prompted the search for ingredients to make potentially bland dishes such as gruels and porridges more palatable. Increasing sedentism would have led to an interest in methods of food preservation, which would undoubtedly have included salt. Lastly, it is harder to document, but equally likely, that the symbolic value of salt would have become more diversified in Neolithic lifeways, leading to its increased symbolic as well as practical importance.

Prehistoric Exploitation of Salt

The past investigation of salt in archaeology has differed with the types of available sources. In state-level societies, the existence of complex legal frameworks governing the exploitation, mining and trade in salt facilitated the understanding of state-level power structures in salt production, the production of extensive and well-documented accounts of the salt trade and informative studies of salt usage and consumption (Adshead 1990; Bridbury 1955; Delafosse 1960; Hughes 1934; Smith 1994). In prehistory, however, the main efforts have been focussed upon extraction sites, whether at famous mines such as Hallstatt, Hallein and the Durrnberg in the Salzkammergut of Lower Austria (Clark 1952; Morton 1954), coastal salt extraction sites, such as in Brittany (Daire 1993, 1994) and the Essex Red Hills of south-east England (de Brisay and Evans 1975; Fawn 1990). Daire and her colleagues have made estimates of the scale of production from several Breton salt production sites, thereby assessing the likelihood of local domestic production vs. production for exchange (Daire 1994; cf. Prilaux 2000). By contrast, earlier prehistoric salt exploitation has been identified in many different parts of Central and Eastern Europe, viz., East Germany, Poland and Romania (Matthias 1961; Jodlowski 1968, 1971; Sandru 1952; Ursulescu 1977).

The geological phenomenon of localisation of salt sources has led to the assumption that any region devoid of local sources (including salty soils) would have satisfied their salt requirements, human and animal, through trade with source areas. There is therefore a tacit understanding that the salt trade played an important economic role from at least later prehistoric times (Clark 1952; Nenquin 1961). Thus the concentration of extraordinary and diverse artifacts in the 7th to 6th century BC Hallstatt cemetery has been explained by the salt trade, without serious attempts to document that trade in any detail. The principal method open to archaeologists interested in the movement of salt has been the identification of (a) artifacts associated with the production of salt and (b) the mapping of such artifacts away from salt source areas. An example is the attempt by one of the present authors to chart the exchange of salt from the town of Tuzla (Bosnia) into the Pannonian lowlands to the north during the Vinca period through the distribution of so-called "Bosnian salt-pots" (Chapman 1988: 13-15, fig. 3). It seems improbable that "briquetage" (the coarse pottery used in the boiling of brine for the production of salt) would be found in salt consumption sites, especially those far from salt sources.

The study of salt consumption in prehistory has rarely been

approached, for reasons presumably connected with the improbability of finding relevant data. As far as we are aware, there are no studies of the contexts in which artifacts associated with salt production are deposited in consumer sites.

However, the sheer quantities of salt transported in the Roman and Medieval periods prompt basic questions about the scale and scope of prehistoric salt exchange. A simple calculation indicates the potential scale of salt exchange in prehistory. Making the assumption of no local salt sources, and with 20 head of cattle in the village herd, each requiring 25g of salt per day for optimal condition, and 50 sheep/goats in a village flock, each needing 10g of salt per day, we reach the astonishing result that such a prehistoric village requires an annual total of 360kg of salt for the optimal physiological conditions of its animals alone (not even mentioning the humans). Even if half these daily salt consumption estimates were actually in use, the amount of salt required for regional exchange reaches massive proportions. The implications for social organisation, transport possibilities and the accumulation of exchange goods should be very carefully considered.

An alternative method of researching salt production, exchange and consumption involves the collection of ethnoarchaeological data. A good example of this is the work in Moldavia of a team including one of the present authors (Monah), who has identified the two current mechanisms of salt exploitation in 30 salt springs in Neamt and Bacau counties, Moldavia (Alexianu et al. 1992). The first is use of salt water, the second the re-crystallization of salt, which is very common even today. The current radial distribution of the resource moves salt a minimum of 10km from the source, implying that any archaeological site found within such a radius may have been related to salt exploitation in prehistory. Three types of site are currently known: (a) seasonal sites found at the source; (b) seasonal sites found up to 500m from the source and (c) consumer sites obtaining salt from a distance of at least 10km.

The general conclusion from the study of salt production, distribution and consumption is that research on production sites, methods of exploitation and production estimates is based on a far firmer footing than are studies of salt trade and exchange, while consumption studies are in their infancy. Does this pattern of research need to remain the same?

Archaeological Science and the Use and Movement of Salt

One of the success stories of archaeological science over the last three decades is the matching of objects to their sources through a wide range of increasingly sophisticated analytical techniques. Admittedly, there is still controversy over the interpretations of the analytical results and the success of the co-operation between scientific and humanistic archaeology (e.g., the latest chapter in the lead isotope debate: Knapp 2000; Gale in press). Nonetheless, many new techniques are coming to fruition, including the claimed ability to "source people" by combined lead, strontium and oxygen isotopes (Montgomery et al. 2000). If it is now possible to identify the areas where people were born and have lived through the identification of diagnostic isotopic ratios linked to specific places or regions, there arises the possibility of sourcing salt by similar techniques.

There would appear to be three links in the chain of diagnostic identification. First, it should be documented that trace elements from salt of known origin can be recognised in living animals through salt intake and preservation in bone and/or teeth. Secondly, if this can be demonstrated, it is worth investigating a range of salt sources to identify the extent and range of potential discrimination between them. This could be investigated on a number of spatial scales, working out from local valleys, to regions and eventually inter-regional comparisons. If both these steps are practicable, a range of human and animal bone and/or teeth from prehistoric contexts should be analysed to assess the possibility of identifying (a) the extent of any salt intake and (b) the location of the salt source which has been preserved in the skeleton.

It is likely that trace elements from salt may be reflected in the bones and teeth of animals consuming the salt. It is known that elemental ratios of the diet are reflected in bone, e.g. Sr/Ca and Ba/Ca (Burton and Price 1990). Perhaps more useful in looking at salt would be the use of the isotope ratio of a trace element, as this will not be subject to physiological alteration of the ratio, unlike elemental ratios. However, archaeological skeletal tissues are known to undergo diagenesis after burial, and it is now clear that enamel is the tissue of choice to avoid this biasing factor (Budd et al. 2000). Enamel suffers from one drawback in this respect – it forms early in the lifetime of the individual, and is then physiologically inactive, so that its composition reflects the diet of the period of its formation, which may be different from the adult diet. The isotope ratios of elements incorporated in biogenic apatite represent the average of the whole diet, so that in order to identify salt sources, we must identify elements which are at sufficient levels in salt for this to be the dominant dietary source. Alternatively where traded salt differs in elemental or isotopic ratio to the locality of production, we may be able to identify animals whose ratio has been altered by salt consumption, without salt being the sole source of the element(s) concerned.

Once appropriate elements have been identified, the analysis of animal or human teeth from archaeological contexts

can be conducted on core enamel extracted from teeth, or possibly using bone with strict controls for diagenesis, together with comparative analyses of local vegetation. The elemental or isotopic ratios obtained can then be used to identify individuals consuming salt, and the sources of that salt.

The Importance of Eastern Carpathian Salt

The East Carpathian piedmont zone is recognised as one of the richest zones for salt in south-east Europe, matching Transylvania for quality and quantity of salt production. Medieval records indicate that, while the vast bulk of Transylvanian salt was traded down the river Mures to the West, the Moldavian deposits were preferentially traded to the East, out into the North Pontic steppe and forest steppe zones, which are devoid of local salt sources until the Donets Basin is reached, well east of Kiev (Lefond 1969). When Moldavia became a tributary state of the Ottoman Empire, salt exports were routed to the Balkans and on to Istanbul. This situation continued until modern times, because the Russian market was closed due to the state monopoly on salt and transport problems.

The principal saliniferous zone in the eastern Carpathians stretches from the valley of the Suceava to the valley of the Buzau. On the exterior of the Carpathian chain, over an area stretching 300km, salt was formed in the Aquitanian period, while salt in the piedmont zone was formed in the Tortonian period (Stoica and Gherasie 1981: 43). These authors (1981: 44) cite 24 major outcrops of Aquitanian salt (70-90% Na Cl), with a further 29 sources of purer, Tortonian salt (90-97% Na Cl) in the flysch zone of the piedmont. In the eastern Carpathians, Aquitanian salt deposits are generally covered by flysch but salt also outcrops in the valley of the Bistrita (Ozana-Schitu Frumoasa valley). The salt in the Posuri and Oglinzi zones is of Aquitanian age, while the salt in the Solca-Cacica area is of Tortonian age. Salt sources are common in the Oituz-Slanic zone, near Poduri, as well as further south, at Vrancea (Stocia and Gherasie 1981: 44). The Oglinzi salt massif is represented by a deposit some 130m in thickness and 4km in length, north-east from Targu Neamt (Stocia and Gherasie 1981: 50).

Prehistoric Exploitation of Salt in Moldavia

The discussion of the prehistoric exploitation of salt in Moldavia was initiated by the geographer Sandru (1952), who noted prehistoric surface remains near many of the 14 salt sources near Cacica, Solonet and Solca, in the county of Suceava, North Moldavia. Since the late 1960s, Moldavian prehistorians have been investigating the Neolithic exploitation of salt in their region, largely through excavation of sites adjacent to salt springs. At Slatina Mare-Solca, in a zone where the soils were so salty that they were deleterious for agriculture, Starcevo-Cris, Pre-Cucuteni, Cucuteni B, Hallstatt and Medieval occupations were identified close to the salt sources (Ursulescu 1977). Another site in this area, Cacica, has yielded briquetage (Andronic 1989:171-77). A second zone of interest defined by a major concentration of salt springs is the Moinesti Basin, in which the only known tell in the entire Late Neolithic Cucuteni distribution is located (Monah et al. 1982; Monah et al. 1987). From 1979, one of the present authors has maintained that the formation of the tell, its long occupation and the large number of imports (copper, flint, obsidian) is closely related to the exploitation of nearby salt sources (Monah et al. 1983). A third example of salt research in Moldavia concerns the series of excavations directed by another of the authors at salt source sites near Targu Neamt, such as Lunca-Poiana Slatinei and Oglinzi-Slatina (Dumitroaia 1992, 1994). It is important to note that both Linda Ellis (1984: 205) and John Nandris (1987: 209) have emphasised the importance of salt exchange in their discussions of the Cucuteni culture.

Previous Fieldwork in Central Moldavia

Excavations in the Targu Neamt zone

Three sites have been investigated in the Targu Neamt zone. Two of these sites, Oglinzi-Slatina and Lunca-Poiana Slatinei, are directly associated to rich salt sources, while the third, Oglinzi-Cetatuia, lies in the hills near the first salt site.

Oglinzi-Slatina is a site next to a salt spring, on several parts of the lower slopes and slopes directly above the salt spring. Excavations by Dumitroaia in 1988 to 1992 revealed a multi-period settlement with Starcevo-Cris, Cucuteni and Bronze Age occupations (Dumitroaia 1992: 85-87, 1994: 75-78). Four occupation zones were occupied in prehistoric times near the salt source: (a) Bai I: 30m south of the source was a Pre-Cucuteni level of 0.50m thickness, containing eroded pottery, daub and burning. The large quantity of pottery, ash and charcoal, together with the remains of four hearths, indicated that communities living here were exploiting the salt; (b) Bai II: 100m SE of Bai I near the Tg. Neamt-Baile Oglinzi road. A sondage here in 1991-92 revealed a 0.50m-thick Starcevo-Cris level identical to that at Poiana Slatinei B; (c) Bai: near the concrete bridge over the Bai stream and on the left side of the Tg. Neamt-Oglinzi road, were found Cucuteni sherds (probably phase B); (d) Fata Slatinei: on a hill above the left bank of the Bai steam, c. 700m from the salt source, was a LBA Noua settlement with "normal" occupation debris.

The major salt spring at Oglinzi-Slatina is located in the bottom of the valley. A second salt spring at Corugea is found c. 1km SSE of the main site. Fresh water can be found in the stream that runs into the site from the west, c. 1km from the salt source. A second spring lies 300m east of the Oglinzi reservoir.

Oglinzi-Cetatuia is a hill-top site in heavily wooded area between 1km and 1.5km north of Lunca. Excavations in 1990-91 by Dumitroaia revealed a multi-period site, with Starcevo-Cris, Cucuteni A and Bronze Age occupations (Dumitroaia 1992: 85-87, 1994: 70-75). Cetatuia is a naturally fortified hill with additional artificial defences. Located c. 1km from Poiana Slatinei, the site was probably controlling access to salt sources in the area, as well as acting as a refuge in times of danger. Four trenches were excavated in areas undisturbed by Second World War partisan trenches. Sporadic traces of Starcevo-Cris and LBK occupation were found, together with two Cucuteni A horizons. Small Copper Age surface houses with no fired clay floors were discovered, with daub made of clay mixed with cereal and grass temper. In trench IV, a Bronze Age defensive ditch was found, probably excavated by a Komarovo-Costisa community, as found at Poiana Slatinei.

Salt water is available from two places: (a) a salt spring some 600m to the south, at the spring called Oglinzi-Fantanita (the stream flowing from the area of the salt spring loses salinity rapidly, after 250m); (b) at the western foot of the hill, but with a very steep descent, there used to be a salt spring feeding a saline stream which flowed NE in the direction of the Moldava valley. This spring currently produces freshwater.

Lunca-Poiana Slatinei is one of the most significant salt sources in Central Moldavia. Located in the hilly country on the flysch, the site lies in a small valley below the 1944 WWII Romanian Army defensive trenches against the Red Army invasion. Even at the site itself, there are remains of defensive trenches and an anti-tank battery was set up only a few metres from the salt spring.

Excavations by Dumitroaia from 1984-93 revealed eight phases of occupation: Starcevo-Cris, LBK, Pre-Cucuteni, Cucuteni, Lunca, Costisa, Noua and Corlateni (Dumitroaia 1987, 1992; Alexianu and Dumitroaia 1990; Alexianu et al. 1992). Major excavations over ten seasons revealed important pre- and proto-historic remains in three sectors. In Zone A: cultural layers of Starcevo-Cris, Pre-Cucuteni, Cucuteni and Komarovo-Costisa; sporadic finds of Carpic groups (2nd to 3rd century AD), Santana de Mures group (4th century AD), material from 5th to 7th, 10th to 12th and 16th to 17th century AD. All deposits show similar signs of salt exploitation through the re-crystallisation of salt using fire. In Zone B: short-term occupation debris from Starcevo-Cris, Pre-Cucuteni, Cucuteni, Komarovo-Costisa and Corlateni-Canlia groups exploiting salt for re-crystallisation. Many briquetage fragments found in Cucuteni A, AB and B levels. In Zone C: Geto-Dacian culture level of 0.65m thickness.

The salt spring is channelled in a wooden well, with the water currently at a depth of 3m below the surface. A deep deposit of salt said to be 130m thick lies adjacent to the salt spring. Freshwater is available from a spring on the west side of the site, near the foot of the hill of Lunca village. In years with higher-than-average precipitation, a small freshwater spring starts up just to the north of the site, discharging into the Nemtisor river.

The Poduri Tell and its Links with Salt

The Chalcolithic occupation at tell Poduri lasted more or less continuously from the Pre-Cucuteni II phase until Cucuteni B2, a period of c. 1,000 years (4620-3700 CAL BC: Mantu 1995:228, 1998: 247-48). In all levels, but especially in the Cucuteni occupations, there are large quantities of imported materials and objects, especially Prut flint, Dniestr flint, "pre-Balkan platform" flint, obsidian from south-east Slovakia / north-east Hungary, copper ingots and pottery. The tell is also distinguished from other Cucuteni sites by the high percentage of painted wares and by the frequent occurrence of grain storage jars. Very few examples of briquetage are known from the tell's very large Pre-Cucuteni and Cucuteni ceramic assemblages.

Within the 5km territory of the tell, there are seven smaller Cucuteni settlements and one site larger than the tell (Dealul Bujoara). Unlike the tell, each of the sites is near a salt stream or a salt spring. Small-scale excavations at Poduri-Prohozesti-La Siliste (Popovici and Trohani 1984) and Poduri-Valea Sosii-Dealul Paltinis (Popovici and Bujor 1984) produced the remains of Cucuteni occupations but no traces of briquetage. It is the view of the excavator that the tell exploited the salt sources in its territory over a lengthy period of time, exchanging salt for other raw materials and objects (Monah et al. 1982, 1983, 1987).

Fieldwork in 2000: Aims and Objectives

The intensity of previous excavation and fieldwork made Central Moldavia an obvious study region for an interdisciplinary project investigating the prehistoric exploitation of salt in two zones: the Poduri zone and the Targu Neamt zone. The mode of salt exploitation appeared to differ in these two zones. The question of the relationship between the only known tell in the entire Cucuteni-Tripolye distribution and the location of nearby salt sources also raised key research questions about the significance of economic and social motives for exchange (or trade). An exploratory season was set up to assess the possibilities of further intensive research in Central Moldavia. A short 10-day season in summer 2000 was set up with the following five aims:

- preliminary characterisation of the relationship between settlement distribution and the location of salt sources (springs and saline streams)
- sampling salt sources for scientific characterisation
- identifying potential briquetage samples for scien-

tific characterisation

- identifying animals which graze on nothing but local (Central Moldavian) salt pastures
- testing the utility of geophysical prospection methods on Neolithic sites

RESULTS

The Poduri zone (Fig. 1)

A total of six days was spent in the Poduri zone, based at the village of Rusaesti, commune of Poduri. In this time, visits were made to six out of eight known Neolithic sites and their "associated" salt springs, as well as to other significant salt springs with no apparent Neolithic sites in proximity. Magnetometry was conducted at six sites, using the following technical specifications: FM 36 fluxgate gradiometer; Sensitivity 0.1nt; Log Zero Drift On; Traverse interval 1m; Sample interval 0.25m; Grid size 20 x 20m.

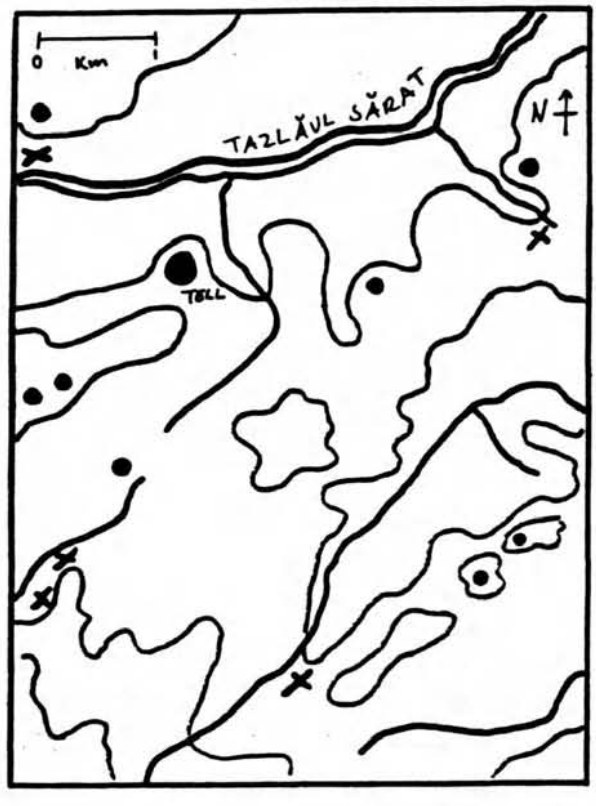
Poduri-Prohozesti-La Siliste

A Cucuteni site on a flat-topped area extending northwards from the general high second terrace, above Tazlaul Sarat, with steep slopes to the north side. The site comprised an open grassy area of c. 0. 5ha. A trial sonda was excavated by Dr D. Popovici in 1982, in the form of one 25 x 2m trench, with an extension in the middle to an area of 15 x 6m, to explore the burnt clay floor of a Cucuteni house (Popovici and Trohani 1984, pl. II).

A salt spring is known some 600 to 700m to the south-east, next to a freshwater stream. There were no surface traces of prehistoric material within a 500m radius of the salt spring, although visibility was poor. Similarly, no prehistoric pottery was found in the nearby maizefields, with better visibility, or the pastureland, with poor visibility. The main river in the Moinesti Basin, the Tazlaul Sarat, flows past the base of the loess bluff on which the site is located. It provides salt water.

Freshwater springs occur at the foot of the bluff immediately to the north of the site. All around the site, there are excellent sources of local potting clay (Middle Miocene clays) below the brown forest soils which are the zonal soils in the Central Moldavian piedmont zone. In the stream valley 500m north-east of the site, there is a 4m exposure of Middle Miocene clays, which Monah supposes was used for potting clays, exposed by deep incision of stream.

An area of c. 100 by 80m was selected for magnetometry, located to the west of the area investigated by Dr Popovici. Seven grid squares (or parts of grid squares) were covered, with traverse direction SW. The results showed several positive anomalies spread across the survey area. The majority of these can be interpreted as pits or burning. The largest of these anomalies, from its large size and



KEY Settlement: ●
Salt Spring: X

Figure 1. Distribution of Neolithic sites and salt sources in the Poduri zone (redrawn after Popovici and Trojan 1984, fig. 1)

shape, most likely relates to a structure of some kind. The results while showing a large positive feature failed to reveal any evidence of past burning. This positive anomaly corresponded with a pit feature on the surface which could relate to past archaeological excavation at the site. The results also showed the presence of metal spread over the area, an indication of more recent activity at that spot.

Poduri-Valea Sosii-Dealul Paltinis

The site is located on a small but dominant hill to the east of the village of Valea Sosii. The hilltop consists of a narrow ridge some 180m in length, running NE-SW, and rarely more than 40m in width. Of the three fields on the ridge top, the easternmost was under maize, the middle field was partially excavated by Dr Popovici and the smallest, triangular field was explored by magnetometry in 2000. Trial excavations were mounted in 1982 by Dr Popovici in the middle field. Three sondas were dug. In Sonda I, a 30 x 2m trench uncovered burnt daub at the NW end. In Sonda II (15 x 2m), a small area of burnt daub in the centre of the sonda was expanded to a 5 x 4m area, where structural remains were found. In Sonda III, a 15 x 2m transect was expanded to two areas with Cucuteni structures – one 5 x 3m, the other 6 x 5m (Popovici and Bujor 1984, pl. I).

There are two potential salt springs, each c. 1km from the site. The first is a rich salt spring at the south-west end of the gypsy quarter of the village of Valea Sosii. The second salt spring is described under the site Dealul Bujoara. No freshwater springs were identified near the site. Extensive deposits of Middle Miocene clays were observed on and near the site.

Because of the trial excavations in the middle field, magnetometry was restricted to a small, sub-triangular field (the "top field"), where three grid squares were completed, with the traverse direction SW. The results showed only a large negative spread of material across the three grids. This could perhaps best be explained by the presence of a collapsed metal wire fence buried in the soil.

Poduri-Valea Sosii-Dealul Bujoara

The site is located on a rounded promontory, c. 160 x 90m, projecting southwards, with steep slopes to east, south and western sides. The Cucuteni site discovered during fieldwalking extends over the whole of the promontory and northwards a further 140m, to the west-east line of trees near the village track from the NE corner of Valea Sosii. Thus, the total site area is likely to be c. 2.5ha. No excavations have been conducted at the site as yet.

Within 250m of the east side of the site, there are two streams, both called "apa sarata" (ie. "salty water"), which once supplied salt water. Tasting the water from these almost-dried-up streams suggests that they now drive from freshwater sources. Around 1km to the south-east is a salt spring Some 25-50m to the west of the spring is a small stream which remains saline for some 300m downstream of the salt spring. Currently, the two "apa sarata" are both filled with freshwater. Between these streams and the salt spring, there are several freshwater springs. There are readily available Middle Miocene clays for potting on and near the site.

A grassy area with low vegetation and a broad stretch of reasonably flat terrain enabled magnetometry data collection in eight grid squares, with a traverse direction of east. The results (Fig. 2) showed a dense scatter of circular positive anomalies of various sizes and reading strength. The majority appear to be less intense in strength and, therefore, possibly relate to pits. The higher readings in the range of 20-30nT are possible hearths or burnt clay floors.

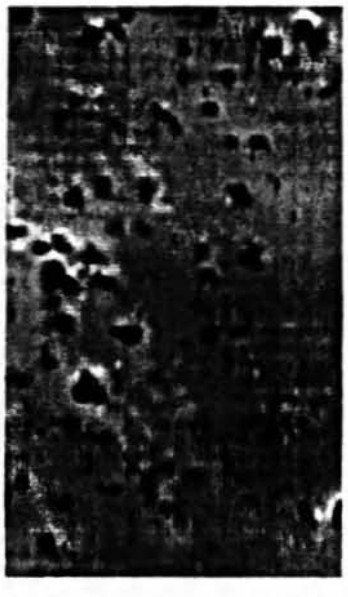


Figure 2. The magnetometry survey at Dealul Bujora

Poduri-Branesti-La Haineala

A Neolithic site discovered by Mr Alexe Bujor, who found pottery and polished stone axes; one of the authors (Monah) discovered Cucuteni A pottery and some undifferentiated Bronze Age ceramics on the site. The site lies across a gently sloping ridge between two deeply incised streams, on a general NE-SW orientation. Low-density finds occur in the area covered by magnetometry and also in the adjoining stubble field to the south-east, making it likely that the total area of the site is c. 0.3-0.5ha. No excavation has taken place at this site as yet. During magnetometry, a gridded surface collection was made over the ten grid squares, all of which had very poor surface visibility. Prehistoric pottery was found at very low densities, with two or three sherds with roughened surfaces and incomplete firing suggestive of Cris pottery. The dating of some of the sherds to the Pre-Cucuteni or Cucuteni period cannot be excluded.

South-west of Dealul Biserici, there are two salt streams with three salt springs above the streams and below the forest line. Salt source (1) lies above the salt stream in a small clearing. It has extensive salt crusts but the salt water has now dried up. This source is c. 500m from the site. Salt source (2) is near the edge of the forest, also c. 500m from the site. The source has been abandoned but once the output was much bigger. The third salt source could not be located. The stream at the north-west boundary of the site is a freshwater stream.

Magnetometry was attempted in a field of pasture with low, almost continuous vegetation cover. The moderate slopes facilitated the laying out of ten grid squares, with a traverse direction of NW. Non-gridded magnetometer traverses in the field to the south-east of the grid indicated no obvious "hot spots". The results showed similar positive features as Dealul Paltinus but of a far lower density. As the positive circular anomalies showed no evidence of intensive burning, these could be large pits relating to a site outside the area surveyed.

Moinest-Dambul Morii

A small Cucuteni site on a dominant sub-triangular hill in a sector of the second terrace on the north side of the Tazlaul Sarat. Varying in altitude by up to 5m, the sub-triangular hill covers an area of 50 x 50m, with a site area of 0.25ha. A dense scatter of Cucuteni sherds was observed in the maizefields of this area. Neither geophysical investigations nor excavations have taken place at this site as yet.

A now destroyed salt spring was once located at the foot of the loess bluffs, some 250m as the crow flies from the site. A still-functioning freshwater spring lies at the foot of the loess bluff, closer to the site than the salt spring.

The pattern of relationships between sites and salt sources soon became obvious: there were no Neolithic sites located in close proximity to salt sources. The general distance was anything between 500m (e.g., Branesti-La Haineala) and 1km (Valea Sosii-Dealul Bujoara). The salt sources were, for the most part, of similar sizes. This spatial pattern was quite different from the known pattern in the Targu Neamt zone of close spatial proximity of sites to salt sources. This unexpected result leaves a wider problem unresolved – to what extent is the location of Cucuteni sites random with respect to salt sources in the Poduri zone? It also raises the question of whether prehistoric communities were able to exploit salt at similar distances to those of the modern populations studied through ethnoarchaeology. If the salt sources in the Poduri zone were so attractive, why were there no traces of (seasonal) occupation close to the springs? In short, the apparent distances between the Poduri zone sites and the salt springs raises the question of whether Poduri tell was really a co-ordinating centre for the salt trade.

The magnetometer surveys of the four Neolithic sites in the Poduri zone indicated that this type is able to achieve results that are compatible with the interpretation of the anomalies detected as being pits, hearths and possible burnt clay buildings. These interpretations can be tested against the results of subsequent excavation work.

The Targu Neamt zone (Fig. 3)

During the 3-day investigation of the Targu Neamt zone, it was possible to visit the following sites and conduct magnetometer survey on two of them.

Baltatesti-Slatina

A salt source is located some 2km south of Baltatesti village, at the bottom of relatively steep north-facing slopes (Dumitroaia 1992: 71). No site has as yet discovered near the steep narrow valley with a very rich salt spring. No excavation has been conducted as yet, since severe erosion in the lower part of the valley prevents recovery of an in situ sample. Moreover, on the higher slopes and the sloping ridges, the domination of orchards reduces visibility to very poor levels.

Two salt springs occur in one part of the site, with a huge salt talus and massive salt crystallisation higher up in the valley. A freshwater source is known c. 500m from the salt source.

Oglinzi-Slatina

Details of this site are presented above. Ungridded magnetometer traverses were walked in three different zones of potential. In Area 1, a large potential area near the excavations would have been ideal for geophysical prospection, had it not been used intensively as a picnic area in the last few years. In Area 2, only one "hot-spot"

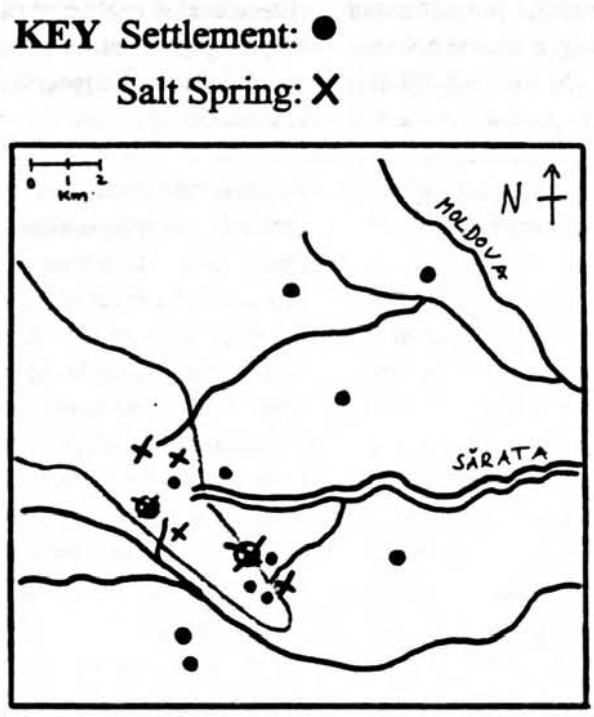


Figure 3. Distribution of Neolithic sites and salt sources in the Targu Neamt zone (redrawn after Dumitroaia 1994, fig. 1)

was located, at the western end and near a gully. In Area 3, on the far side of the valley from the excavations, one isolated "hot-spot" was located in a large gently sloping area. On the basis of this preliminary work, it was decided to open up a single grid square to cover the hot-spot in Area 2, with a traverse direction of NE. A 5 x 3m feature was located, which was remarkably rectangular in shape. A small section in the gully immediately southwest of the hot-spot was cleaned up. It yielded burnt daub, small fragments of probably prehistoric pottery and calcareous concretions. Limited excavation in autumn under the control of Dr Dumitroaia revealed a fired clay surface associated with undatable prehistoric pottery.

Oglinzi-Cetatuia

Details as presented above. No magnetometry was possible owing to the steepness of the site topography, the heavy vegetation cover and the depth of tree litter.

Lunca-Poiana Slatinei

Details as presented above. Taking account of the excavations in Zone A, the disturbance around the salt spring and the location of the WWII defensive trenches, it was decided to target Zone B, where there is believed to be a concentration of Pre-Cucuteni materials. Six grid squares were completed, with a traverse direction of east. The results revealed little in the way of positive anomalies against high levels of background noise (Fig. 4).

It became clear that a very different pattern of relationships existed in the Targu Neamt zone: close proximity of settlements to the largest, most important salt sources (e.g.,

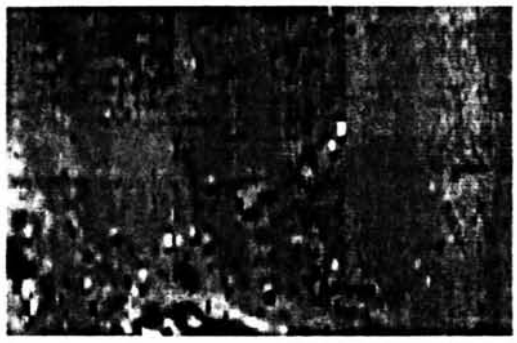


Figure 4. The magnetometry survey at Lunca-Poiana Slatinei

Lunca, Oglinzi), with more remote access to smaller salt sources (e.g., Oglinzi-Fantanita spring, accessed from the hill-top site of Oglinzi-Cetatuia). On the basis of this model, it seems highly probable that a prehistoric site will be found near the rich salt source of Baltatesti. An obvious research question is the explanation of such different modes of salt exploitation in the two study zones.

Magnetometry Results

Magnetometry was conducted at six sites – four in the Poduri zone and two in the Targu Neamt zone. The Durham fluxgate gradiometer was most successful in recording signals from burnt Cucuteni structures, somewhat less useful for periods such as the Early and Middle Neolithic groups of Starcevo-Cris and Pre-Cucuteni, whose inhabitants burnt their structures less regularly. Nonetheless, these were the first magnetometric results from any Neolithic sites in Moldavia and have amply demonstrated the potential of the method for recovering intra-site data, especially for Cucuteni sites. The large number of signals corresponding to small burnt features (awaiting image enhancement in Durham but with a preliminary interpretation as hearths) may well indicate that open-air hearths were used for salt exploitation and perhaps crystallisation.

Scientific Characterisation Studies

Sampling of salt springs and/or, when dried up, associated salt crusts or crystallisation, was organised on a systematic basis. Sixteen samples were collected from sources in both study zones for preliminary mass spectrometer analysis in the Department of Geology, University of Durham. The aim is to discriminate between potential geochemical signatures in the trace elements of the salt sources, so as to be able to identify possible places of exploitation and, perhaps, even trade routes in the zone east of the Carpathian piedmont. Further research is necessary before it will be possible to identify such source signatures in the remains of teeth in recent animals and, in the second stage, from human and animal teeth in archaeological contexts. An additional set of samples for analysis in Durham comprises sherds from pottery forms believed to represent briquetage. Samples were collected from tell Poduri and from Lunca-Poiana Slatinei. It is an important research aim both to define a geochemical trace for briquetage in Moldavian prehistoric pottery and to link the signature(s) to specific zones or even particular salt sources.

All attempts failed to identify shepherds whose sheep were pasturing solely on salt-pasture from a closely-defined salt spring source. Every shepherd stated that they purchased industrial block salt from outside Central Moldavia for additional salt intake. This makes it difficult to identify trace elements from Moldavian salt sources which are preserved into the bone and/or teeth of local sheep populations. An alternative strategy has been adopted of setting up a small-scale experiment on the farm of two of the University of Durham Department of Archaeology's Research Associates, Paul Stokes and Louisa Gidney. They have offered to feed two lambs over the winter on the same, clearly identifiable salt blocks, while keeping two other lambs without any form of salt additive. In the late spring to early summer of 2001, the lambs' bones and/or teeth will be investigated for trace elements of the salt additives. Further preparatory research is necessary on the rate of salt uptake in sheep.

Conclusions

The summer 2000 season in Central Moldavia started out with a specific set of questions related to the distributions of Neolithic sites and salt sources. Questions were defined for initial characterisation studies of the salt sources for the investigation of the possible intake of salt from specific sources in prehistoric human and animal populations. Analyses of suspected briquetage samples from Moldavian Neolithic sites have been set in train. A preliminary test of the efficacy of fluxgate gradiometry on these sites demonstrated an extremely successful set of results, especially on Cucuteni sites.

Based on previous fieldwork and the summer 2000 season, a preliminary definition can be made of two potentially divergent modes of salt exploitation in two study zones in Central Moldavia – the Poduri zone and the Targu Neamt zone. This result can be summarised as follows (Table 1):

Neamt Zone		**Poduri Zone**
SITES ON TOP OF SOURCES	LOCATION	SITES REMOTE FROM SOURCES
DIRECT (? CONTROL)	MODE OF EXPLOITATION	REMOTE (? WHEELED TRANSPORT)
BRIQUETAGE	TECHNIQUE OF EXPLOITATION	VERY LITTLE BRIQUETAGE ON THE TELL
EARLY AND CONTINUING	DATE OF EXPLOITATION	LATER AND ?EPISODIC

Table 1. Two modes of salt exploitation

Much future work remains to be done in the investigation of the overall relationship in the two microregions between the distribution of Neolithic sites and that of salt sources, especially in the Poduri zone. An excellent suite of results from magnetometer prospection has been achieved, for both Cucuteni and earlier sites but in particular for Cucuteni sites with burnt houses. A number of potential sites has been identified for future fieldwork. An initial collection of samples has been made from salt sources in these two zones, with the aim of differentiating salt zones and perhaps even salt sources through mass spectrometry at the University of Durham. A small suite of sherds potentially identified as "briquetage" has been collected, for further analytical work at Durham. Finally, a methodology has been identified, using local lambs, for testing the extent to which trace elements from different salt sources are kept in animal bone and/or teeth.

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