К ВОПРОСУ ОБ АБСОЛЮТНОЙ ХРОНОЛОГИИ КЕРАМИКИ ВЕРХНЕВОЛЖСКОЙ КУЛЬТУРЫ: НОВЫЕ ДАННЫЕ ПО МАТЕРИАЛАМ СТОЯНКИ ЗАМОСТЬЕ 2

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Аннотация. Стоянка Замостье 2, расположенная на реке Дубна в 100 км к северу от Москвы, представляет собой идеальную возможность понять относительную и абсолютную хронологию керамики ранненеолитической верхневолжской культуры. На данный момент доступно более 100 радиоуглеродных дат, охватывающих всю стратиграфическую последовательность отложений памятника от позднего мезолита к среднему неолиту. Среди 18000 фрагментов представлены все периоды развития верхневолжской культуры, и большинство из них содержат остатки карбонизированных органических остатков (нагара), который может быть непосредственно продатирован. Всего на настоящий момент получено 30 радиоуглеродных дат по остаткам нагара на верхневолжской керамике. Тем не менее до сих пор остаются определенные неясности, связанные со временем бытования верхневолжской керамики на стоянке Замостье 2, и большинство из этих вопросов связано с датированием керамики на других памятниках. Более того, абсолютная хронология верхневолжской керамики должна быть подтверждена на основе радиоуглеродных данных по керамике соседних регионов. В данной работе мы обсуждаем альтернативную интерпретацию новых данных, полученных для стоянки Замостье 2.

Ключевые слова: Ранний неолит России; верхневолжская керамика; нагар; радиоуглеродное датирование; пресноводный резервуарный эффект; стабильные изотопы; EA-IRMS; биомаркеры липидов; GC-MS; GC-c-MS; технология керамики; петрография.

Introduction

Pottery first appeared between the Urals and the Baltic at sites dated to between c.7000–5000 cal BC (c.8000–6000 BP1). Often these sites are dated by only a few radiocarbon (14C) samples with large measurement errors (>±100 14C years), whose chronological association with pottery is unclear, leaving considerable room for interpretation and disagreement about the absolute chronologies of different pottery types. By critically discussing the 14C dating of Early Neolithic pottery at Zamostje 2, this paper aims to highlight the various challenges arising in developing absolute chronologies for early pottery types in this vast region.

In principle, Zamostje 2 is the ideal situation to address these challenges, because it has:
- An undisturbed stratigraphic sequence, from the Late Mesolithic to the Middle Neolithic [1, 2, 3].
- Hundreds of potsherds with food-crusts, from Early Neolithic (Upper Volga culture, or UV) and Middle Neolithic (Lyalovskaya culture) pottery, of which 30 have been dated directly [4, 5].
- c.70 14C dates from single-entity terrestrial samples (wood, plant fibres and bone) of archaeological material, and c.25 14C dates on bulk organic sediment (sapropel) from the archaeological layers [6].
Food-crust dating

Although two sapropel dates are clearly too young for the Late Mesolithic layer, they have been deposited mainly after the Late Mesolithic dates. The organic content of sapropel may be derived, in varying proportions, from sources with different 14C ages – redeposited older peat, and the decomposition of freshly deposited plant remains from littoral vegetation as well as submerged species and other aquatic organisms, which may be depleted in 14C compared to contemporaneous terrestrial species (freshwater reservoir effects; see below), and of intrusive (younger) roots and archaeological wood. In principle, therefore, we might disregard all sapropel dates, but we can use sapropel depositional sequences and dates from horizontally-beded wood to decide which sapropel dates are valid, and to estimate dates of archaeological strata (Fig. 1).

Food-crust dating

Fifteen food-crusts from UV sherds have been dated by the Herzen University laboratory in St Petersburg (laboratory codes SPb-), and 3 UV food-crusts and 3 UV potsherds were dated by the Kiev radiometric laboratory (Ki-). The precision of these results (which have 1-sigma errors of ±100 to ±150 14C years) is limited by small sample sizes. Four UV food-crusts have now been dated by the AMS laboratory in Uppsala, Sweden (Ua-), and eight by the Leibniz-Labor, Kiel, Germany (KIA-), with errors of between ±30 and ±63 14C years.

The Kiel 14C samples have been analysed by isotopic and biomolecular methods to detect aquatic ingredients, which could cause 14C reservoir effects. Dietary freshwater reservoir effects (FRE) have been demonstrated at prehistoric cemeteries in central-eastern Europe (e.g., Ostorf, Germany [7]; Ząbie, Poland [8]; Lake Burtnieks, Latvia [9]; Minino, Russia [10]), where human bones appear to be hundreds of years older than organicgrave samples. These examples show that rivers and lakes in this region are often very depleted in 14C, and that fish therefore contain carbon with a significantly higher 14C age than contemporaneous terrestrial ingredients, which should lead to spuriously old 14C ages for food-crusts made with aquatic ingredients. Hartz et al. [11] have argued that some 14C ages from food-crusts on UV sherds from Ozerki 5, c.150km west of Zamostje 2, and Sakhtysh 2a, c.150km to the east, were subject to FRE, as their 14C ages were inconsistent with stratigraphic and typological sequences. In the only clear test, however, when a food-crust and a plant fibre used to repair the pot were both dated, their 14C ages were not statistically different, suggesting that most of the carbon in the food-crust was from terrestrial ingredients. One Early Neolithic sherd from Zamostje 2, V002 (Fig. 3), has now been dated by the same approach, and the food-crust 14C age is nearly 300 years greater than the 14C age of a woody plant fibre used to repair the pot. As microscopic fish scales were seen in the food-crust, the best explanation is that the real date of the pot is given by the plant-fibre 14C age, and that the food-crust 14C age is misleadingly old, because of FRE. These results raise two questions: can we retrospectively decide which of the other 30 food-crust dates at Zamostje 2 are subject to FRE, and what is the scale of these 14C age offsets?

FRE offsets will depend on two parameters, the proportion of carbon derived from, and the 14C-depletion in the aquatic ingredients. At inland prehistoric sites in northern Germany, it appears that fish is so isotopically distinct from terrestrial ingredients that food-crusts can be screened using EA-IRMS analysis (Elemental Analysis-Isotope Ratio Mass Spectrometry) to identify those likely to be subject to FRE, but the extreme variability of FRE in local fish (demonstrated in modern samples) makes it almost impossible to estimate the FRE in food-crust 14C ages [12]. In other situations, the local FRE may be less variable, but isotope values (particularly δ13C) may not be sufficiently different between terrestrial and
aquatic species to distinguish which food-crusts may be subject to FRE. Depending on preservation, lipid biomarker analysis can demonstrate that aquatic species were present, but most of the carbon in food-crusts is not found in the form of soluble lipids. Equally, δ15N values in food-crusts may be used to infer whether protein-rich ingredients were predominantly terrestrial or aquatic in origin, but the carbon in food-crusts may be derived mainly from low-protein ingredients, which have little effect on δ15N values. Thus it is difficult to quantify the proportion of carbon derived from aquatic ingredients in a dated food-crust.

At Zamostje 2, the 14C ages from V002 are currently the best evidence that local fish was depleted in 14C. EA-IRMS and biomolecular data from the V002 food-crust are not yet available. Isotope data from the other food-crusts dated in Kiel appear to show a shift towards higher δ15N and lower δ13C values between the Early and Middle Neolithic, which in other contexts would imply a greater emphasis on aquatic species in the Middle Neolithic [13], and which may be reflected in lipid biomarkers from the food-crusts dated in Kiel. Biomolecular analyses of a larger set of Upper Volga pottery food-crusts at Zamostje 2 show that aquatic biomarkers were ubiquitous in the Early Neolithic, however [14], and it thus seems likely that at least some of the other food-crust dates (presumably including the ‘oldest’) are subject to FRE offsets at least as large as that observed in V002. For most of the dated food-crusts, however, the only indicator of such an offset is the 14C age itself.

Pre-Neolithic Pottery?

AMS 14C results from food-crusts on Upper Volga pottery at Zamostje 2 range from 6835±40BP (KIA-50685) to 6480±30 BP (KIA-50684). V002’s food-crust 14C age, 6816±49 BP (KIA-50906), is at the upper end of this range, but the plant fibre result, 6545±48 BP (KIA-50907), is one of the latest AMS dates for UV pottery. Given the larger measurement uncertainties reported, most of the radiometric results could also come from food-crusts whose real 14C ages fall within the same range as those of the AMS samples (e.g., what appears to be the latest result, Ki-15032, 6300±130 BP, has a 2-sigma range of 6560–6040 BP). Wooden artefact 14C results from the Early Neolithic layer range from 6651±38 BP (structure 156, mean of two 14C ages) to 6505±30 BP (fish-trap – sample 86, mean of two 14C ages); a paddle in one of the fish-traps was dated to 6676±47 BP (CNA-1342) [15]. Thus one reading of the results is that food-crust 14C ages of c.6700–6500 BP may be valid, and that higher food-crust 14C ages are due to FRE. According to this reading of the evidence, Upper Volga pottery first appeared at Zamostje 2 around 5600 cal BC, or only shortly before, and the four radiometric 14C results from food-crusts that appear to significantly pre-date 6700 BP (SPb-720, 7537±150 BP; SPb-721, 6975±100 BP; SPb-722, 7105±150 BP; SPb-723, 6975±100 BP) are misleadingly old, due to FRE. Only SPb-720 would require a greater FRE than that seen in sherd V002 (271±69 14C years) to fit this late, short chronology for UV pottery.

An alternative reading of the evidence would emphasise the following observations:

- Even if SPb-720 (7537±150 BP) was subject to an FRE equal to that observed in V002, after calibration it would still indicate that the sherd almost certainly dates to the 7th millennium cal BC
- SPb-721 (6975±100 BP) was from a food-crust containing visible terrestrial plant remains (Viburnum sp. fruits), so it should not be subject to a large FRE
- Given known problems with sapropel 14C ages, the dating of the Final Mesolithic layer is problematic, and the use of sapropel 14C results to estimate the start of the Early Neolithic may also be misleading; it is notable that the rejected sapropel 14C results are too recent (Fig. 1)
- Fish-trap 14C results provide only a terminus ante quem for the start of the Early Neolithic, as the oldest Early Neolithic fish-traps may easily have been removed
- The lack of vertical timbers dated to the first third of the 6th millennium may be coincidental, given the presence of timbers dated to later periods that are not apparently represented by ceramics.

Furthermore, there are technological similarities between undecorated sherd from Zamostje 2 and pottery at Serteya and Rakushechny Yar, with even earlier food-crust 14C ages [16, 17]. There are, as yet, no petrographic studies on other Upper Volga assemblages for comparison. The ‘oldest’ food-crust 14C ages (SPb-720–723) are from undecorated or sparsely decorated sherds, which may also be expected in later phases; ‘younger’ 14C ages from undecorated sherds (e.g. Ki-15032, 6300±130 BP) thus do not invalidate the perception that there was an early 6th millennium phase of undecorated or sparsely decorated pottery.

If there was an older pottery phase at Zamostje 2, it might be visible in the spatial distribution of the dated sherds. The ‘oldest’ food-crust 14C ages (SPb-721–723; SPb-720 was from a stray find) are from sherds found in a restricted area of the site (quadrats B10–11) and at the same depth (layer 4a), but ‘younger’ 14C ages were obtained on food-crusts from the same layer and adjoining squares (SPb-725, 6720±150 BP; SPb-728, 6485±150 BP), and four AMS dates for food-crusts from the stratigraphically earlier layer 5 range from 6835±40 BP (KIA-50685) to 6650±30 BP (KIA-50684). If the very early results (SPb-721–723) from undecorated sherds are not subject to significant FRE offsets, therefore, these sherds may be residual (redeposited, and older than the layer in which they were found), although it must be noted that neither the dated layer 5 sherds nor the Early Neolithic fish-traps were found in the same excavation area as the SPb-721–723 sherds.

Overall, it is easier to fit the 14C evidence to a scheme in which pottery only appeared at Zamostje 2 in c.5700–
of the 6th millennium cal BC2. The oldest 14C age for phase of UV pottery, but they nevertheless accept that and stratigraphically the Ozerki 5 sherds belong to a late Sakhtysh 2a and both of those from Ozerki 5, on the Hartz et al. [11] reject the ‘oldest’ food-crust date at (KIA-39308–39311) and Ozerki 5 (AAR-14542, 14545). Four radiometric 14C results on UV food-crust samples from Sakhtysh 2a (GIN-10924, 12987–12989; [19, 20]) are comparable to the AMS results at Zamostje 2, but other sites already had UV pottery by this date, and from a technological perspective we should focus on these earlier sites to understand the relationship between UV pottery and other, earlier traditions to the south and east.

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К ВОПРОСУ ОБ АБСОЛЮТНОЙ ХРОНОЛОГИИ КЕРАМИКИ ВЕРХНЕВОЛЖСКОЙ КУЛЬТУРЫ...
Рисунок 1 – Байесовская хронологическая модель для стоянки Замостье 2, созданная в программе OxCal v.4.3.1 [21], в которой устанавливаются даты для конца позднего мезолита и началу раннего неолита (распределения вероятностей с черной штриховкой датируют конец позднего мезолита и началу раннего неолита), базирующиеся на их позиции в пределах 5 стратиграфических последовательностях образцов сапропеля (распределения вероятностей с серой штриховкой), начало раннего неолита также сопрягается с калиброванными датами для вершей и для образцов древесины с обработкой из слоя раннего неолита (вероятности с косой штриховкой). Два образца по сапропелю (обозначенные знаком "?") имеют калиброванные даты достаточно молоды для их стратиграфической позиции, не учтены в данной модели. Другие результаты соответствуют стратиграфической последовательности и синхронизация всех 6 последовательностей получена по перекрестному датированию конца позднего мезолита и началу раннего неолита.
Figure 1 – A Bayesian chronological model for Zamostje 2, created in OxCal v.4.3.1 [21], which estimates dates for the end of the Late Mesolithic and the start of the Early Neolithic (black probability distributions Date LM end and Date EN start), based on their positions within 5 stratigraphic sequences of sapropel samples (grey probability distributions); the EN start Date is also constrained by the calibrated dates of fish-traps and other artefactual wood in the Early Neolithic layer (hatched distributions). Two sapropel samples (denoted by “?”) whose calibrated dates are too recent for their stratigraphic positions are omitted from the model. The other results are compatible with the stratigraphic sequences and the synchronisation of these 6 sequences obtained by cross-referencing (Date=) end LM and start EN.

Figure 2 – Comparison of the estimated dates for the end of the Late Mesolithic and the start of the Early Neolithic (Date LM end and Date EN start) at Zamostje 2, derived from the Bayesian chronological model shown in Figure 1, with cumulative probability distributions (OxCal function Sum) for the calibrated dates of fishing equipment (13 dates from 11 samples) and timber piles (36 dates from 35 samples), which show that all of the dated timbers could either pre-date the end of the Late Mesolithic or post-date the start of the Early Neolithic.

Figure 3: site Zamostje 2. Early Neolithic sherd V002, photographs of (top left) exterior, showing repair hole; (top right) internal surface, showing food-crust and repair hole; (centre) top edge, showing resin used in repair (H. Lübke; scale bar 50mm); Scanning Electron Microscope imaging of (bottom left) woody plant fibre in repair hole (area c.0.20x0.16mm), (bottom right) fish scale embedded in food-crust surface (area c.0.80x0.64mm) (M. Spataro).
ABSOLUTE CHRONOLOGY OF UPPER VOLGA-TYPE POTTERY: MORE EVIDENCE FROM ZAMOSTJE 2

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Annotation. Zamostje 2, on the Dubna River, c.100km north of Moscow, appears to offer an ideal opportunity to understand the relative and absolute chronology of Upper Volga Early Neolithic pottery. More than 100 radiocarbon (14C) dates are available from a stratigraphic sequence which spans from the Late Mesolithic to the Middle Neolithic. All typological stages are represented among over 18,000 sherds of Early Neolithic pottery, and many of these sherds bear deposits of carbonised food remains (food-crusts), which can be dated directly by 14C; more than 30 food-crusts have been dated directly. Nevertheless, there remains considerable uncertainty about the date range of Upper Volga pottery at Zamostje 2, and many of the issues raised are relevant to dating early pottery at other sites. Moreover, the absolute chronology of Upper Volga pottery must have some bearing on the interpretation of 14C dates for pottery from adjoining regions. In this paper, we discuss alternative interpretations of the Zamostje 2 evidence.

Keywords: early Neolithic Russia; Upper Volga pottery; food crusts; radiocarbon dating; freshwater reservoir effects; stable isotopes; EA-IRMS; lipid biomarkers; GC-MS; GC-c-MS; ceramic technology; petrography.