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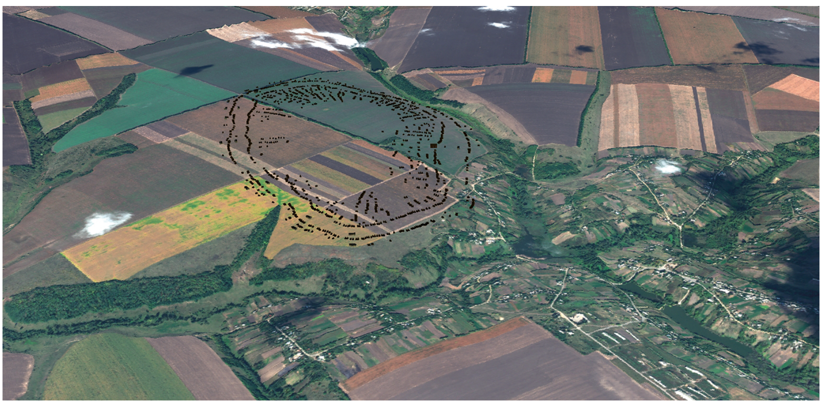
4 Site Studies

In this chapter, we draw together and integrate the studies relating to the Nebelivka megasite at the site level. Three sources of palaeo-environmental evidence – pollen analysis, soil micro-morphology and molluscan analysis – are used to build up a picture of the landscape on and around Nebelivka before, during and after the occupation of the megasite. The pollen, charcoal and non-pollen palynomorphs from the Nebelivka P1 core provide crucial insights into the unexpectedly low level of human impact on the landscape, which has had such profound effects on our approach to the understanding of the megasite. In a fundamental part of this chapter, Duncan Hale presents the only complete geophysical plan of a Trypillia megasite to date, enabling Brian Buchanan's analysis of movement in and through the site by Visual Graph Analysis and a series of nested analyses of the social space comprising the megasite – the Quarters, Neighbourhoods and houses. Stuart Johnston summarises the results of the experimental programme of house construction, house-burning and excavation of the burnt house. A lengthy section by Bisserka Gaydarska summarises the results of the Ukrainian-British excavations at Nebelivka. Andrew Millard presents the Bayesian analysis of the over 80 AMS radiocarbon dates for the megasite, while Natalia Shevchenko reports on her analyses of the building materials from the Mega-structure.



Bruce Albert, Jim Innes, Konstantin Kremenetski, Andrew Millard, Marco Nebbia, Bisserka Gaydarska & John Chapman

4.1 Palaeo-Environmental Studies

4.1.1 The Nebelivka P1 Core

4.1.1.1 Introduction

The geology of the Nebelivka area consists of Pre-Cambrian granite and gabbro. This bedrock is deeply incised by valleys, including all tributaries to the local stream network. The study is focused in the valley of an unnamed tributary with steep transportational slopes (ca. 30°) on the eastern edge of the megasite. Interfluves are draped with Pleistocene loess of variable thickness – typically 1.5m but deeper in gulley fills. Carbonate-rich soils, including chernozems, developed out of the loess at various points in the Holocene. Modern climate is temperate and moderately continental, with a mean July temperature of 20°C and a mean January temperature of -6°C, mean annual precipitation being ca. 550 mm. Vegetation in the study region is classified as forest-steppe. The interfluves today are largely cultivated with a variety of non-cereal crops, with forested boundaries of large fields also consisting of many introduced species. Primary mixed-oak woodland with *Tilia cordata* elements is found at the South-Eastern edges of the Nebelivka Cooperative Farm in the direction of Borschova village.

The study focuses on Holocene sediments in a six-metre sediment core where pollen is preserved under reducing and neutral conditions, designated P1 and located at 48°38’59.4” N 30°33’38.1” E (Fig. 4.1). The core was taken at the South-East edge of a small basin ca. 200m in length and ca. 80m in width. The topography indicates that the coring site was an alluvial site rather than a cut-off side-channel with fen or bog characteristics. On the West side of the basin, nearest the megasite, slopes approached 30° – the steepest slopes of any area on the edge of the megasite – with more gradual slopes of 15–20° on the East side of the valley. The methods involved in the coring are fully described in Albert et al. (2020).

4.1.1.2 Megasite Human Impacts

Investigations of the palaeo-environment at Nebelivka provide an excellent opportunity for testing the human impact of a megasite, the more so since the coring site is only 250m from one edge of the megasite. Previous investigations of Trypillia lifeways (Videiko 2013; Pashkevitch 1997, 2005; Pashkevych 2012; Pashkevitch & Videiko 2006) and their ecological implications indicate an expectation of five kinds of cumulative impact: (1) forest clearance to provide land for intensive or extensive farming, with timber for building the hundreds of houses as well as cooking and heating (Kruts 1990); (2) intensive micro-charcoal concentrations marking the regular

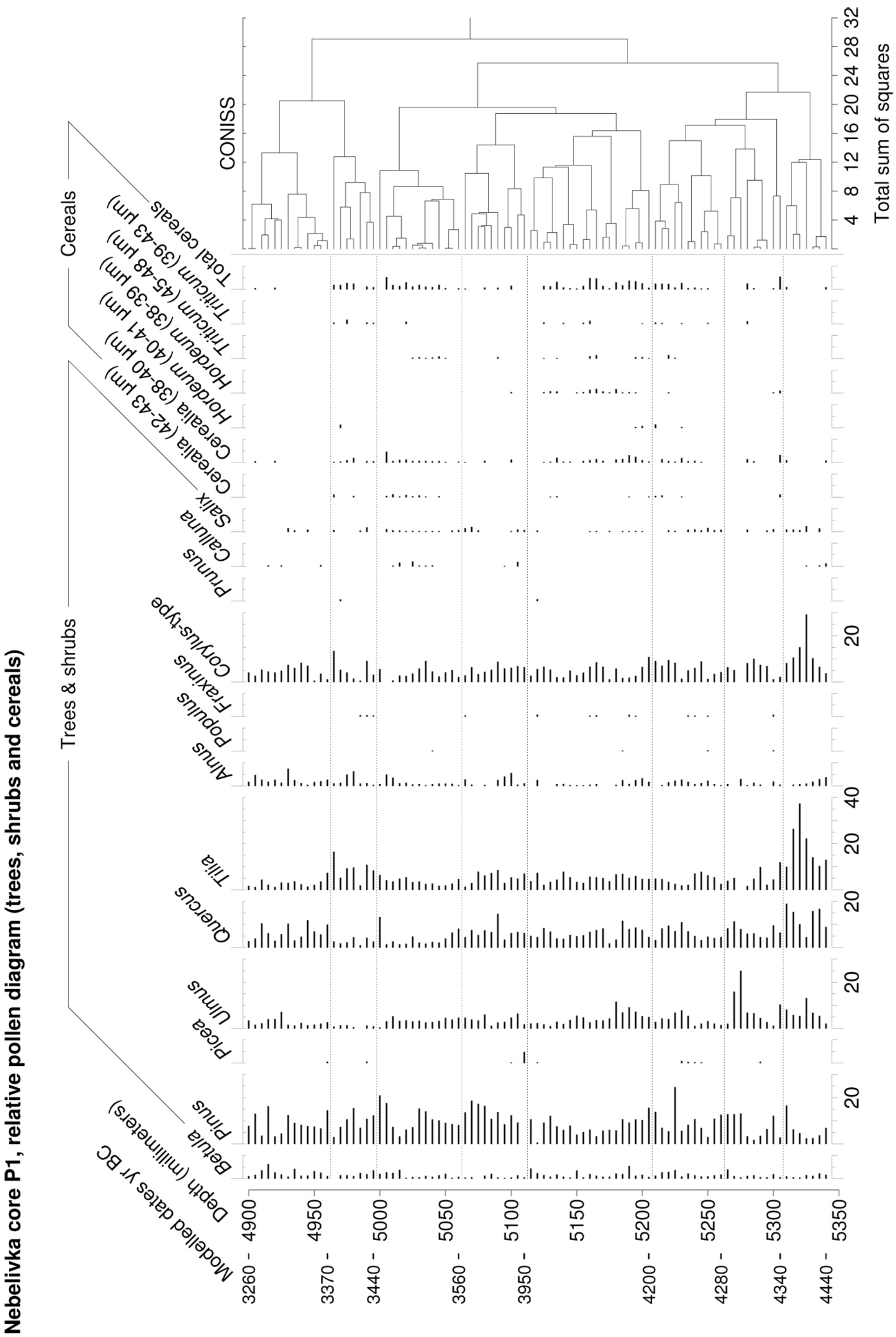


Figure 4.1: Pollen diagram, Nebelivka P1 core (by B. Albert).

burning of houses at the end of their life-cycle (Chapman 2015); (3) agricultural and/or pastoral indicator species; (4) high soil erosion caused by megasite settlement which would have resulted in high sedimentation rates; and (5) the stress that a supposedly large site population would place on the water supply provided by a network of small streams. The aim of this section is to assess the scale of the human impact identified in the Nebelivka P1 core with a view to adjudicating between the 'minimalist' and 'maximalist' models of Trypillia settlement and lifeways. The results of previous studies (Albert & Pokorný, 2012) translate into the following generalised predictions for Nebelivka: cereal pollen levels up to 4% (Total Land Pollen, or 'TLP') or less would suggest minor extensive cultivation, pollen levels above 5% would be typical of short-fallow agriculture, while total cereal pollen of 10–15% TLP would suggest major, extensive cultivation of a majority of interfluve soils. This third scenario might be an expected result of very high population levels at the megasite, for example, with permanent populations in excess of 10,000 individuals. The three cultivation scenarios would also yield predictors of sedimentological change, in particular erosion.

4.1.1.3 The Age – Depth Model

Dating was conducted on eleven samples from the core. An iterative approach was used to focus efforts on the sections most likely to be coeval with the megasite occupation. Where samples contained both fine organic material and plant macrofossils, the fine organic material was dated as the macrofossils appeared to be roots intruding from plants growing at a higher level. Initial samples were sieved to remove macrofossils and the fine organic sediment fraction was dated. As some dates produced by this approach were out of chronostratigraphic order, later dates were measured on 'pollen residue': the fine residue was prepared by the Department of Geography, Durham University. All results are calibrated using IntCal13 (Reimer et al. 2013) and reported according to international conventions (Millard 2014). Chronology construction was performed in the OxCal software (Bronk Ramsey 2009a) using the P_Sequence age depth model (Bronk Ramsey 2008; Bronk Ramsey & Lee 2013). Outlier analysis with a prior outlier probability of 10% (Bronk Ramsey 2009a) was used in a preliminary model with low-resolution interpolation to confirm which dates were out of sequence, and those definitively identified as outliers, with posterior probability 100%, were omitted from the final modelling. The chronology was interpolated at 5 mm intervals to match the pollen sampling, and durations and sedimentation rates for each pollen zone were calculated.

Although some of the AMS determinations date sediments secondarily re-deposited from the valley slopes, there are sufficient dates in stratigraphic order to broadly align the sediments with the well-dated Nebelivka megasite. It is important to differentiate between precision and resolution in the dating – between the high resolution of the sampling interval and the low precision of the dating.

4.1.1.4 A Sedimentological Hiatus?

The ambiguities in the age-depth model and the possible absence of the predicted environmental impact of human populations led us to consider two hypotheses concerning sedimentation in the small valley where the pollen core was taken: the Hiatus Hypothesis, in which sediments contemporary with the megasite occupation are absent due to an interruption in sedimentation or subsequent erosion, and the self-explanatory Continuous Sedimentation Hypothesis (Albert et al. 2020). The overall conclusion from Loss on Ignition, Particle Size and Carbonate analyses show that there is no positive evidence in favour of a hiatus in core P1. Although we cannot rule out short hiatuses in the core, it is unlikely that there was an absence of sediment representing a continuous period of several hundred years.

4.1.1.5 Assessment of Ecological Impact

The general assessment of each of the five kinds of human impacts we expected to find in the Nebelivka P1 diagram – cereals, charcoal, agro-pastoral indicators, erosion and hydrology – is based upon a tabulation of the key depths at which changes can be noted (Fig. 4.2) (for detailed results, see Albert et al. 2020).

Forest cover was highest before the megasite occupation, reaching peaks of 55% total land pollen in Zone 1 and 45% in Zones 2 and 3 (Fig. 4.1). There was a gradual, cumulative decline in forest cover with cycles of forest clearance and re-afforestation before, during and after the megasite occupation. Minor episodes of elm decline are dated to the megasite period but both were reversed within a period of decades. Both episodes were of a magnitude found before and after the megasite occupation. In the entire diagram there is no single forest clearance event indicating a massive phase of building and/or burning.

The micro-charcoal sequence shows a series of peaks in either two or all three size ranges but nothing on the scale of the major 5210 mm fire event before the megasite was settled. Although cereal indicators pre-date this event, it is likely that it represented a significant opening-up of the Nebelivka landscape for agro-pastoral activities through widespread burning of the primary forest. Age-depth modelling puts this fire event at least 100 years before the foundation of the megasite. Thereafter, the periodicity of minor micro-charcoal peaks before, during and after the megasite period, rarely matched those of Cerealia pollen, suggesting the cause lay in house-burning rather than burning of primary forest.

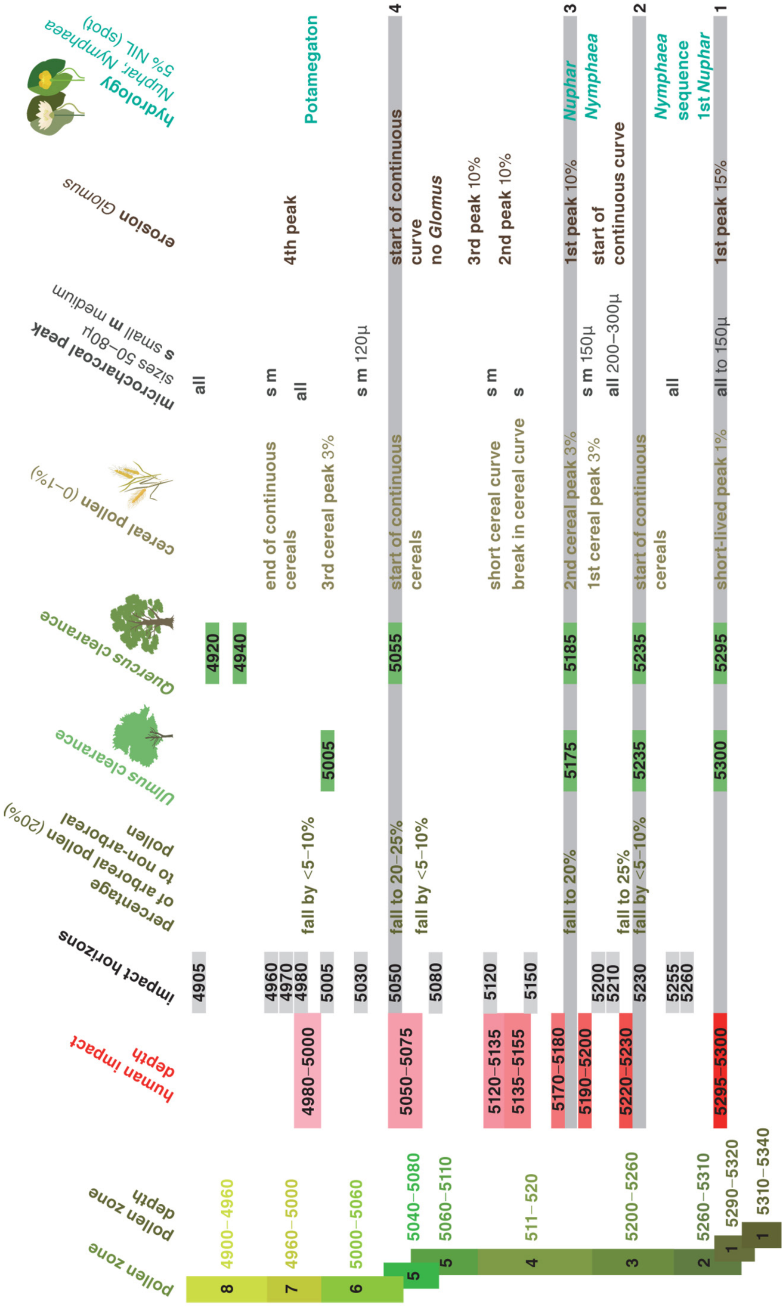


Figure 4.2: Human impact proxies, Nebelivka P1 core: pollen zone, pollen zone depth and human impact depth columns show darker shades with increased depth (by C. Unwin).

The age-depth model suggests a long duration of cultivation over at least 500 years and probably 900 years from initial cultivation before the megasite to a maximum of 5.1% cereals during the late megasite occupation. This time-span is much longer than the modelled occupation period of the megasite. After an early Zone 3 spike in Cerealia pollen at 5305 mm, a continuous curve of *Triticum*, *Hordeum* and Cerealia pollen lasted well into the megasite period. The sequence of cereal pollen findings indicates variable levels of cultivation rather than increased agricultural intensification, with the poverty of definitive annual weed flora suggestive of a four – five-year fallowing system. There is a decline in cereal indicators post-megasite in Zone 8. Pastoral indicators began to be important before the start of dwelling on the megasite and increased during the occupation. Further increases in Zone 8 indicate the likelihood of greater reliance on pastoralism in the post-megasite period.

Identification of sedimentation from A-horizon sources relied on the high levels of the spore *Glomus*, suggesting that moderate land erosion was a long-term effect of megasite dwelling. Our indicators for palaeo-hydrology reveal a striking pattern of increasing water depth and flow through the pre-megasite occupation, with a fall in water quality and a drop in the water table during the megasite occupation. The megasite demand for drinking water, water for the construction of houses and animal use of rivers and streams must have placed a strain on the relatively small water resources of the Nebelivka basin.

We have identified four ‘impact events’ where three of the five classes of impact information changed at the same depth (Fig. 4.2). All but the fourth ‘impact event’ occurred before the occupation of the megasite. The fourth ‘impact event’, in the late megasite occupation, is defined by a combination of a fall in arboreal pollen – mostly *Quercus* – with the re-start of a continuous curve for Cerealia and *Glomus* (an erosion and therefore cultivation indicator). One significant conclusion is that the impact events are by no means limited to, or indeed correlated with, the megasite dwelling period, reinforcing the suggestion that there were pre-megasite settlements in the Nebelivka area which have not yet been discovered during fieldwalking. A surprising finding is the lack of synchronisation between the micro-charcoal peaks, of which ten were found in the core, and any of the impact events. Only three microcharcoal peaks were found in layers coeval with the megasite occupation and, of these three, only one peak was found in all three microcharcoal sizes.

It is important to underline what is perhaps the most important conclusion of our investigations – namely that there is no sign of major human impact at **ANY** point in the P1 sequence. The well-preserved pollen, charcoal and NPPs[42] permit an assessment of ecological impacts and there is no concentrated impact of all five forms of evidence anywhere in the sequence. Based on the age-depth model, what we find are increases in erosion rates and a decline in water quality during the megasite occupation. Given

42 NPPs refer to 'non-pollen palynomorphs'.

the variations in population numbers even between the various ‘minimalist’ models (currently modelled at 1,500–4,000), not to mention the ‘maximalist’ estimates of 10,000–46,000, the increase in land erosion rates and the decline in water quality in what is, after all, a small hydrological network, come as no surprise. What is more significant is the lack of sustained high cereal values and high pastoral indicators, as much as the absence of spikes in the micro-charcoal curve, especially at the end of the megasite occupation. It is these absences which suggest that the minimalist models are far more likely to be correct and that it is time to consider them seriously as the ecological impact required by maximalist models is not observed.

The second most important conclusion stemming from the acceptance of the age-depth model concerns the high probability that there were indeed mixed farmers living in the Nebelivka area before the settling of the megasite, even though their artifactual footprint has not yet been found. There is ceramic evidence for an earlier (Phase A) settlement only 20 km from Nebelivka. Intriguingly, the persistence and strength of pre-megasite agro-pastoral indicators were comparable to those found in the megasite period. However, the strongest evidence for a major fire event indeed dated to the pre-megasite period, as the probable opening-up of the area for agro-pastoral activities. Nothing on the same scale as the 5210 mm event has been detected in the micro-charcoal record for the megasite occupation. It seems highly likely that this pioneer clearance event increased the attractions of the Nebelivka promontory for subsequent dwelling (see below, pp. 119–122, for the molluscan evidence for a cleared, grazed-grass promontory).

4.1.1.6 Conclusions

Palynology and allied sediment studies at the Nebelivka megasite have enabled the reconstruction of environmental changes in close proximity to this large site. The reconstruction of a moderate impact according to palynology and local sedimentology is in some ways surprising, and indicates that the trajectory towards agglomeration of settlement populations here is not related to agricultural intensification, although natural hydrological conditions were favourable to such an agglomeration in Phase BII. Pre-megasite environmental conditions attest to the creation of a small-scale ‘cultural steppe’ in the process of extensive farming in the Nebelivka area.

The Nebelivka core is the first sediment core ever to have been recovered so close to a Trypillia megasite with detailed pollen, loss on ignition, particle size analysis and microcharcoal analyses. It is also the first core from outside major valleys, such as the Southern Bug or the Dnieper, to provide a vegetation history of the loesslands of South Central Ukraine. The eight AMS dates in stratigraphic order provide the basis for a reasonably robust age-depth model, linking the core to the megasite occupation.

The moderate human impact recorded at the time of the megasite occupation, combined with the stronger evidence for fires both before and after this occupation, come as a considerable surprise to Trypillia specialists and those interested in early urbanism in Europe. It should be emphasized that the absence of a major ecological impact at **any** point in the sequence means that, despite dating issues, the results on human impacts are reliable.

Three possible scenarios should be considered in the light of such findings. The first and most obvious implication of these results is that the 'maximalist' scenario of truly massive populations in Trypillia megasites – ranging from 12,000 to 46,000 people living coevally at Majdanetske – must be rejected. In the second scenario, Pashkevitch's (2005) traditional interpretation of Trypillia megasite agricultural practices as extensive, inefficient, low-yield arable farming with a modest level of pastoralism, implied a large area of cultivated land reaching 10 km or more from the megasite and the necessity for wheeled vehicles and animal traction. However, this scenario is potentially fatally threatened by the lack of off-site discard anywhere within the Nebelivka micro-region. The third scenario requires us to reckon with the possibility of smaller-scale permanent settlement or seasonal agglomerations at Trypillia megasites rather than long-term, massive, permanent populations. This challenge requires a new approach to Trypillia taphonomy, house-burning and object deposition (see Chapters 4 and 5). The moderate human impact on the Nebelivka environment and the dispersed nature of burning episodes would support the third scenario of smaller or less permanent agglomerations (for comparison of the three models, see Chapter 6) more than the maximalist scenario or the second scenario of extensive agriculture and pastoralism.

Dan Miller

4.1.2 The Molluscan Evidence

Holocene molluscan assemblages relating to the poorly dated period before the establishment of the megasite, are strongly indicative of heavily grazed grassland. Even allowing for the potential complex taphonomy of chernozem soils with their *krotovina* and other pedogenic processes, and the potential post-depositional mixing of Holocene/Pleistocene strata, the absence of woodland species and the predominance of grassland/steppe taxa is stark in the time interval after the end of the Pleistocene and the start of the megasite occupation. This conclusion may have ramifications for the landscape where the megasite was settled.

Although mollusc shell was often quite sparse, a total of ca. 4,000 shells has been recovered and classified (for details, see https://doi.org/10.5284/1047599 Section 3.5). Samples were collected from excavated pits, ditches and house deposits, as well as test pits into the Holocene soils and substrate, and samples from the strata sealed by an Early Bronze Age barrow. Given the low abundance of shells, many samples could be immediately scanned and assessed at the sieving stage. The majority of molluscs has been scanned and examined off-site.

The dominance of *Heliocipis striata* and *Vallonia* sp., in combination with the regular findings of *Chrondula tridens* and *Tuncatellina* cf. *cyclindrica*, indicates a diagnostically steppe-like assemblage in all contexts and periods. In fact, the highest densities of these steppe-grassland species occurred in the buried Holocene soil and underlying layers, suggesting the persistence of steppe biota over the entire examined sequence. Notably absent is virtually the whole suite of 'classic' Holocene climax-forest species. Clausiliidae and Zonitidae, which are rare here, are only suggestive of limited shrub-like habitats or isolated stands, and not necessarily woodland *per se*. *Caryichium tridentatum* is also present, suggesting some shrub-like/minimally-wooded shady areas in the open steppe, but not really a forest-steppe as such.

The aquatic species are obviously imported to the site. It should be noted that the freshwater mussel, *Unio* sp., is not a suitable foodstuff but some shells have been used as temper in 'shell-tempered' coarse ware (see below, Chapter 5.1.3). *Unio* sp. should be considered along with *Theodoxus fluviatalis* and *Pisidium* sp., in terms of viable transport mechanics. The possibilities include transport in nets with large fish brought to the site. Importation of reeds and maybe other long grasses such as the *Succinea* sp. elements found in 'floor' and pit deposits could also be considered in relation to the use of hay/straw-like materials in fodder and bedding, and possibly also the presence of herbivore dung, mud, and 'hoof-trample'. Peaks of *Succinea* in 'house floor' deposits hint that bundles of reeds may have been used in house construction. This opens a new approach to Trypillia house-building, especially in the light of the arched rooves of some Trypillia clay house-models. The highest density of *Unio* sp. fragments occurs in the daub-rich destruction layers but only a single (terrestrial) shell has been observed as an inclusion in all the available daub sampled or seen on site.

Finally, samples from the ditches provide some interesting suggestions for archaeological interpretations. Species variance from the local Pleistocene substrate is suggestive that the Northern Ditch segment was indeed perhaps up to ca. 1.4m deep (Fig. 4.55 upper), and appears to have been an open feature, creating a favourable sheltered habitat for *Succinea* sp. This model is not inconsistent with additional structural features such as a palisade reinforcing the deep, open ditch. This situation differs from the Southern Ditch segment, where each ditch appears much shallower (maximum ca. 0.4 to 0.7m) (Fig. 4.55 lower) and with an associated fauna that suggests the 'ubiquitous steppe-grassland' was uninterrupted, with no evidence for the development of a distinct microhabitat for molluscs.

In summary, there were periods in the Holocene when the landscape of the Nebelivka megasite appeared significantly open but it is not yet possible to date these periods to a specific part of the Holocene. The existence of local open conditions would have favoured the selection of the promontory for the location of the megasite.

John Chapman

4.1.3 Summary

In the general, comparative analysis of the landscapes of Trypillia settlements based upon the four variables of elevation, slope, distance from rivers and soil type, the conclusion was reached that there was no significant difference between the environs of megasites and smaller sites (see above, p. 99). In terms of human practices, this may be taken to mean that Trypillia groups of all sizes had a clear concept of the kind of site which they preferred to inhabit – a finding supported by the Project's fieldwalking programme (see above, Chapter 3.2). It is noteworthy that Nebelivka fits precisely into that 'template'. But what were the characteristics of the actual landscape before the megasite was settled?

Two different views emerge from two kinds of evidence. The picture of the wider pre-megasite landscape of a pollen catchment of perhaps 2–3km radius is of a well-wooded landscape, with arboreal pollen of over 50%, which was dramatically altered by a major 'fire event' a century or more before the megasite occupation. This fire event is thought to have created a small-scale 'cultural steppe'. Thereafter, a series of clearance episodes and re-afforestation phases indicated a cyclical pattern of landscape modification throughout and indeed after the megasite occupation.

The more localised picture from the molluscan evidence collected from the megasite only showed that, at some time in the Holocene, the Nebelivka promontory was a heavily grazed steppe grassland, with a complete absence of woodland species and the occasional indications of shrub-like habitats and isolated stands of trees. There is no close dating of the significantly open landscape, which may well date to long before the pre-megasite 'fire event'. It is not surprising that molluscs characteristic of open habitats continued all through the megasite occupation. But we cannot currently document a continuously open landscape on the Nebelivka promontory from the Early Holocene through to the megasite occupation.

There can be little doubt that the Nebelivka area was an open steppe landscape at the end of the Pleistocene and that increasing Holocene temperature and precipitation would have stimulated the re-afforestation of this landscape into a forest-steppe, as supported by the pollen data. The extent to which the poorly dated molluscan evidence can give us a picture of an open landscape shortly before the occupation of the megasite is hard to assess. One way to resolve the variance in the two views of the Nebelivka landscape is to invoke the notion of scale. It is feasible to have a more open Nebelikva promontory on a local scale (molluscs) at the same time as a largely wooded catchment around the promontory at the landscape scale (pollen). This account is reminiscent of the ecological term 'wooded grassland' (Agnoletti & Emanueli 2016, pp. 78–79) rather than the open natural steppe of Gradmann's (1933) *Steppenheide* hypothesis – a human creation of a parkland which required frequent small-scale burning to prevent its reversion into woodland. Such a parkland may well have included the largely open Nebelivka promontory. A wooded grassland would have provided the Nebelivka inhabitants with an open space for their megasite and plentiful cleared croplands as well as the forest resources vital for house-construction, house-burning and everyday firewood.

Duncan Hale

4.2 Geophysical Investigations and the Nebelivka Site Plan

4.2.1 Introduction

Between 2009 and 2013, a team of archaeological geophysicists from Archaeological Services Durham University completed a detailed magnetometer survey over the Nebelivka megasite, creating the first virtually complete geophysical plan of a Trypillia megasite (Chapman et al. 2014a). The only parts that could not be surveyed were small wooded areas along the extreme Eastern edge of the site. The survey covered approximately 286ha. The results are shown both as a plan of magnetic gradient data (Fig. 4.3) and an interpretative plan (Fig. 4.4).

The vast majority of magnetic anomalies reflect the remains of burnt, partly burnt or unburnt buildings; other features include soil-filled pits, ditches, palaeo-channels and possible kilns. Almost 1,500 buildings have been identified in the geophysical survey, all but 23 of which are believed to be dwelling houses. Three-quarters of the structures appear to have been burnt at the end of their 'use-lives', with one-quarter unburnt.

The Nebelivka megasite conforms to the five key planning principles established by Ukrainian archaeologists in the first methodological revolution in the study of Trypillia megasites (Dudkin & Videiko 2004; Videiko 2012, 2013):

1. at least two, and possibly as many as four, principal concentric circuits of structures
2. an open space in the centre of the site, inside the inner circuit
3. an open space between the two circuits, constituting a buffer zone of varying widths
4. the construction of some structures inside the inner circuit
5. the construction of some structures outside the outer circuit

However, the second methodological revolution (Chapman et al. 2014b), exemplified by recent international projects such as the Kyiv-Durham and Kyiv-Frankfurt-Kiel collaborations, has enabled the identification of several additional planning principles and classes of feature (Fig. 4.4). These recent projects have used new generations of magnetometers to cover huge areas with higher sampling densities and greater spatial precision. Several new elements have been identified at Nebelivka: perimeter ditches, internal ditches, palaeo-channels, pit clusters, household clusters ('Neighbourhoods'), bounded unbuilt spaces and buildings which are much larger than typical dwelling houses ('Assembly Houses'[43]) (Figs. 4.8–4.9). Many elements of the Nebelivka site plan have also been identified at other megasites, such as Majdanetske and Taljanki (Müller & Videiko 2016). These new elements reveal a far greater degree of internal spatial ordering than was ever detectable on the older plans. The result is that we have begun to understand much more clearly the spatial components of megasites and their combinations and recombinations in 'Neighbourhoods' and 'Quarters' (Chapman et al. 2014a, 2014b).

A Neighbourhood has been defined as a minimum of three structures in a group with a gap at either end separating the unit from adjacent Neighbourhoods (Chapman & Gaydarska 2016). Application of this definition has identified 150 Neighbourhoods at Nebelivka. The number of structures in a Neighbourhood ranges from three to 27, with a strong trend towards fewer instances of the larger Neighbourhoods: over half of all Neighbourhoods comprise only three to seven structures.

The locations of the Assembly Houses, as focal points for small communities (described below), are considered to be of critical importance for the spatial division of the house circuits and inner radial streets into a level of spatial order termed Quarters (Fig. 4.5). The plan of the settlement can thus be examined on four levels or scales: the entire site, Quarters, Neighbourhoods and individual features, such as houses and pits.

Eight criteria have been used to partition the Nebelivka megasite into Quarters (Chapman & Gaydarska 2016): (1) natural features, such as palaeo-channels (BUT there are only two palaeo-channels); (2) the border half-way between Assembly Houses (BUT this ignores local topographical variation); (3) the boundary between (pairs of) Assembly Houses (BUT sometimes there are three Assembly Houses or only one); (4) any large gaps between Neighbourhoods (BUT there is often a continuous spread of houses (e.g., E–F, F–G); (5) kinks in circuits (BUT these are absent in many parts of the circuits); (6) major variations in the width of the middle (inter-circuit) space; (7) gaps in the ditch (BUT some one-third of the outer circuit has no surviving ditch); and (8) 'obvious' entrances and passageways (BUT these gaps are not always obvious). Note that no Assembly House has been detected in Quarter N, though it seems likely that at least one may have stood in an unsurveyable part of this area. The judicious combination of as many of the multiple criteria as possible has led to a partition of the Nebelivka megasite into 14 Quarters, labelled A to N (Fig. 4.5).

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43 We acknowledge with thanks Tim Pauketat's suggestion of the term 'Assembly House', instead of 'Clan House', during the Amerind Foundation workshop of 2014.

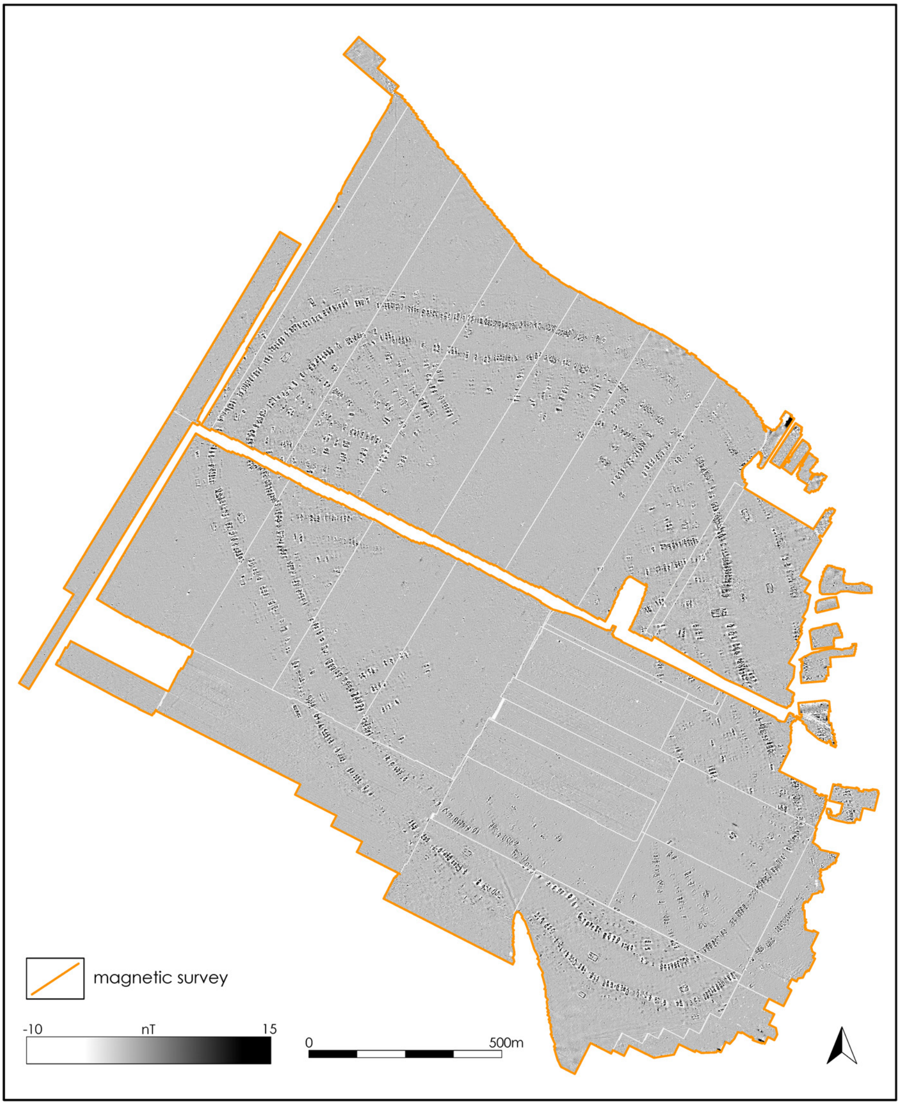


Figure 4.3: Geophysical plan of Nebelivka showing magnetic gradient data (by J. Watson).

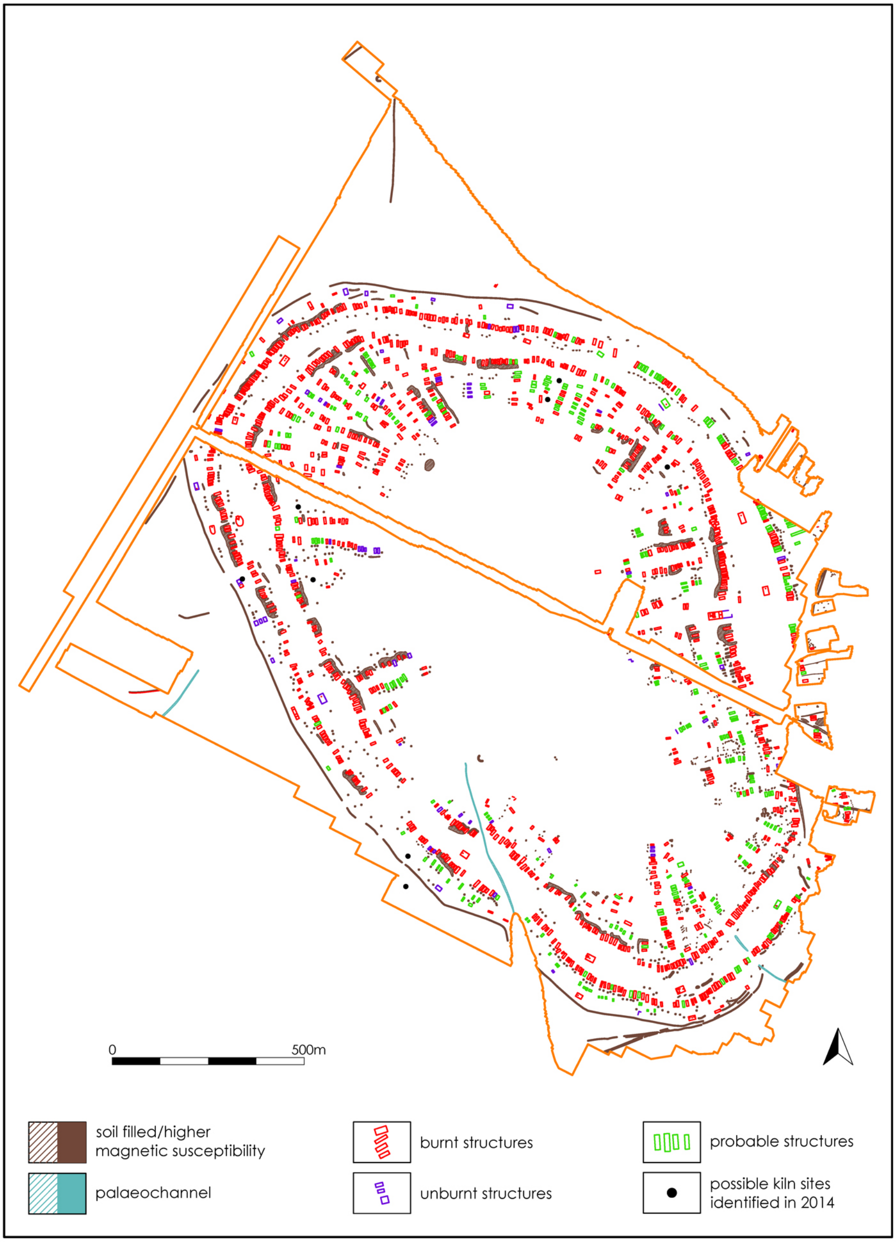


Figure 4.4: Interpretative geophysical plan of Nebelivka (by J. Watson).

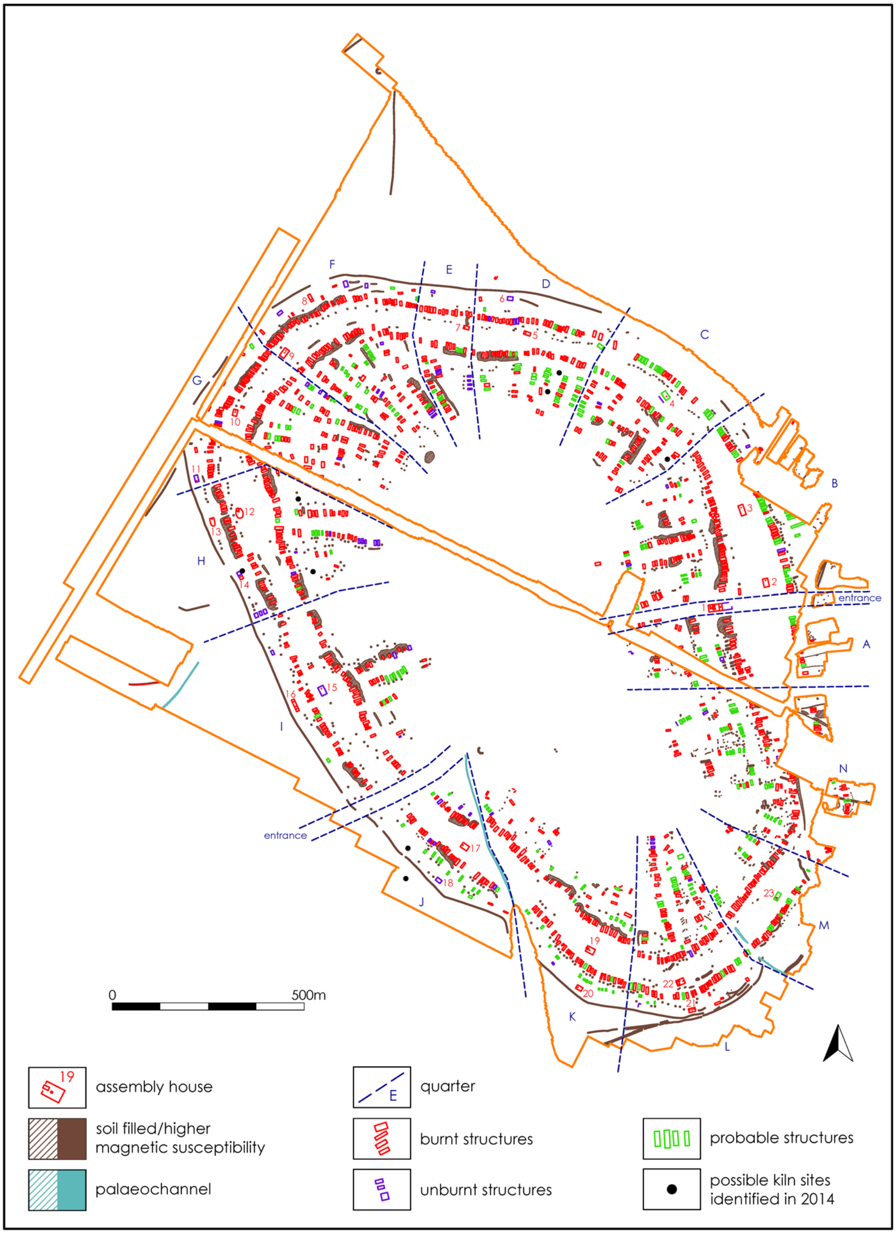


Figure 4.5: Interpretative geophysical plan of Nebelivka, showing boundaries of Quarters (by Y. Beadnell on the basis of D. Hale's geophysical plan).

These themes will be explored further below (see pp. 139–140). Suffice it to say here that Quarters appear to have developed in markedly different ways, perhaps indicating a localised, bottom-up decision-making process within overall planning constraints.

4.2.2 The Site Plan

At the site level, the outermost feature is a boundary ditch, within which are two concentric circuits of houses (Table 4.1). Further houses inside the inner circuit are typically arranged along radially oriented streets or around open squares. The large central area of the site appears completely devoid of any structures. Occasional larger buildings are present between the house circuits and outside the outer circuit. Probable entrances have been identified in the Eastern and South-West parts of the megasite.

The principal features which provided a framework for the whole site were the perimeter ditch and the two house circuits (Fig. 4.4). Between these features were three largely open spaces:

1. the outer space, between the perimeter ditch and the outside of the outer circuit, with occasional Assembly Houses, domestic houses, smaller structures, pits and perhaps gardens
2. the middle space, between the inside of the outer house circuit and the outside of the inner circuit, perhaps an area for garden plots or a processional zone with Assembly Houses
3. the inner space, inside the inner radial streets or the inside of the inner circuit in the absence of radial streets; a major space for congregations, perhaps also used seasonally for animal keeping, whether domestic livestock or wild horses

4.2.2.1 Perimeter Ditch

This ditch was detected as a very weak curvilinear positive magnetic anomaly around the edge of the megasite. This type of anomaly reflects slightly higher magnetic susceptibility materials relative to the natural subsoil; these are typically sediments (within features such as ditches and pits) whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning. The anomaly was relatively narrow and discontinuous, with apparent breaks up to 55m across, reflecting a segmentary or 'interrupted' ditch. The ditch was typically between 40–70m from the houses in the outer circuit, a considerable distance from the more intense occupation areas, which probably accounts for its relatively weak magnetic signal.

It was not possible to detect the ditch around the entire perimeter of the site due to patches of woodland and erosion down a steep slope in the East. Assuming the ditch originally continued around the Eastern side of the site, it would measure approximately 5.9km in length and enclose an area of approximately 238ha. Although interrupted in places, some particularly long stretches of uninterrupted ditch were also detected. For example, a length of approximately 720m was recorded along the Northern part of the boundary (Quarters D-F) and another continuous length of approximately 640m was recorded along the South-Western side of the site.

The ditch appears to have defined the megasite's extent rather than served a defensive function, since: 1) there appear to be several, often very wide, causeways across it; 2) on excavation, it was found to be relatively shallow, measuring less than 1.5m in depth and up to 4m in width; and 3) at 5.9km, the perimeter is too long for an effective defence against attack. The ditch is significant, however, in that it demonstrates that this Trypillia community was concerned to define the limits of its settlement, to distinguish 'inside' from 'outside', an idea previously discussed by Harding et al. (2006).

4.2.2.2 House Circuits

Approximately half of all the buildings identified at Nebelivka are arranged in two oval circuits (Table 4.2). Two broad types of rectilinear geophysical anomaly have been interpreted as buildings: intense anomalies (typically in the range -30 to +80 nT), considered to be burnt houses, and weak anomalies (typically +1 to +6 nT), considered to be unburnt houses. The anomalies of the burnt houses reflect rectilinear or rectangular deposits of burnt daub and other fired clay structures such as platforms, benches, ovens or hearths, bins and thresholds. In very rare instances, one end of a building appears burnt while the other end does not. Another category of anomaly comprises those which are considered likely to reflect houses, but which are amorphous to varying degrees, and either weak or strong, or a combination of both (Fig. 4.3). What anomalies in this category have in common is that they reflect discrete magnetic variation at specific locations where houses might be expected, often on 'streets' where the other houses are better defined. All three types of house anomaly can be identified on some of the radial streets (for example in Quarter H, Fig. 4.12 lower), whereas almost all of the houses in the circuits appear to be burnt. Table 4.1 provides details of the numbers of all structures (partial/complete houses and Assembly Houses) within each Quarter and in the circuits and 'spaces' at Nebelivka (Fig. 4.4).

A greater proportion of houses within the circuits are burnt than in the radial streets. For example, 94% of houses in the inner circuit and 83% of houses in the outer circuit are burnt, compared with 63% of houses inside the inner circuit (Table 4.2).

Table 4.1: Numbers of all structures (partial/complete houses and Assembly Houses) within each Quarter and in the circuits and 'spaces' at Nebelivka (OC – outer circuit, IC – inner circuit) (by D. Hale).

	Quarter	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Total
Outside OC	Burnt	1	1	0	1	0	7	4	2	1	2	1	5	0	0	**25**
	Unburnt	0	1	0	1	1	3	1	4	1	1	1	0	0	0	**14**
	Probable	0	5	0	1	0	2	1	0	1	11	14	4	0	0	**39**
Outer Circuit	Burnt	8	20	9	27	13	38	37	27	35	21	27	23	17	16	**318**
	Unburnt	0	1	0	3	0	0	1	0	0	3	0	0	0	0	**8**
	Probable	4	19	11	2	0	0	0	0	1	1	2	7	7	2	**56**
Between OC & IC	Burnt	4	3	0	1	1	1	2	1	1	1	1	1	0	4	**21**
	Unburnt	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**1**
	Probable	0	0	1	1	0	0	0	0	0	0	0	0	1	1	**4**
Inner Circuit	Burnt	14	38	15	25	7	27	23	33	34	12	38	22	21	27	**336**
	Unburnt	0	0	0	0	0	0	0	1	0	1	1	1	0	0	**4**
	Probable	0	0	6	2	3	0	0	2	0	1	4	0	0	1	**19**
Inside IC	Burnt	18	47	50	17	14	46	60	24	18	0	16	39	4	24	**377**
	Unburnt	1	2	1	0	6	5	4	7	2	2	1	4	0	1	**36**
	Probable	11	17	8	22	5	22	14	6	8	1	10	18	10	35	**187**
Total		**61**	**154**	**101**	**103**	**50**	**151**	**147**	**107**	**103**	**57**	**116**	**124**	**60**	**111**	**1445**

Table 4.2: Summary of all structures (partial/complete houses and Assembly Houses) in the circuits and spaces at Nebelivka (OC – outer circuit, IC – inner circuit) (by D. Hale).

	Outside OC	Outer Circuit	Between OC & IC	Inner Circuit	Inside IC	Total structures	
Burnt structures	25	318	21	336	377	1077	74.5%
Unburnt structures	14	8	1	4	36	63	4.4%
Probable structures	39	56	4	19	187	305	21.1%
Total structures	78	382	26	359	600	1445	
	5.4%	26.4%	1.8%	24.9%	41.5%		100%

The area of every complete burnt house-plan in the megasite has been measured from the interpretative plan (see below, Section 4.3.1). Partial houses (i.e. of unknown length/width) and Assembly Houses have not been included in these measurements. At 63m^2 for the measured houses at Nebelivka, the average house size is very similar to that estimated for the megasite at Dobrovodi (64m^2) and slightly smaller than the estimates for Majdanetske (67m^2) and Taljanki (71m^2) (Rassmann et al. 2016).[44]

In terms of house density, the area within the perimeter ditch (238ha) minus the central open space (65ha) gives an 'occupied' area of 173ha; this provides a density of 8.3 houses per hectare. This is also very similar to the house densities reported at other megasites: Majdanetske – 8 houses/hectare; Taljanki – 7 houses/hectare (Chapman et al. 2014b; Diachenko 2016). Inclusion of the central open space means that the number of burnt houses per hectare falls to 4.5, in comparison with Diachenko's figures for Taljanki (5.1) and Majdanetske (7) (Diachenko 2016, p. 188).

The layout of the two house circuits shows both segmentation and irregularity, with three kinds of layouts: (1) groups of closely-set structures (some of which may even have shared walls); (2) small groups of parallel structures (both (1) and (2) have been termed 'Neighbourhoods'); and (3) widely spaced structures with perhaps more individual than group identity (Fig. 4.6). Several abrupt kinks or small breaks are evident in both house circuits, where the course of a circuit on one side of the break is displaced either in towards the interior or out towards the perimeter (Fig. 4.7 upper–middle). These shifts in alignment can measure between 25–40m either clockwise or anti-clockwise. There are two instances in the North-West of the site and one instance in the South where slight kinks are present in each circuit at matching locations (Fig. 4.7 upper–middle). These kinks probably relate to different groups of house-builders, perhaps operating at different times. In any event, it appears that the kinks are associated with deviations from a pre-determined site plan, or planning principle, with subsequent adjustments in alignment made as necessary. There are many slight changes in the course of each circuit, resulting in considerable differences in the width of the space between the two circuits, but these variations are typically smoothed out rather than an abrupt kink being created. Indeed, a principal characteristic of the space between the two house circuits is its great variability in width, ranging from 60m in some parts to 160m in the East. This characteristic has also been recorded at other megasites. For example, at Dobrovodi the distance between the two outer house circuits is recorded as about 50–150m (Rassmann et al. 2016), while at Taljanki the distance between the two principal circuits is recorded as 100–150m (Rassmann et al. 2014).

44 If the unburnt houses at Nebelivka are included, the density per ha rises to 6.1.

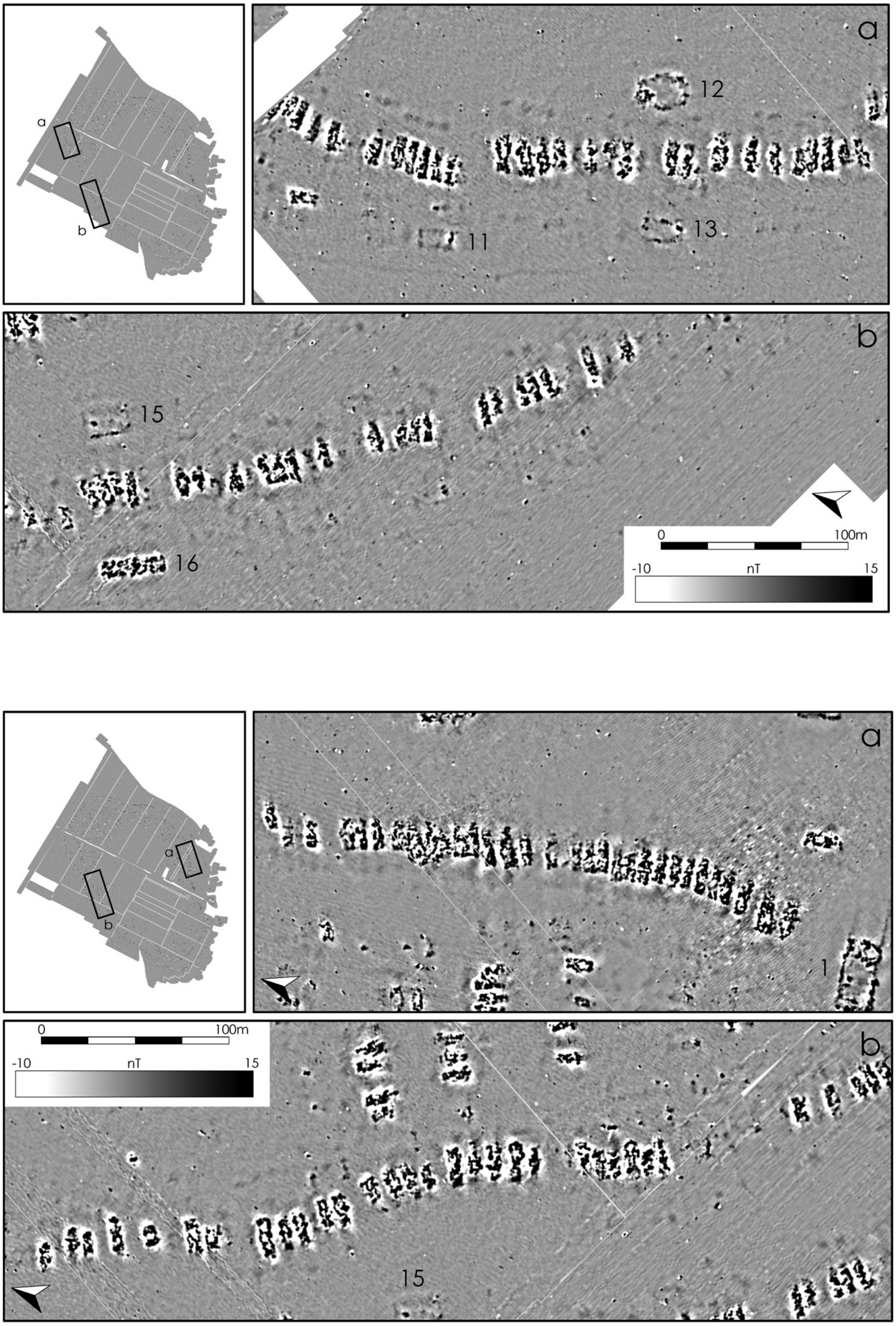


Figure 4.6: Tightly-spaced and loosely-spaced houses, Nebelivka (by J. Watson).

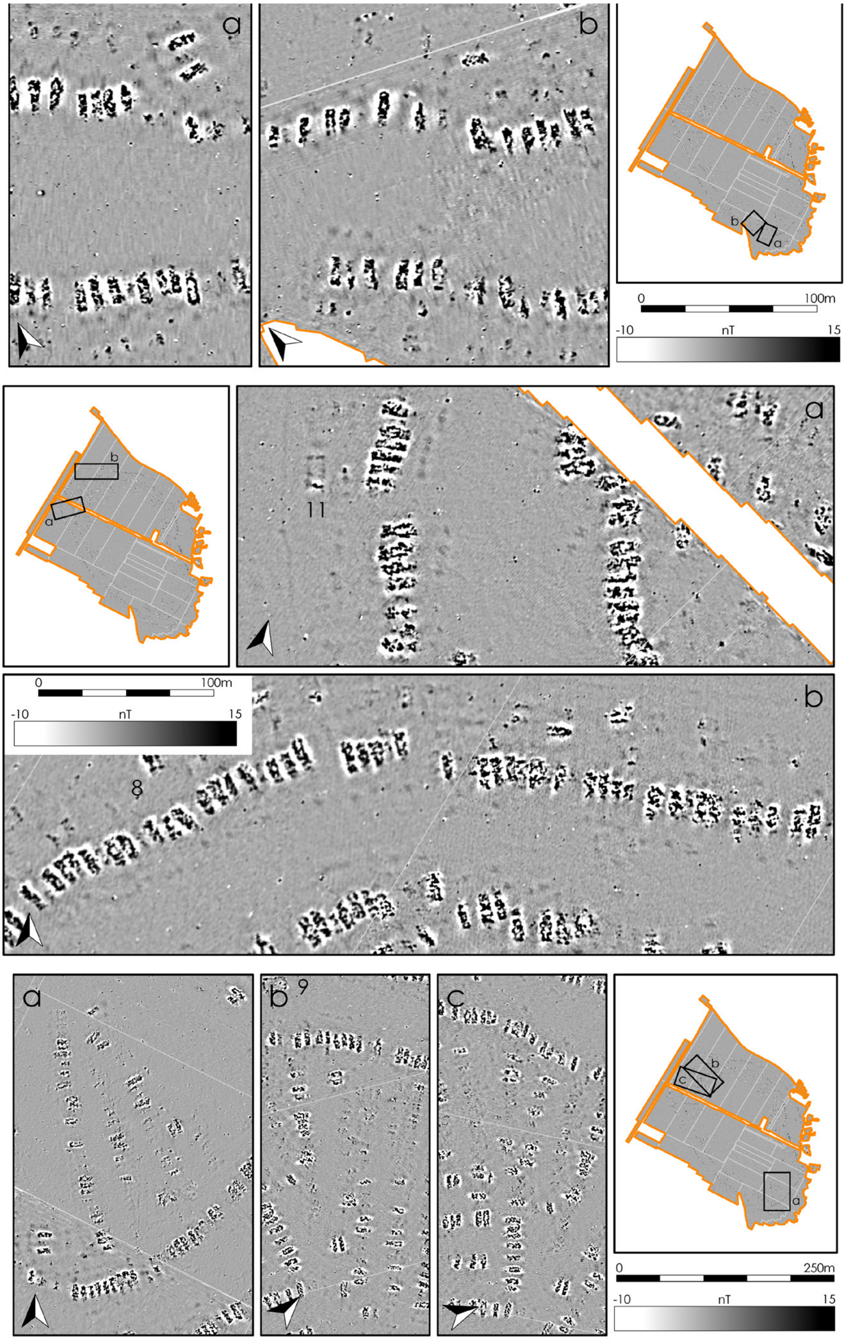


Figure 4.7: Upper & middle: gaps and kinks in house circuits; lower: converging inner radial streets, Nebelivka (by J. Watson).

Two wide breaks were detected in both house circuits on the East side of the site (Quarters A–B) and at the South-West (Quarters I–J). These are likely to be the principal entrances to the megasite (Fig. 4.11 upper). The breaks in the house circuits on the East side (i.e. the distances between houses) measure approximately 64m in the outer circuit and 72m in the inner circuit. A particularly large structure (AH1, below) occupies part of the gap within the inner circuit. The gaps between identified houses in the South-West measure approximately 108m (outer circuit) and 84m (inner circuit). There is no evidence for either ditches or palisades towards the sides of these gaps, which would better define the extents of these probable entrances. Extremely weak positive magnetic anomalies detected beyond the outer house circuit at both locations appear to reflect short lengths of perimeter ditch. In the South-West, at least, the ditch does not extend across the whole width of the potential entrance, but has an apparent causeway at each end which could still allow access. Survey coverage of the perimeter ditch at the Eastern entrance was fragmentary and it is not known if the ditch also had causeways here or not.

Since the Neighbourhoods within the house circuits are relatively small, with gaps at either end, many of the causeways through the perimeter ditch are aligned with, or are very close to, the gaps between Neighbourhoods. It is likely that some of these will also have served as access routes into the site.

4.2.2.3 Assembly Houses

A new category of building has been identified at Nebelivka, distinguished by both its large size and its location relative to standard dwelling houses and to other large buildings. Three such buildings were detected in the initial survey at Nebelivka in 2009 (Hale et al. 2010) and now 23 of these buildings have been identified (Figs. 4.8–4.9). These large structures are located at varying intervals around the house circuits, often standing between the house circuits or outside the outer circuit. Some of these buildings have been identified in apparent pairs, with one structure located between the circuits and the other located outside the outer circuit. Indeed, five such pairs are located at regular intervals around the South-Western side of the megasite. There are also several instances of single large structures. The buildings are most commonly, but not always, aligned parallel to the house circuits and perpendicular to the dwelling houses. These large structures are presumed to have served as public places, with integrative functions perhaps including meetings and rituals, and have been termed 'Assembly Houses' (Chapman & Gaydarska 2016)[45].

A common characteristic of the Assembly Houses, but relatively rare among the dwelling houses, is the presence of a strong, typically rectilinear, magnetic anomaly (which reflects the bases of the walls) but a noticeable absence of almost any other

45 NB the recent summary of evidence for Assembly Houses (Hofmann et al. 2019).

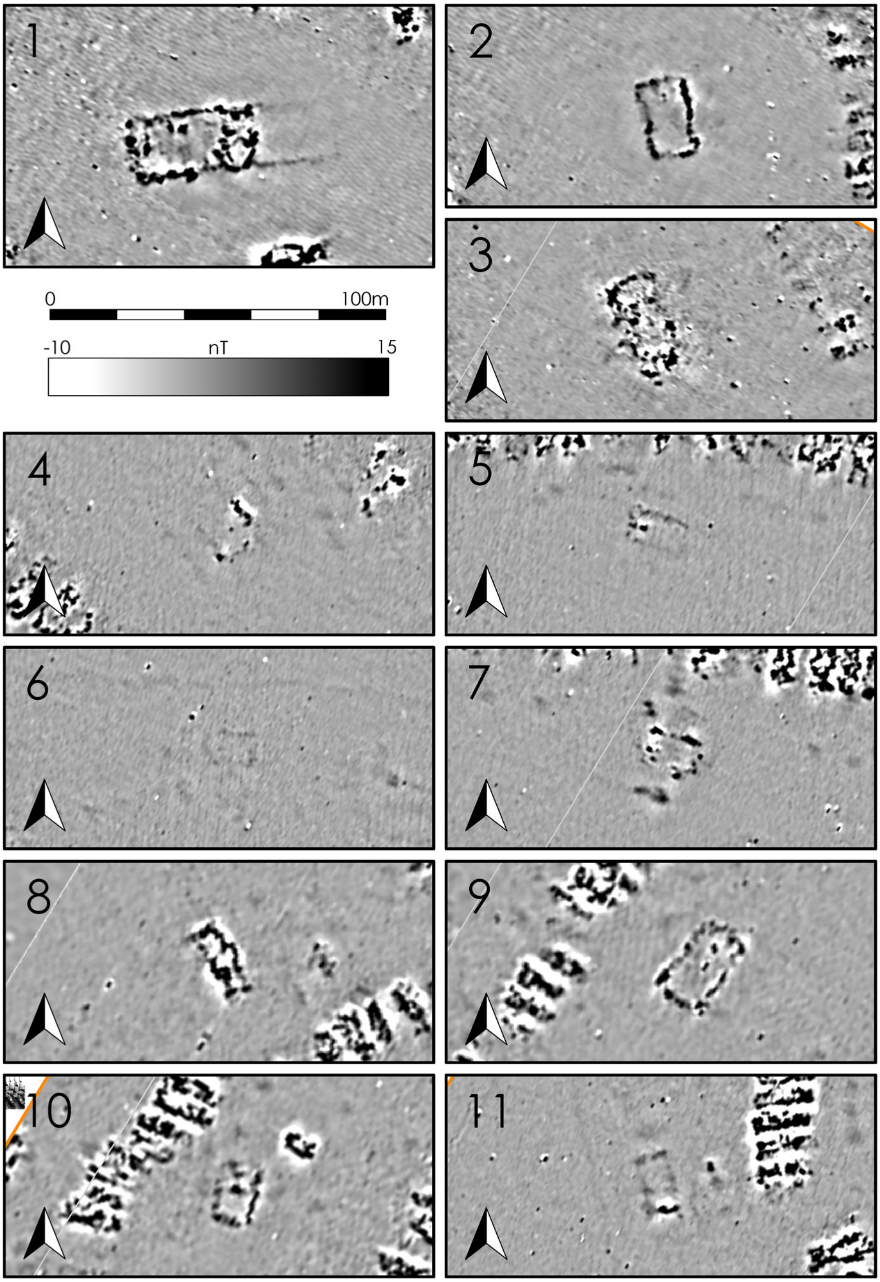


Figure 4.8: Assembly Houses 1–11, Nebelivka (by J. Watson).

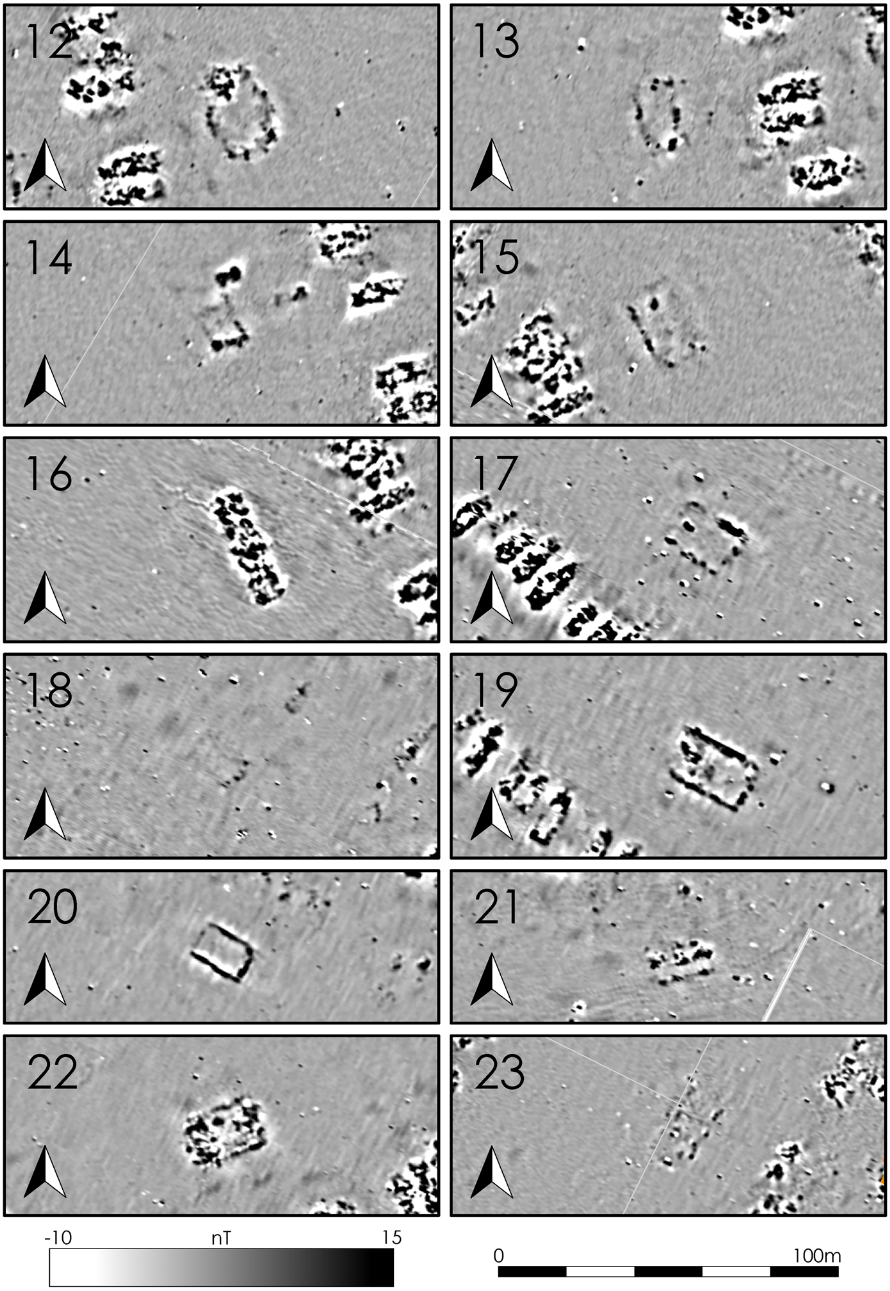


Figure 4.9: Assembly Houses 12–23, Nebelivka (by J. Watson).

strong magnetic anomalies (e.g., AH2 in Quarter B (Fig. 4.8) and AH19 & 20 in Quarter K (Fig. 4.9). There are often no concentrations of strong anomalies to indicate the presence of burnt wall, floor or roof remains, in contrast to the association of such anomalies and remains with dwelling houses. If these Assembly Houses had been burnt, and then the burnt remains had been cleared away, one might still expect to see anomalies reflecting the underlying soil which had been burnt during the fire; if the temperature of the underlying soil exceeded its Curie point (perhaps 600º–700ºC), the soil would have acquired a thermo-remanent magnetism which could be detected during survey. Given the absence of such anomalies, it would appear that these Assembly Houses were not burned down in the manner of most dwelling houses. The almost 'empty' rectilinear anomalies which were often detected in this survey may instead reflect fired clay slots or troughs used as foundations to support upright timbers or planks directly, or perhaps to hold sleeper beams for upright timbers. Such fired clay slots were found during excavation of the largest Nebelivka 'Mega-structure' (see below, pp. 136, 199) (Fig. 4.35 lower); although the Western part of this particular structure was burnt, it provides an excavated, proven, example of the fired clay slots which appear to be present at many of the other Assembly Houses.

The discovery of these slots has implications for both the construction and use of the Assembly Houses. In the absence of burnt soil around the slots, it is likely that they were pre-fabricated and fired nearby and then brought to the construction site and installed. Perhaps the walls of these large structures were primarily made of upright timbers, with little or no burnt daub present, consistent with some of the magnetic anomalies. Rather than being burned at the end of their use-life, like the dwelling houses, this type of construction would facilitate the erection and dismantling of the super-structure, and could perhaps indicate a more occasional or seasonal use of these large structures. The relative lack of anomalies could supports the possibility that Assembly Houses may mostly have been unroofed.

Additional anomalies were detected within most of these large buildings, almost certainly reflecting internal features. Some linear examples appear to reflect internal divisions or podia (e.g., AH1, and possibly also 3, 8, 14, 19 and 22), while single discrete, small, strong anomalies, invariably located near one end of the building, almost certainly reflect platforms or ovens/hearths (e.g., AH2, 5, 7, 9, 10, 12, 13, 15, 17 and 19: cf. Figs. 4.8–4.9 with Fig. 4.46/3). The details of Assembly House sizes and features are presented below (Table 4.3).

The largest Assembly House detected at Nebelivka (AH1) is exceptional in two respects: 1) it is located within a broad gap in the Eastern side of the inner house circuit (Quarter A–B) rather than between or outside the circuits; and 2) it measures approximately 56m x 20m[46] (2.5 times larger than the next largest structure). In fact,

46 The original estimated dimensions, based upon the geophysical plot of 60m x 18m, were corrected following the excavation of the Mega-structure.

this ‘Mega-structure’ is currently the largest structure yet to be found on any site within the Trypillia-Cucuteni culture.

There is considerable variation in the size of Assembly Houses, with an average size of 276m^2 (including the Mega-structure) or 238m^2 (excluding the Mega-structure). Assembly House sizes between the house circuits range from 123m^2 up to 435m^2, with an average size of 282m^2, while those outside the outer circuit range from 132m^2 to 247m^2, with an average size of 174m^2. The average size of the Assembly Houses between the house circuits is considerably larger than that of the Assembly Houses outside the outer circuit.

The variation in the strength of the magnetic anomalies at the Mega-structure largely reflects the varying amounts of burnt daub and fired ceramics recorded during subsequent excavation in 2012 (Chapman et al. 2016). The Eastern part of the large rectilinear anomaly therefore reflects an open, featureless, enclosed yard or entrance area; parts of the built area indicate a series of rooms, possibly roofed, in the Eastern part, with another open area in the centre and probable further rooms to the West.

The Mega-structure is aligned broadly East-West along what appears to be a band of relatively near-surface granite rockhead; one other Assembly House (AH2) sits on top of this same geological feature. This may have been more evident as a ridge before the loess was deposited, giving greater prominence to these two large structures as they are approached through the East entrance into the site. The only other Assembly House that sits on top of a similar presumed near-surface band of granite is AH15 in the West of the site.

Table 4.3: Assembly Houses at Nebelivka (OC – outer circuit, IC – inner circuit) (by D. Hale).

Assembly House	Quarter	Dimensions / Area (located between IC–OC)	Dimensions / Area (located outside OC)	Notes
1	A	56 x 20m / 1120m^2		at North edge of Quarter A, in E entrance; burnt in W, unburnt in E; internal features in central and W
2	B	21.9 × 13.5 m / 296 m^2		burnt; small internal feature near N end
3	B	27.9 × 13.0 m / 363 m^2		burnt; internal features
4	C	22.0 × 13.1 m / 288 m^2		poorly preserved
5	D	17.0 × 8.6 m / 146 m^2		burnt; small internal feature near W end
6	D		14.2 × 9.3 m / 132 m^2	unburnt

Continued **Table 4.3**: Assembly Houses at Nebelivka (OC – outer circuit, IC – inner circuit) (by D. Hale).

Assembly House	Quarter	Dimensions / Area (located between IC–OC)	Dimensions / Area (located outside OC)	Notes
7	E	14.3 × 8.6 m / 123 m²		burnt; small internal feature near W end
8	F		20.1 × 7.1 m / 143 m²	burnt; ?internal division
9	F	24.7 × 13.9 m / 343 m²		burnt; small internal feature near NE end
10	G	16.9 × 11.2 m / 189 m²		burnt; small internal feature near N end
11	G		17.6 × 9.1 m / 160 m²	unburnt
12	H	24.6 × 17.7 m / 435 m²		burnt; oval; small internal feature near N end
13			20.0 × 10.5 m / 210 m²	burnt; apsidal S end; ?small internal feature at S end
14	H		21.1 × 9.1 m / 192 m²	unburnt in N, burnt in S; internal division
15	I	24.0 × 14.6 m / 350 m²		unburnt; small internal feature near NW end
16			32.9 × 7.5 m / 247 m²	burnt; size of two dwelling houses end-to-end
17	J	19.3 × 13.7 m / 264 m²		burnt; small internal feature near NW end
18			14.8 × 9.3 m / 138 m²	unburnt
19	K	22.6 × 15.3 m / 346 m²		burnt; small internal feature near W end
20			16.0 × 10.4 m / 166 m²	burnt
21	L		17.5 × 10.0 m / 175 m²	burnt
22	L	20.8 × 14.9 m / 310 m²		burnt; internal division; small internal features
23	M	21.3 × 10.2 m / 217 m²		poorly preserved

4.2.2.4 The Quarters

The 14 Quarters at Nebelivka represent an analytical construct defined on the basis of eight multi-dimensional criteria; as such, another analysis may produce a different division of the site into a different number of Quarters. However, constituting a local optimal solution rather than a global optimal solution, the current division is stable and can be operationalized for the purposes of the comparison of the 14 examples. Quarters also form the basis for one of the three megasite explanatory models – the Assembly Model (see Chapter 6.2).

Even a cursory glance at the Nebelivka plan will indicate the opposing structural tendencies of the Quarter – an overall similarity of 'pie-slice' form to include part of each concentric zone of the megasite, from perimeter ditch to inner open space, which sits in tension with considerable diversity in the form and size of individual Quarters (Fig. 4.5). The principal factor affecting similar overall shape is the presence of the Southern palaeo-channel, which truncates the inner open component of Quarter J by displacing it into Quarter K. In terms of size, Quarters vary from 5.3ha (Quarter E) to 21.8ha (Quarter B), with a mean of 13.1ha. The distribution of Assembly Houses also varies, from none to three per Quarter, although it is possible that one Assembly House was located in what is now wooded, and hence unsurveyed, terrain in Quarter N. The number of Neighbourhoods also varies by Quarter from a low of five (Quarter E) to a high of 18 (Quarter N). This variation is carried over into the number of houses per Quarter (Table 4.1), with a low of 50 houses in Quarter E and a high of 151 houses in Quarter F – a mean of just over 100 houses per Quarter. These basic statistics provide a picture of a key structural element of the megasite concealing massive variation across the plan. The most obvious explanation for such variation is the building-up of the Quarters from the bottom-up rather than as a series of top-down, hierarchical decisions. There would be no bottom-up logic which would have led to an emphasis on regularities in the number of Neighbourhoods, houses or Assembly Houses in each Quarter.

4.2.2.5 Inside the Inner Circuit

Many more dwelling houses, amounting to some 600 structures, were also identified inside the inner circuit, comprising 41.5% of the total number of structures at the megasite. Many of these houses (459 or 31.7% of the total) were arranged along radially oriented streets ('Inner Radial Streets') with the long axis of each house parallel to the house circuits. As with the houses in the main circuits, it is the gable end of the house that fronts onto the open area or street. There are 45 Inner Radial Streets of four or more houses, rising to 52 if rows of two or three houses are included. The greatest number of houses on one street is 26, in Quarter L, where the street extends approximately 280m towards the interior. Whilst radial streets are present around much of the interior, the highest density of radial streets is in the North-west (Quarters E–H) and the lowest in the South-West of the site (Quarters I–K). No radial streets were identified in Quarter J, though this Quarter is constrained by a palaeo-channel. Similarly, only one radial street, of only three houses, has been identified in the adjacent Quarter K. The composition of the streets shows as much variability as that of the circuits, with some houses clustered into Neighbourhoods and some more widely spaced. If the inner open area was a key social assembly place, the radial streets would have defined processional routes towards the sacred centre of the site.

Whilst many of the radial streets are parallel to their neighbours, there are also instances where the streets converge, such as in Quarter L, and two instances where two adjacent streets actually merge into one street, in Quarters F and G (Fig. 4.7 lower).

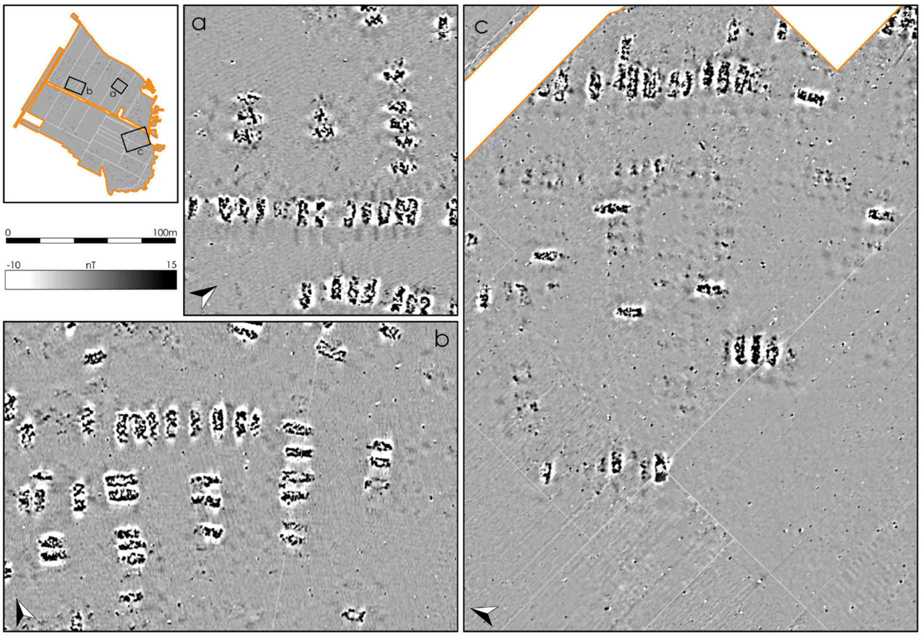


Figure 4.10: Squares and short inner radial streets, Nebelivka (by J. Watson).

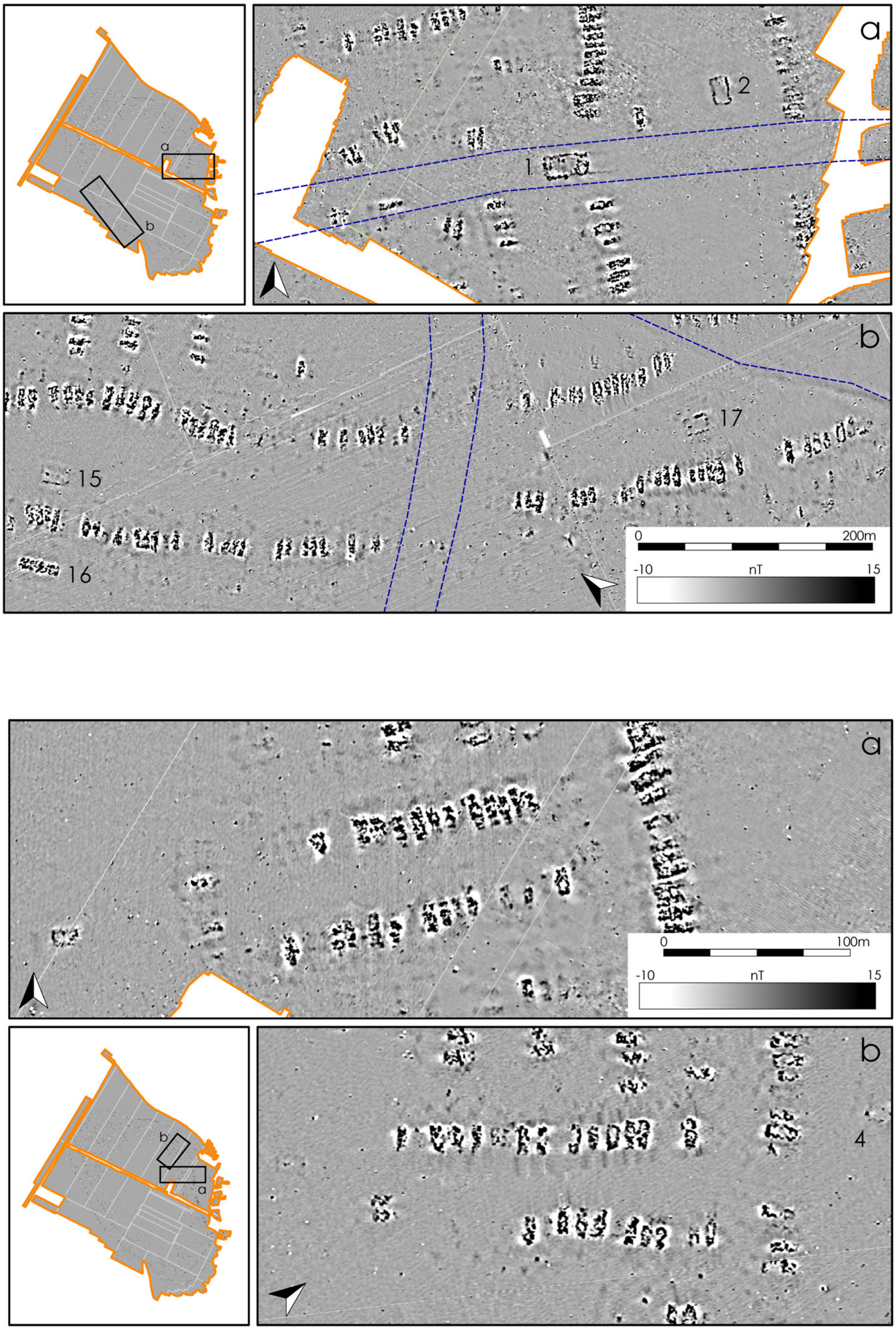


Figure 4.11: Upper: megasite entrances and the main palaeo-channel; lower: short inner radial streets and blocking structures, Nebelivka (by J. Watson).

Although the majority of houses within the inner circuit were arranged along these radial streets, 141 houses (9.8% of the total structures at the site) have also been identified which are not located on radial streets. These houses are oriented radially, that is, with their long axis oriented towards the centre of the site, perpendicular to the houses on the radial streets. Again, there is a great deal of variation in the spatial organisation of these houses. Many of these houses do not have close neighbours. For example, there are individual houses in Quarters B, G and I which are over 40m away from their nearest neighbour. However, many are also grouped into small clusters of parallel houses or Neighbourhoods, as evident in Quarters A, B, G and N, for example. Indeed, four such Neighbourhoods in Quarters N–A are located just inside and parallel to the inner house circuit, resembling a small arc of another internal circuit. Other small groups of radially oriented houses appear to span gaps between radial streets (Fig. 4.10). These short transverse or tangential streets can also have the effect of creating small open 'Squares'. In Quarter N, many of the internal Neighbourhoods appear to form parts or sides of Squares, enclosed areas which do not contain further houses but may contain pits (Fig. 4.10). In Quarters B & C, there appear to be similar open spaces, but with houses on only three sides. Other short transverse streets appear to block the end of a radial street. For example, in Quarters B, C, D, F and G, groups of between 2–5 houses are located across the inner end of a street, perhaps being deliberately located to mark the end of a street, to define the point at which no further houses are built and prevent further incursion into the central open area (Fig. 4.11 lower). The large central part of the site (approximately 65ha) appears to be devoid of any structures or cut features; this may perhaps have been used as a central congregation area but also as a seasonal area for animal husbandry or the corralling of wild horses. Another feature of the Inner Radial Streets is the occasional occurrence of very short or 'failed' streets, streets which were not continued for some reason (Figs. 4.12 upper and 4.13 upper).

4.2.2.5.1 Pits

Small, typically weak, positive magnetic anomalies were detected throughout all parts of the site where houses were detected, as well as in a few small areas where no houses were detected. The anomalies generally measure between 3–4m across and reflect small areas of slightly enhanced magnetic susceptibility. They were initially interpreted as soil-filled pits – an idea subsequently confirmed by excavation. Over 850 of these features have been identified at Nebelivka; investigation of a sample of pits has indicated that they contained highly organic deposits, some with little cultural material and others with large quantities of animal bone, pottery and figurines (Chapman & Gaydarska 2016). The majority of these pits are associated with dwelling houses and are located outside one end of a house (Fig. 4.12 lower).

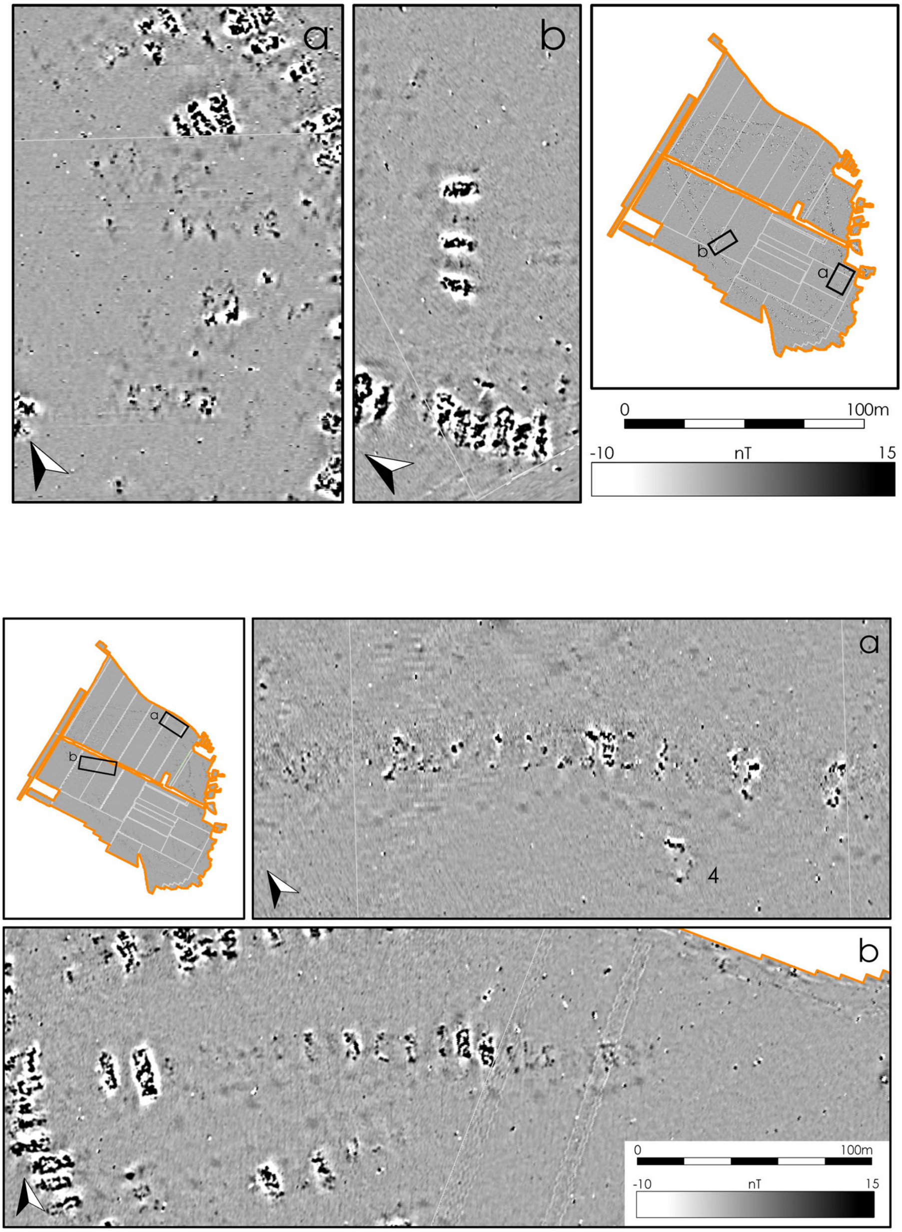


Figure 4.12: Upper: blocking streets; lower: poorly burnt dwelling houses and pits, Nebelivka (by J. Watson).

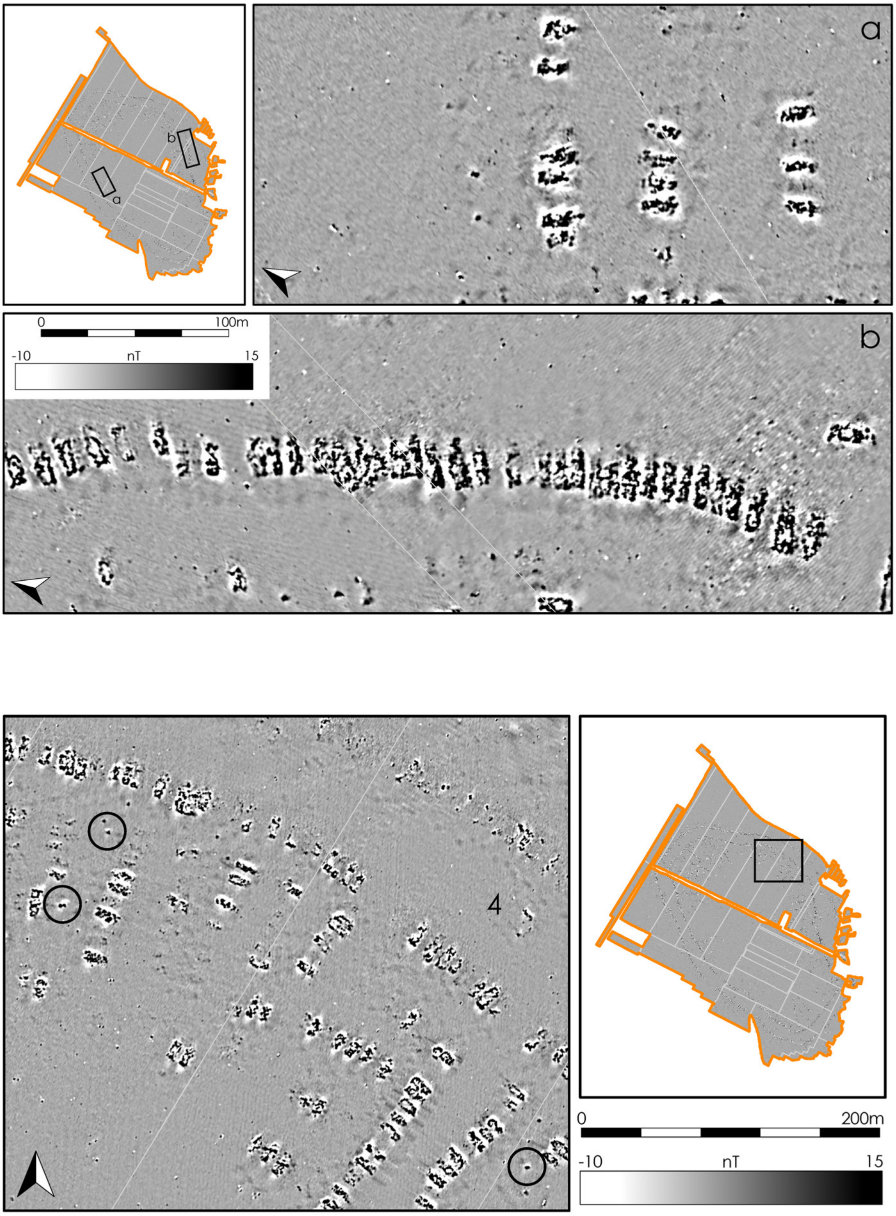


Figure 4.13: Upper: linear pits and short inner radial streets; lower: strong anomalies possibly representing 'kilns', Nebelivka (by J. Watson).

The placement of pits either outside or inside the house circuits varies by Quarter and even by Neighbourhood in some places. For example, in Quarter B, the pits associated with the outer circuit of houses are located on the outside of the circuit, whereas, in the adjacent Quarters C and D, the pits are located by the gable ends inside the circuit. Where two parallel rows of houses extend radially towards the centre of the site, the associated pits are typically located on the outer side of the house rows, thus leaving an uninterrupted space between the two house rows, perhaps for procession (for example, Quarter H; Fig. 4.12 lower). Conversely, in the apparent house Squares in Quarter N, the pits are generally located within the squares rather than outside.

In places where the houses are very close to one another, in both the circuits and the radial streets, the pits appear to overlap or merge, appearing to form 'linear' pits (Fig. 4.13 upper). Similar features have also been detected at Taljanki, Majdanetske and Dobrovodi. In some instances, the linear pits extended around the sides of houses. Investigation of one such feature at Nebelivka in 2013 revealed part of the feature to be a linear pit and part of it to be a layer of cultural material (Chapman et al. 2014b).

It is believed that the pits were originally excavated to provide clay for use in house construction. In some parts of the site, however, there are groups or lines of probable pits which do not appear to be associated with houses. It seems plausible that clay extracted from these pits was for use in pottery production; such groups of pits could therefore indicate the areas where pottery was being made. In the East of the site, there appear to be pit groups in Quarters L, N and A; other groups of pits have been detected in Quarters F through to I in the West. Future investigations may identify kilns in those areas, though they do not currently correspond to the sample of possible kiln sites below.

4.2.2.5.2 Kilns

Given the quantities of pottery found on megasites, it was anticipated that pottery kilns would be present on site. There are many small strong geomagnetic anomalies which could potentially reflect the remains of such features. However, using a combination of criteria including size, orientation of anomaly, strength of anomaly and location, none of the geomagnetic anomalies at Nebelivka appeared entirely consistent with what might be expected of a well-preserved kiln. Many of the anomalies could nevertheless reflect small fired structures or the remains of such features. Several possible kilns were therefore identified and selected as targets for intrusive investigation in 2014 (Fig. 4.13 lower). Although they did not appear to be surrounded by concentrations of fired debris, as might be expected of a kiln, the anomalies could still reflect small ovens or hearths and were considered worthy of further investigation. Though distributed around the megasite, an increased frequency of possible kilns was noted in Quarter H.

Three anomalies were targeted by the Ukrainian team in 2014 (Fig. 4.13 lower). The first two (in Quarter D) were reported as 'modern features with numerous iron items' (Burdo & Videiko 2016), which had given rise to the strong magnetic anomalies. However, the third target (in Quarter C) proved to be a fired structure. This was interpreted as the remains of a pottery kiln by the Ukrainian team (*ibid.*) and as a communal cooking feature by the Durham team (John Chapman, pers. comm.). The structure comprised a 2 × 2m clay platform with four low walls creating three channels or flues (see below, Chapter 4.7.4 & Fig. 4.58). The structure was located at the end of a very short radial street. Other three-channel fired structures of somewhat different design, interpreted as pottery kilns, have been found at Majdanetske and Taljanki (Korvin-Piotrovskiy et al. 2016).

4.2.2.6 Features Outside the Outer Circuit

Of the 78 structures identified outside the outer circuit of houses, eight have been interpreted as Assembly Houses; these are generally located in the West of the megasite between Quarter F in the North-west and Quarter L in the South. A few of the other structures appear to be larger than the average house, many are similar in size to the average house and many more are particularly small features but detected as quite strong magnetic anomalies (Fig. 4.14 upper). The latter anomalies are most apparent in the South of the site, in Quarters J to L; several similar features were also detected inside the inner circuit in Quarter K (Fig. 4.14 lower). Whilst these features are considerably smaller than typical dwelling houses, they appear to comprise similar burnt daub and could perhaps be small workshops or sheds, perhaps storage structures for construction materials such as withies, reeds or chaff (see Section 6.2), or indeed they may have had many other varied functions. There are slight indications in the survey of many more possibly similar small features, represented by very weak magnetic anomalies. Indeed there are a great many extremely weak positive magnetic anomalies between the outer house circuit and the perimeter ditch (Fig. 4.14 upper). These anomalies have been detected around much of the outer space and reflect areas of slightly enhanced magnetic susceptibility, almost certainly variation in the soil as opposed to burnt or fired materials, and could be associated with garden features such as beds and paths.

4.2.2.6.1 Palaeo-Channels

Three probable palaeo-channels have been identified in the magnetometer survey; these are natural former stream beds, detected as weak curvilinear positive magnetic anomalies. One of the palaeo-channels in the South of the megasite corresponds to a topographic feature observed on the ground, which extends Southwards into a narrow wooded ravine (Fig. 4.14 lower). This channel forms the boundary between

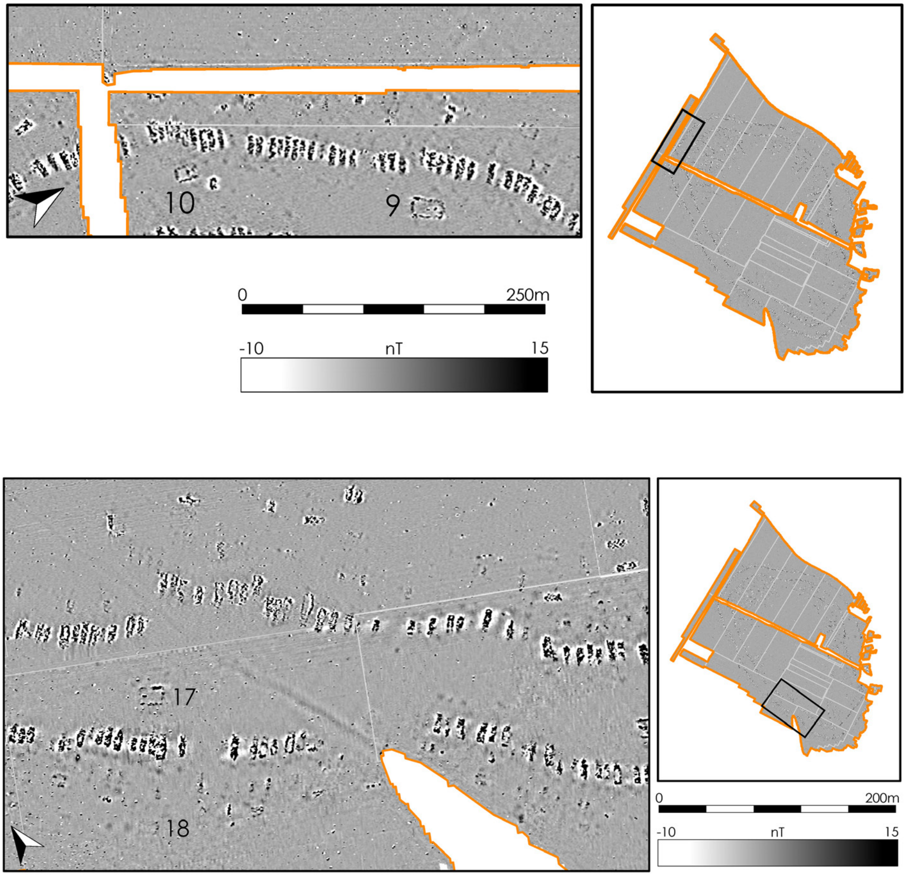


Figure 4.14: Upper: anomalies outside the Northern end of the megasite; lower: main palaeo-channel with kinks in house circuits, Nebelivka: numbers refer to Assembly Houses (by J. Watson).

Quarters J–K. In the geophysical survey, the linear positive magnetic anomaly measures approximately 5m in width, at its widest, and has been detected for just over 400m within the site, extending through both house circuits and into the interior space. The locations of the buildings close to the channel indicate that it was a significant landscape feature at the time of the megasite; however, it is not currently known if the stream was an active water source at that time. On the Eastern side of the palaeo-channel, both the inner and outer house circuits appear to be diverted slightly Northward, to avoid the hollow and accommodate more buildings, rather than simply continuing on their alignment and stopping at the edge of the hollow.

Further probable palaeo-channels have been detected in the South-East of the site (taken as the boundary between Quarters L–M) and to the West, outside the perimeter ditch in Quarter I. A similar soil-filled feature detected to the North of the megasite beyond Quarter F could reflect another palaeo-channel or ditch. These features are all similar in nature and measure up to approximately 4m in width.

4.2.2.7 Summary

The Nebelivka plan is a classic example of cumulative, local decision-making leading to an emergent, regular layout which conforms to recognisable planning principles. Substantial variations can be found in Neighbourhoods and Quarters, the Inner and Outer Circuits, the inner radial streets and the width between the Outer and Inner Circuits, leading to the conclusion that there was a prevalence of bottom-up decision-making based on local groups of people. A key, presumably early, construction was the digging of the perimeter causewayed ditch, defining 'inside' from 'outside' rather than acting as a defensive barrier, providing two main entrances and with the positioning of the causeways often linked to gaps between Neighbourhoods in the Outer Circuit. It is surely significant that the proportion of burnt houses in the Outer and Inner Circuits was much higher than that of the inner radial streets. It is also interesting that one of the newly discovered plan elements – the Assembly House – was not only constructed in a different way from dwelling houses but also was itself differentiated into the larger buildings located between the Circuits and smaller structures built outside the Outer Circuit. The open inner space has been identified as a positive space for congregation – retained as central to Trypillia culture – rather than only as a negative space lacking structures and therefore abandoned to nature (animals – even wild horses!).

Duncan Hale, John Chapman, Bisserka Gaydarska, Marco Nebbia & Brian Buchanan

4.3 Architectural Analyses

Duncan Hale, John Chapman, Bisserka Gaydarska & Marco Nebbia

4.3.1 House Size Analysis

The analysis of house sizes based on the interpreted geophysics plan was initiated by Duncan Hale (see above, Chapter 4.2). Because of the uncertainty of the dimensions of the unburnt and possibly burnt houses (coded 'green' and 'purple') (Fig. 4.4), Hale restricted his CAD-based measurements to burnt houses (coded 'red'), considering a sample of 36 houses in each of two Quarters (Quarters G and L). In the second analysis, we measured all the burnt houses, which limited the sample size to 1,077 out of a possible 1,445 houses (for the full table of house sizes, see https://

doi.org/10.5284/1047599, Section 4.6). We do not consider the analysis of the total group of burnt houses useful in our understanding of the development of Nebelivka in the sense that there is a very low probability – approaching zero – of all of the houses in coeval use. Nonetheless, since the measurements of the burnt houses at Nebelivka constitute one of the largest samples of house dimensions, the analysis has some comparative value. It is our view, however, that house size analyses at the Neighbourhood or Quarter level is more meaningful.

The analyses were conducted in three ways: (a) a length by width bivariate plot (Fig. 4.15/1); (b) histograms of house area using ranges of 10m^2 for the total sample (e.g., 15–25m^2; 26–35m^2; 36–45m^2, etc.) and ranges of 20m^2 for Quarters and Neighbourhoods (e.g., 15–35m^2; 36–55m^2, etc.) (Fig. 4.15/2–3 & 4.16); and (c) a GINI co-efficient analysis of house sizes by Quarter (Table 4.4). A trial analysis of the second method using slightly different ranges (viz. 10–20m^2, 21–30m^2, etc.) produced almost identical results, confirming the robustness of the results.

4.3.1.1 The Total Sample

The bivariate plot of the sizes of all the burnt houses produced a clear central cluster with outliers in all directions (Fig. 4.15/1). The trendline of this distribution showed a typical length of 7.5m for a width of 4m (a L:W ratio of 1:2), with 15m lengths for 5m-wide houses (a ratio of 3:1) and lengths of 23m for 6m-wide houses (a ratio of 4:1). This shows that Nebelivka houses tended to add ‘modules’ of 7.5m of length for each metre of increased width. However, it is important to note that these are only general trends. The total variation in length for 4m-wide houses is 7m–18m, with 7m–19m for 5m-wide houses and 10m–24m for 6m-wide houses. Any increase in house width would result in a directly proportional increase in the height of the house; a design choice for a more monumental, higher house would have been predicated on selecting a wider house. Needless to say, the reasons underlying individual house sizes are complex, requiring much further discussion (see below, pp. 151–155, 417–418, 422).

The plot of the sizes of all burnt houses approximates to a Gaussian distribution with a unimodal peak of 56–65m^2 house area (Fig. 4.15/2). This continuous distribution shows the difficulty of dividing houses into different categories of house sizes (viz., ‘large’, ‘medium’ and ‘small’), with the exception of structures with an area smaller than 20m^2, which we have interpreted as ‘huts’, ‘sheds’ or ‘workshops’ – probably not for residential use in the general sense of ‘houses’[47].

47 It should be noted that structures of 20m^2 were frequent in the West Balkans in the 4th millennium BC, where they have been considered as ‘houses’ (Chapman, in prep.).

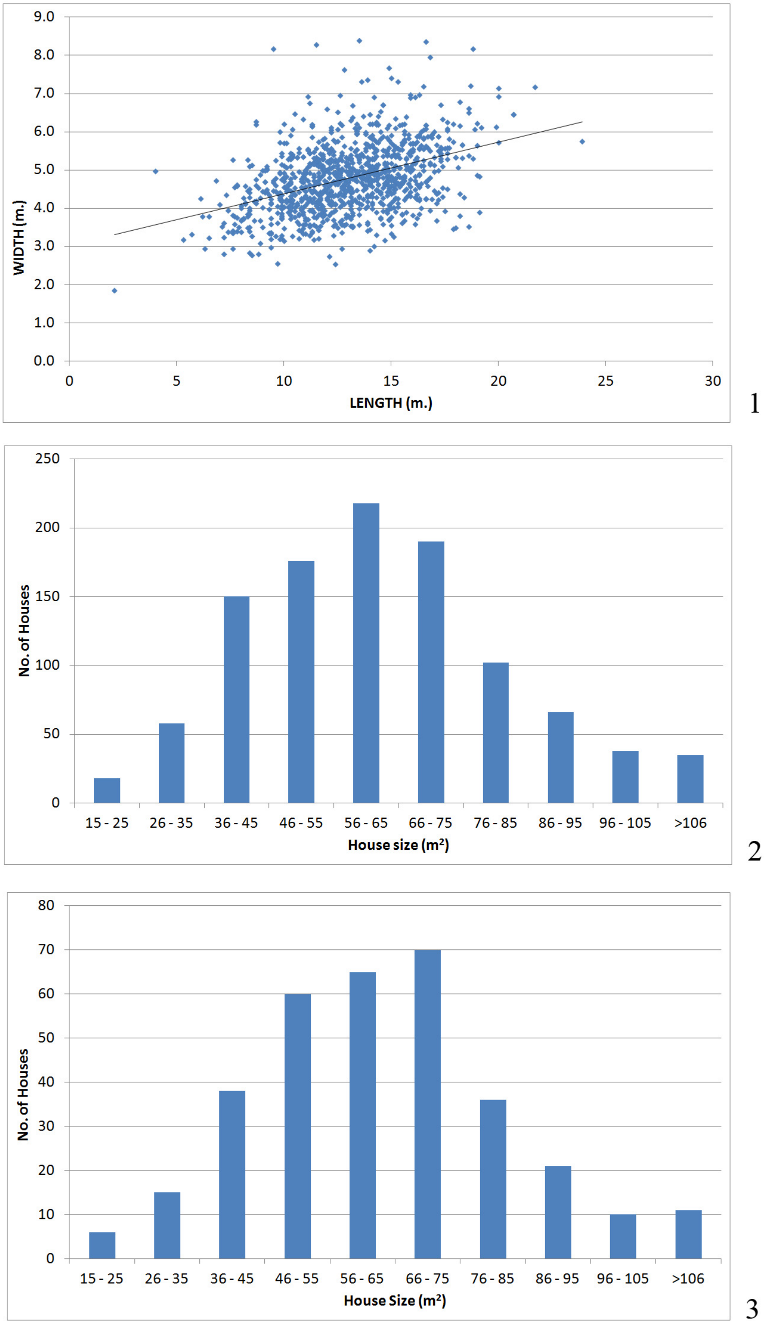


Figure 4.15: (1) bivariate plot of house sizes; (2) histogram of all house sizes; (3) house sizes by Outer Zone, Nebelivka (by J. Chapman).

4.3.1.2 The Zonal Analysis

For a more detailed analysis, the Nebelivka plan was divided into three Zones – an outer Zone (including the Outer Circuit and houses outside the Outer Circuit); the middle Zone (the Inner Circuit and houses between the Inner and Outer Circuits); and the inner Zone (all houses inside the Inner Circuit). There were more differences between the Outer Zone and the other Zones than between the Middle and Inner Zones. The main difference was that the Outer part's size peak of 66–75m^2 (Fig. 4.15/3) was higher by one 10m^2 range than in the other Zones. The Inner part differed from the other Zones through the higher frequency of houses of area 36–45m^2. There was a steeper drop in large houses in the Outer Zone, after 75m^2, than in the other Zones. These variations indicate differences in the cumulative development of the three Zones which require further discussion at a more detailed level.

4.3.1.3 The Sector Analysis

The further subdivision of the Nebelivka plan into more defined areas brings further clarity to the overall pattern. Outside the Outer Circuit ('OOC'), the 17 burnt houses were typically small structures, with a size peak of 26–35m^2 (Fig. 4.16/1) – the joint smallest, with the houses between the Inner and Outer Circuits (n=6), of all sectors. Both these sectors had a narrow size range, with only one house in the OOC larger than 85m^2 – a massive 143m^2 structure that may well have been an Assembly House. The cross-streets ('XS') which potentially blocked radial streets showed a double size peak, at 36–45m^2 and 56–65m^2 (Fig. 4.16/2), while the houses in the Squares showed an intermediate peak of 46–55m^2 (Fig. 4.16/3). With the exception of the Outer Circuit houses ('OC'), with their size peak of 66–75m^2, all of the other main sectors, as well as houses inside the Inner Circuit ('IIC'), conformed to the total sample size peak of 56–65m^2. These more detailed analyses confirmed the mean size differences between the Outer, Medium and Inner parts but more detail shows the tendency of most houses outside the main three plan elements – the Outer and Inner Circuits ('IC') and the Radial Streets ('RS') – to be built as smaller structures. This was particularly the case in the OOC and IC–OC sectors, suggesting different functions and meanings for houses in these sectors.

4.3.1.4 The Analysis of the Quarters

The calculation of GINI co-efficients for a data series such as house sizes provides information on intra-group differences often explained through inequality (Kohler et al. 2017). These co-efficients have been calculated for house sizes by Quarter (Fig. 4.18/3 and Table 4.4). The results show that, while the majority of Quarters built houses of a size that was very similar to that of the overall site average, Quarters in the Southern half of the megasite showed greater house size diversity, with a resulting

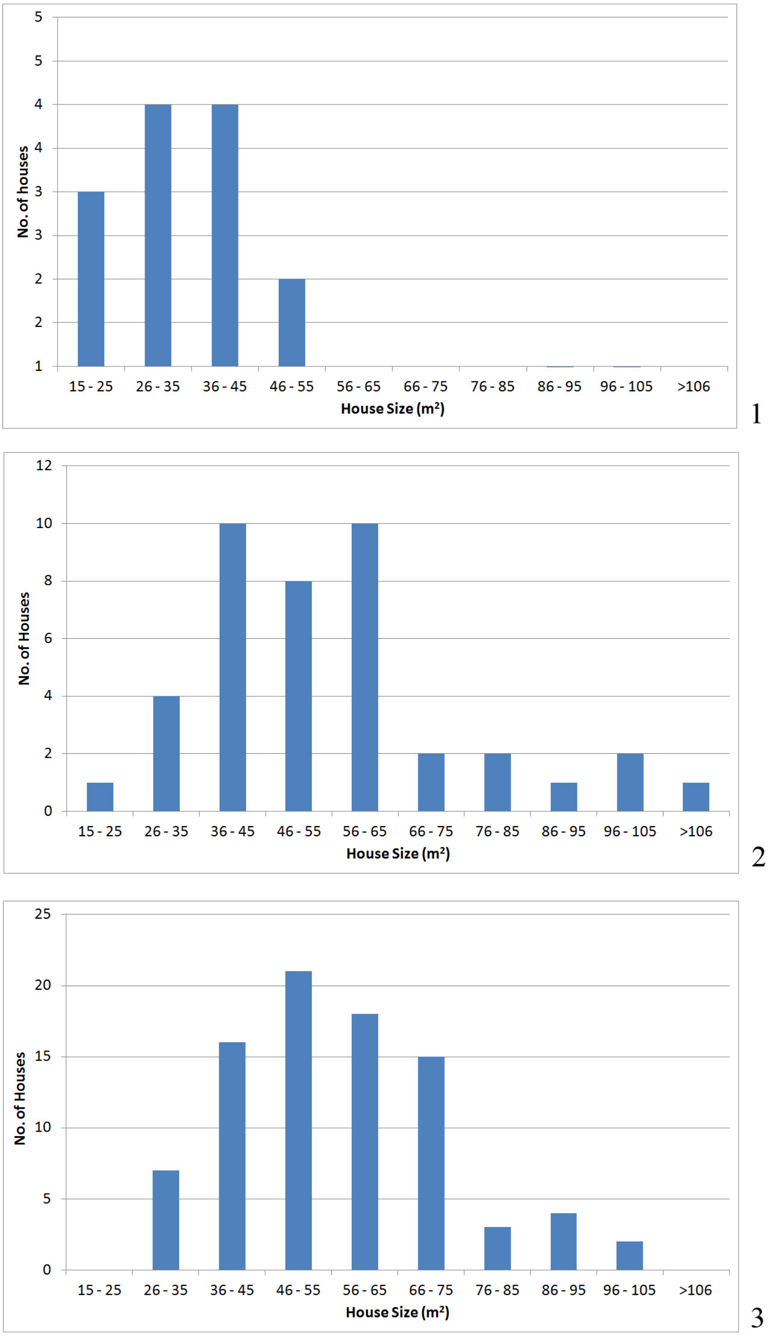


Figure 4.16: (1) house sizes outside the Outer Circuit; (2) house sizes in cross streets; (3) house sizes in Squares, Nebelivka (by J. Chapman).

increase in 'inequality'. This in turn suggests that groups within Nebelivka were trying to create and re-create similar visual architecture all over the site – as the growth of an architectural habitus or even part of the ‘Big Other’. The overall result is a picture which, overall, supports egalitarian tendencies at this megasite, while confirming some Quarters built houses larger than others.

Table 4.4: GINI Co-efficients for House Size by Quarters (by M. Nebbia).

Quarter	GINI	No of Dwellings	Area	Density
A	0.2700198	58	122016.9	2103.74
B	0.2444237	146	218093.7	1493.792
C	0.1906812	101	115849.8	1147.028
D	0.196473	104	102904.2	989.4635
E	0.179496	50	53401.83	1068.037
F	0.2172476	151	138439.9	916.8205
G	0.1703885	147	139005.3	945.6143
H	0.2211206	106	146844.7	1385.327
I	0.2180508	104	139008.2	1336.617
J	0.2438355	54	79303.9	1468.591
K	0.3010071	118	155454.8	1317.414
L	0.2531448	121	163780.4	1353.557
M	0.2708698	60	63444.85	1057.414
N	0.2389944	113	166724.8	1475.441
Nebelivka	0.2340455	1433	238000	166.0851

4.3.1.5 The Analysis of House Sizes in Neighbourhoods

Since the measurement of house sizes included only burnt houses, the number of Neighbourhoods with appropriate sample sizes fell to 105; the smallest number of Neighbourhoods in a Quarter was six (Quarter M), while there were 18 Neighbourhoods in Quarter N. The most obvious conclusion is the massive variability of individual Neighbourhoods – there are no two Neighbourhoods that are similar in terms of house size. This result merely emphasises the already formulated conclusion (see above, p. 148) that Neighbourhoods were developed from the bottom up through myriad decisions about what and where to build new houses. Although these dynamics were mainly rooted in the local rather than the global, we can recognise common patterns in the range of house sizes found in Neighbourhoods in different Quarters, suggesting shared responses to those local dynamics. The analyses focussed on two aspects of the complex data: (a) the maximum size class in a Neighbourhood[48]; and (b) the mean breadth of size classes in a Neighbourhood[49].

The maximum class sizes fall into two groups: a larger group where Class 3 is dominant (11 Quarters) and a smaller group where Class 3 is equal to, or less frequent than, other size classes (Quarters A, I and N) (Fig. 4.17/1). The larger group is divided into three sub-groups: those with Class 4 but no Class 5 (Quarters C, F, H, J, K and M) (Fig. 4.17/2); those with Classes 4 and 5 (Quarters B, G and L) (Fig. 4.17/3); and those with neither Class 4 nor 5 (Quarters D and E). The dynamics of choice of house size are complex but it may be suggested that Neighbourhoods with a dominance of Class 4 or 5 houses betoken a greater sense of size-based emulation or competition than in other groups, reinforcing the number of residents living in such large houses.

Scores for the mean breadth of size classes varied between 2.5 to 4.5, with low scores indicating a narrow range of house sizes and high scores a wide range (Fig. 4.18/1). These mean breadth scores can be arranged in ascending order (lower group with 2.5–3.4: Quarter G–C /A–I–F–E–H / N; upper group with 3.5–4.5: Quarter L–K–B–D / J–M). It is worth noting that two of the three Quarters with the highest mean breadth scores (J and M) also have the smallest number of Neighbourhoods. There is a general correlation between Quarters with higher maximum house sizes and those with higher mean breadth scores.

Several patterns are apparent which link the size breadth trends of different Quarters. The least common pattern is the spread of size classes 1 to 2 or 1 to 3 – found in only four out of 14 Quarters. In the opposite direction, the spread of size classes 1 to 4 or 1 to 5 occurs in all but one Quarter, as is also the case with size classes 2 to 4 or 2 to 5 (Fig. 4.18/2). The presence of all size classes in a Neighbourhood shows that the maximum potential for size differentiation has been acted upon and selected, with all the implications for acquisition of building resources and, eventually, firewood for a successful burning. The decision not to enlarge the breadth of existing size classes was taken so regularly that we can assume that size differentiation was considered a positive, if not standard, feature of Nebelivka Neighbourhoods.

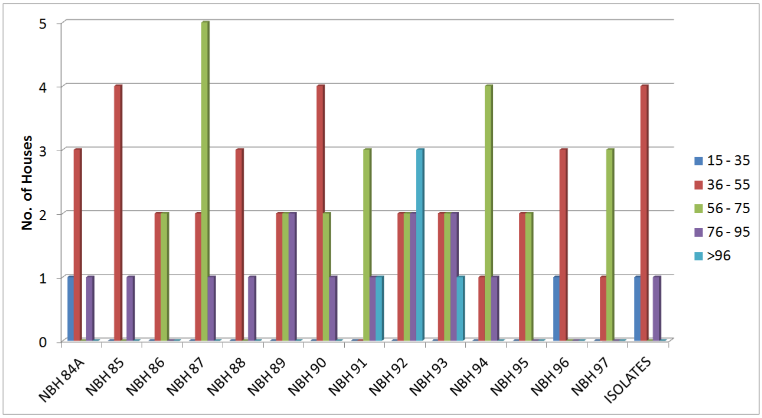
48 Five size classes were distinguished: Class 1: 15–35m^2; Class 2: 36–55m^2; Class 3: 56–75m^2; Class 4: 76–95m^2; and Class 5: >96m^2.

49 Mean breadth of size classes was measured as follows: a score was assigned to each Neighbourhood (1 point for 1 size class; 2 points for a size range of 2 classes, etc.) and the total divided by the number of Neighbourhoods.

4.3.1.6 Summary

The analysis of Nebelivka burnt house sizes shows a clear overall trendline with a core module of 7.5m in length and 4m in width and successive 1m increases in width producing 7.5m increases in length. However, it is important to note that these are only general trends and the range of house lengths for a 4m width is 7m–18m, for a 5m width 7m–19m and for a 6m width 10m–24m. Different house widths have important implications for the design of roofing and the materials used. The mean house area for all burnt houses is 63m^2, similar to that for Dobrovodi (64m^2) and slightly smaller than for Majdanetske (67m^2) and Taljanki (71m^2). The house size plots show a unimodal peak (56–65m^2), with a continuous distribution that makes it hard to divide houses into 'small', 'medium' and 'large' classes. The analysis of house size by Zones shows an important trend towards larger houses built in one of the three main plan Zones (Outer and Inner Circuit, Inner Radial Streets) and smaller houses built outside these Zones, especially outside the Outer Circuit and between the Outer and Inner Circuit. The GINI Co-efficient analysis of house size by Quarters shows how the GINI value of most Quarters lies close to the mean value for the whole megasite, suggesting an attempt to reproduce visually similar living zones wherever people settled at Nebelivka (Fig. 4.18/3)[50]. Looking at the variability of house sizes by Neighbourhoods within Quarters re-emphasised the importance of the bottom-up principle of building Neighbourhoods all over Nebelivka. Nonetheless, some of the patterns of the mean breadth of house sizes by Neighbourhood were found in most of the Quarters, suggesting tendencies wider than the local group were in action. Moreover, there was a general appreciation of house size differentiation within Neighbourhoods, as measured by the breadth of size classes. The conclusion from all of these house size analyses is that the cumulative effect of many local decisions was a complex, varied settlement plan formed through the tension between general principles of house size and local initiatives.

50 Minor differences in the totals of houses by Quarter found between Tables 4.1 and 4.4 are explained by the fact that only complete houses could be measured for the GINI calculations.



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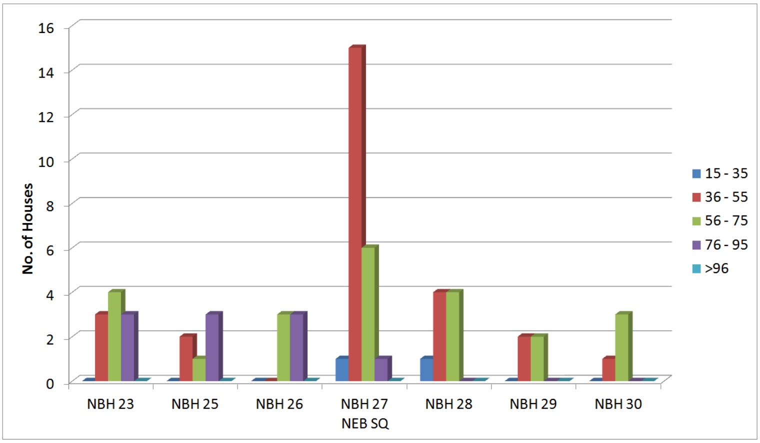

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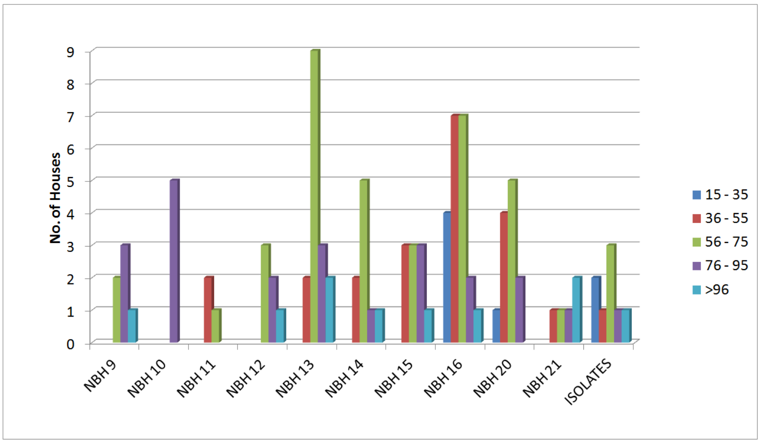

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Figure 4.17: Maximum class sizes by Quarter; (1) Class 3 equal to, or fewer than, other size Classes; (2) Class 3 dominant, with Class 4 but no Class 5; (3) Class 3 dominant, with Classes 4 and 5, Nebelivka (by J. Chapman).

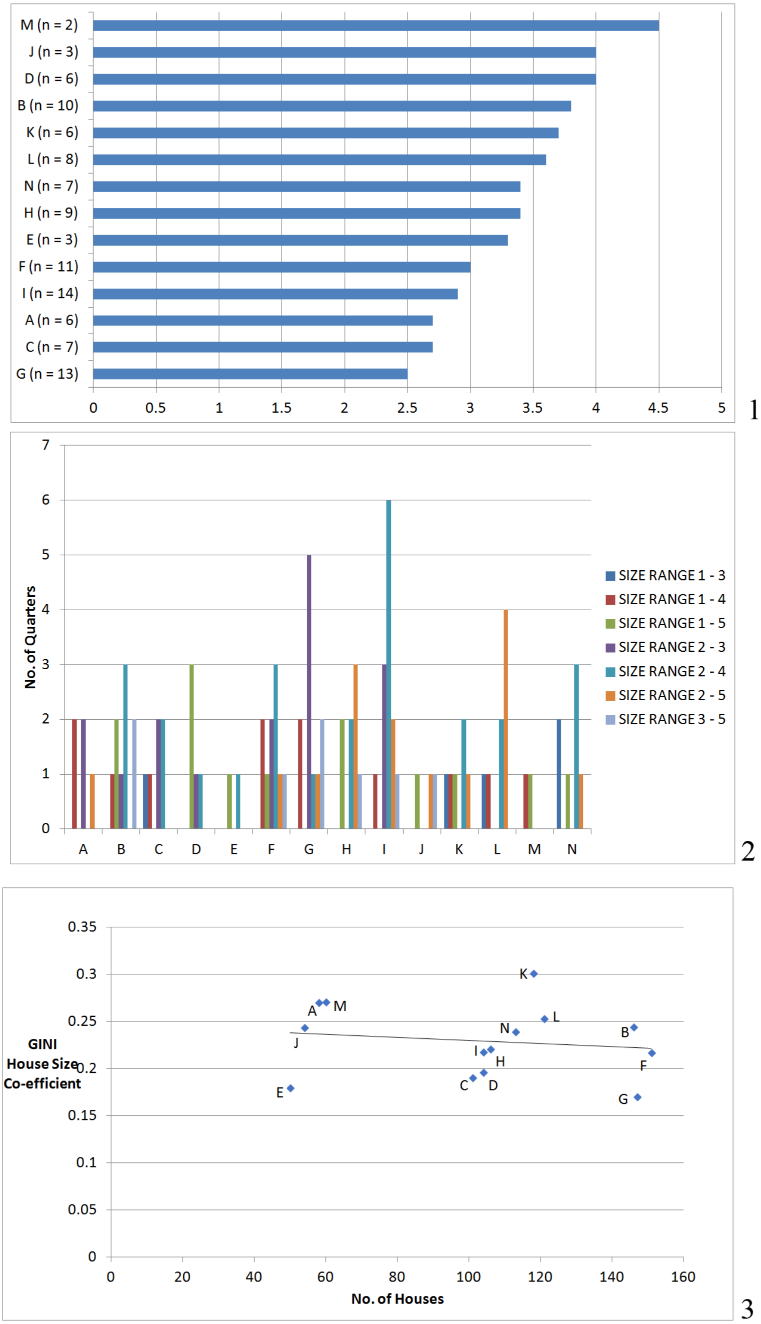

Figure 4.18: (1) mean breadth of all house size classes; (2) spread of house size classes; (3) No. of houses vs. GINI House Size Co-efficient plot by Quarters, Nebelivka ((1) & (2) by J. Chapman; (3) by M. Nebbia).

Brian Buchanan

4.3.2 Visibility Graph Analysis

4.3.2.1 Introduction

The high-precision geophysical plan of Nebelivka provides a distinctive dataset to analyse the origin and formation of a Trypillia megasite in a wider context. This complete plan details the organisation of the structures of the site over its lifetime of use as a gathering place. The plan presents a unique opportunity to analyse the entirety of a Trypilia megasite's structural organisation to improve our understanding of the development and use of this type of site and to investigate spatial developments within smaller Quarters or in different models of site development (Burdo and Videiko 2016; Chapman et al. 2014a; Chapman and Gaydarska 2016). An innovative use of Visibility Graph Analysis (VGA) allowed the investigation of the geophysical plans and the visual characteristics of the spaces and places of Nebelivka to gain insights into the structuring organisational principles at different time periods. VGA investigates the visual characteristics of a built environment by combining aspects of visibility fields (Benedikt's *isovist*), space syntax theory, and small-world network approaches to "(…) derive a visibility graph of an environment – the graph of mutually visible locations in a spatial layout" (Turner et al. 2001, p. 104). This technique has increasingly been used in archaeological contexts and provides a unique method to interrogate the complexities of Nebelivka's plan.

The groups that inhabited or interacted with Nebelivka over its lifetime may have perceived 'empty' space (the areas of the site between built forms) differently owing to a variety of social, environmental, and cultural factors. The basic premise of why VGA was used is that the more visually integrated parts of a built environment (the 'empty space') have greater chances of attracting human movement and activities, and it is an application that can quantify these areas and compare if there were significant differences in the overall plan of Nebelivka or in the models of development (Turner 2003). The VGA adaptation employed here differs from the original use of the technique, which is focused on understanding human movement based on visibility fields within interior architectural space (Turner et al. 2001; Turner 2001). Instead, VGA expands the method beyond the interior of houses to the intra-site level to improve our understanding of the visual characteristics of Nebelivka's overall built environment, constituting dwelling houses, smaller structures (huts), Assembly Houses and broad, but related, open spaces. This chapter discusses the scholarly background of intra-site analyses of the built environment and how VGA was used at the site before turning to the results.

4.3.2.2 The Built Environment

Space and *place* are important concepts for considering archaeological communities, as the spatial organisation of these terms reflect how groups of individuals interact with and move through their local and regional environments. These somewhat abstract terms have become critical areas of study across the humanities and social sciences and refer, at a basic level, to where something is located (a place) and where something is not (a space). These concepts are interrelated and they tend to define one another, with the more abstract spaces often demarcated and defined by their relationship to places (Tilley 1994; on the transformation of space into place, see Chapman 1988a). Examples include the empty areas between walls or buildings at a small scale or the vacant regions between settlements, cities, or states at larger scales. Together, space and place comprise the *built environment*: the cultural alterations to the natural environment where human practice and events take place. Although the duality of space and place as noted above has been disputed (for example Ingold, 2009, p. 38), there is broad agreement on the importance of the built environment by social scientists due to its influences on social groups' behaviours and practices while at the same time its reflection of the socio-cultural norms of societies (Agnew 2011; Fisher 2009; Gieryn 2000; Goodchild & Janelle 2010; Hillier 2014; Hillier & Hanson 1984; Ingold 2009, 1993; Lawrence & Low 1990; Tuan 1977). Archaeologists have long been attracted to many of these approaches and their focus on the physical effects of walls, ditches, structures and monuments on individuals' perceptions, movements, and activities at the household, settlement, and landscape levels of analysis (Allison 1999; Aslan 2006; Delle 1998; Ferguson, L. 2012, Ferguson, T. 1996; Flannery 1976; Hastorf 1991; Steadman 1996; Tringham and Krstić 1990; Wilk and Rathje 1982).

The built environment structures day-to-day interactions within and between cultural groups in socially-specific ways. Edward Hall's notion of *proxemics* argues that individuals' interactions with spaces and places are specialised and dependent on social group membership (Hall 1966) – an idea that has influenced much of the scholarship examining the relationship between spaces and places within the built environment. This idea allows an understanding not only of the development of the built environment but also its alterations due to continual use by ever-changing social interactions. Amos Rapoport built on these ideas, arguing that individuals' interactions and use of space within the built environment are linked to how people understand the social meaning, cues, and conditions of the constructed world (Rapoport 1982). His cognitive congruence model demonstrates that the organisation and usage of the built environment reflects the social norms and practices of cultural groups (Rapoport 1982, pp. 287–289). Thus, people arrange and alter their environment according to their specific shared social memories, norms, and practices as well as making changes and alterations to these places based on changing normative frameworks. Based on these ideas, the organisation and development of the built environments at Trypillia sites can be thought of as a form of non-verbal communication that was inherently understood by members of the social group(s) that utilised these settlements. Therefore, a study that quantifiably addresses the built environment of Nebelivka can produce better understandings of social interactions and cultural norms.

One of the more popular as well as practical methodological frameworks for accessing the built environment was Bill Hillier and Julienne Hanson's space syntax theory. Space syntax argues that there are underlying rules to the built environment related to patterns of movement or practice, and these rules can be mapped and understood (Hillier & Hanson 1984). It quantitatively investigates the configurational properties of the built environment using a variety of techniques that identify how humans proceed through and process the complexities of the built environment (Hillier 2005, p. 5). Originally designed to improve understanding of urban planning and development, space syntax has evolved and been utilised by a variety of disciplines. It has appealed to archaeologists working on past built environments, and it has been used to better understand differential zones within structures and settlements as reflecting distinctive activities, norms, and statuses within past social groups (Chapman 1990a; Bowser & Patton 2004, p. 170; Deetz 1996; Fairclough 1992; Ferguson, T. 1996; Steadman 1996; Van Nes 2009). The analytical techniques developed by Hillier & Hanson have arguably been accepted more by archaeologists than the theoretical underpinnings of space syntax theory. T.J. Ferguson (1996), for example, used the access and axial maps proposed by space syntax theory to examine historic-period Zuni architecture in the American South-West. Although he argued that the techniques were a valuable analytical tool, he noted that the theoretical models of space syntax needed to be adjusted for archaeological research needs (Ferguson, T. 1996, p. 152). In addition, although space syntax theory has been an extremely useful methodological framework for investigating the archaeological built environment it is a time-intensive technique to both prepare the hand-drawn access and axial maps correctly and to interpret the results of these processes.

4.3.2.3 Computational Approaches to Space and Place

Arguably the most significant innovation for investigating the built environment over the last twenty years has been the integration of spatial analysis in Geographic Information Systems (GIS) with archaeological datasets. GIS has the unique abilities of combining highly accurate cartographic map layers, detailed databases and powerful analytical tools for the investigation of the spatial world (Conolly & Lake 2006). As Wheatley has noted, the integration of GIS into archaeological investigations has provided a 'meaningful archaeology of place' due to its powerful computing abilities and high accuracy (Wheatley 2004). One of the GIS techniques that has received a relatively large amount of attention is visibility, or viewshed analysis (see Brughmans et al. 2015; Conolly & Lake 2006; Gaydarska 2007; Gillings 2017, 2015; Llobera 2003; Llobera et al. 2010; Wheatley & Gillings 2002). Viewshed analysis interpolates digital elevation models into ground surfaces and, based on elevation surface changes affecting line of sight, models what is visible from any given point. This technique has revolutionised landscape studies and reinforced the importance of intervisibility between sites and/or monuments for understanding past cultural practice (Gillings 2017, 2015; Wheatley & Gillings, 2002).

In general, viewshed analysis has investigated intervisibility between sites or monuments across broad areas of the landscape instead of assessing visibility within archaeological sites. Although a powerful tool for investigating viewsheds in the landscape, this technique is not suitable for investigating the visual characteristics within the built environment of structures or settlements. It is preferable, therefore, to use VGA, which combines aspects of viewshed analysis, space syntax analytical frameworks, and social theory for analyses of visibility fields and their effects on movement within the built environment of households and settlements. VGA models the intervisible connections between grid points of a graphical plan of the built environment. As structural forms alter visual perceptions of a place, VGA can model visual fields that alter movement and practice (Buchanan 2017; Turner et al. 2001; Turner 2004). VGA charts the most and least visible areas of a graphical representation of a household or settlement, using a combination of concepts derived from Hillier and Hanson's space syntax theory with the graphical representations of visibility fields in architectural space which are known as *isovists* (Benedikt 1979; Turner et al. 2001). Originally introduced by Braaksma and Cook (Braaksma & Cook 1980), VGA was refined and redesigned by Alasdair Turner and the Space Syntax Laboratory of University College London in the software package *Depthmap*, which calculates VGA and produces measurements of integration, connectivity, and depth by quantifying the visual connections of grid points within a graph (Turner et al. 2001; Turner & Penn 1999). In effect, it quantifies how space within an environment is culturally demarcated by examining the intervisible connections in a graph.

VGA determines the areas of a graphical plan of a built environment that are the most and least visible to other portions of an area and can see or not see the largest number of other areas. It investigates these areas based on how the structural elements of a built environment impede visibility fields, thereby producing areas of a plan that are more public or more private. These more public or more private areas would have impacted movement and activities practiced within these areas. Whilst natural features such as topography, vegetation and waterways also affect practice, VGA is here considered a useful proxy for understanding how the physical arrangement of structural forms affect individuals' interactions. In addition, this investigation has focused on the archaeological remains identified during the geophysical survey. Undoubtedly there were more ephemeral features of the site such as temporary dwellings or fence-lines that are both more invisible to the geophysics and would have altered perceptions and use of the site. It was felt that a focus on the known and identified features provided a valuable understanding of the social structuring of the site regardless of the more temporary (and unknown) features of the site. Future research could run simulations on these features if and when they are better understood.

Depthmap processes VGA by attempting to connect the vertices, or nodes, within a graph to all of the other visible locations within the graph. It examines the graph node by node and then interprets the results using a variety of measurements (Turner 2001,

p. 3). Every node within a graph has its own unique number of connections to the other nodes, known as a *vertex's Neighbourhood* (Turner 2001, p. 3). The Neighbourhood connections can be analysed using global measurements or local measurements, with global measurements calculating information from all the vertices in the graph and the local measurements using information from the immediate Neighbourhood of a vertex (Turner 2001, p. 4). The analysis at Nebelivka used global measurements, as these were deemed more appropriate for the open spaces of the site (Turner 2004, p. 14). *Depthmap* calculates the above VGA comparisons, and the results are colour-shaded images of the most and least-connected areas of a built environment based on a variety of measurements related to the visual connections of the grid nodes. In addition to the colour-shaded imagery, *Depthmap* provides measurement scores based on ideas from space syntax theory that can be used in comparison between different plans of the built environment (Buchanan 2015, 2017). Turner (2004, pp. 14–15) notes that the integration, entropy, and mean depth scores are the most reliable for analysis, and the connectivity measurements are the best for visualisation of the graphical plans.

VGA has received limited usage within archaeological investigations, with much of the scholarship focusing on the interior architectural space of standing ruins. For example, David Chatford Clark used VGA to investigate the visual integration and spatial relationships of sanctuaries with the broader assembly places of Byzantine-era churches in present-day Jordan, demonstrating that the churches reinforced visual and spatial separation between the clergy and the masses related to different roles and interactions in the services (Chatford Clark 2007). Archaeologists have more recently adapted this methodology to investigate the spatial organisation of archaeological settlements and grave plans (Brookes et al. 2017; Buchanan 2017, 2015). This adapted methodology has increasingly been used in archaeological research and focused on how the built environment was spatially and visually organised, and as such provides an innovative method to understand the complexities and potential patterns in the organisation of the site. It does so through a quantifiable investigation of the built environment based on the visual and spatial arrangement of structural elements and the interpretation of these findings within a framework of established ideas regarding how individuals perceive and use space and place within their households, their communities, and in the landscape (Buchanan 2015, p. 23).

4.3.2.4 Nebelivka and VGA

The structural plan of Nebelivka has been divided into fourteen Quarters on the basis of eight characteristics of the site (Chapman & Gaydarska 2016; here, Chapter 4.2.1 and Fig. 4.5). The Quarters generally centred on at least one Assembly House that was located within empty areas between two parallel, concentric rings of structures. Within the ring, there were clusters of linearly arranged structures that extended, like spokes of a wheel, into the relatively empty centre of the site. These arrangements created radiating avenues – termed ‘Inner Radial Streets’ – that extended from the Assembly

Houses inwards. The selected boundaries of the Quarters were divided based on the spatial patterning and orientation of the structures as well as the topographical features of the landscape (Chapman & Gaydarska 2016). Ten of the fourteen Quarters were examined using VGA to examine if there were any similarities in different parts of the site in the visual arrangement of the Quarters. Ideally, all of the Quarters would have been surveyed, but due to time and computational constraints a sub-sample was used in the analysis. VGA tested the extent of differences or similarities between the plans of the Quarters. Quarters B, C, D, F, G, H, I, L, M, and N were selected to provide a valid sample size of the spatial patterning of the site. It has been previously argued that the buildings at the site were not all standing at the same time (Chapman & Gaydarska 2016; Gaydarska 2019, 2019a). The lack of overlapping buildings as shown in the geophysical survey plans, therefore, suggests either a physical awareness or social memory of where buildings had previously stood as well as a respect shown to these zones which prevented buildings from disturbing these spaces (Nebbia et al. 2018; Gaydarska 2019). This was somewhat fortuitous for the VGA analysis, for the acknowledgement that all the structures were not standing at one time could be investigated as a proxy for understanding visibility and movement, given the avoidance of previously built-on space.

Six of the Quarters (B, C, F, I, L, and N) were further analysed in VGA using two models of the evolution of the Quarters' plan at three temporal stages of development (Nebbia et al. 2018; Gaydarska 2019). Models A and B were developed to examine the origins of the site and as a way to rationalise the limited material culture found at the site alongside the high number of burnt houses (n=1,445) (Gaydarska 2019). The two models were divided into three stages – Early, Middle and Late – representing time-slices of the life-cycle of the Quarters and denote two competing ideas on how the plan of Nebelivka developed. Model B demonstrates that a small core population permanently lived at the site, and the population grew seasonally due to large assembly gatherings. In contrast, Model A contends there was a larger permanent occupation of around 400 houses at any one time, and seven to ten houses were burnt annually, and the same number were built to create the large plan of burnt houses seen in the geophysics plan (Gaydarska 2019). The identified Quarters ranged in size and composition but had basic similarities in the spatial arrangement of the structural evidence in size, scale, and organisation. The Quarters were divided based on observable differences in the topographic characteristics of each area along with the position and arrangement of the structures (Gaydarska 2019).

VGA was performed to address a few key questions about the visual arrangement of Nebelivka structural evidence, and, more specifically, how this connects with the division of the site into the above-discussed Quarters. First, were the Assembly Houses key to the integration and connectiveness of the Quarters? The large Assembly Houses appear to command a special place within both the concentric ring of houses and within each Quarter, separated from the other structures by large areas of empty space. By testing the Quarter plans using VGA, quantitative results can be reached that can suggest the degree of visual connection of the Assembly Houses to other parts of the Quarter, i.e., by public vs. private space. Secondly, VGA allows us to test if there were significant differences in the organisation of the Quarters using the various models and temporal stages. Similar or significantly different measurements could imply either differences or similarities in how Nebelivka developed over time. Finally, VGA could also be used to examine quantitatively if there were similarities or differences in various parts of the site by providing visual and statistical evidence to test many of the observations that have previously been made on the structural evidence (Chapman et al. 2014a; Chapman & Gaydarska 2016).

4.3.2.5 Methodology

The steps required to accurately run *Depthmap* to assess Nebelivka's built environment amounted to a lengthy and involved process. The geo-rectified geophysical survey plans of Nebelivka's Quarters were converted from digitised, GIS shapefiles into AutoDesk drawing exchange format (.dxf) files and then imported into *Depthmap*. These files preserved the scale, shape, and orientation of Nebelivka's structural forms. Each Quarter was examined with all of the known buildings present and with reduced numbers within the models and stages. In addition, the proposed Quarter boundaries were imported into *Depthmap*. Once a Quarter was fully imported into *Depthmap*, a rectilinear grid was overlaid on the entirety of the Quarter plan. The grid was overlain on the imported files at a defined interval of 2m. This interval allowed a fine resolution of VGA outputs, accurate results, and a satisfactory processing speed. A flood-fill algorithmic command filled all of the space within the Quarter that were not within one of the structures from the plan. The now filled grid plan was used to calculate VGA connections from each part of the Quarter based on visibility (Turner 2004, p. 1). Every grid node within the graph has a unique number of connections to the other nodes, which are then displayed using a colour-range from indigo for low values through magenta for high integration values (Turner 2001, p. 3). Global measurement averages of these connections were produced using calculations derived from space syntax. All of the global measurement averages were recorded (Fig. 4.21/1 & Table 4.6). However, the analysis focussed on three categories as they have been shown to be the most useful for investigating the visual arrangement of the built environment (Turner 2004, pp. 14–15).

- *Mean depth* determines how many turns are required to connect grid points to the other visible points within the graph. The results are totalled and then divided by the total sum total of grid points in the graph to derive a mean depth score for each grid node (Turner 2004, p. 14). Graphic colours: darker blue – more easy movement; yellow–green – more circumscribed movement (e.g., Fig. 4.22).
- *Integration* investigates how visually connected the grid points are to the other visually accessible grid points and approximates the relative "depth" or permeability of a grid point to all of the other points in a graph. This important

measurement is a normalised form of the mean depth measurement and has been found to correlate with the intensity of pedestrian movement (Turner 2004, p. 14). Graphic colours: magenta–red–orange – high permeability of space; indigo–blue – low permeability of space (e.g., Fig. 4.23).

– *Entropy* refers to the overall complexity of an analysed area by calculating the depth distribution within a graph. Entropy was developed to analyse the distribution of locations near every node to determine a relative measure of complexity to avoid prioritising open spaces within a graph (Turner 2004, p. 15, Turner 2001, p. 7). VGA produces two measurements of entropy: visual entropy and visual relativised entropy which is a normalised measurement of the entropy results. Graphic colours: yellow–green – complex movement; dark blue – simple movement.

4.3.2.6 VGA Analysis of the entire Quarters

The division of the geophysical plan of Nebelivka into Quarters was based on visual observation of similarities in the spatial organisation of the build environment, in the topographical features of the landscape, similarities in the clustering of Neighbourhoods and buildings to at least one assembly house, and the orientation of the structural evidence. VGA was conducted on 10 Quarters using the entirety of structural evidence. As there is little to no evidence of the buildings overlapping one another, it is suggestive that the structural arrangement of each Quarter respected the location of previously occupied buildings, implying a long after-life of buildings in social memory and the planning of the Neighbourhoods and Quarters, and as such VGA could be used as a proxy to identify avenues of movement and areas of visual integration.

Table 4.5: Explanation of 10 forms of VGA analysis (see Fig.4.19) used at Nebelivka (by B. Buchanan).

Type of map	Summary
Connectivity	The number of connections each grid node can 'see' in a graph, this measurement is a useful visualisation of the connectedness of Nebelivka based on the structural plan. However, as Turner notes, connectivity does not produce as meaningful a measurement for comparative studies as the integration, entropy, and mean depth measurements (Turner, 2004, p. 10). This is because connectivity is highly influenced by the total size of an area, with larger areas naturally more connected using VGA
Point First Moment	Point first and second moments are mathematical measurements of the graph. Point first moment is the sum of the visible distances from every node to other nodes in the graph (Al Sayad et al., 2013, p. 35)
Point Second Moment	This mathematical measurement calculates the sum of the dispersal of a graph's isovists, the visibility fields of the graph interpreted as geometrical polygons (Krukar & Conroy Dalton, 2013, p. 16)

Continued **Table 4.5**: Explanation of 10 forms of VGA analysis (see Fig.4.19) used at Nebelivka (by B. Buchanan).

Type of map	**Summary**
Visual Entropy	Entropy defines the overall visual complexity of a graph based on the distribution of depths within an area. It was developed specifically as VGA in *Depthmap* appeared, when the program was first developed, to prioritize open spaces (Turner, 2004, p. 15). Entropy is '[…] a measure of the distribution of locations in terms of their visual depth from a node rather than the node itself (Turner, 2004, p. 15). Therefore, if the depth is evenly dispersed, the entropy measurement is high and if more areas are close to a node, the entropy scores are low
Visual Integration [HH]	Integration is a normalised calculation of mean depth, and as Hillier et al. note, correlates well with pedestrian movement within the built environment (Hillier et al, 1993). It determines how visually connected every grid point is to the other nodes in a graph, and approximates the permeability of a point to all the other points in a graph. This normalisation is based on efforts Hillier and Hanson proposed when normalising axial maps in order to make areas of different sizes comparable to one another (Hillier & Hanson, 1984). This normalisation measurement proposed by Hillier and Hanson (1984) produces the Visual Integration [HH] measurement in VGA
Visual Integration (p-value)	This integration score was a normalization suggested by De Arruda Campos & Fong (2003, 35.9) as a more appropriate measurement for analysing VGA than Visual Integration (HH). The P-value measurement is similar to the D-value but divides an area into pyramid-shaped patterns of analysis and, as such, may be better suited for examining broader spaces (Hillier & Hanson 1984, p. 114)
Visual Integration [TEK]	The Visual Integration [TEK] measurement is similar to the Visual Integration [HH] measurement in that it is a normalised calculation of mean depth and determines the permeability of a graph. It differs in that it utilises an integration normalisation variant proposed by Teklenberg et al. (1993), which Turner notes is a simpler normalisation of integration than HH (Turner, 2004, p. 15)
Visual Mean Depth	This measurement calculates the fewest number of turns needed to connect all of the grid points within a graph to all of the other grid points. The shortest route to traverse through the graph based on the least number of turns is calculated, and these calculations are divided by the total number of vertices to provide a mean depth score for every node in the graph (Turner, 2004, p. 14)
Visual Node Count	This measurement is the total number of nodes within a graph as defined by the area of the graph and the grid spacing set by the user. It is the basis of all the other global measurements (Turner, 2004, pp. 14-15)
Visual Relativised Entropy	Like the visual entropy measurement but considers the expected distributions around a node in order to normalise the entropy measurement

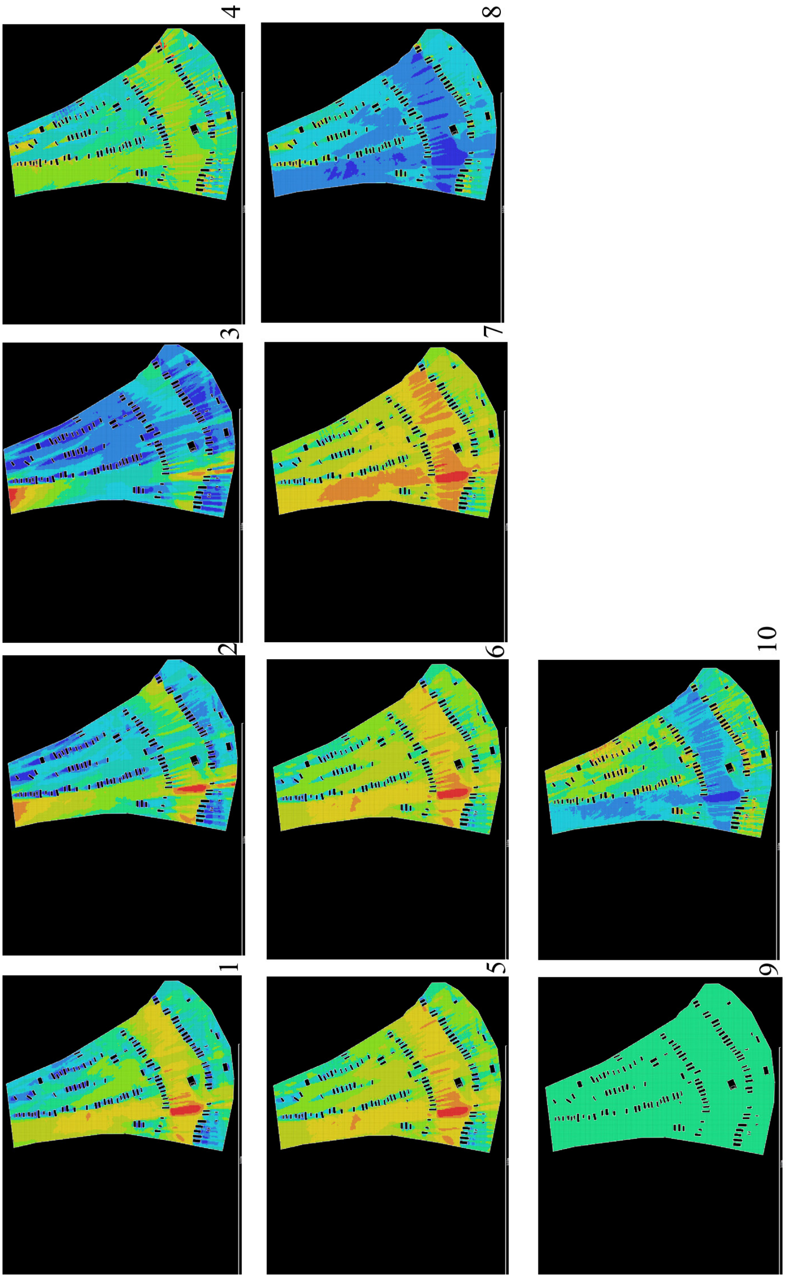

Figure 4.19:Visibility Graph Analysis of Quarter L: (1) Connectivity; (2) Point First Moment; (3) Point Second Moment; (4) Visual Entropy; (5) Visual Integration: HH; (6) Visual Integration: P-value; (7) Visual Integration: TEK; (8) Visual Mean Depth; (9) Visual Node Count; (10) Visual Relativised Entropy (by B. Buchanan). For explanation of these models, see Table 4.5.

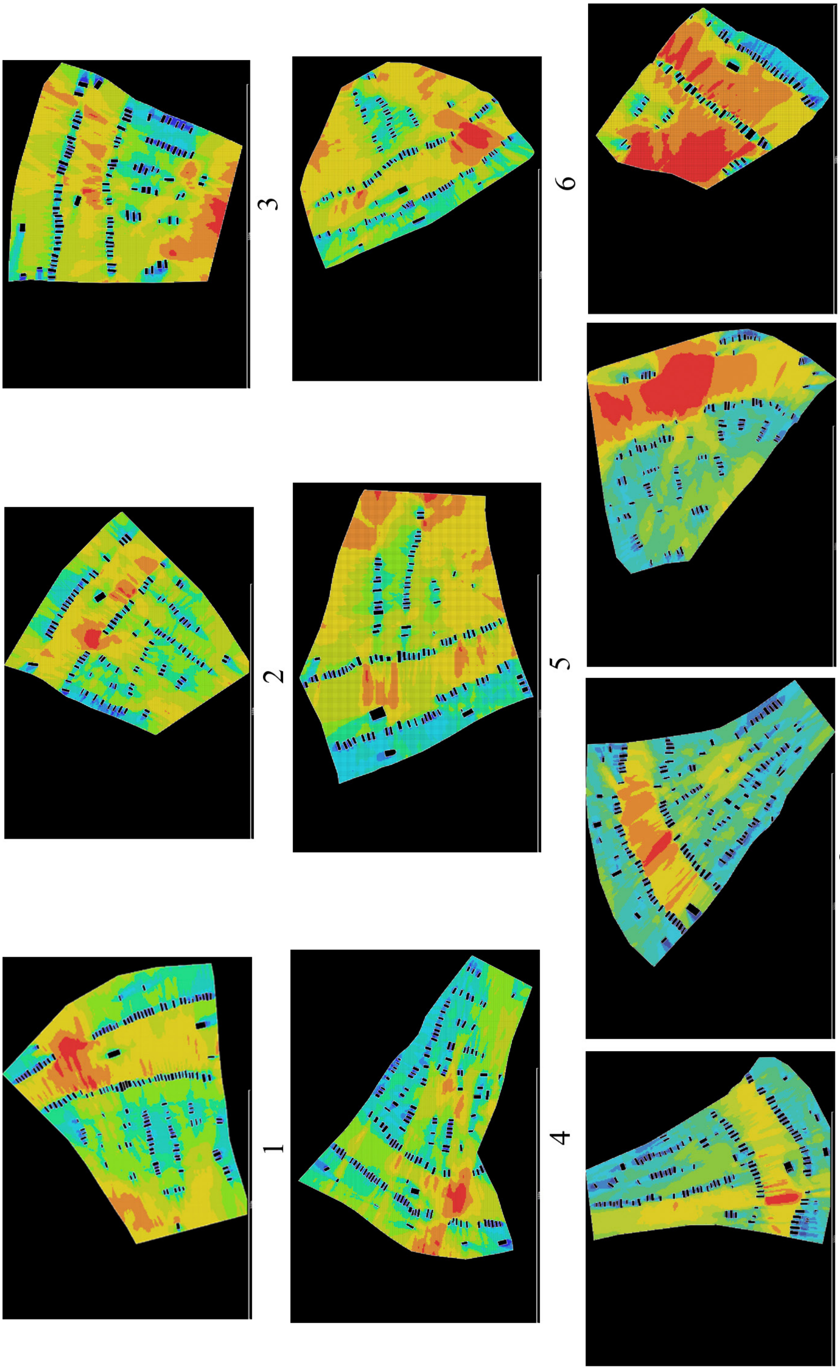

Figure 4.20: Connectivity analysis of all 10 Quarters: (1) B; (2) C; (3) D; (4) G; (5) H; (6) I; (7) L; (8) F; (9) N; (10) M (by B. Buchanan).

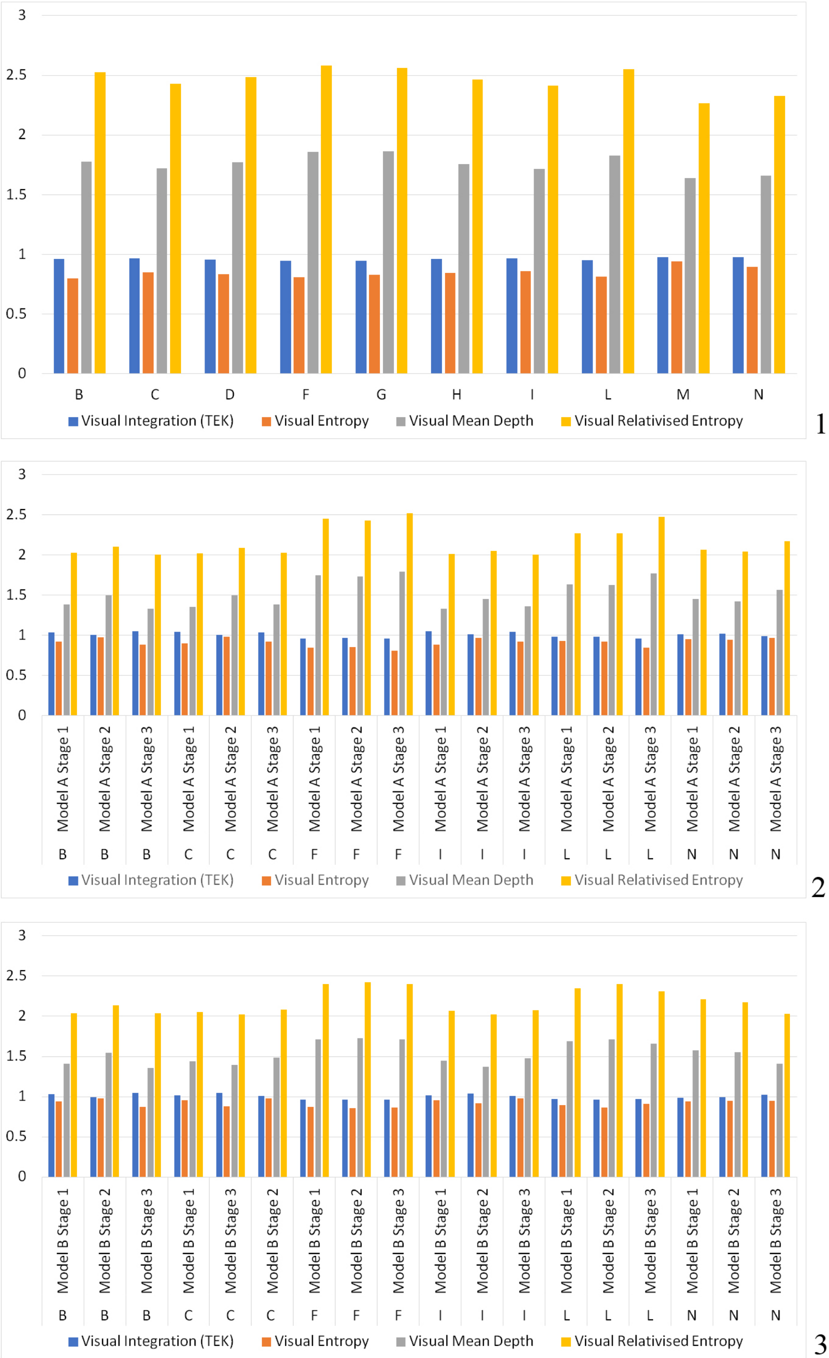

Figure 4.21: (1) Average measurements of VGA analysis of entirety of structural evidence; (2) Average VGA measurements of Model A; (3) Average VGA measurements of Model B (by B. Buchanan).

The comparison of the VGA results using the entirety of the structures within the Quarters suggests similarities in the spatial and visual arrangement of the buildings across the site, with no significant differences noted in the measurements as discussed above (Fig. 4.21/1). The colour-shaded images of the VGA results demonstrate that the portions of the site outside of the concentric ring of structures were significantly less permeable/visually integrated than the rest of the Quarters, suggesting the more connected areas of both visibility and activities were within the site. The outer ring of structures effectively blocked visibility to regions outside the site from areas within the Quarters. The interior of the parallel concentric rings, on the other hand, tended to be the most integrated areas of each Quarter, with these zones around the assembly houses being highly visible to the other parts of the Quarters.

The perceived similarities on the colour images were further tested using an Analysis of Variance statistical test (ANOVA) of the average global measurements, which demonstrated there *were no significant differences* in the VGA measurements between the 10 Quarters that were analysed. This implies similar long-term visual access across the Quarters throughout the site. Although there were no significant differences, there were outliers in the measurements. Quarters M and N, in particular, were more visually integrated than the other Quarters due to having fewer structures overall and clustering these buildings within distinct and smaller portions of each Quarter (Table 4.6; Fig. 4.21/1). This increased the number of large, open areas within Quarters M and N, which led to outlying VGA scores for these areas. This is particularly true for Quarter N, the only Quarter analysed without a large Assembly House within the empty space between the concentric rings of structures. This made this already relatively empty space more open in Quarter N and, within the VGA analysis, made it very well connected and integrated to the other regions of the Quarter. Quarter M, on the other hand, did not have the same number of inner radial streets, which in turn made a large and well-integrated public area in the Northern half of the Quarter. Fig. 4.20 shows how much more connected Quarters M and N are than the other Quarters using the Connectivity measurement[51]. Although these were outliers, the results still demonstrate a high degree of similarity in the spatial and visual organisation of the Quarters across the site when examining all of the structures.

The analysis of the ten Quarters (Fig. 4.20) suggests that the inhabitants of the site were utilising similar patterns of spatial organisation based on visibility and movement and that the successive occupations of the Quarters were replicating traditional spatial structures. As previously discussed, it was unlikely all of the structures existed at once, but they appeared to respect one another by not being built on top of one another, and thus represent cultural memory and social cues to avoid or interact the previously burnt structures in specific ways. The image results

51 The set of maps for every VGA analysis has ten plots; however, owing to limits of space, not all are presented in this chapter. The complete set of maps can be found at the Archaeological Data Service https://doi.org/10.5284/1047599 also indicate that the most visually connected areas of the investigated zones were near the Assembly Houses, with highly connected linear corridors leading to these visually connected, and presumably quite public, structures. The least visible areas were on the outer perimeter of the site, with the outer house circuit almost operating as a screen of visibility and/or movement, producing in effect a demarcation between the place of Nebelivka and the space near the edge of the settlement, marked by the perimeter ditch. These results are excellent barometers to compare with the analysis of the two proposed models of development.

4.3.2.7 The Distributed Governance Model (Model A) and the Assembly Model (Model B)

Six of the Quarters were more closely interrogated in VGA, comparing the results of the above investigations of the maximal structural plan with two models of the development of the site – Model A (the Distributed Governance Model) and Model B (the Assembly Model). These models were further sub-divided into three separate temporal stages. The models and stages had differing numbers of houses and placements of these structures, with the total size and number of buildings in each Quarter/stage shown in Table 4.7. As noted by Diachenko (2016) and Gaydarska (submitted), the number of structures and corresponding number of potential inhabitants (about six per house) fit the range of populations of smaller and medium-sized Trypillia settlements in the region (0.3–2ha to 35ha) and reinforce the division of the site into Quarters and developmental models helping us to a better understanding of the overall plan. The Quarters, therefore, can be seen as a structural practice, forming smaller units of habitation to help deal with the scalar stress of living at a megasite (Gaydarska 2019).

Table 4.6: Average VGA measurements of the entirety of structural evidence (by B. Buchanan).

Area	Visual Integration (TEK)	Visual Entropy	Visual Mean Depth	Visual Relativised Entropy
B	0.958857	0.795993	1.77479	2.52364
C	0.965055	0.8468	1.71953	2.42759
D	0.956214	0.834379	1.77355	2.48599
F	0.947765	0.80666	1.85775	2.5821
G	0.94765	0.830496	1.86102	2.56293
H	0.95971	0.842899	1.75848	2.46494
I	0.965468	0.858762	1.71666	2.41388
L	0.950528	0.813058	1.82634	2.5501
M	0.974847	0.938742	1.63974	2.26744
N	0.974684	0.89327	1.66087	2.32861

Table 4.7: Number of houses in each Quarter by Model and Stage (by B. Buchanan).

Quarter/Size	Total No. of Houses	Stage	Model A (Distributed Governance): No of Houses	Model B (Assembly): No. of Houses
B (21.8ha)	154	1	47	30
		2	48	52
		3	46	28
C (11.6ha)	101	1	33	26
		2	34	41
		3	26	27
F (13.8ha)	151	1	44	50
		2	44	60
		3	55	11
I (13.9ha)	103	1	34	20
		2	32	36
		3	35	20
L (16.3ha)	124	1	36	45
		2	32	54
		3	52	26
N (16.6ha)	111	1	29	55
		2	29	65
		3	47	44

First, and not surprisingly, the VGA results of three temporal stages of Models A and B were *significantly* different from the VGA measurements of the entirety of the structural evidence (Gaydarska 2019) (Fig. 4.21/2–3). At the same time, the VGA analysis of the two models did not display *significant* differences between each other or between the three stages of development. The significant differences between the models and the entirety of the structural evidence is most likely due to the fact that each stage of each model had markedly different numbers of structures and therefore spatial arrangements (for more details, see Figs. 4.22–4.25 and respective Tables).

The global measurements of the two models at the varying stages displayed remarkably similar scores, although there were outliers in the measurements of Quarters F and L (Table 4.8). These outliers had scores demonstrating Quarters F and L were more visually complex and less integrated. Both Quarters were within the Southern half of Nebelivka, which suggests that there was regional differentiation of spatial complexity within the site.

Table 4.8: Average VGA measurements of Models A and B (by B. Buchanan).

Area	Group Number	Visual Integration (TEK)	Visual Entropy	Visual Mean Depth	Visual Relativised Entropy
B	Model A Stage 1	1.03538	0.921318	1.38045	2.02497
B	Model A Stage 2	1.00242	0.973094	1.49918	2.1008
B	Model A Stage 3	1.04784	0.883064	1.33075	2.00705
B	Model B Stage 1	1.02738	0.939518	1.40561	2.03501
B	Model B Stage 2	0.99202	0.980965	1.54357	2.13864
B	Model B Stage 3	1.04765	0.873754	1.35681	2.04099
C	Model A Stage 1	1.04392	0.896309	1.3517	2.01703
C	Model A Stage 2	1.00296	0.978189	1.49429	2.09165
C	Model A Stage 3	1.03284	0.923707	1.38569	2.02823
C	Model B Stage 1	1.01759	0.956007	1.43841	2.05413
C	Model B Stage 3	1.04672	0.88247	1.39493	2.02622
C	Model B Stage 2	1.00457	0.98002	1.48639	2.08216
F	Model A Stage 1	0.960927	0.844794	1.75093	2.45508
F	Model A Stage 2	0.963307	0.854241	1.73131	2.42954
F	Model A Stage 3	0.955328	0.809199	1.79242	2.52499
F	Model B Stage 1	0.965995	0.868157	1.71373	2.40042
F	Model B Stage 2	0.963713	0.859313	1.72641	2.42102
F	Model B Stage 3	0.965817	0.865543	1.71038	2.40131
I	Model A Stage 1	1.04854	0.88119	1.33261	2.0105
I	Model A Stage 2	1.01324	0.968356	1.44852	2.054
I	Model A Stage 3	1.03835	0.917564	1.35694	2.00452
I	Model B Stage 1	1.01461	0.956051	1.44923	2.06492
I	Model B Stage 2	1.03604	0.915204	1.36988	2.0195
I	Model B Stage 3	1.00686	0.977027	1.47553	2.0738
L	Model A Stage 1	0.977925	0.924914	1.6329	2.27367
L	Model A Stage 2	0.979952	0.919601	1.62669	2.27124
L	Model A Stage 3	0.957762	0.844009	1.76998	2.47248
L	Model B Stage 1	0.969386	0.894585	1.68709	2.35169
L	Model B Stage 2	0.965054	0.865666	1.7129	2.40324
L	Model B Stage 3	0.973354	0.908682	1.65816	2.31316
N	Model A Stage 1	1.01471	0.954462	1.44904	2.06599

Continued Table 4.8: Average VGA measurements of Models A and B (by B. Buchanan).

Area	Group Number	Visual Integration (TEK)	Visual Entropy	Visual Mean Depth	Visual Relativised Entropy
N	Model A Stage 2	1.0221	0.944956	1.41902	2.04387
N	Model A Stage 3	0.98969	0.963286	1.56376	2.17341
N	Model B Stage 1	0.988429	0.937367	1.57879	2.21016
N	Model B Stage 2	0.993534	0.947114	1.55086	2.17407
N	Model B Stage 3	1.02371	0.946736	1.41001	2.03342

Overall, the Model A plans were more visually complex than Model B for each temporal stage, with corridors of more easily integrated space. The Model B plans tended to produce less visually complex and more open spaces, which created broader permeable (public) areas instead of smaller, grouped integrated space (Gaydarska 2019). More visually complex areas and less integrated (private) spaces in both models were located close to structures. The Assembly Houses were located in more public and well-integrated areas. These measurements reflect the differences in the morphological layout of the Quarters and their structural arrangements. Although there were observable differences when they were mapped out, there were not significant differences within the stages of the model – only between the models. The VGA results are summarised above and the average global measurements are detailed in Table 4.8.

4.3.2.7.1 Entropy

Across the six Quarters, this measurement produced the most standardised values, with a majority of visually simplistic space in the open areas and more complex space clustered near the houses. Entropy measurements did not show much intermediary space within the models or stages, which contrasts with the VGA of the entire structural evidence which showed much more intermediate space across the Quarters. These observations are fairly consistent across the temporal stages and within each model.

The two models differ in both how they were arranged over time, and how they would have been inhabited, with Model B more likely to have been populated for small periods of time in a year and Model A with more permanent dwelling but in smaller numbers. These differences would have affected the activities that would have been performed at the site, and the movement corridors in the entropy measurements thus reflect the unconscious and conscious perceptions of the spatial arrangement of the site. These are perhaps unsurprising measurements, as entropy measures the overall complexity and both model A and B are less visually complex than the complete plans.

4.3.2.7.2 Mean Depth

Like the entropy measurements, there are inverse relationships between the more public and private zones within all of the Quarters in both models and all three stages within the mean depth maps. The more public, open areas shift over time depending on the model and/or stage, with the more private areas clustered near the structures. The mean depth measurements appear to show a diachronic relationship between easy and intermediate movement zones due to the visual dynamics of the structural arrangements of space. The results suggest in the mean depth scores that it would have been easier to traverse the Quarters in Model B than Model A, with more visually accessible areas allowing multiple avenues of movement and access. A more detailed analysis of the two models for Quarters F and L shows similar results (Figs. 4.22 & 4.24 & Tables 4.9 & 4.11), with more integrated and/or connected areas allowing easier mobility.

4.3.2.7.3 Integration

The integration maps show no clear-cut correlation between the unbuilt areas and highly permeable spaces as compared to the mean depth and entropy measurements (e.g., Quarters F and L: Figs. 4.23 & 4.25 and Tables 4.10 & 4.12). Whereas entropy measures the complexity of a graph and mean depth measures how many turns needed to go in any one direction, integration notes how many grid nodes can be seen from any one point. Therefore, the unbuilt areas are not necessarily the most integrated areas, as visibility lines to these unbuilt areas can be blocked by the structures that demarcate that space – in effect, making some of the open areas more private. It appears that there is a general increase in high-permeability areas over time in the use of the integration measurement, which aligns with the differences in the models and stages of development.

4.3.2.8 Discussion and Conclusion

The results of the VGA of the Quarters of Nebelivka have both confirmed some of the original hypotheses and raised new questions on the development and spatial organisation of the site. First, the results suggest that the inhabitants of the site were following similar patterns of spatial organisation of the structures, and each Quarter would have had similar structuring of visibility and movement across the entirety of the site and over long periods of time. The models and corresponding stages of use provide similar visual accessibility measurements, which reinforces the viability of these models in explaining the site's development. The long-term similarities in visual accessibility across all parts of the megasite show the extent to which megasite spatial order emerged as a monumental part of the Trypillia *habitus*. At the same time, all of the outlying measurements were located in the Southern half of

Table 4.9: VGA Mean Depth analyses of all Stages of both Models, Quarter F, Nebelivka (see Figure 4.22) (by B. Buchanan).

STAGE	DG MODEL – MEAN DEPTH, QUARTER F	ASSEMBLY MODEL – MEAN DEPTH, QUARTER F
1	Easy Movement focussed along the OC–IC corridor, with Intermediate zones dominating the rest of the Quarter, and Circumscribed Movement restricted to house groups.	Areas of Easy Movement focussed on the OC–IC corridor, with Intermediate Movement in the rest of the Quarter and little expansion of Circumscribed Movement beyond house groups.
2	Expansion in Easy Movement along the OC–IC corridor, with the rest of the Quarter as in Stage 1.	Similar to Stage 1 but with smaller area of Easy Movement in the corridor.
3	Fragmentation of spaces affording Easy Movement, with continuing dominance of Intermediate Movement and expansion beyond a greater number of house groups.	Areas of Easy Movement dominate the OC–IC corridor, with Intermediate Movement in the rest of the Quarter and little expansion of Circumscribed space beyond house groups.

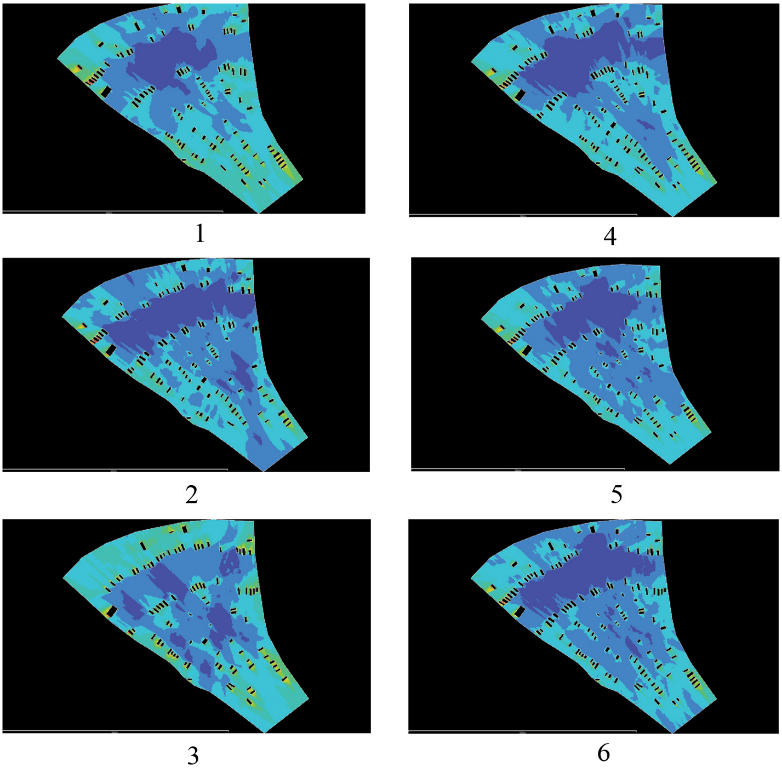

Figure 4.22: VGA Mean Depth analyses of all Stages of both Models, Quarter F, Nebelivka: (1) Distributed Governance Model (A), Stage 1; (2) Model A, Stage 2; (3) Model A, Stage 3; (4) Assembly Model (B), Stage 1; (5) Model B, Stage 2; (6) Model B, Stage 3 (see Table 4.9) (by B. Buchanan).

Table 4.10: VGA Integration-TEK analyses of all Stages of both Models, Quarter F, Nebelivka (see Fig. 4.23) (by B. Buchanan).

STAGE	DG MODEL – INTEGRATION, QUARTER F	ASSEMBLY MODEL – INTEGRATION, QUARTER F
1	The area of High Permeability is focussed on the OC–IC corridor, with Intermediate Permeability dominating the OOC and IIC and major expansions of Low Permeability beyond house groups, especially in the IIC.	As in Stage 1 of the DG Model
2	High-Permeability areas have fragmented across the OC–IC corridor, with continuing dominance of the OOC and IIC by areas of Intermediate Permeability and somewhat less expansion of Low-Permeability space beyond house groups.	As in Stage 2 of the DG Model
3	Increasing fragmentation of areas of High Permeability, with greater dominance of the OOC and IIC than in Stage 2 and even more expansion of areas of Low Permeability space beyond house groups.	Expansion of areas of High Permeability in the OC–IC corridor, with dominance of the OOC and IIC by areas of Intermediate Permeability and limited expansion of Low Permeability beyond house groups.

Table 4.11: VGA Mean Depth analyses of all Stages of both Models, Quarter L, Nebelivka (see Figure 4.24) (by B. Buchanan).

STAGE	DG MODEL – MEAN DEPTH, QUARTER L	ASSEMBLY MODEL – MEAN DEPTH, QUARTER L
1	Small areas of Easy Movement in the West part – mostly in the OC–IC corridor – with Intermediate areas dominating the OOC and IIC and expansion of Circumscribed space beyond house groups mostly in the IIC.	Area of Easy Movement confined to East side of the OC–IC corridor and part of the IIC; zonal distribution of Intermediate space on the West side, with expansion of the Circumscribed area beyond most house zones.
2	Expansion of Easy space from the OC–IC corridor into the IIC, with a zonal distribution of Intermediate space on the East side. Little expansion of Circumscribed zone beyond house groups.	Changes in location of areas of Easy and Intermediate movement, with the latter a zonal distribution on the East side and the former a zonal distribution on the West side. Expansion in the areas of Circumscribed movement outside house zones.
3	Contraction and fragmentation of areas of Easy Movement, replaced by Intermediate zones in the OC–IC corridor and the IIC; continued expansion of Circumscribed zone beyond house groups.	The Intermediate-Movement zonal distribution has expanded to take in the Centre as well as the East side, with a further reduction in areas of Easy movement and the pattern of Circumscribed movement the same as in Stage 2.

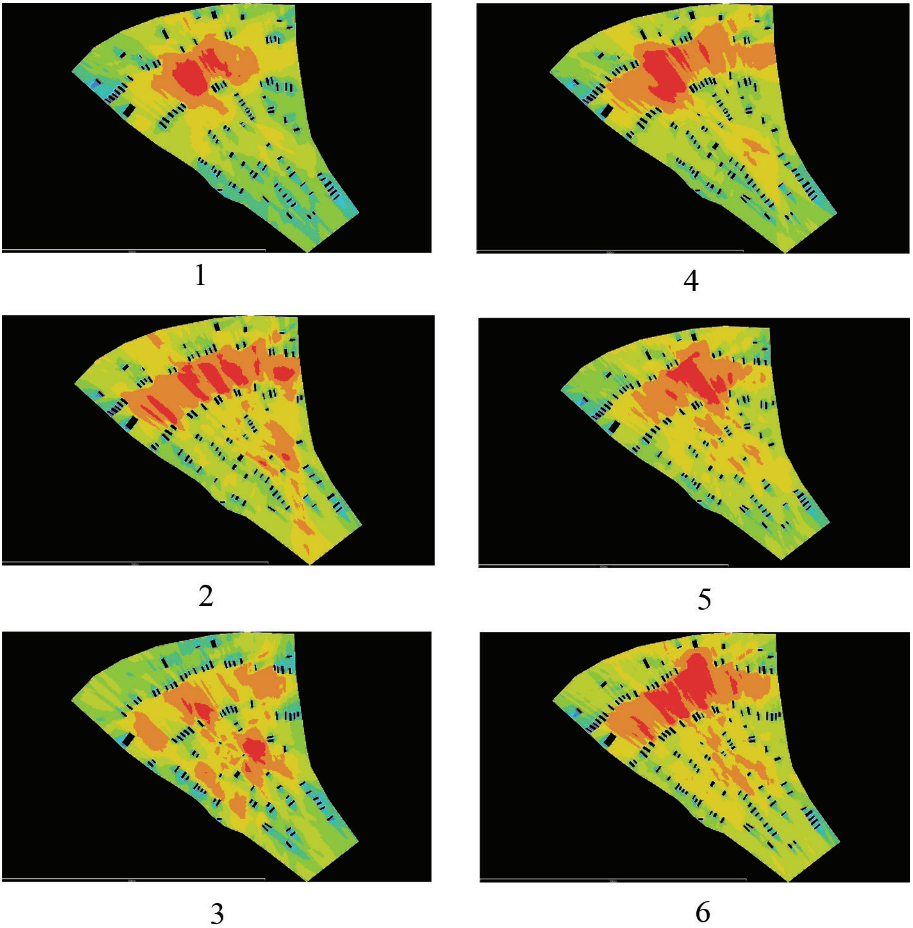

Figure 4.23: VGA Integration-TEK analyses of all Stages of both Models, Quarter F, Nebelivka: (1) Distributed Governance Model (A), Stage 1; (2) Model A, Stage 2; (3) Model A, Stage 3; (4) Assembly Model (B), Stage 1; (5) Model B, Stage 2; (6) Model B, Stage 3 (see Table 4.10) (by B. Buchanan)

the site, suggesting possible differential arrangements based on location within the site complex. These differences could be due to these areas developing at different times, or to different social groups inhabiting or using these areas and thus altering the spatial arrangement slightly from their neighbours to the North.

The VGA results also reinforce the importance and status of the Assembly Houses for the development and use of the site overall and more specifically the defined Quarters. These places show striking visual accessibility within the Quarters, with highly connected visual fields in the immediate vicinity of the Assembly Houses as well as corridors of movement and visibility leading to the large structures. Taken together, they suggest that the spatial location of the Assembly Houses is not

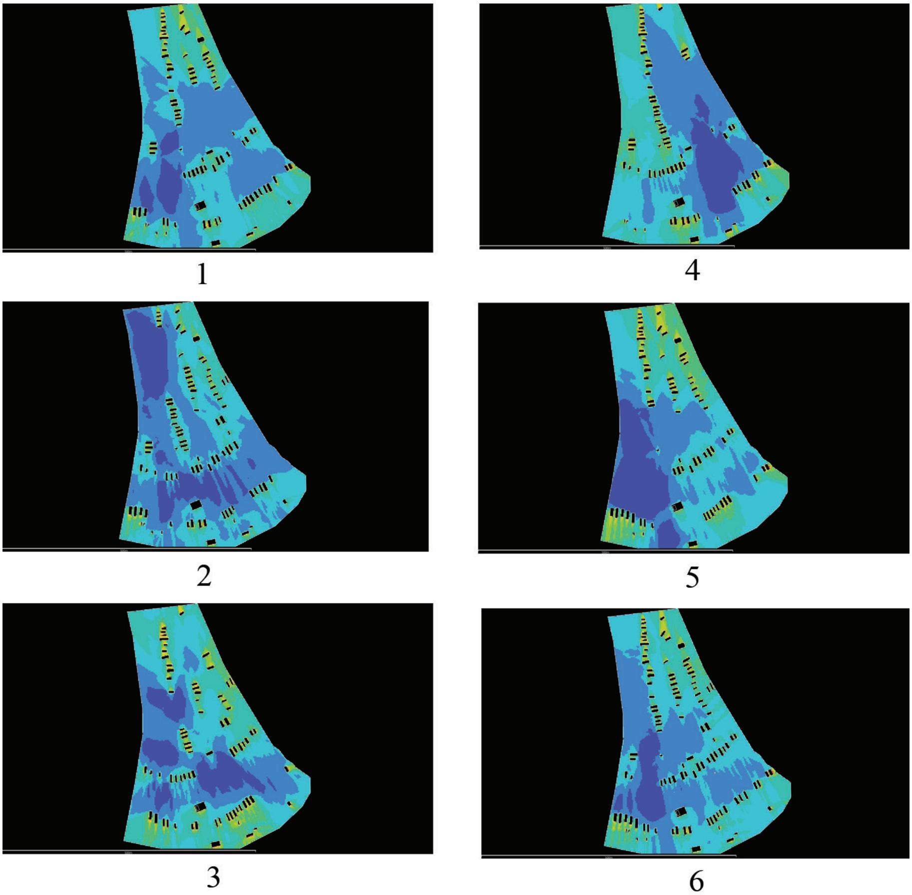

Figure 4.24: VGA Mean Depth analyses of all Stages of both Models, Quarter L, Nebelivka: (1) Distributed Governance Model (A), Stage 1; (2) Model A, Stage 2; (3) Model A, Stage 3; (4) Assembly Model (B), Stage 1; (5) Model B, Stage 2; (6) Model B, Stage 3 (see Table 4.11) (by B. Buchanan).

accidental; they are located in the most integrated and public zones of the Quarters and thus located in the areas of easiest mobility and highest public interaction. Their locations may also have been related to sound, as nodes in an interconnected soundscape. Their different construction (see above, pp. 133–136) may have enabled a higher permeability of sound than in ordinary buildings. Although it has been hypothesised that these structures were important for the development of the site as a whole due to their size and spatial regularity across the site, the VGA of the Quarters suggests that their location was key to the development of the Quarters across time, as they remain highly integrated across models and temporal periods.

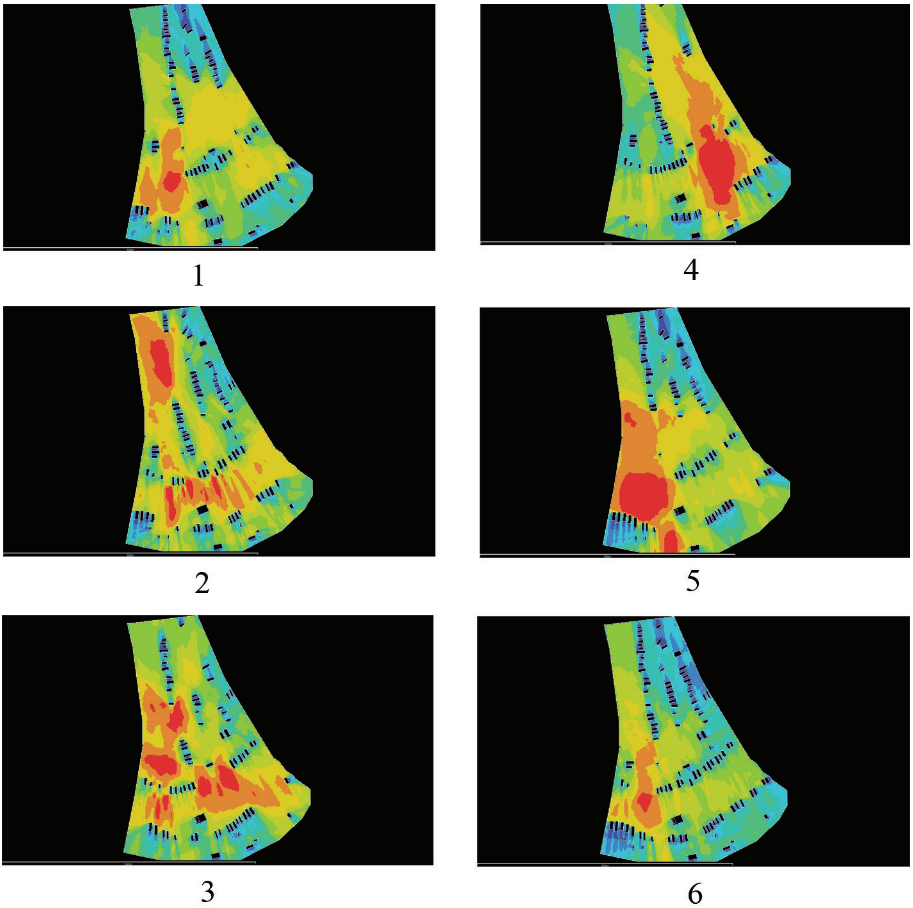

Figure 4.25: VGA Integration-TEK analyses of all Stages of both Models, Quarter L, Nebelivka: (1) Model (A), Stage 1; (2) Model A, Stage 2; (3) Model A, Stage 3; (4) Assembly Model (B), Stage 1; (5) Model B, Stage 2; (6) Model B, Stage 3 (see Table 4.12) (by B. Buchanan).

The geophysical plan of Nebelivka has inherent importance for understanding the development and use of Trypillia sites. Its completeness and high resolution have shown a complex plan of a large number of burnt and unburnt structures, ditches, and Assembly Houses. This high resolution has allowed the interrogation of the site through visibility graph analysis, which examined the spatial organisation and visual arrangement of the built environment and noted that, while there were outliers, there was no significant difference in the visual arrangement of the structures across the site. In addition, two models of development were tested using VGA and, although they displayed different zones of integrated space, the analysis of the models also displayed fairly similar average measurements of integration, entropy, and depth.

Table 4.12: VGA Integration-TEK analyses of all Stages of both Models, Quarter L, Nebelivka (see Fig. 4.25) (by B. Buchanan).

STAGE	DG MODEL – INTEGRATION, QUARTER L	ASSEMBLY MODEL – INTEGRATION, QUARTER L
1	High-permeability space limited to West part of OC–IC corridor and South-West part of IIC; Quarter dominated by Intermediate space, with low permeability around buildings and expanded from houses in IIC, OC and OOC.	Large corridor of high-permeability space in East side of Quarter, with corridor of intermediate space immediately to the West; major expansion of low-permeability space around all houses, as in DG Model
2	Increase in high-permeability space but more fragmented, with patches in IIC and across the OC–IC corridor; decrease in intermediate space, with low-permeability space as in Stage 1.	Similar corridor of high-permeability space but shifted to West side of Quarter, with similar areas of intermediate space to Stage 1 but expansion of low-permeability space, especially in IIC and OOC
3	Similar fragmentation of high-permeability space but in different parts of OC–IC corridor and IIC; intermediate and low-permeability spaces as in Stage 2	Major expansion of low-permeability space to dominate the Quarter, especially in IIC, IC, OC and OOC; small area of high-permeability space in West side (shrunk from Stage 2) and intermediate space limited to OC–IC corridor and West side of IIC.

Both models suggest possible patterns in how Nebelivka could have developed and demonstrate the importance of public vs. private zones in our understanding of the site's diachronic development.

Stuart Johnston

4.4 The Experimental Programme

4.4.1 Introduction

One of the research goals of the Project was an improved understanding of the taphonomy of the Trypillia burnt houses and, in particular, those excavated at Nebelivka, where by far the largest excavated sample comprised houses, whether complete (House A9 – 2009; House B17 – 2013), parts (House B18 – 2013) or test pits in over 80 (mostly burnt) houses.

Much of Cucuteni-Trypillia archaeology can be defined as the excavation of burnt houses. But the Project has been unable to find a thorough, detailed account of the taphonomy of a burnt house in what has become a rather traditional field of recording of excavated features and finds and their interpretation as a reflection of a living house assemblage that has collapsed in a narrow range of ways (Monah & Monah 1997; Korvin-Piotrovskiy et al. 2012; Müller & Videiko 2016). Excavators of burnt Cucuteni-Trypillia houses have accumulated vast databases of specific forms of remains, especially the mass of burnt clay known in Russian as the '*ploshchadka*' (Fig. 4.26 upper) and various burnt clay features thought to be walls, podia, altars (or 'platforms') etc. Equally, although eight house-building experiments of eleven houses have been previously conducted (for summary, see Burdo 2011; Cotiugă 2009), only one excavation of an experimental burnt house has been made (the excavation is summarised in Chabaniuk 2008) in order to make direct comparisons with the excavated remains of 6,000-year-old houses. It was for this reason that the Project decided to build two smaller-than-life-size Trypillia experimental houses – one single-storey and one two-storey – burn them down and excavate the burnt remains in order to make a comparison of different house remains. A report has been published for the construction of the one-storey and two-storey houses and the burning of the two-storey house (Johnston et al. 2019; https://doi.org/10.5284/1047599 Section 6), while the detailed report on the excavation of the burning of the experimental house (Johnston et al. 2018; https://doi.org/10.5284/1047599 Section 6.6) is the first of its kind.

There were four major issues to which the Nebelivka house-burning experiment could make a useful contribution – Issue 1: whether the burning of an experimental two-storey house left traces that would be recognisable in excavations of Cucuteni-Trypillia *ploshchadki*; Issue 2: the comparative interpretation of features, fittings and objects in the experimental house and Trypillia burnt houses; Issue 3: the nature and quantity of fuel needed for a successful house-burning; and Issue 4: whether house-burning was a deliberate social practice. Because of its timescale, the experiment could not contribute to debates over the effects of soil formation processes, the results of *krotovina* action[52] or the preservation of different constructional materials such as ash, charred material or weakly burnt daub that would eventually have reverted to clay or soil.

4.4.1.1 Issue 1: The Creation of a Ploshchadka

The presence of a *ploshchadka* in the excavation of a Trypillia house has been a certain indication of a high-temperature fire from the earliest Trypillia investigations (Khvoika 1901). The converse – the recognition of unburnt houses – came much later and was based on a weak geomagnetic anomaly and the absence of a *ploshchadka* (e.g., in Nebelivka Test Pit 1/4: Burdo & Videiko 2016, p. 107, Fig. 9; see also below, p. 217, 221). It is, therefore, perhaps surprising that none of the previous Trypillian house-burning experiments have claimed to produce a convincing *ploshchadka* (A. Diachenko, pers. comm.; Burdo 2011). This was presumably because of the absence of one or more key ingredients or circumstances: well-dried clay, plentiful fuel to

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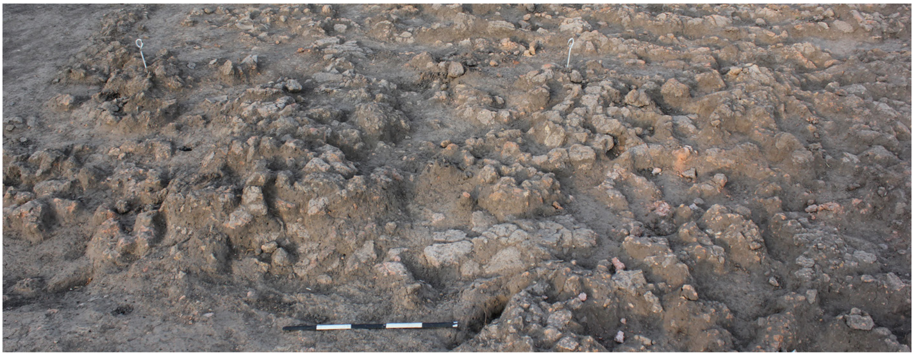
52 *Krotovina* are the traces of underground movements by rodents whose effects on stratigraphy can be severe.



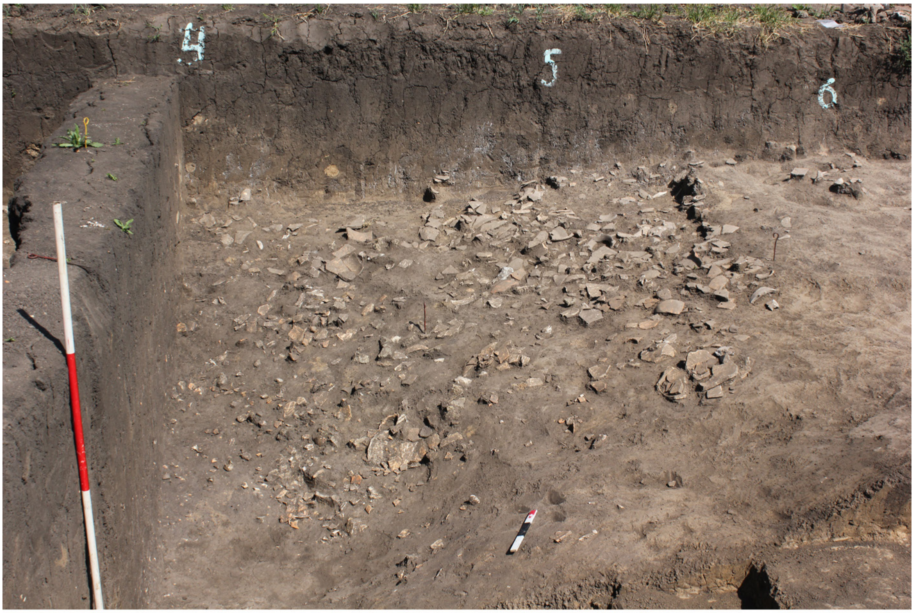


Figure 4.26: Upper: Burnt house remains (*ploshchadka*), Mega-structure Context 55; lower: bone and ceramic scatter, Pit near House B17, Nebelivka (upper by J. Chapman; lower by M. Videiko).

produce a high temperature, conditions for the creation of a good draught, and/or a bright, sunny and windy day. In the case of the Kruts & Chabanuk experiment, the design choice of a log cabin consumed 2.5 times as much timber as a Nebelivka house of the same size and 1.5 as much clay (Chabaniuk 2008, pp. 219–220); therefore, the lack of clay cannot be invoked to explain the lack of a *ploshchadka*. Most of the previous experiments did not quantify the fuel utilised or the temperature of the house-burning. However, the personal observation by A Diachenko of several house-burning experiments showed that far less fuel had been used than in the Nebelivka house-burning (30m^3 of timber). A high temperature of over 700°C was essential to convert the low-conductivity clay into a burnt mass; without sufficient fuel, the temperature needed for a *ploshchadka* could not be achieved. It is important to note that, after the successful Cucuteni Experimental Archaeological Park experiments (Cotiugă 2009), the Nebelivka experiment was only the second recorded house-burning[53] which produced a *ploshchadka* identical to those on excavated Trypillia sites (see DOI https://doi.org/10.5284/1047599 Section 6.6.2.1). However, the production of vitrified daub in the Nebelivka experiment was the first such in the house-burning experiments, confirming that a temperature of over 1000°C was reached.

4.4.1.2 Issue 2: Detailed Interpretations of House Features

The Nebelivka experiments can contribute to three long-running debates concerning the interpretation of excavated Trypillia house remains: the use of fire in construction burning; the design choices for walls; and the presence of one- or two-storey houses.

The claim from Korvin-Piotrovskiy et al.'s (2012) experimental programme is that controlled firing of the lower walls of a house or its internal features could strengthen without destroying them. A small-scale house-firing experiment organised in the grounds of Durham University (https://doi.org/10.5284/1047599 Section 6.3) attempted to re-create the distinctive cracked surface of the house platforms (aka 'altars') often found in Trypillia houses (Fig. 4.27 upper). This experiment showed that construction burning did cause the development of a cracked surface but that this construction burning would have damaged the house walls unless the firing was done before the building of the walls. This indicates that construction burning worked for the building of a platform provided it was built on the ground floor, before the wall construction. However, there is no obvious difference between the effects of construction burning and post-dwelling destruction burning on platforms or other features. This experiment raises serious doubts about the likelihood of construction burning in wall-building.

The question of wall-design of Trypillia houses arises from the well-documented absence of post-holes in house excavations, as well as the paucity of wall remains. Both excavations of experimental burnt houses – Chabaniuk's (2008) excavation of the Legedzine burning of a log cabin and the Nebelivka burning of a wattle-and-daub house with vertical posts set in sleeper beams – demonstrated that wall remains were preserved in burnt house remains. At Nebelivka, wall daub could be differentiated from floor daub through the small size and regularity of the withy impressions, as compared with larger, semi-circular or squared-off floor timbers. Several wall panels whose collapse was documented at the time of the house-burning were discovered in

53 By a 'recorded house-burning', we mean a graphic record of the objects placed in the house-to-be-burned and a timed photographic record of the burning, with analyses of daub firing temperature.

the excavation in the expected state and place. Identical withy impressions to those in the Nebelivka experiment (Fig. 4.27 lower) have been found in burnt Trypillia houses such as Nebelivka House A9 and Dobrovodi House 4. The experimental results confirm that wall remains can be well preserved in, and form part of, Trypillia *ploshchadki*.

Figure 4.27: Upper: platform, Durham Experiment; lower: withy impressions, Nebelivka Experimental Burnt House Excavation (by S. Johnston).

Since local permission was denied us to burn down both the one- and two-storey houses at Nebelivka, there were no direct comparative results from the experiment. Nonetheless, useful information was gathered on both types of house. There were several lines of evidence supporting the effects of burning on two-storey houses. In this discussion, it is important to note the terminology applied to floors: for a one-storey house, the ground floor and the upper floor (dividing ground-floor room from loft) and, for a two-storey house, the ground floor, the middle floor (separating the ground-floor room from the second-floor room) and the upper floor (separating the second-floor room from the loft). Schematic reconstructions of the destruction of one- and two-storey houses provide a range of potential scenarios (Figs. 4.28–4.29).

The most obvious effect was the way that our excavation located a total of 11 wall-panels, which fell inwards into the house (five cases) (house-burning example: Fig. 4.30 upper) or outwards (experimental burnt house excavation: Fig. 4.30 lower). Well-fired panels would have been preserved whichever direction they fell. For poorly-fired wall panels, inward-falling panels would have been protected by other house debris, while the lack of protection of outward-falling panels meant a lower chance of surviving to the present-day.

The issue of whether middle-floor features such as hearths, podia and platforms could have survived intact a fall onto the ground floor was more complex. While we cannot rule out the possibility of an entire floor sliding downwards to show good preservation of internal features, the experimental evidence of hearth fragments and fragmented floor daub showed the impact of the fall. Wherever middle-floor fragments and fragments of features (especially platform fragments, as found in the Nebelivka excavations) appear in excavation, it is suggested that this is good evidence of a two-storey house; conversely, intact or fragmented but *in situ* features and floor remains indicate the high probability of a one-storey building (see below for Test Pits: Chapter 4.6.1).

4.4.1.3 Issue 3: Construction Materials and Fuel for House-Burning

The production of an individual house can be viewed as a symbolic fusion of the different elements that made up the Trypillia landscape. Creation and fusion was achieved through combining clay from the earth with straw from the steppe or as a by-product of agriculture, wood from the forest and reeds and water from rivers and lakes. The coordinated construction of parts of the megasite can similarly be viewed as an expression of co-operation within and outside a supra-household group.

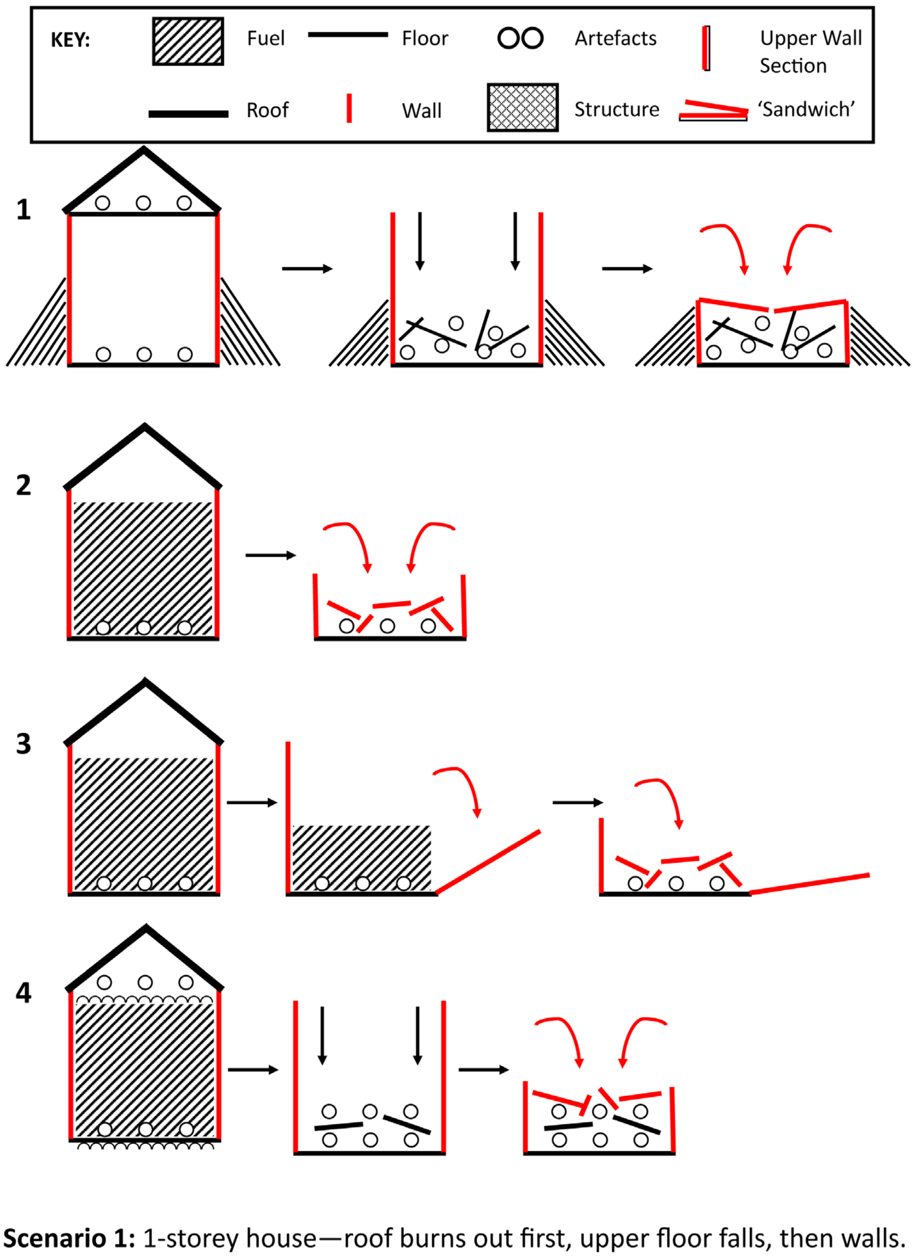
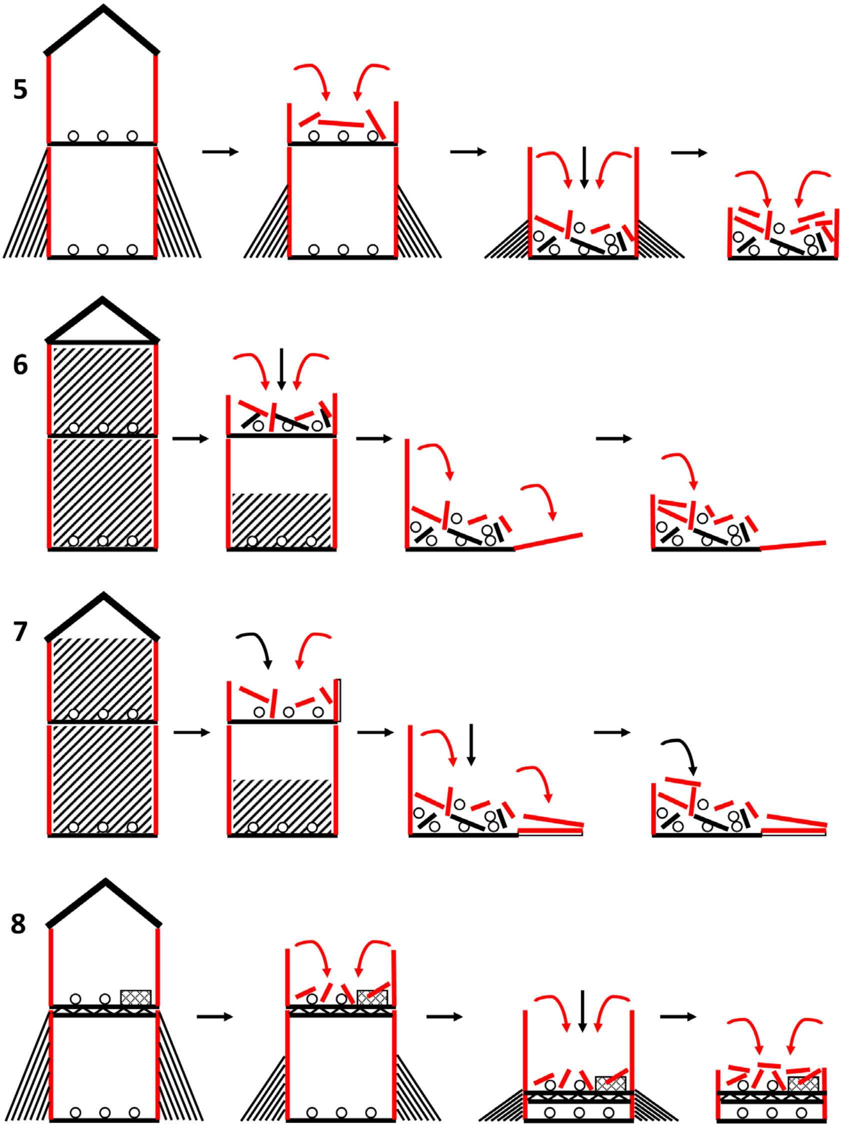


Figure 4.28: House collapse scenario 1 (1-storey houses) (by L. Woodard).



Scenario 2: 2-storey house—roof burns out, upper wall falls first, then upper floor, then walls.

Figure 4.29: House collapse scenario 2 (2-storey houses) (by L. Woodard).

Figure 4.30: Upper: house panels falling inwards, Nebelivka House Burning Experiment; lower: house panel fallen outwards, Nebelivka Experimental Burnt House Excavation Contexts 425 & 426 (upper by M. Nebbia; lower by J. Chapman).

The quantity of wood necessary to build a Trypillia house has been discussed on many occasions (e.g., Kruts 1989; Kruts et al. 2001; Korvin-Piotrovskiy et al. 2012). This figure is dependent on several factors, principally the number of storeys and the type of architecture, whether a wattle-and-daub upper storey built on a log-cabin ground floor (e.g., Legedzine: Korvin-Piotrovskiy et al. 2012, Fig. 9.4) or a timber-framed house with wattle-and-daub walls on sleeper-beams (e.g., the two Nebelivka houses: Fig. 1.9).

The estimates for the construction materials for the one- and two-storey houses are shown below, with values for full-size Majdanetske houses for comparison (Table 4.13). Scaling-up of timber requirements to the standard Nebelivka 'Module' of 100 15m × 5m houses would have meant the felling of over 13,000 trees for one-storey buildings and almost 25,000 trees for two-storey buildings – ca. 20,000 trees for a mixture of one- and two-storey houses. Even the coeval construction of 10 houses would have required the transport of almost 400 tonnes (170 m^3) of clay, over 150m^3 of reeds and the collection of timber resources from a 1km^2 area of forest. The production of houses on the scale required to construct large parts of a megasite would have required co-ordinated management of skills, labour and the landscape. This includes woodland management, with coppicing of hazel trees beginning several years in advance to produce withies of suitable size. In the process of constructing a Neighbourhood or Quarter, the coordination of these activities and the formation and maintenance of a reliable supply chain would have had organisational and administrative effects beyond the comparatively modest efforts necessary to construct a single dwelling.

Kirleis and Dal Corso (2016, p. 201) claim that de-husking took place within the settlement and the waste material was either discarded in pits or used in daub-making. Such a statement has important implications for temporality and storage. The large-scale building of megasite houses in one site phase would have required large-scale storage of husks for daub-production (see below, Section 6.2). This is not impossible but such a scenario needs further evaluation in terms of planning and logistics. Alternatively, the building programme was much slower, lasting decades rather than a few years. This would have allowed the storage of the husk waste from one household for subsequent use in the next planned house building. If, by contrast, all the houses had already been built, the husks produced by the Majdanetske households would not have been needed and then all husks would have been discarded in pits. We suggest that a steady building programme that would incorporate and recycle the daily waste into useful building material was more likely; it also matches a broader strategy of woodland management, including the coppicing of hazel, for a constant supply of building material.

The large quantity of fuel placed in the house before firing was probably instrumental in achieving a complete combustion of the two-storey structure. We cannot, however, be certain whether complete combustion could have been achieved without the filling of the upper room with much fuel (cf. Kruts 2003). We maintain that the main fuel element was timber, because of the logistical problems of collecting large quantities of animal dung or reeds and their insufficient thermal properties when used alone.

Table 4.13: Estimates for house-building of (a) Nebelivka experimental houses and (b) full-sized Trypillia houses, Majdanetske (by S. Johnston).

a: Estimate of quantities of materials used in the construction of the single- and two-storey house models with a footprint of 3m × 4m at Nebelivka, 2014 (data from S. Johnston)

House models	Single-storey	Two-storey
Total volume of timber (m^3)	2.52	3.44
No of trees of 0.15m diameter and 4m length required	35	48
Total volume of wattle (m^3)	0.29	0.56
Total volume of daub (m^3)	2.95	5.61
Comprising:		
Clay at roughly 80% by volume (m^3)	2.36	4.49
Temper at roughly 20% by volume (m^3)	0.59	1.12
Total volume of roofing material (m^3)	3.00	3.00

b: Estimate of quantities of materials used in the construction of full-sized single- and two-storey houses with a footprint of 4.8m × 12.7m at Maidenetske (Müller & Videiko, 2016)

Full sized houses of 4.8m × 12.7m (Müller and Videiko, 2016)	Single storey	Two storey
Total volume of timber (m^3)	9.65	17.73
No of trees of 0.15m diameter and 4m length required	135	248
Total volume of wattle (m^3)	1.20	2.37
Total volume of daub (m^3)	14.65	28.52
Comprising:		
Clay at roughly 80% by volume (m^3)	11.72	22.81
Temper at roughly 20% by volume (m^3)	2.93	5.70
Total volume of roofing material (m^3)	15.24	15.24

The estimates made for the fuel requirements for a successful, deliberate house-burning show that the quantity of fuel for house-burning far exceeded the quantity of timber for house-construction. Extending the fuel requirements to the burning of a mix of 100 houses requires ca. two million trees or deciduous forest cover of 10km^2. This is the first of the two most important conclusions of the Nebelivka experimental programme – the severe logistical implications of burning one house, let alone ten or a hundred. Prehistorians have barely begun to explore the social implications of this logistical requirement.[54]

By the same token, unburnt or weakly burnt houses, forming one-third of the total houses at Nebelivka, may have been a result of insufficient timber or other variants on the poor or rushed planning of a house-burning. This still implies a deliberate decision to burn the house down, even if this may not have been fully successful.

Let us return to Ohlrau et. al's (2016) figures of 20m^3 of construction timber per dwelling, which, despite a higher estimate than that of Johnston, we can broadly accept for this exercise. Ohlrau et al. (2016) have excluded from their calculations the estimated quantity of timber required to burn the houses and produce a *ploshchadka*. Ohlrau et al. (2016) propose 91ha of woodland for the construction of all of the Nebelivka houses to be burned; our experimental figures suggest that up to 10 times the quantity of fuel was needed to burn the houses than build them, indicating an area of up to 910ha was needed to produce the fuel for this burning. Even if we halve that figure, potentially jeopardizing the production of the *ploshchadka*, this is still a very large area especially given that these are not densely wooded regions but a forest-steppe zone.

We suggest that a single massive burning at the end of the settlement was far less likely than house-burning performed at a constant rate (for example, 10 houses per year), thus not compromising the availability of a scarce resource used not only for building and burning but also for cooking, heating and pottery manufacture. In such a scenario, a forest steppe area of 30ha, with a regeneration cycle of 30 years (Ohlrau et. al 2016) would provide enough fuel for the firing of the burnt Nebelivka houses. If we include the daily needs of timber, too, and increase the area to 50ha, this is a far more realistic figure than 910ha for the availability of this resource in the forest steppe and for the requisite woodland management.

54 In a very recent article, Dal Corso et al. (2019, p. 4) maintain that no extra fuel at all was needed for deliberate Trypillia house-burning, citing Harper's (2017, p. 46) claim that mature house-timber had dried sufficiently for ready combustion. However, no experimental research is quoted to support this claim.

4.4.1.4 Issue 4: Deliberate House Burning – the Alternatives

The debate over deliberate house-burning still continues in European prehistory, more than 40 years after the seminal work of Zinkovskiy (1975), extended by Stevanović (1997). Contrary opinions such as the following are still rife in Balkan prehistory:

> *We could therefore think of the deliberate burning of some such, but perhaps finite, unit within the tell at Belo Brdo, as an ongoing coring programme and limited test excavation some 60m from the centre of the tell do not show burning everywhere in late Vinča levels. This could leave open the possibility of accidental burnings that got out of hand, rather than deliberate, malicious or otherwise aggressive fire-settings. But the formal chronological models presented here may weigh in favour of a deteriorating social context, with putative deliberately aggressive burnings repeated within a generation or so* (Tasić et al. 2015, pp. 1078–9).

To the contrary, the Nebelivka experiment has demonstrated the requirement for large quantities of fuel to produce a *ploshchadka*, as did the Cucuteni Archaeological Park experiments (Cotiugă 2009). There are at least four problems with accidental house combustion or even burning as a result of a military attack:

1. the floor and wall daub coverings are poor conductors of heat, which would have protected the unexposed structural timbers from fire-damage;
2. the poor heat conduction of the wall daub would have prevented a fire from spreading to nearby timber-framed houses[55];
3. only the roof of a neighbouring house would have burned but not the rest without additional fuel to maintain the fire; and
4. even if the houses were tightly packed, as in the case of Balkan tells, the outward collapse of walls onto neighbouring houses would not have sustained a damaging fire without additional fuel; while the walls may have baked, they would not have collapsed.

All of these reasons make it highly improbable that a complete combustion of a timber-framed, wattle-and-daub house leading to the creation of both a *ploshchadka* and vitrified daub would have been possible through an accidental fire or even a military attack. This is the second of the two most important conclusions of the Nebelivka experimental programme.

In summary, the Project's experimental programme combined three elements – the building of two 4m × 3m 'Neolithic' houses – one one-storey and the other two-storey, the burning of the two-storey house one year later and the excavation of its burnt remains two years later. The programme shed light on four important issues. The burning of the experimental house showed that it was possible to create a Trypillia

55 In the Nebelivka house-burning experiment, the one-storey house stood only 2m from the burning two-storey house yet its outside wall daub was barely warm to the touch and the inside of the wall was not warm at all.

ploshchadka as well as produce true vitrified daub – showing a firing temperature of close to 1000°C. This was the first such house-burning experiment to produce either of these results – probably because of the high density of timber for burning. Issue 2 focussed on the reproducibility of certain features regularly found in, or claimed for, Trypillia excavations. There was little evidence in favour of the hypothesis of construction burning. By contrast, the question of whether house-walls survived a high-temperature burning could be demonstrated both by the wall panels themselves and by the multiple daub impressions produced by the wattle. In addition, a reliable method was developed for distinguishing between one- and two-storey houses from excavated remains of daub. The nature and quantity of fuel needed for successful house-burning comprised Issue 3. Here, the surprising result was that a successful burning required many times more timber than for the house-building – in the Nebelivka experiment, up to 10 times the amount of timber. This result stimulates many important implications for European prehistory in any region, such as the Central Balkans, with a high proportion of burnt houses on excavated sites. The final, fourth issue tackled the fraught question of whether burnt house remains were the product of accidents, attacks or deliberate household action. Although there are several strong arguments for the third explanation, the issue of the high level of fuel required is the final argument in favour of deliberate house-burning in most cases.

It is now time to turn to the accounts of the various excavations carried out under the aegis of the Project. It is appropriate to begin with the largest, joint excavation that the Ukrainian and Durham sides managed to complete – the excavation of the Mega-structure.

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4.5 Joint Excavations

Bisserka Gaydarska, Marco Nebbia, Mykhailo Videiko & John Chapman

4.5.1 The Mega-Structure

4.5.1.1 Introduction

Since Assembly Houses represented rare buildings, it was decided to explore the largest example through excavation in summer 2012. The preliminary description of the 'Mega-structure', as the building has been termed, has been presented elsewhere (Chapman et al. 2014), with an account of the drastically differing interpretations of the Ukrainian and British sides. In this account, we shall summarise the British view before making an assessment of the meaning of such buildings for overall megasite settlement order.

The excavation of the largest of the three large structures identified in the geophysical investigations in summer 2009 at Nebelivka (Chapman & Videiko 2011) took place over eight weeks in the summer of 2012. Samples of each context were collected for dry-sieving and froth-flotation. All finds in Weeks 2–7 of the excavation were plotted with Total Station co-ordinates. The burnt daub and features were drawn in the field, with later digitisation transferred to a GIS platform.

The Mega-structure was built on a granite rockhead that would have been close to the surface, if not actually appearing as a surface feature. The large bi-partite structure covered an area of 1120m^2, with 720m^2 represented by burnt remains (Fig. 4.31; for GIS data, https://doi.org/10.5284/1047599 Section 5_1_4). The Mega-structure was divided into two large areas – the Eastern, unburnt part and the Western part, partly burnt and partly unburnt. In the former, there were relatively few features, which could not be differentiated into earlier or later phases. By contrast, the latter was defined in the Eastern area primarily by a mass of burnt daub normally interpreted as the remains of the deliberate burning of the structure. The unpicking of the sequence of construction remains and destruction debris proved to be the principal challenge in the excavation. The stratigraphy of the burnt part of the Western part of the Mega-structure can be divided into four Phases: Phase 1 – pre-Mega-structure; Phase 2 – use of Mega-structure (Fig. 4.35 upper); Phase 3 – two phases (3 Lower and 3 Upper) of deposits representing the destruction of the Mega-structure (Figs. 4.32–4.33); and Phase 4 – the soil fill above the destruction deposits (for long section, see Fig. 4.37 upper) (cf. daub plot for Phases 2 and 3 combined: Fig. 4.34).

Four animal bone samples were recovered for AMS dating, one of which produced an unacceptable result in the centuries AD. Bayesian modelling of the remaining dates within the overall model for the site (see Chapter 4.8.6 and Fig. 4.62) indicates the highest probability of the Mega-structure's use covered 0–160 years, from 3970–3840 to 3900–3760 BC (all at 95.4% probability) (Fig. 4.38/2–5).

The following account focuses on the principal features of each Phase of the Western part.

4.5.1.1.1 Phase 1: Pre-Mega-Structure Features

There are currently three contexts indicating prior deposition in the area subsequently covered by the Mega-structure: a filled pit beneath the level of the base of the podium, a foundation deposit under a Platform and a post-hole below the central open area. These contexts indicate a minimal presence in the area where the Mega-structure was subsequently constructed – probably of less significance than the natural granite rockhead in this part of the megasite.

Figure 4.31: Kite photo of Mega-structure, Nebelivka: North to Right side; burnt area 36m East-West (by M. Houshold).

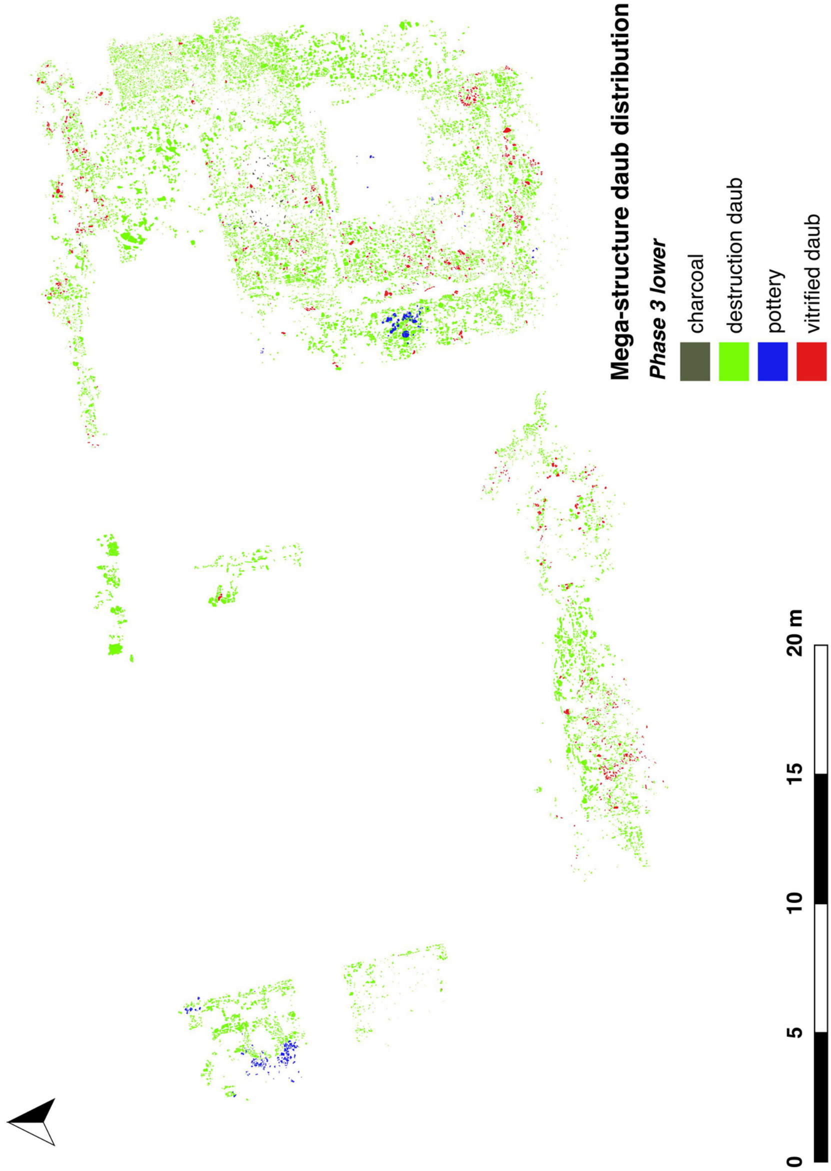

Figure 4.32: Digitised remains, Nebelivka Mega-structure; Phase 3 Lower (by M. Nebbia).

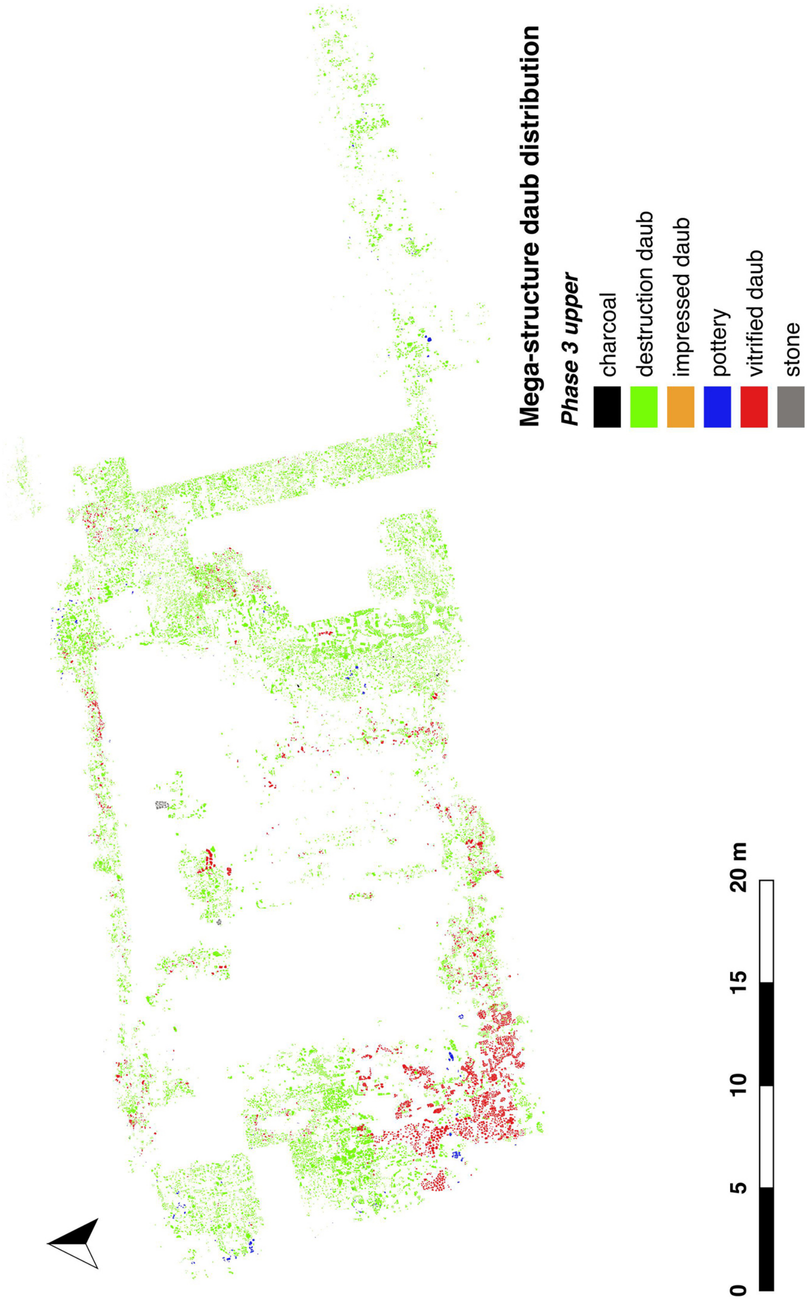

Figure 4.33: Digitised remains, Nebelivka Mega-structure; Phase 3 Upper (by M. Nebbia).

4.5.1.1.2 Phase 2: The Construction of the Mega-Structure

The digitisation of all the construction daub shows the overall features of Phase 2 of the Mega-structure (henceforth, 'East' and 'West' refer to parts of the built area) (Fig. 4.35 upper; cf. kite photograph Fig. 4.31). Linear daub concentrations indicated the place of external and internal walls. Parts of the East area and the West wall revealed fired clay ‘slots’ to support vertical planks (Fig. 4.35 lower). It remains doubtful that a roof or rooves covered the whole of the Mega-structure. The Eastern end has by far the most intensive concentration of daub, which is broadly similar to a burnt house *ploshchadka*. In two parts in the East area, evidence of two-phase construction consisted of a threshold which had been blocked in Context 236.

The initial interpretation of the complex stratigraphy of the Eastern part of the Mega-structure was based on a kite photo, allowing a bird’s-eye view of this rather large building (Fig. 4.31). This suggested that it consisted of seven somewhat irregular ‘rooms’. However, the experimental programme of building, burning and excavating of the Trypillia-like dwelling (see above, Chapter 4.4) made us reconsider many of our assumptions, including the interpretation of the Mega-structure. The complete digitisation of all features and destruction daub further reinforced the need for a fresh look into the possible layout of the Eastern part. Thus, what was initially identified from the kite photo as some kind of dividing lines suggesting the separation of space was outlined now with greater precision, revealing the existence of two large rooms (Fig. 4.35 upper). The ‘voids’ that were observed and documented during the excavations may derive from long-decayed sleeper beams that once formed the base of walls. The oblique voids or lines visible on the kite-photo that appear somewhat straightened on the digitized plan as a result of the regularisation of the geo-referencing may represent long-decayed, fallen timber uprights. Obliquely fallen timber was observed during the burning and excavating of the experimental house (Fig. 4.36).

The rest of the Mega-structure was closer in structure to the Assembly Houses as shown in the geophysical plots (Figs. 4.8–4.9), viz., a largely open structure surrounded by wattle-and-daub walls whose destruction daub has remained in place (most of the North Wall), fallen inwards (the Western part of the North Wall) or fallen outwards (most of the South and West Walls). The daub lines in the Western part suggest a corridor running along the West wall, probably roofed over. A reconstruction of the Mega-structure according to the British view shows these features intact (Fig. 4.38/1).

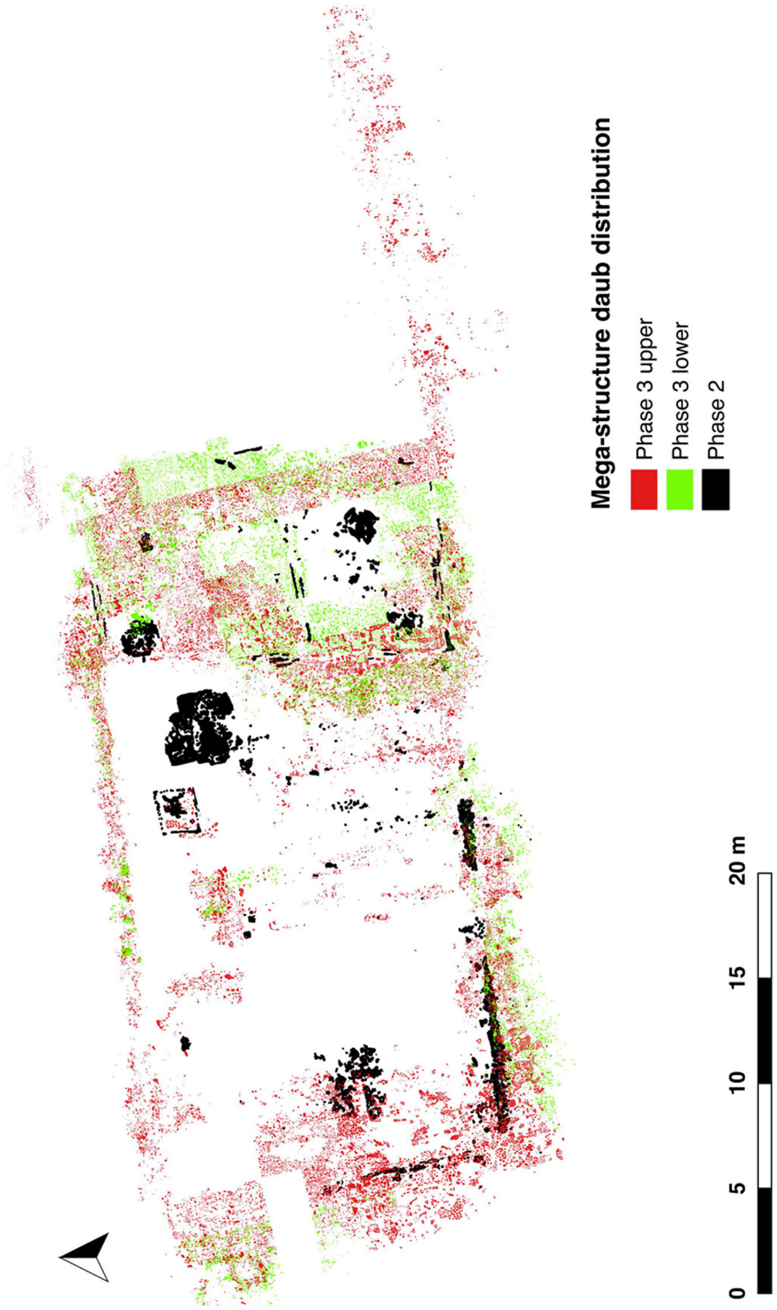

Figure 4.34: Digitised remains, Nebelivka Mega-structure; Phases 2 and 3 Lower & Upper (by M. Nebbia).

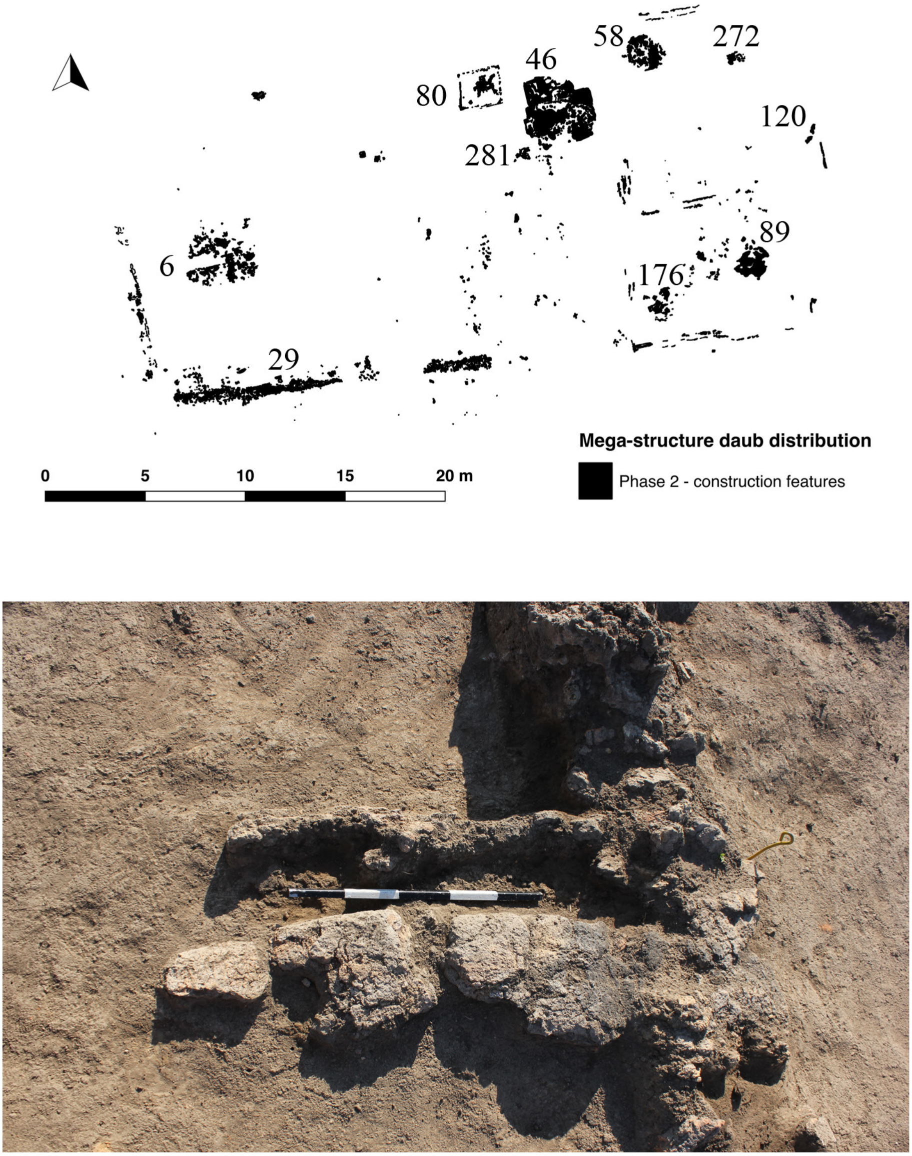

Figure 4.35: Upper: digitised remains, Phase 2. Key to Context Numbers: Fired Clay Bin – 80; Platforms – 6, 46, 58, 89, 176 & 272; Podium – 29; Threshold – 120; Platform 257 was excavated on the last day of Week 7 and therefore not digitised; it is found in Grid Square C21–22; lower: fired clay slot, Nebelivka Mega-structure (upper by M. Nebbia; lower by J. Chapman).

Figure 4.36: Burnt timber remains, Nebelivka Experimental Burnt House Excavation: upper: burnt timber fallen obliquely, Context 419; lower: timber void, Context 226 (by J. Chapman).

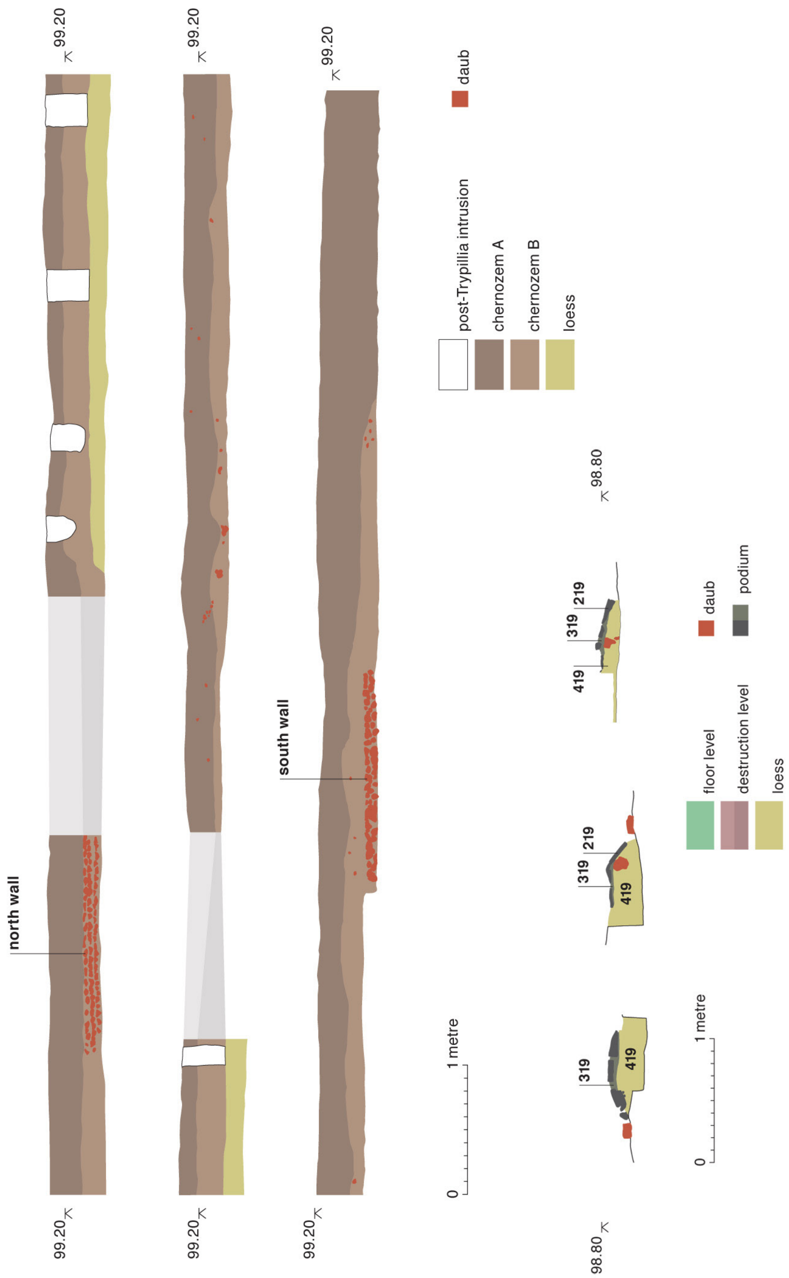

Figure 4.37: Upper: long North-South section (the width of both walls reflects daub tumble out from the walls); lower: three sections across podium, Nebelivka Mega-structure (by C. Unwin).

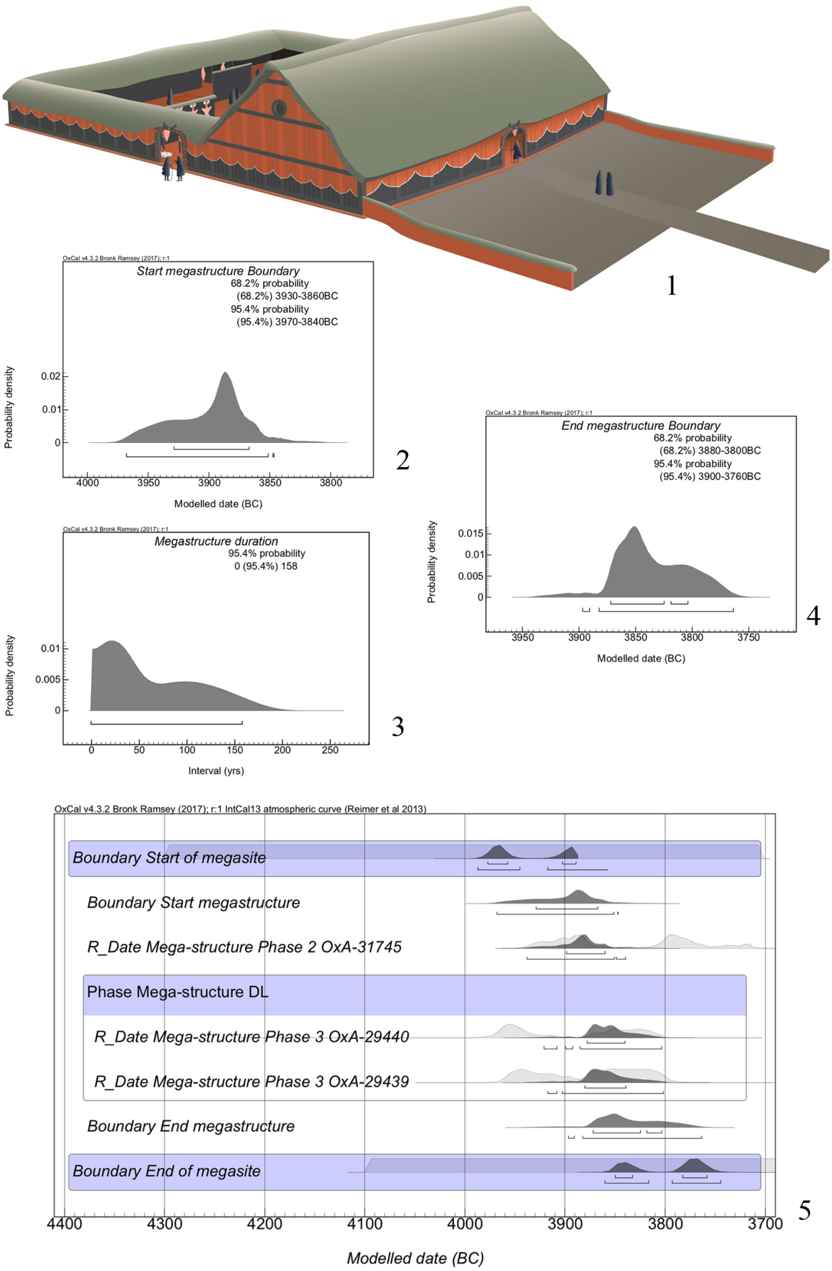

Figure 4.38: (1) Durham reconstruction; (2)–(5) Bayesian plots of AMS dates, Nebelivka Mega-structure (1 by C. Unwin; 2–5 by A. Millard).

A total of 10 interior features was found in the Mega-structure (Fig. 4.35 upper). All of these features were sufficiently well preserved to indicate construction on the ground floor rather than a upper floor construction followed by a fall to the ground floor. The first feature comprised a 2m-long dark-fired clay threshold in the Eastern end of the building, near massive daub fragments probably representing a monumental superstructure of the East entrance. The slope of 0.25–0.30m from the open unburnt part of the Mega-structure to the burnt area enhanced the dramatic effect of this entrance. This means that anyone approaching the Mega-structure from the East side would have been confronted by a 2m ± high wall, with a possibly monumental entrance at the top of a slope.

A 10m-long fired clay 'podium', an estimated 15cm high, was built along the inside edge of the South wall. The podium was built of clay (Contexts 319 and later 219) on a sandy loess-derived soil (Context 419) (Fig. 4.37 lower). The upper surface of the podium became cracked as a result of the fire, as happened with the Platforms. In most parts of the podium, the daub slabs were found beneath destruction daub (Phase 3), showing that the South wall fell on top of the podium. However, in one area (Context 161), the finding of podium fragments above wall daub shows a reversal of the usual sequence.

Eight fired clay Platforms of various sizes had been built up with two to four layers of fired clay, some decorated with incised motifs or a red painted wash. The total of eight Platforms in the Mega-structure is unprecedented for Trypillia buildings. Two of the four Platforms placed inside the East end rooms were found in each room (North room – Platforms 58 and 272; South Room – 89 and 176), while the remaining four were built in the central open space (Platforms 6, 46, 257 and 281). Since there were no signs of burning on the Platforms, it is suggested that they were not used as hearths or fireplaces but, rather, for temporary displays of special items during Mega-structure ceremonial.

Very few objects remained on the upper surface of the Platforms – exceptional finds were the two animal bones placed on Platform 6. However, the largest Platform 46, at 3.6m × 3.5m, shows evidence of the incorporation of cultural material in its construction. The lowest layer was built on yellow loess (Fig. 4.40). Each successive Platform layer of sandy clay was slightly larger than its preceding one. The basal Platform layer contained one large and two tiny animal bones; old, worn, small sherds, daub and Platform daub were found in the body of the second layer (Fig. 4.46/3).

Platform 89 was the most highly decorated; it was lifted by a team led by the conservator Stanislav Fedorov and moved for reconstruction and display in Kirovograd Historical Museum (Fedorov 2015). Platform 281 was the smallest and most fragmented, with a diameter of 0.5m, and lay so close to the largest platform (Context 46) that it may have been made in a different time-interval.

Figure 4.39: Upper: general view from East; lower: Stage 4 placement of vessel from North; Fired Clay Bin, Nebelivka Mega-structure (by J. Chapman).

Figure 4.40: Platform 46 from East, Nebelivka Mega-structure (by J. Chapman).

The multiplicity of the Nebelivka platforms showed a complex, changing sequence of creations designed to stage ritual performances in the Mega-structure. These performances varied according to the size and setting of the Platforms, whether located inside or in the open courtyard. Perhaps no more than six persons would have stood round Platform 281, while up to fifty participants could have encircled Platform 46 (Figs. 4.40 & 4.46/3). The four expansion phases of Platform 46 combined a commitment to place over an as yet undefined temporality presenced by old objects with the desire to create increasingly impressive visual effects. However, at the end of the ceremony, most offerings were removed, either by the Nebelivka ritual leaders or by those who had brought the offerings there in the first place, to presence the Mega-structure by retention of objects sanctified by their participation in the performance.

A large fired clay 'bin' was constructed near the largest Platform; according to the field observations of one of the authors (JCC), it enjoyed a long and complex biography in ten stages, which did not include the storage of grain (Fig. 4.39):

– Stage 1: after clearing and flattening of the area to form a stamped floor, a low fired clay wall was made in what appears to be a continuous manner;
– Stage 2: a clay surface was constructed, which was found cracked as in a Platform, possibly over the whole of the walled area but perhaps in the central area only;
– Stage 3: the construction of the central fired clay feature – an altar or a pillar? – up to 10cm high. This feature has been so badly damaged that no original walls were left. The primary use of this feature then followed.
– Stage 4: some time after the stamped floor was made, a large vessel was placed in the South-West corner (Fig. 4.39 lower) but the dark brown fill between the vessel and the floor suggests this was not at the start of Stage 2.
– Stage 5: traces of burning on the daub fragments around the central feature, on the feature itself and on the Stage 2 cracked clay surface must have occurred before the general collapse of the Mega-structure.
– Stage 6: the collapse of the central feature onto the cracked clay surface (Stage 2), with burnt daub falling onto the cracked clay surface and possibly even the stamped floor. This also must have occurred before the general destruction of the Mega-structure.
– Stage 7: The infilling of the now-disused bin with dark brown fill mixed with sherds and daub fragments up to the level of the top of the central feature.
– Stage 8: following this infilling, the bin was 'closed' by the placing of a complete, upside-down grindstone in the North-West corner (Fig. 4.39 upper).
– Stage 9: a daub scatter related to the destruction of the Mega-structure was deposited over the surface of the infilled bin, perhaps at the same time as the grindstone surface was cracked by the temperature of the fire.
– Stage 10: in post-Trypillia times, the bin suffered damage by animal burrows, while plough damage removed the top of the bin and the top of the large vessel in the South-West corner.

This biography of a fired clay bin shows a temporality to which we rarely have access in the megasite. Although the time dimension is not defined, the stratigraphic sequence shows three main phases: a construction phase and an abandonment phase, both occurring before the destruction of the Mega-structure.

4.5.1.1.3 Phase 3: The Destruction of the Mega-Structure (Figs. 4.32–4.33)

There is a fundamental assumption that Trypillia houses have been burnt down deliberately at the end of their lives (Kruts, 2003; Burdo et al. 2013; Chapman 2015). However, the distribution of fired clay daub across the Mega-structure is by no means continuous nor always massive, revealing patches of dense, often vitrified daub, zones of medium density daub with little or no vitrification and areas of low-density daub with no traces of vitrification (Fig. 4.41). These findings emphasise the combination of 'dwelling-house destruction' (the East end) and 'Assembly House destruction' (the central area and West end), so far unique in the Trypillia world. There seems little doubt that there were major variations in the temperature at which different parts of the Mega-structure burned down (see Shevchenko, Chapter 4.9). This may have been a by-product of the conditions of the fire or perhaps the different burning strategies designed to burn different areas in different ways.

According to one of the author's field observations (JCC), stratigraphic evidence from more than 10 contexts showed the covering of the Phase 2 living surface of the Mega-structure with a thin layer of dark soil prior to the first daub destruction deposits. The features where the thin soil layer was found include the podium, two Platforms and the fired clay bin. It seems probable that this soil was derived from the local chernozem and blew into the Mega-structure over a period of time whose duration is currently difficult to assess. The suggestion is that a Mega-structure that was relatively open may have been abandoned for a period of time before it was burned down.

The digitisation of all destruction daub led to the insight that there were two stratigraphic stages of destruction daub – here termed Phases 3 Lower (Fig. 4.32) and 3 Upper (Fig. 4.33; cf. combined Fig. 4.34). These data show that different parts of the Eastern block, the North wall, the Western block and the Southern area fell 'earlier' than other parts of the building. However, these two stages of mostly wall collapse may well have happened during the same destruction event, as indeed happened during the recent house-burning experiment at Nebelivka (see Section 4.4).

In Chapman's view, there were three stages in the biography of the Mega-structure's destruction: (1) the temporary or permanent cessation of social practices inside the building; (2) a period of as yet unknown duration allowing the build-up of thin levels of chernozem-derived soil layers within the Mega-structure; perhaps the Mega-structure was not used in this period; (3) the burning and collapse of the building to produce the *ploshchadka*.

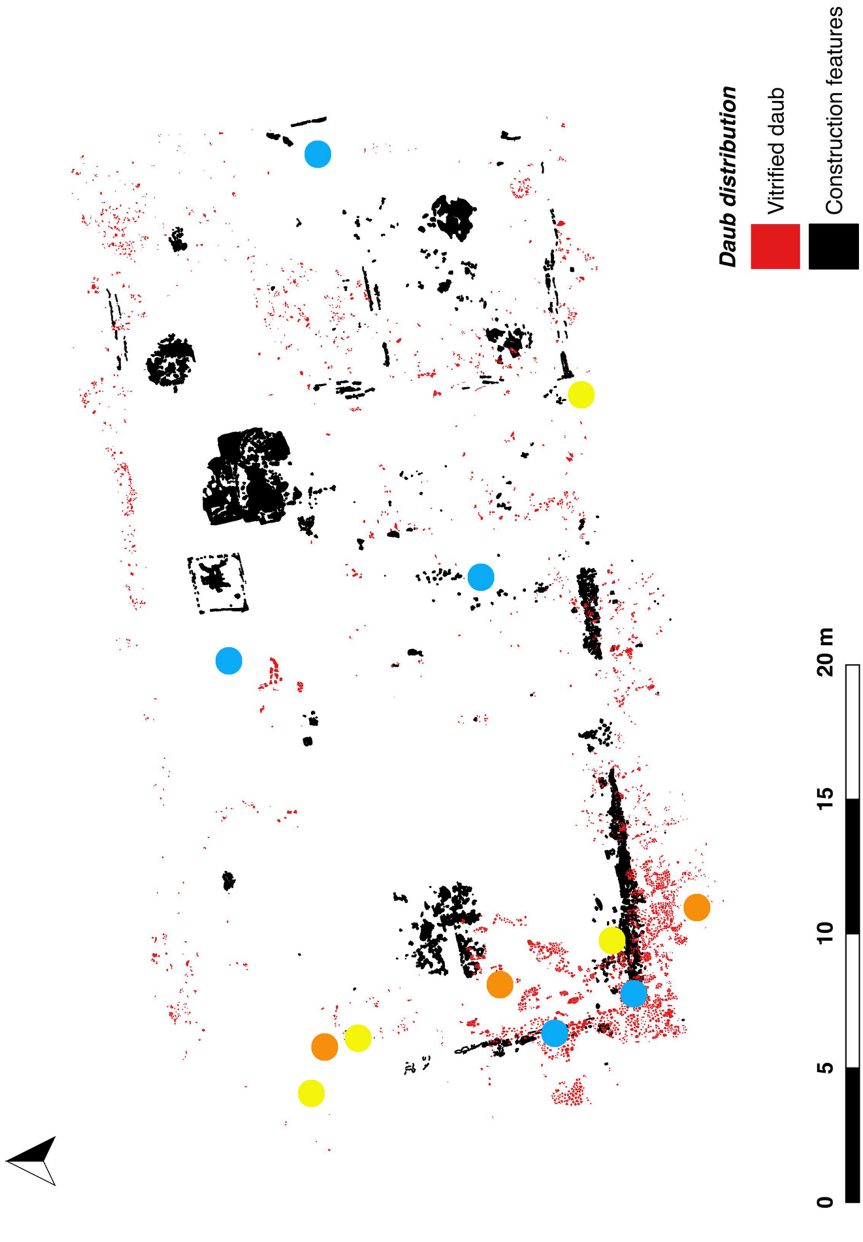

Figure 4.41: Plot of daub firing temperatures and vitrified daub, Nebelivka Mega-structure (by M. Nebbia based upon information from N. Shevchenko); Colour Key for daub firing temperatures: blue: 200–400°C; yellow: 400–900°C; orange: >900°C.

4.5.1.1.4 Phase 4: After the Destruction of the Mega-Structure

The main characteristic of the period after the burning of the Mega-structure was a period of chernozem formation indicating an absence of cultural activity above where the Mega-structure once stood. Some 0.80–1m in thickness, this soil covered the entire megasite and was possibly partly caused by secondary erosion of loess blown into the site in the historic period. One can suppose that this period of soil formation was, at the same time, a period of little local deposition of artifacts or ecofacts; any finds in the post-Trypillia chernozem horizon would constitute an internal residue *sensu* Kuna (2015) (see above, p. 53).

The ploughing of the soil above the megasite in general, and the Mega-structure in particular, was so deep as to leave traces of furrows in the top of the *ploshchadka*. It is this modern ploughing that has removed a large quantity of Trypillia pottery from its original location and created a large and varied plough-zone ceramic assemblage of at least 1,500 sherds with Total Station recording. The best guess that we can make for the source of this plough-zone assemblage is near the top of the *ploshchadka* – a notion that would lend support to Burdo et al.'s (2013) view that there was much deposition on the burnt remains of Trypillia houses, viz., on the top of the *ploshchadka*. Such deposition may have included the large number of unburnt bones found within the destruction layer, which may have been deposited *on* the house after the destruction event, only to become included in the daub layer by subsequent disturbance. The demonstration of the deliberate deposition of objects would represent secondary refuse *sensu* Schiffer (1987).

4.5.2 Interpretation

A consideration of the principal features of the Mega-structure suggests that the basic elements of the Trypillia house have been borrowed and adapted to fit the great size of what remains a public building but one without the depositional characteristics of a ritual or administrative centre. The layout of the rooms and internal features in the Mega-structure do not fit any of the 'typical' domestic house layouts as defined by Chernovol (2012, Fig. 8.8). Korvin-Piotrovskiy (2015) proposes two alternative interpretations of the Mega-structure: the first, which he favours, is a complex of related domestic structures with household functions; the second as a ritual complex of seven rooms, each with an altar for an extended family. Instead, we propose that the Mega-structure was a monumental public building (Fig. 4.38/1), visible from several km on the South part of the micro-region, which created the potential for major congregations of several hundred people within the open courtyard in the Eastern part and the inner Central area of the Western part. The multiplicity of platforms was a result of the varied social groups (clans or lineages rather than families) participating in Mega-structure ceremonies. The destruction of the Mega-structure by fire would have been one of the great ceremonial manifestations of the

Trypillia world - impacting on the lives of both Nebelivka inhabitants and visitors to the megasite. Offerings to the dead building may well have continued for years after the fire as a contribution to cultural memory and the heightened place-value of the Mega-structure. The Mega-structure can be perceived as a microcosm of the entire megasite, with its built-up space contrasting with the open inner areas in the same way as the megasite combined an inner, open area with an outer, dwelling area.

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4.5.3 The Barrow[56]

Barrow burials were common in the Eurasian steppe zone from the late 4th millennium BC onwards (Ivanova 2014), with examples known from the forest-steppe zone of South Central Ukraine. Many barrows were identified and recorded in the Nebelivka fieldwalking programme (see Chapter 3.2). While few of the Ukrainian barrows have been excavated, the earliest date to ca. 3200 BC, indicating an overlap of several centuries with the latest Trypillia settlements (dating to 29/2800 BC).

The single barrow found on the area of the Nebelivka megasite is therefore likely to post-date the megasite by 500 years to a millennium – and maybe even longer (see below, p. 250ff.) (Ivanova, S. 2015). It was located ca. 65m from the closest house – the innermost burnt house in an inner radial street in Quarter F – and marked the ancestral (Trypillia) transition from inhabited area to inner open congregational space. The barrow was 16m in diameter and rose 2.2m from the current ground surface (Fig. 4.42). Looting of the barrow in the 1980s left a large rectangular pit excavated to a depth of 3m. The North profile of this pit was cleaned and prepared for geoarchaeological recording and sampling to a depth of 3.5m.

The South-facing section of the test pit (https://doi.org/10.5284/1047599 Section 5_7_2_2) showed the following stratigraphy (Table 4.14).

Worthy of particular interest was the fact that the buried A horizon did not resemble the deep chernozem A horizon of the current soil mantle. This could point to environment changes in the locale during and since the megasite occupation took place, or be an artefact of the considerable surface modification of the buried A horizon prior to burial by the building of the mound.

56 See https://doi.org/10.5284/1047599 Section 5.7.

Figure 4.42: General view of Nebelivka barrow from South-West (by J. Chapman).

Table 4.14: The barrow stratigraphy (by S. Ivanova).

Layer	Description
5	barrow fill – sediments identical to present chernozem B horizon (1.4m thick)
4	no clear sign of spoil removed from burial pit; traces of black and yellow inclusions suggest this occurred at a depth of 0.6m from top
3	post-Trypillia buried occupation layer in the form of a black chernozem A horizon – uneven with varied thickness (up to 10cm thick) and subjected to *in situ* trampling; different morphology from that of current chernozem A horizon
2	Trypillia-age buried soil – light brown chernozem with small pieces of yellow daub (60–65cm thick)
1	sterile yellow loess (sampled to a thickness of 1.1m)

The analysis of molluscan assemblages from the barrow profile suggests that grassland-type habitats have dominated the immediate location in poorly dated but in any case Holocene sediments deposited since the late Pleistocene (viz., the loess stratum). *Vallonia excentrica* dominates nearly every sample, and there are notable absences of many snail species indicative of climax Holocene forest. Indeed snail diversity seems slightly higher earlier in the Holocene, with the assemblages potentially indicative of a mix of established grassland and colonising woodland. By the time of the megasite, and probably significantly earlier, snail faunas became less diverse, and indicate uniform grassland over a significant local area. This finding is potentially linked with the important discovery that chernozem formation had already taken place on the Nebelivka promontory by the time of the megasite occupation (see Section 4.1.2).

The discovery of a fragment of a Greek imported amphora dated to the Early Iron Age in the intra-site gridded collection (see above, p. 80) can be interpreted in at least two ways: (a) this sherd dates a visit to the Nebelivka promontory by a group using imported pottery who then built the barrow and discarded the sherd; or (b) the amphora-using group visited the promontory and discarded the sherd in awe of an ancestral barrow to which they could visually relate as part of their 'heritage'.

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4.6 Excavations, Durham Side

Bisserka Gaydarska, Marco Nebbia & John Chapman

4.6.1 The Test Pits[57]

Preliminary test pit excavation of two test pits was started in the 2009 season, with a view to testing the precision of the geophysical investigation of apparently burnt houses; four more test pits were dug in 2012. The success of the 2009 and 2012 test pit trials (https://doi.org/10.5284/1047599 Section 4.8) led to the excavation of a further 82 test pits – 41 in 2013 and 41 in 2014/15 (Fig. 4.43). Not only did the test pit excavations produce vital organic samples for AMS dating but they proved to be a major source of information about techniques of house construction and the taphonomy of house-burning. The excavations also contributed to a large sample of Trypillia pottery, many animal bones and a range of special finds. All three types of house were investigated through test-pitting – burnt houses, unburnt houses and Assembly Houses (Fig. 4.44). Those Assembly Houses which were test-pitted showed few finds and low concentrations of destruction daub (e.g., Test Pit 27/3: Fig. 4.50/3).

57 See https://doi.org/10.5284/1047599 Section 5.3.

Figure 4.43: Distribution of all excavated areas, Nebelivka (by M. Nebbia).

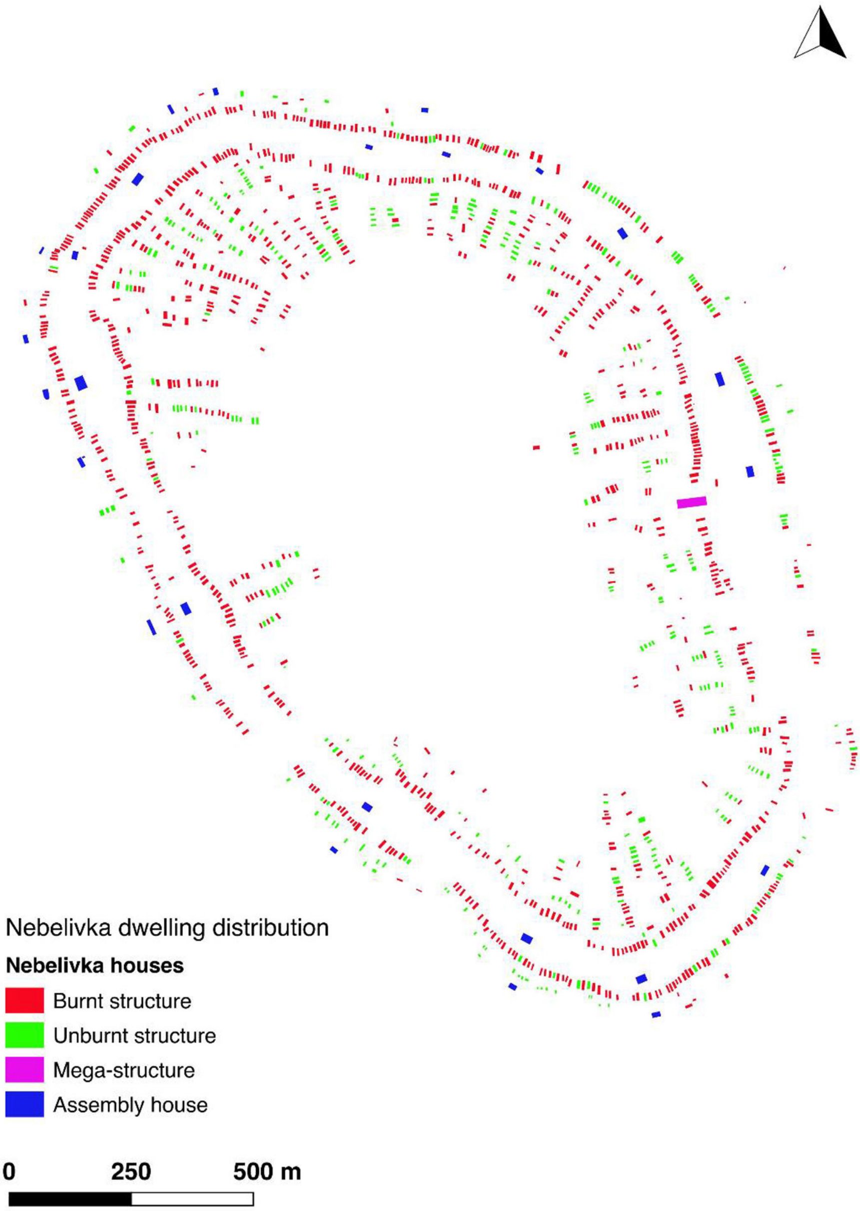

Figure 4.44: Distribution of burnt houses, unburnt houses and Assembly Houses (by M. Nebbia).

The recording of the test pit excavations followed a standard format, with pre-defined contexts for ease of comparability. Five contexts were defined according to the 'standard' stratigraphic sequence (from top to bottom) (Fig. 4.45). The depths of the test pit stratigraphies are shown below (Fig. 4.47).

- Context 1: the ploughsoil, equivalent to the A horizon of the chernozem soil.
- Context 2: the lower part of the ploughsoil, where it can be distinguished by colour and texture from Context 1. In the rare cases where no destruction daub was found, the Context 2 unit could be very deep (e.g., Test Pit 26/7, where Context 2 is 0.25–0.6m in depth);
- Context 3: the destruction daub which resulted from the burning of the structure. This was sometimes a single layer but there were many examples of two layers of destruction daub (3 Upper, 3 Lower) and occasional examples of three layers (3 Upper, 3 Middle, 3 Lower).
- Context 4: the living surface or floor level of the structure. In an earlier excavation (2013 season), we had misinterpreted the lower layer of destruction daub as a solid baked clay floor; in fact, there were very rare examples of a solid floor level, with most structures having a stamped earth living surface. Instead of ascribing separate Context numbers to fired clay features (e.g., boxes) or dug features (e.g., pits), these were described with the site-wide Context numbering system but with descriptors such as Context 4/Feature 1.
- Context 5: the deposits which pre-dated the construction of the excavated structure. Standard practice was to excavate 20cm below the base of Context 4, although deeper finds were occasionally made. In the case of Contexts where daub and pottery was scattered, it was generally inferred that material from the living surface had been pressed down into a marginally lower level (e.g., Test Pit 26/2). However, those rare Contexts where features were encountered or larger quantities of daub and pottery were found (e.g., Test Pit 24/4) were taken to indicate pre-construction activity in that part of the megasite.

Soil micro-morphological investigations of a burnt house (Test Pit 1/3) and an unburnt house (Test Pit 1/4 – Sondazh 5, 2014: Burdo & Videiko 2016; https://doi.org/10.5284/1047599 Section 5.2.3) showed some surprising results. The section of Test Pit 1/4 was predominantly composed of chernozemic soils and had little evidence of anthropogenic modifications. However, in contrast to the burnt house, this test pit had far less burnt daub but, interestingly, more abundant microscopic charcoal. Although daub is present, it was in smaller quantities than in the burnt house. Furthermore, the daub fragments appear less rubified, possibly indicative of lower firing temperatures. These observations have implications for how house architecture and burning are understood at Nebelivka. Furthermore, the larger abundances of charcoal in the 'unburnt' house as opposed to the burnt house are significant for understanding contextually variable taphonomic processes at the megasite. One resolution of this issue is that the weak anomalies interpreted as 'unburnt' houses

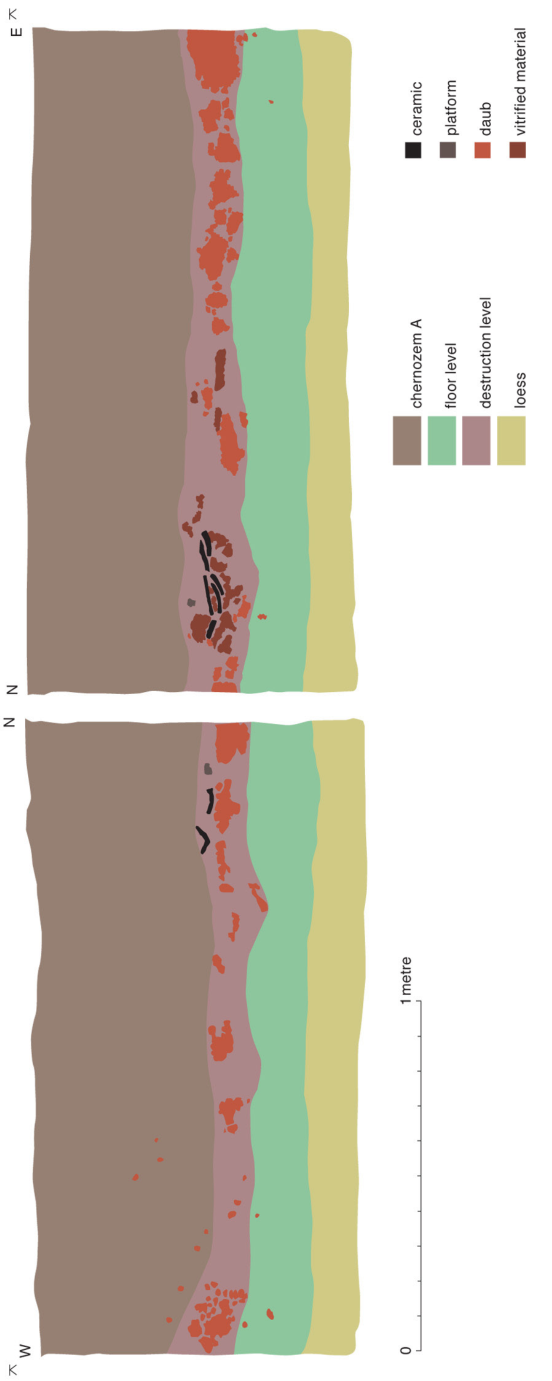

Figure 4.45: Typical Test Pit stratigraphy, Test Pit 26/6, Nebelivka (by C. Unwin).

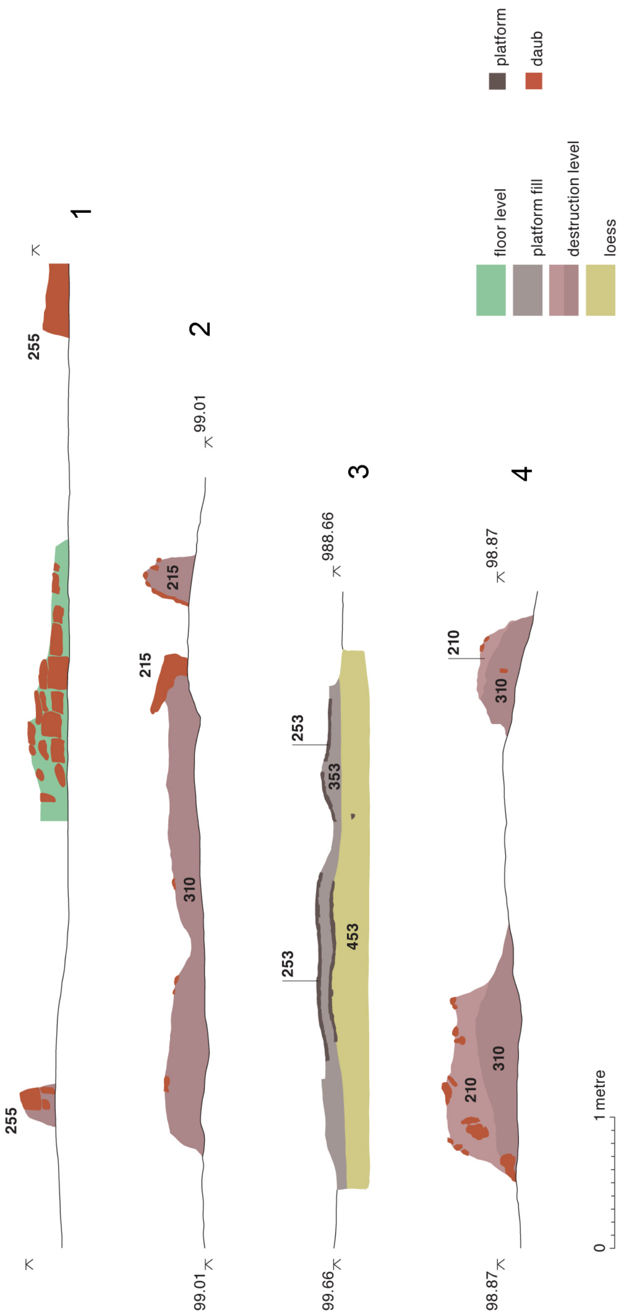

Figure 4.46: Sections across (1) Fired Clay Bin; (2) Contexts 215 & 310; (3) Platform 46; and (4) Contexts 210 and 310 (by C. Unwin).

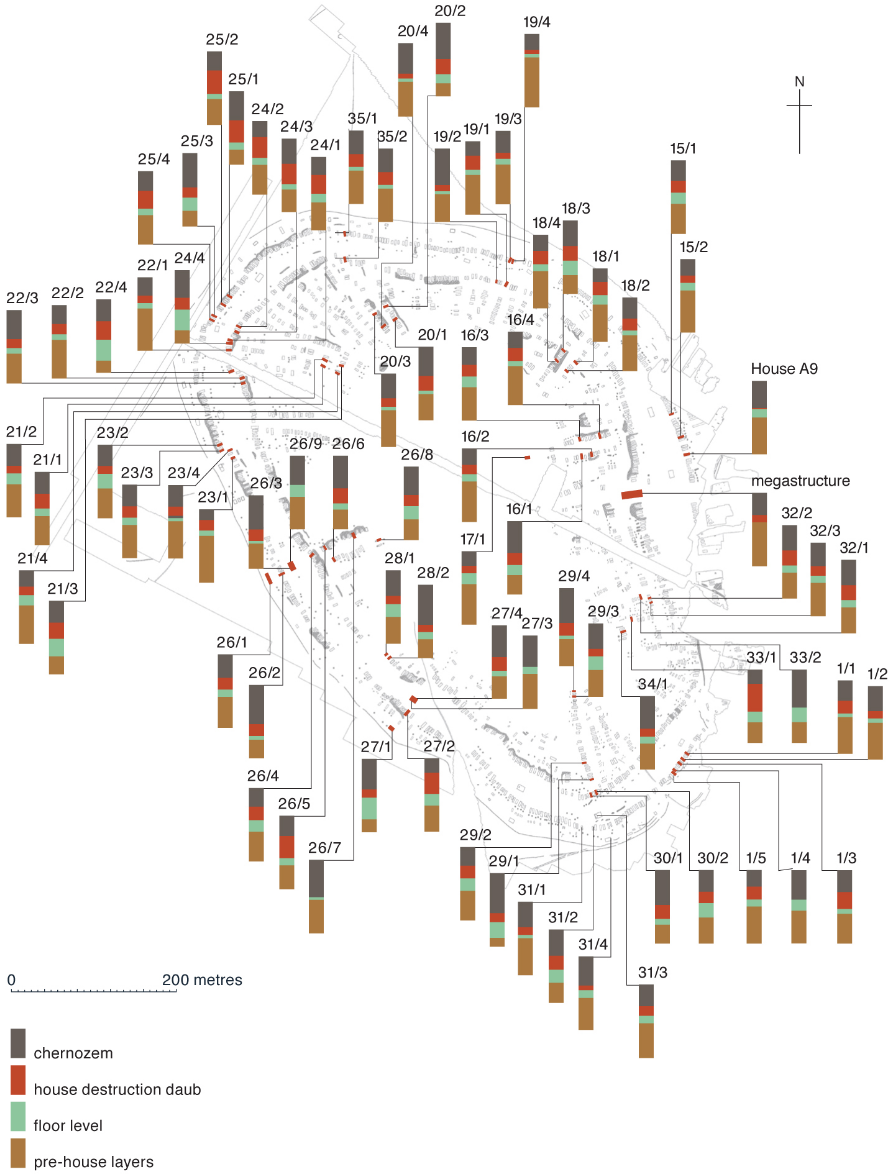

Figure 4.47: Depth of burnt houses in excavation units and Test Pits (by C. Unwin).

may reflect structures burnt at lower temperatures which were insufficient to destroy all of the charcoal but also too low to create daub that survived six millennia of *krotovina* or other soil processes.

The test pits subsumed much architectural variation, partly caused by the location of the test pit in a particular place in a house. Houses were divided into nine 'zones' and the location of the test pit was recorded. However, few cases of a significant difference at the 0.1% level were found in any chi-square test assessing the importance of the position of the Test Pit in a specific House Zone. One exception is the discovery of vitrified daub – generally regarded as a sign of a 'hot-spot' in a house fire. Almost ⅔ of all vitrified daub came from test pits located in the centre of the house (Zone 9) – a finding related to the concentration of added timber fuel placed in the centre of the house. However, there is no correlation between test pit zone and the discovery of either decorated daub or construction daub from living floor features such as podia or bins.

A self-defining feature of burnt houses in the test pits was the presence of often large quantities of destruction daub (e.g., Test Pit 15/2: Fig. 4.48 lower). Conversely, the so-called 'unburnt' houses contained no destruction daub (e.g., Test Pit 26/7) or very few small fragments (e.g., Test Pit 1/4: Fig. 4.50/1). While unburnt houses showed no level of destruction daub, up to three levels were found on some houses but two levels of destruction daub were more common than three (e.g., Test Pit 33/1, with two levels: Fig. 4.49 upper).

An important feature of one in nine investigated burnt houses was the production of a low mound of burnt debris which survived in test pit sections (e.g., Test Pit 24/4: Fig. 4.50/4). These mounds would have remained visible on the surface for some time after the collapse of the house, marking the place of the former house and preventing any further building on the place. We can term these mounds 'memory mounds', since they preserved the memories of the long-dead house into the future, preventing the abandonment of the megasite from becoming a loss of memory. The slow accumulation of memory mounds across the megasite effected a gradual transformation of the site from a living site into a site where the living and the dead were more in everyday contact.

An important question for the megasite was the ratio of one- to two-storey houses on the site as a whole and in different Quarters. The experimental programme showed that the discovery of scattered platform daub meant it may have fallen from an upper floor, viz. of a two-storey house, while *in situ* platform daub built on the living floor indicated the existence of a one-storey house (see above, Chapter 4.4). Close study of the distribution of *in situ* and scattered platform daub in 38 of the test pits (Fig. 4.51) showed that the majority of these test pits contained insufficient fragments of platform daub to determine clearly that they had fallen from an upper floor.

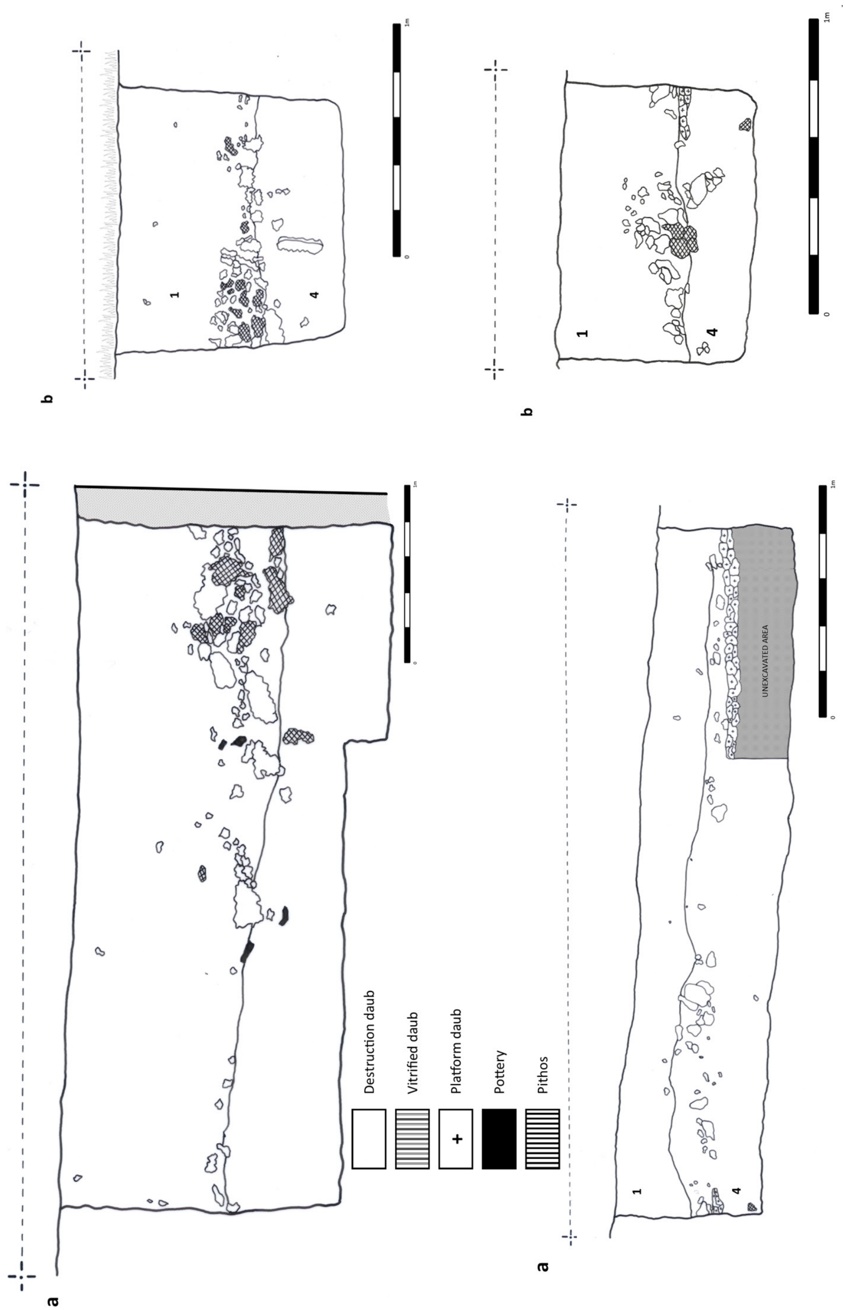

Figure 4.48: Upper: section of thick pile of destruction daub, Test Pit 13/3; (a) South-facing; (b) East-facing; lower: sections of platform below destruction daub, Test Pit 15/2; (a) East-facing; (b) South-facing (by L. Woodard). Numbers in Figs. 4.48–4.50 refer to general pit stratigraphic sequence in Fig. 4.45.

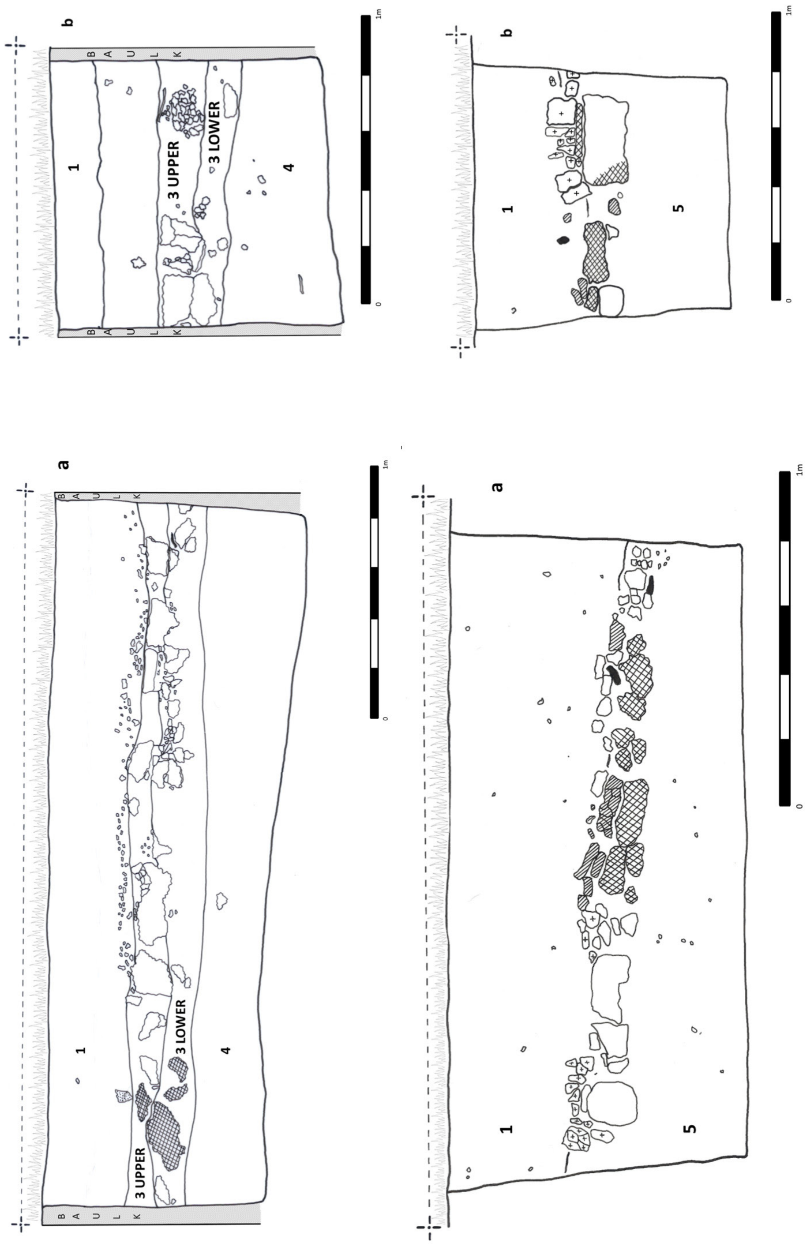

Figure 4.49: Upper: sections of two well-defined layers of destruction daub, Test Pit 33/1; (a) SSE-facing; (b) WSW-facing; lower: sections of two-storey house with platform above destruction daub, Test Pit 26/5: (a) West-facing; (b) North-facing (by L. Woodard).

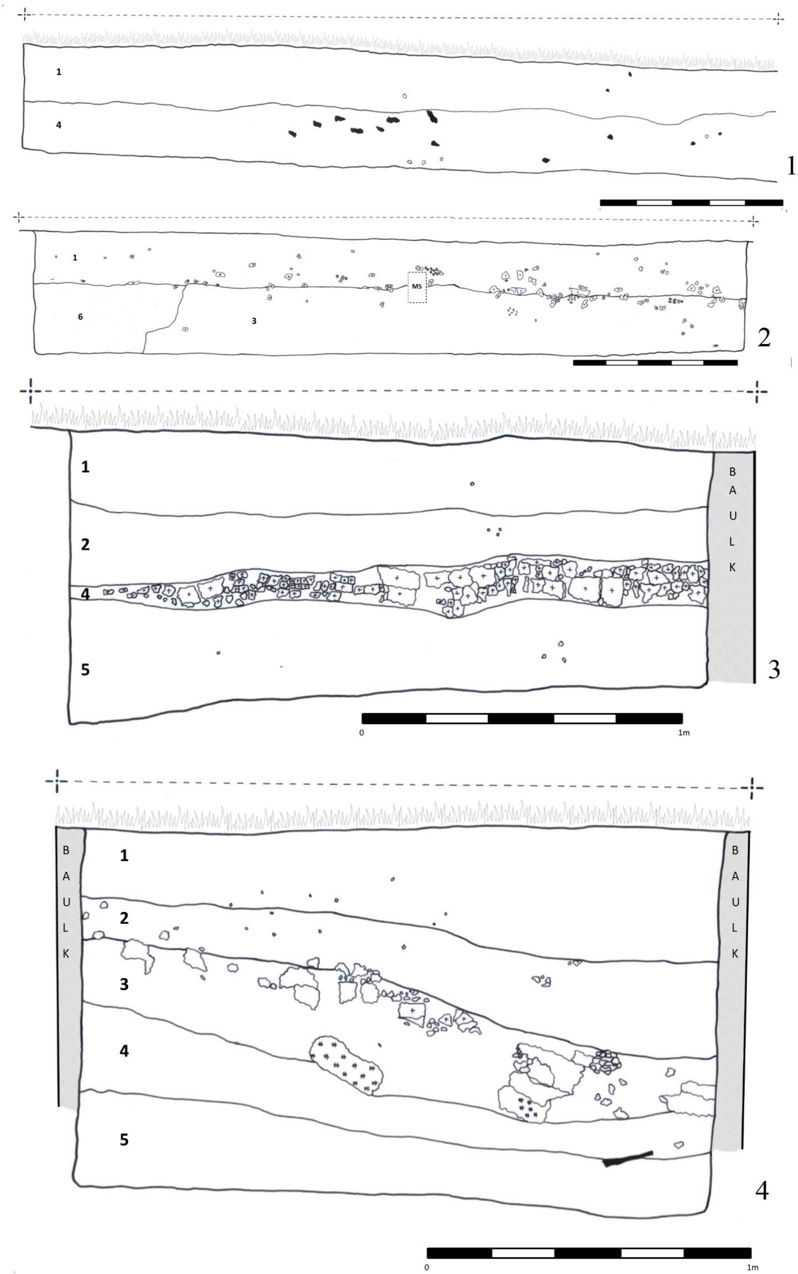

Figure 4.50: (1): West-facing section of unburnt house, Test Pit 1/4; (2): North-facing section of burnt house with platform daub with pit under floor, Test Pit 17/1; (3) SW-facing section of platform in Assembly House, Test Pit 27/3; (4) section of mound of burnt house debris, Test Pit 24/4; (a) ESE-facing; (b) NNE-facing (by L. Woodard).

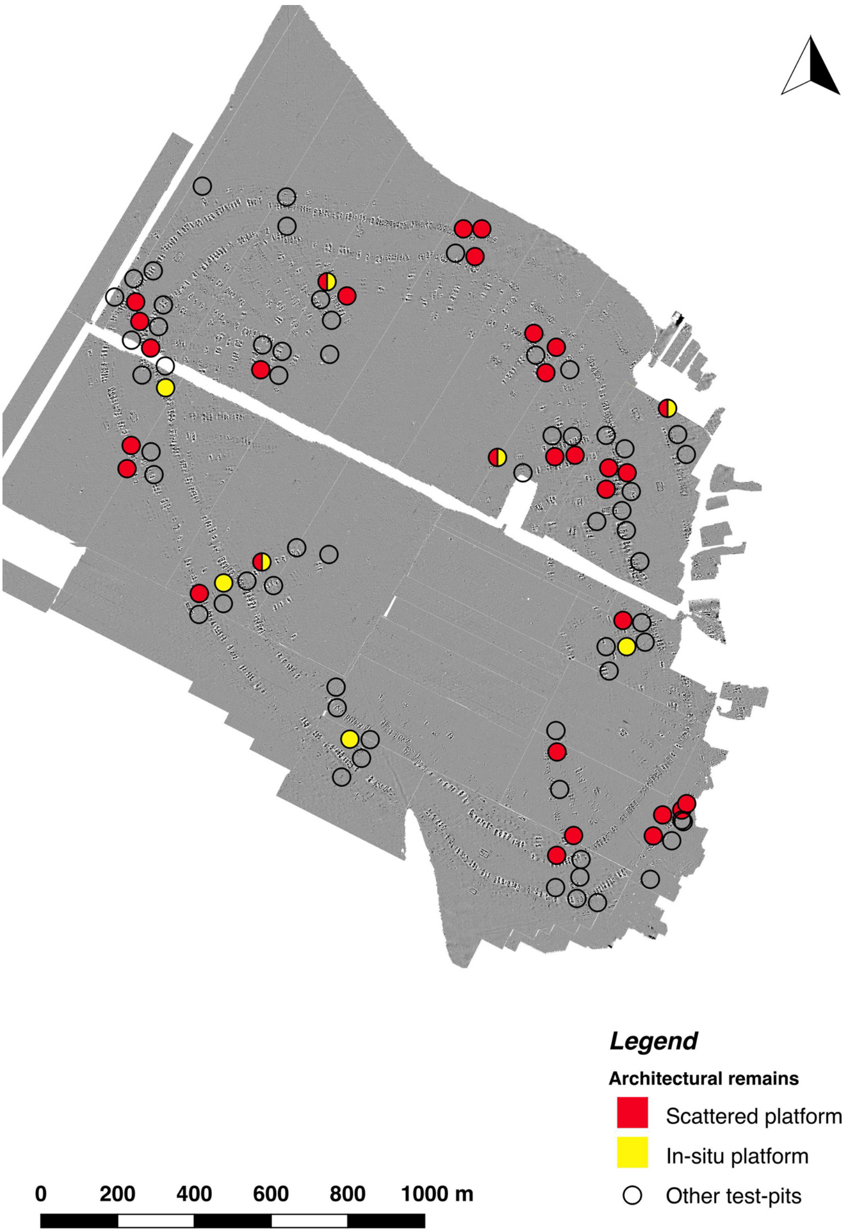

Figure 4.51: Distribution of Test Pits with *in-situ* vs. dispersed platform daub (by M. Nebbia).

Detailed consideration of the type, fragmentation and location of platform daub can give valuable indications of the kind of house in which the daub had fallen. Unusually, there were signs of *in situ* platform daub in two 'unburnt' house (Test Pits 29/3 and 33/2), with the former containing only a single piece of platform daub. This suggests one-storey houses with platforms constructed on the ground floor. A second case – this time of two test pits with scattered platform daub (Test Pit 1/1 and 19/1) – showed platform fragments that had fallen from an upper floor, with the implication of a two-storey house. A third case found in three or four further test pits showed that scattered daub had probably fallen from an upper floor, again with the implication of a two-storey house. The fourth and final case showed four test pits with both types of platform daub – *in situ* and fragmentary – but with opposite results. In Test Pits 15/2 (Fig. 4.48 lower) and 17/1 (Fig. 4.50/2), *in situ* daub showed the existence of a platform built on the living floor but with plough or other post-depositional processes causing the scattering of daub from this feature. By contrast, some of the platform daub that had fallen from the upper floors in Test Pits 20/2 and 26/5 (Fig. 4.49 lower) fell into concentrated areas of daub resembling an *in situ* platform. These examples show how careful structural and contextual analysis can unpick the collapse sequence of a burnt house. Very rarely do we find stratigraphic evidence for the most obvious indication of a two-storey house – two layers of destruction daub separated by platform daub – (e.g., Test Pit 26/5: Fig. 4.49 lower).

The variation in numbers of destruction daub layers (Fig. 4.52) gives an idea of the complexity of the house destruction process, with multiple layers suggesting walls falling on top of each other. The distribution of test pits with these varying numbers shows some regional and some zonal differences. There are no examples of three layers in the South-West half, with all four examples in the North-East part. In terms of zones, there was a clear domination of houses with two layers in the inner radial streets, while houses with one and two layers were evenly distributed in both house circuits. The inner circuit was the only zone lacking examples of no layers at all. The various destruction processes implied by this finding may suggest the prevalence of some modes of burning over others in the inner radial streets compared to the house circuits, although this is not a categorical difference.

These results indicate that we can still distinguish between one- and two-storey houses on the basis of the distribution of platform daub where there are good quantities of such material. This suggests that, where such a judgment was possible, many more two-storey than one-storey houses were found in the test pit houses, with an estimated ratio of 5:1.

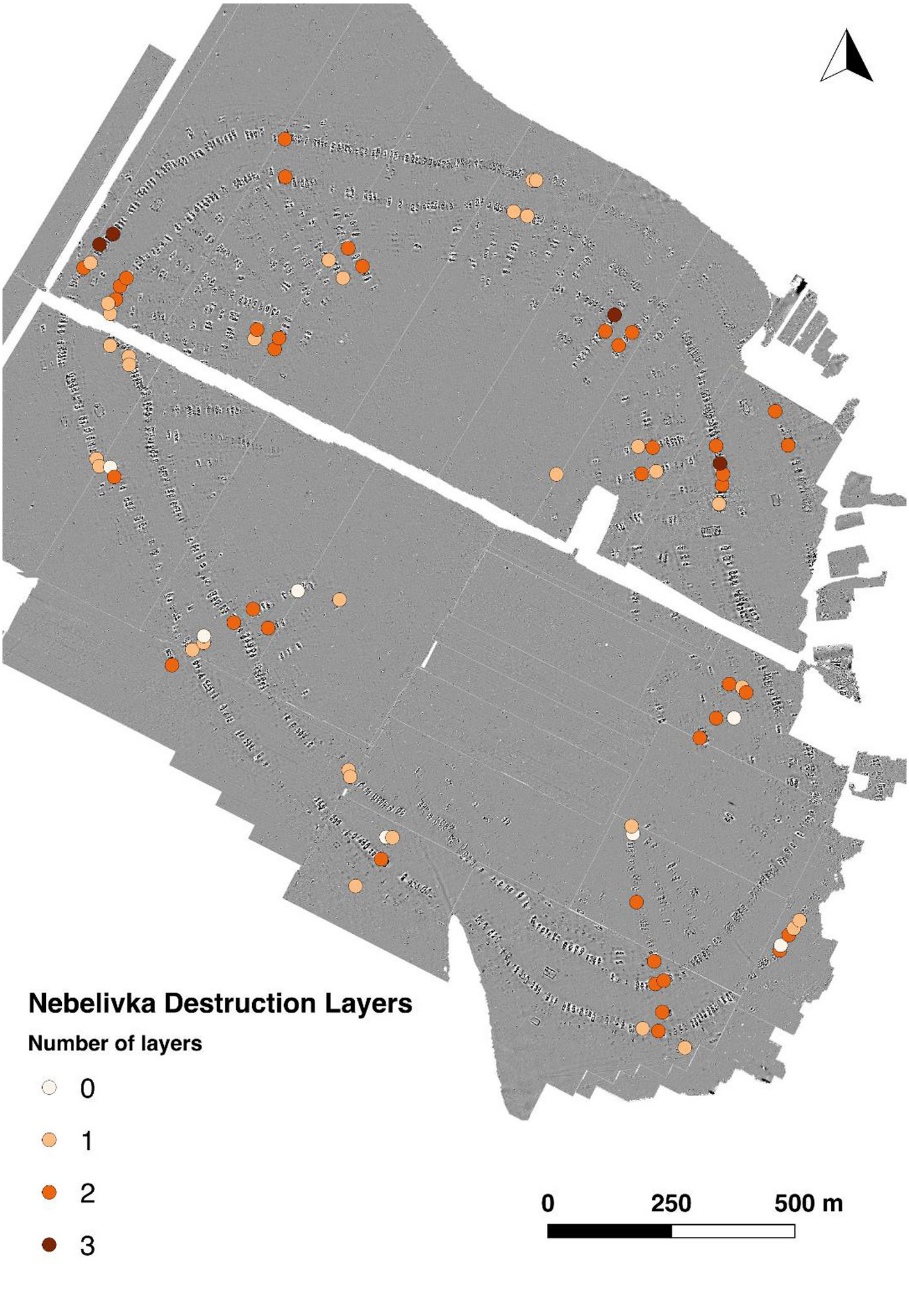

Figure 4.52: Distribution of number of layers of Destruction Daub by Test Pit (by M. Nebbia).

The manner in which Nebelivka houses were destroyed has been discussed in terms of a dichotomy – unburnt vs. burnt (see above, p. 128). Although Roe (above, pp. 76–80) has noted a statistically significant difference between the proportion of burnt houses in the main house circuits over the inner radial streets, it is possible to investigate the distribution of ‘unburnt’ (or, better, ‘poorly fired’) houses at a Neighbourhood level (Fig. 4.54 lower). Using a sample of six Quarters containing 80 Neighbourhoods, it can be shown that four Neighbourhoods contain only poorly fired houses, 31 Neighbourhoods contain only burnt houses and the remainder – a majority at 60% – contain a mixture of burnt and poorly fired houses. A division of these Neighbourhoods by Quarter shows that, in comparison with the mean proportion of mixed destruction practices, people living in one group of Quarters (F, I and N) tended to select mixed practices less frequently (ca. 40%) while mixed practices were much more frequent (ca. 80%) for those living in the other Quarters (B, C and L). The higher the proportion of mixed house firing practices, the greater the potential differentiation between houses in terms of labour control and timber/fuel acquisition.

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4.6.2 The Pit in Sondazh 1[58]

Sondazh 1, a trench measuring 6.70–6.95m East – West by 3.97–4.07m North – South, was set over a large geomagnetic anomaly, which turned into a pit so large that it required two seasons of excavations (2013 & 2014). In the South wall of the trench, an identical profile to that found in Sondazh 2 was encountered: an A horizon to 0.45m depth, with a B horizon dominated by carbonate in-washing to a depth of 1m (Fig. 4.53).

The first 40cm from the surface were excavated over the entire area in two 20cm spits. Although there were sherds in both layers, clear concentrations of archaeological materials and pit boundaries were not identifiable. This imposed a change of excavation strategy, with subdivision of the trench into a North and a South sector and identification of finds concentrations to define the blurred edges of the pit. A combination of factors – collapsed pit walls in the past, ‘sinking’ of dense material in the loess, later re-cuts and very intensive animal burrowing activity (*krotovina*) – contributed to a situation whereby the ‘original’ pit walls were difficult, if not impossible, to define and archaeological materials were found ‘outside’ the pit.

58 See https://doi.org/10.5284/1047599 Section 5.4.

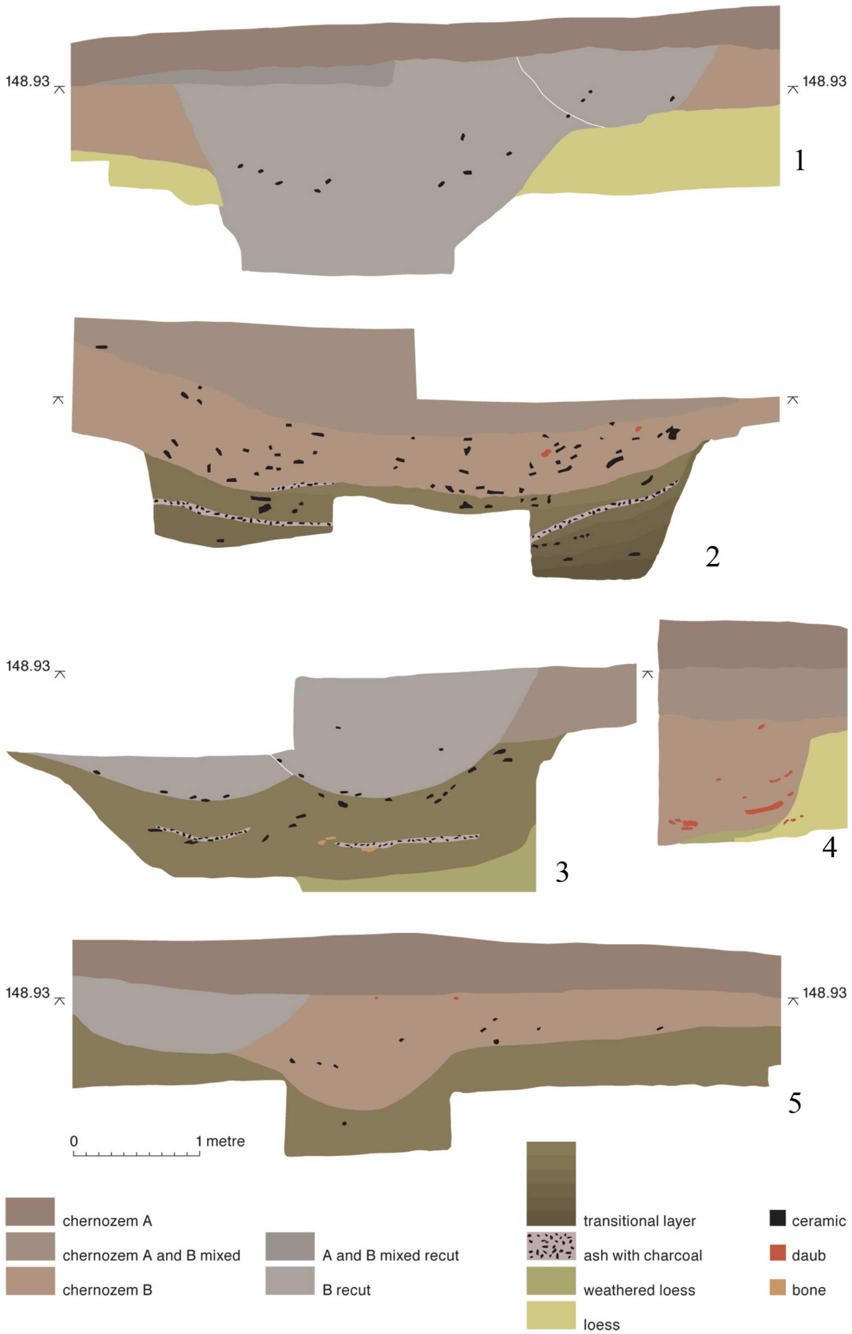


Figure 4.53: Sections of Pit, Sondazh 1: (1) East-facing; (2) West-facing; (3) East-facing; (4) South-facing; (5) West-facing (by C. Unwin).

A consideration of the pit stratigraphy prompted a division into five ‘Stratigraphic Units’ (SUs), numbered 1 to 5 from the earliest to the latest (Table 4.15).

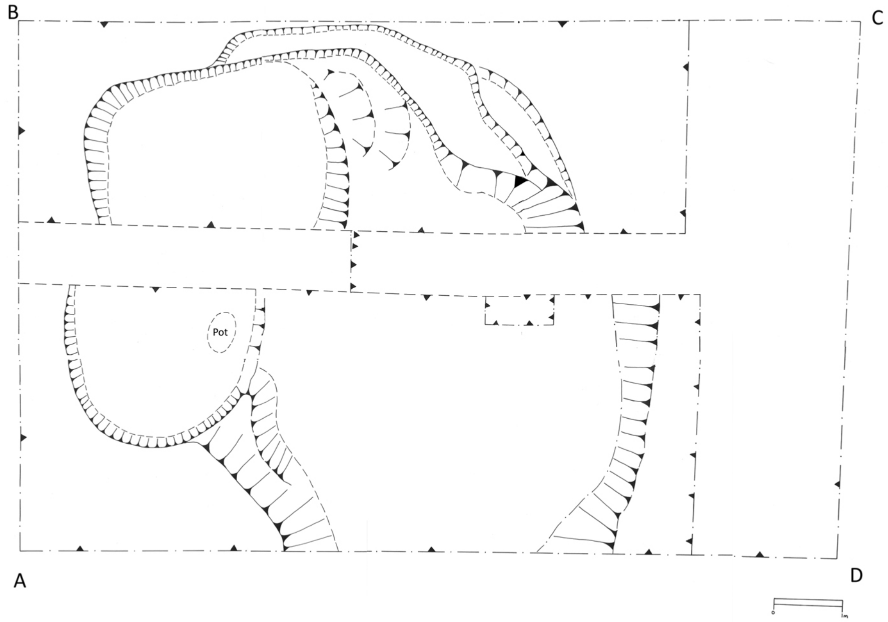
Table 4.15: Stratigraphic division, Pit, Sondazh 1 (by J. Chapman).

Strati-graphic Unit	Relative depth from Trench Datum (m) (Level depth (cm))	Fill	Depth of Episodes from surface (m)
5	1.75–0.44 (148,25–149,56)	Chernozem A horizon (topsoil); much of this deposit is a post-Neolithic soil build-up and therefore containing material ploughed up from the uppermost pit layer, including one anthropomorphic figurine.	No Episodes could be recognised in this SU.
4	2.3–1.75 (147,75/70–148,25)	Crumbly black-brown fill in all Zones, with the uppermost fill representing the top of the pit in Trypillia times. The largest number and diversity of Episodes (n = 16), with occasional examples of only bone or only pottery, but often the combination of pottery + bone + chipped stone+ daub; 10 anthropomorphic figurines.	Zone NE/ 1.83–2.01 (148,17–147,99) Zone NE/ 1.84–2.11 (148,16–147,89) Zone NE/ 2.2–2.33 (147,8–147,67) Zone 2&3/ 1.95–2.06 (148,05–147,94) Zone 2&3/ 1.95–2.25 (148,05–147,75) Zone 2&3/ 1.96–2.27 (148,04–147,73) Zone 3/ 1.84–1.96 (148,16–148,04) Zone 3/ 2.01–2.14 (147,99–147,86) Zone 2/ 1.99–2.09 (148,01–147,91) Zone 2/ 2.13 (147,87) Zone 1/ 1.75–1.85 (148,25–148,15) Zone 1/ 2.05–2.15 (147,95–147,85) Zone 1/ 2.11–2.2 (147,89–147,8) Zone 1/ 2.15–2.24 (147,85–147,76) Zone 1/ 2.15 (147,85–147,85) Zone 1/ 2.19–2.21 (147,81–147,79)
3	2.65–2.3 (147,35–147,75/70)	Crumbly black-brown fill in all Zones; eight Episodes with more varied deposits, including a *Bos* horn-core, 13 anthropomorphic figurines, grindstones, chipped stone, other bone, charcoal and daub, as well as much pottery.	Zone NE/ 2.31 (147,69) Zone NE/ 2.34–2.52 (147.66–147,48) Zone 3/ 2.59–2.65 (147,41–147,35) Zone 2/ 2.3–2.4 (147,7–147,6) Zone 2/ 2.33–2.44 (147,67–147,56) Zone 1/ 2.32–2.44 (147,68–147,56) Zone 1/ 2.42–2.52 (147,58–147,48) Zone 1/ 2.55 (147,45)

Continued Table 4.15: Stratigraphic division, Pit, Sondazh 1 (by J. Chapman).

Strati-graphic Unit	Relative depth from Trench Datum (m) (Level depth (cm))	Fill	Depth of Episodes from surface (m)
2	2.8–2.18 (147,2–147,82)	Crumbly black-brown fill mostly in Zone 2; two Episodes, containing overwhelmingly pottery but no figurines.	Zone 1/ 2.5–2.59 (147,50–147,41) Zone 1/ 2.63–2.73 (147,37–147,27)
1	3.06–2.49 (146.94–147.51)	Basal part of two test boxes – one in Zone 1 and the other in Zone 2 – (2013), with lower part of fill in Zone 2 (2014); four Episodes, containing a very high proportion of pottery. one anthropomorphic and one zoomorphic figurine.	Zone 2/ 2.49–2.62 (147.51–147.38) Zone 2/ 2.5–2.4 (147,50–147,60) Zone 2/ 2.7–2.85 (147,30–147,15) Zone 2/ 2.93–3.06 (147,07–146,94)

In terms of the soil micromorphological study, the pit fill and the sediment into which it was cut resemble the natural Chernozem A and B horizons respectively. However, bio-cultural inclusions in the former distinguish it from all the other contexts included in the soil micromorphological study. In contrast to the anthropogenically-enriched fill, the sediment into which the pit was cut lacks any cultural inclusions and closely resembles the natural Chernozem B horizon. The pit fill resembles the Chernozem A horizon in terms of its structure, contents and common bioturbation. However, in contrast to the Chernozem or the house features, the fill has a far higher abundance of coarse organo-cultural inclusions, including burnt daub, decomposed sherds, unburnt bone, excrement and many large charcoal fragments. However, it is not clear whether these inclusions originate from the houses, which are largely devoid of such materials, probably because of good house-keeping (Miller et al. 2010). Among all the samples studied, the charcoal fragments are the most abundant and best preserved in the pit fill. The fragments appear to be concentrated in loose clusters, and often the larger fragments appear to be undergoing further *in situ* fragmentation and comminution. The virtual absence of charcoal from the natural B horizon also suggests that the charcoal has been confined to the fill and its origin may be traced to occupation activities in the surrounding area.



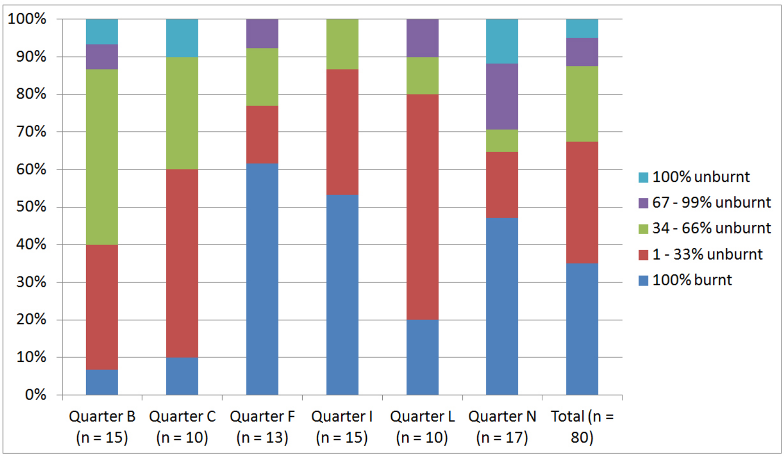


Figure 4.54: Upper: plan of base of pit; Pit, Sondazh 1 (by L. Woodard); lower: proportion of burnt and 'unburnt' houses by Neighbourhood and Quarter (by J. Chapman).

Structurally, the pit lacks observable micromorphological evidence for distinctive infilling episodes, whether because the samples did not capture transitional boundaries indicative of discreet infilling episodes, the pit was filled in a single event or bioturbation has homogenised structural variation beyond microscopic recognition. Nonetheless, concentrations of finds which we term 'episodes' were readily distinguishable from the background noise of low-level sherd discard. A total of 30 episodes was identified (https://doi.org/10.5284/1047599 Section 5_4_4_1_EPISODES), sometimes marked by indices of burning, with a high proportion of ceramic clusters and rather fewer concentrated animal bone deposits. These depositional episodes were created by cutting into the fill, placing material in the negative features and then re-filling it – often with the same material. Parts of the pit had little evidence for this re-cutting/re-filling cycle, while such cycles were common in other parts of the pit (Fig. 4.53). By far the higher frequency of Episodes came in the middle layers of the pit, especially in SU 4. The initial interpretation is that the beginning and the end of a fill episode was marked in material ways. Two AMS dates from the pit (a third sample had low collagen yield and a fourth date was an outlier) show an overlap at 1 sigma, and within the model for the overall duration of the site (see Chapter 4.8.6), OxA-29598 calibrates to 3950–3780 BC (95.4%) and OxA-29599 to 3940–3830 BC (74.4%) or 3820–3760 BC (21.0%) (Fig. 4.63/3). There are so few dates that a sensible estimated duration of pit deposition cannot be made. We can cautiously suggest that the pit was oval in shape at the base (Fig. 4.54 upper) and mid-depth, while its upper part was much larger and amorphous in shape.

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4.7 Excavations, Ukrainian Side

Mykhailo Videiko & John Chapman

4.7.1 Ditches[59]

4.7.1.1 Introduction

At Nebelivka, the perimeter of the site covers a linear distance of ca. 5.9km, of which 76% (ca. 4.5km) was available for geophysical investigation. The geophysical plot shows a single ditch over much of the available perimeter, specifically the North, West and South sides of the settlement; erosion down the steeper slope of the East side probably removed traces of the ditch in that area (Figs. 4.3 and 4.4). A triple ditch appeared to show up in the South part of the geophysical plot, in Quarter L, and was confirmed by excavation (Sondazh 10).

59 See Chapman et al. (2016); https://doi.org/10.5284/1047599 Section 5.6.

There are 13 well-defined gaps in the well-preserved parts of the perimeter ditch, with the width of the smallest gap being 10m and the largest 180m. Since there were no geological or pedological reasons to cause the magnetometry to miss existing stretches of ditch in these Quarters, we can assume that these gaps were genuine and thus resemble the kind of porous perimeter boundary well known to British prehistorians in the class of monument known as the 'causewayed enclosure' (*aka* 'interrupted ditch enclosure': Mercer 2006; Whittle et al. 1999).

4.7.1.2 Ditch Coring

The initial exploration of the oval linear anomaly took place by coring and trial excavation in 2013. The first core was placed in the North-East part of the linear anomaly and reached a depth of 5.50m, without hitting any obvious ditch fill. Instead, there were two principal deposits in the core: a lower reddish silty clay deposit 1.79m in width (4.29m–2.50m) and an upper off-white silty clay deposit 1.80m in width (2.50m–0.30m). Informal testing of these clays showed that both were suitable for pottery-making. It is currently hard to explain how such thick clay deposits came to be present in a feature that may have been a ditch.

The second core through the linear anomaly was placed in the North-West part of the megasite. At the base of the 4.50m-deep core, a buried chernozem C horizon had developed over 1.10m (4.50–3.40m), with a 1.40m-thick deposit of alluvial clay above the first C horizon (3.40–2m). Above the alluvial clay, a typical chernozem sequence developed with an A, a B and a C horizon. Intriguingly, the contents of both cores into the so-called 'ditch' differed markedly from each other, as did the types of clay found in the two cores.

4.7.1.3 Sondazh 2

This sondazh was laid out over a linear geophysical anomaly just North of Sondazh 1. Despite two extensions, no signs of a ditch profile were encountered (https://doi.org/10.5284/1047599 Section 5.6.1 SONDAZH_2_S-facing_profile). This meant that a priority for excavation in summer 2014 was at least one section cut across the linear anomaly.

The initial excavation of sections across the Northern part of the perimeter ditch (Sondazh 4) and its Southern part (Sondazh 10) was accomplished by the Ukrainian side using ambitiously large trenches (Sondazh 4: 22 × 5m; Sondazh 10: 15 × 2m). In both trenches, the geophysical plans proved accurate guides of the location of the ditches but in neither trench were the ditches as deep as had been expected.

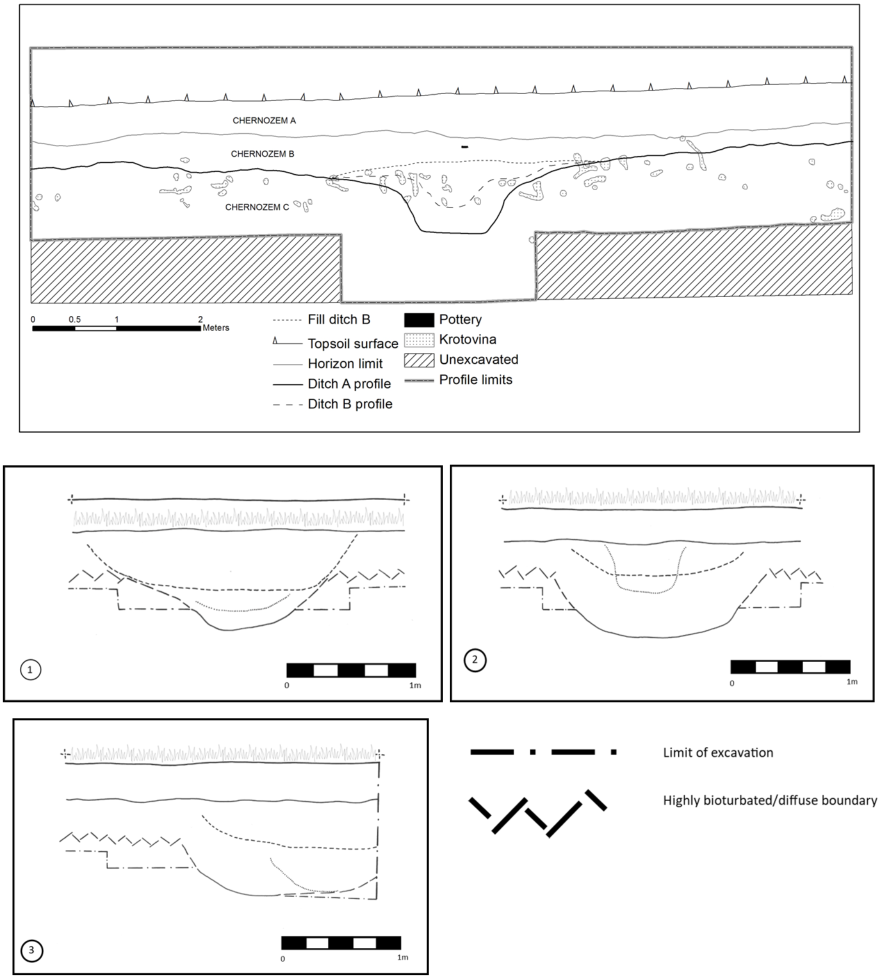

Figure 4.55: Upper: North Ditch profile from South-East; lower: Triple Ditch profiles 1–3 from East (by L. Woodard).

4.7.1.4 Sondazh 4

Trypillia sherds were recorded from the middle and upper fill of the Northern ditch, as well as from the cultural layer above the ditch, but not in the lowest fill, where daub was encountered; no animal bones were recovered from within the ditch. However, daub was also found outside the ditch in the supposedly 'natural' sediments. The width of the Northern ditch segment was ca. 1.5m, while there was considerable debate about the depth of the Northern ditch exposure, with different views recorded on Vince Cherubini's section drawing (Fig. 4.55 upper). While the shallower depth was believed to be 1.30m, the deepest ditch line was considered to be closer to 1.50m. Analysis of molluscs retrieved from bulk samples from the ditch fill indicated a distinctive habitat which persisted for some time – for example; an open, gradually infilling ditch, mainly dry, but holding significant pockets of moisture, with thick/long grasses and other herbaceous plants, perhaps sparse trees, but in a landscape dominated by short grassland. Thus the debate over whether this shallow ditch contained a palisade has not entirely been settled, although there were no post-holes visible to document this kind of feature.

4.7.1.5 Sondazh 10

This sondazh was laid out across an area in which three parallel ditch sections were indicated by the geophysical plot (https://doi.org/10.5284/1047599 Section 5.6.3 SONDAZH_10_Plan). Each ditch was recognizable but their depths were less than the shallowest interpretation of the Northern ditch segment, in no case exceeding 1m in depth (Fig. 4.55 lower). One Trypillia sherd was found in the middle fill of Ditch 1, with one sherd loosely associated with Ditch 3. One animal bone sample was recovered from near Ditch 3 for AMS dating but proved to have insufficient collagen.

The interim conclusion is that the shallowness of the ditch segments in the Northern and Southern areas was not commensurate with a defensive ditch but, rather, a marker of an enclosed space.

Mykhailo Videiko & John Chapman

4.7.2 House A9[60]

In the first season of geophysical investigations (2009), parts of the Outer and Inner House Circuits defining the Nebelivka plan were revealed, enabling the choice of a dwelling house (A9) for complete excavation during that trial season. The contours of the excavated house rubble coincided closely with the archaeo-magnetic plot, which showed a narrower Southern part and a wider Northern part of the dwelling. In some cases, a geophysical anomaly was registered even where parts of the house were totally destroyed by ploughing. The total excavated area was 236m², with a recording grid set to 2 × 2m (Fig. 4.56). The remains of the building consisted of burnt daub found at depths of 0.25–0.4m. The investigated area was on a slope and the difference in height between the ends of the burnt daub was up to 1.3m (Fig. 4.57). The burnt daub scatter had a rectangular shape and was nearly 18m in length and 4.5–5.6m in width. This area consisted of two daub scatters of different dimensions:

60 See Chapman et al. 2015; https://doi.org/10.5284/1047599 Section 5.2.1.

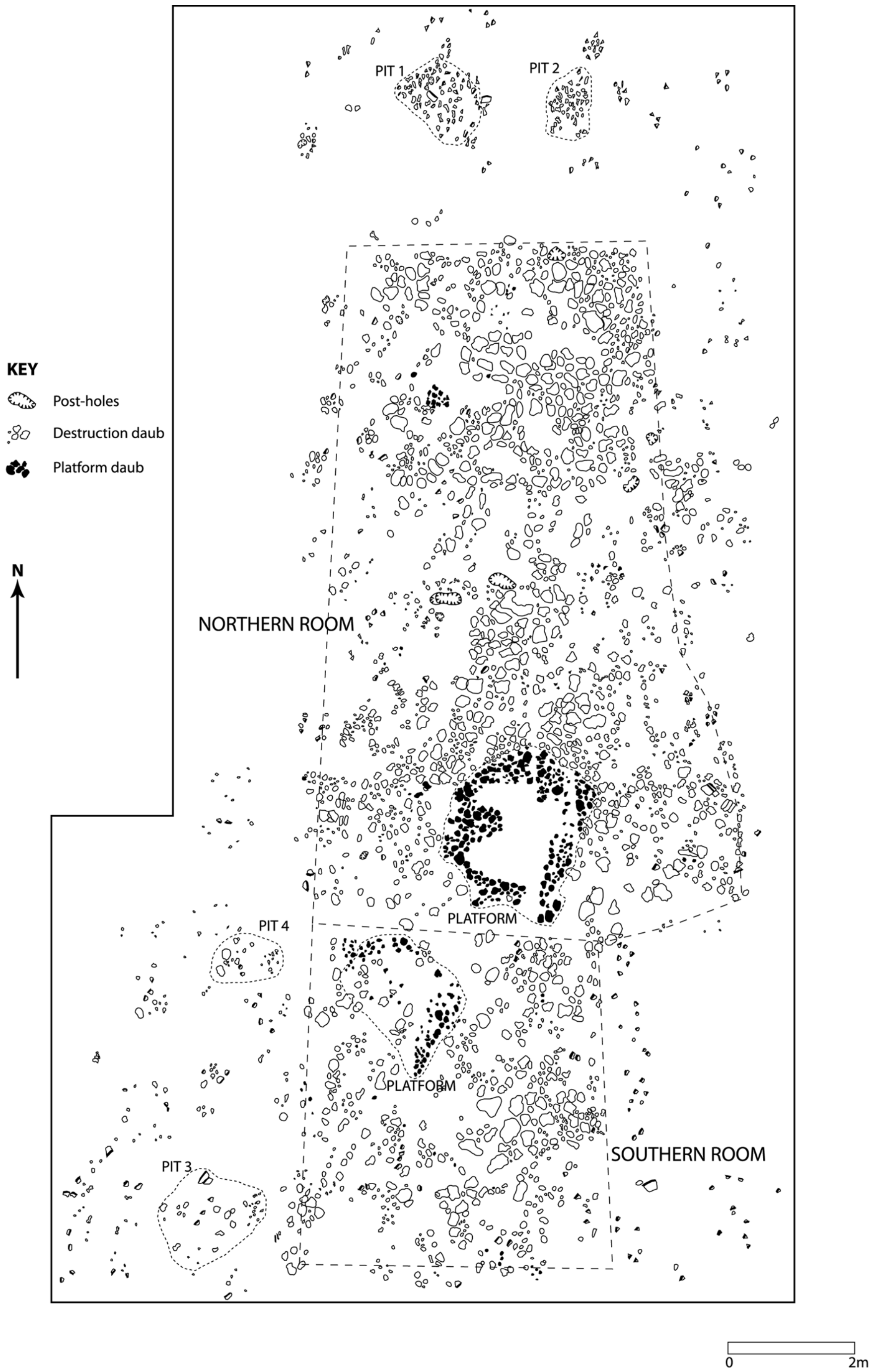

Figure 4.56: Plan of House A9, Nebelivka (by L. Woodard).

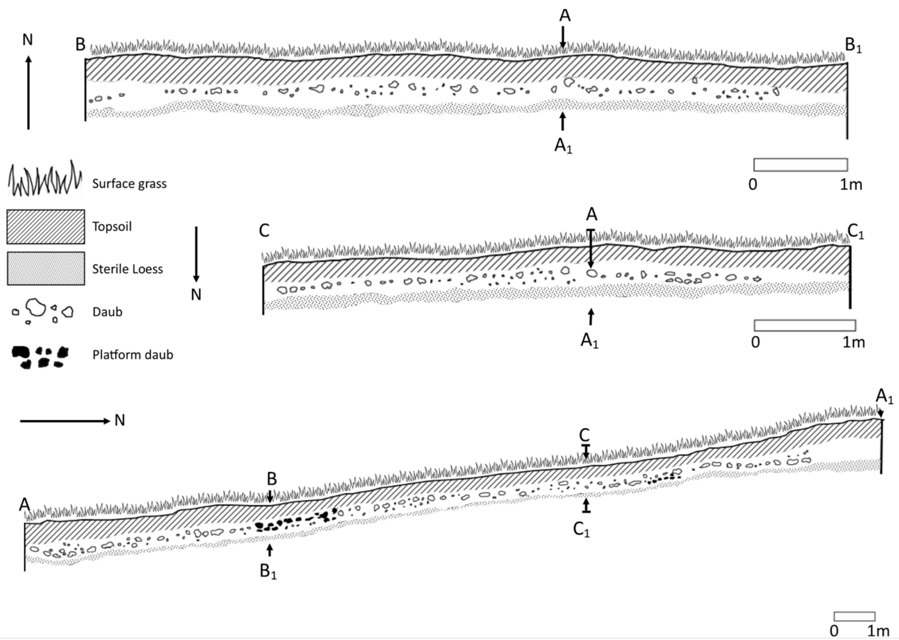

Figure 4.57: Upper: sections of House A9: B–B1 – South-facing; C–C1 – North-facing; A–A1 – East-facing (by L. Woodard).

a Northern, trapezoidal daub scatter measuring 10.5m (North-South) in length and 4.1m (Northern part) 6 or 7m (Southern part) in width; and a Southern, rectangular daub scatter, measuring 5–5.5m (North-South) in length and 4.3m in width. The difference in widths of the two rooms is considered to reflect the additional wall tumble falling outwards (i.e., to the East) from the Northern room (the outer limit of wall tumble is marked by a dashed line on the plan in Fig. 4.56). In the South-West part of the scatter, an area of daub was found that remained outside the area of compact rubble. The edges of the excavated area lay 1.5–3.5m from the edge of the compact daub, allowing the investigation of the culture layer surrounding the building. For example, two sherd and bone scatters located opposite the short side of the building, 1–1.5m from its end, marked the position of two pits (Pits 1 and 2) – 1.2–1.5m in diameter and up to 0.2m deep. A detailed discussion of pottery distributions in House A9 is presented below (p. 319 & Figs. 5.22–5.25).

Burnt daub was identified over the entire area of the house. The building remains consisted mainly of pieces of burnt daub mixed with the remains of threshed cereals/grasses. The surface and the cross-section of the daub contain visible traces of stubble, ears and grains of cereals and/or grasses. The smooth part of the daub faced up; some pieces have traces of smoothing by hand. On most pieces, the lower part of daub had the imprints of a wooden post, including longitudinally-cut beams of timber 15–25cm in diameter. In one area, matching pieces of daub with wood impressions were traced over 2m in length, suggesting fallen walls of the kind observed in the excavation of the experimental burnt house. Fragments with impressions of rods 2–2.5cm in diameter were found in some places outside the main rubble area. It is possible that these fragments are the remains of walls that had fallen outside the house (cf. the experimental results). In addition, impressions of three vertical posts 8 to 12cm in diameter, probably supporting some sort of a structure, were identified in the Northern room. In general, there were no traces of postholes, which suggests that usually the posts were inserted into sleeper beams. Each room had its own platform constructed on the earthen floor. The Northern room had a larger platform, covering 2m × 2m, while the Southern room had an eroded platform measuring ca. 1m × 1m. Both platforms consisted of three layers of clay mixed with sand (each 20–25cm thick), the lowest of which had been laid directly on the ground surface. The next layers were laid during later repairs. The remains of a large vessel and a flask, as well as some stones, including one grindstone, were found next to the platform of the Northern room, while vessels and two small grinding stones were found near the Southern room's Platform.

The construction of House A9 is typical for Trypillia settlements in this region. It was destroyed by fire as is evident from the burnt daub, some of which was vitrified. The complete excavation of House A9 as a single unit allowed a broader perspective on dwelling-house taphonomy, with several features replicating both the test pit observations and also the findings of the excavation of the experimental burnt house. The diffuse scatter of destruction daub probably represents the falling of wall daub out from a core house area of two rooms, one no larger than 10m × 4m and the other no larger than 5m × 4m, rather than a house with rooms of differing widths. The presence of *in situ* platform daub in both rooms suggests that this was a one-storey house. The fallen wall panel marked by parallel withy impressions is well matched in the experimental burnt house excavation (Fig. 4.27 lower); its location suggests a section of fronton or wall that fell inside the house. The discovery of figurines and binocular vessels mixed with the destruction daub suggests they fell with the walls and ceiling from shelving or wall-pegs during the burning of the house.

Mykhailo Videiko & Natalia Burdo

4.7.3 Houses B17 and B18 and Their Pits[61]

The 2009 geophysical plot revealed part of the inner and outer house circuits which lay close to the Mega-structure excavated in 2012 (Quarter A). The Ukrainian side chose to excavate two adjoining houses (B17 and B18) which lay closest to the Mega-structure, as well as investigating the supposedly associated house pits for each house. One complete burnt house was excavated (House B17), as well as part of a second house

61 See Burdo & Videiko (2016); https://doi.org/10.5284/1047599 Section 5.2.2.

(House B18). The shapes of the houses corresponded to the shape of the anomalies on the geophysical plot.

House B17 was constructed on a natural Chernozem A horizon. Its dimensions were 24m in length by 8 to 12m in width. Most of the area of the house was covered in destruction daub to a depth of over 0.30m (viz., the classic '*ploshchadka*': Fig. 4.26 upper), with few organic remains other than charcoal. Micromorphological analysis showed the absence of cultural inclusions other than daub reinforces field observations of houses that the structures are relatively impoverished in biocultural materials (Chapman et al. 2014). The lack of microscopic cultural inclusions (such as straw or charcoal) other than daub suggests that the building was kept clean during its use-life. Degrees of heat alteration are indicated by the range of yellow to red colours and optically inactive, undifferentiated b-fabrics, probably resulting from the firing of clay in temperatures exceeding 800–850°C (Macphail & Goldberg 2010; Quinn 2013). However, no dewdrop-shaped quartz grains could be observed at the available magnifications, suggesting that temperatures did not greatly exceed these readings (cf. Courty et al. 1989).

Interior details from House B-17 show a possible threshold in the West side. One example was noted of two sections of wall overlying each other – perhaps a sign of a two-storey building but also possibly one wall falling on top of another. Wall plaster showed occasional signs of incised and red-painted decoration; in particular, near the edge of the house, plaster fragments were found to have painted decoration. Under the daub were three Platforms decorated with incised ornament, comparable to that on the 'Platforms' in the Mega-structure. Two hearths were found near the Platforms. Up to eight sherd scatters in House B-17 corresponded to groups of once-complete pots, comprising smaller and medium-sized vessels but no storage-jars.

It was observed that chernozem had accumulated on top of the burnt remains, indicating continuous soil formation under relatively stable conditions after the settlement was abandoned. Whether and how Trypillian or later pre-modern land management contributed to this soil formation remains for future study.

The pit to the North-West of House B17 proved to be much bigger than the geophysical anomaly, amounting to 8m in diameter and 3.5m at its deepest point, near the Northern edge. The Southern edge of the pit came within 1m of the Northern edge of House B17 but this shallow area increased in depth as one moved North. The upper fill was a chernozem with a large number of small sherds and animal bones (Fig. 4.26 lower).

There were many placed deposits in the pit, which was extremely rich in material remains. At 1.2–1.3m depth, a sloping layer 10–25cm-thick contained many large sherds and animal bones, including a *Bos* horn core. This layer sloped into the centre of the pit at 1.6–1.8m depth and contained 14 finds concentrations, some with anthropomorphic female figurines (a total of over 20 was found in the pit as a whole). Under this layer was a burnt daub layer 5–10cm thick, which overlaid a 2–3cm-thick charcoal layer; 10–20cm deeper was a second charcoal layer separated by a yellow loessic sediment from the upper charcoal layer. Many sherds and animal bones were recovered from all of these layers. A special style of pottery consisted of many sherds with incised decoration, starting at 1.2–1.3m depth; interestingly, this type of incised decoration was rare in House B-17.

The pit to the North of House B18 held fewer finds but was even larger than the B17 pit, although only an 8m-long section was excavated to a depth of 2.5 m. The upper fill, to 1.2m depth, was a chernozem; under this layer, the cultural layer shared the same properties as in the B-17 Pit.

It is clear that the initial use of both pits was to extract clay for house construction. Both pits were filled in at the time of dwelling. The pits were still visible as negative features at the time of the end of the settlement: the upper fill consisted of a lower layer of soil mixed with cultural material, and an upper layer formed by chernozem.

The linear pits were dug on three sides of House B17 but were much more shallow than the B17 or B18 pits. The primary use of all of these pits could have been to produce soil for mixing with clay in house construction, as in the LBK system of digging pits close to houses (Bickle 2013, pp. 167–9). These pits were much more shallow than the pits at the short end of the houses – usually no more than 30cm depth. The further the linear pit was laid out from the house, the fewer the finds that were discovered. Unlike the larger pits, by the time of the house-burning the linear pits had completely filled up to the general surface level.

Mykhailo Videiko & Natalia Burdo

4.7.4 The 'Industrial Structure' and Its Pit[62]

One of the most interesting developments in Trypillian megasite archaeology in recent years has been the discovery of high-intensity, concentrated geomagnetic anomalies which, upon excavation, turned out to be pottery kilns (Korvin-Piotrovskiy et al. 2016). The discovery of such geomagnetic features at Taljanki in 2013 prompted the question as to whether there were similar kilns at Nebelivka. Duncan Hale is of the view that, using criteria of size, orientation of anomaly, strength of anomaly and location, none of the geomagnetic anomalies at Nebelivka is entirely consistent with what would be expected of a kiln anomaly (see above, Chapter 4.2).

Nonetheless, the Ukrainian side tested three features with strong, concentrated magnetic anomalies in the North-East part of the megasite. In the first Sondazh (Sondazh 7), modern iron-working was found in the upper levels, mixed with Trypillia pottery. In Sondazh 8, a pit-like feature containing a high concentration of Trypillia pottery was also a modern feature, with metal finds at a depth of 0.50 m. A historical map of the Nebelivka area shown to the Project indicates how a village street

62 See Burdo & Videiko (2016); https://doi.org/10.5284/1047599 Section 5.5.

extended Northwards from the main village focus, crossing the Eastern edge of the megasite. It is believed that the modern pits were associated with this street. Although the prehistoric finds were 'contaminated' with recent material, this experience is noteworthy in indicating that we cannot automatically make the assumption that all of the features identified on the megasite geophysical plot are datable to the Trypillia occupation.

The most successful Ukrainian trench was Sondazh 9, in which an enigmatic daub feature was found close to a pit. This Trypillia feature was a 2m × 2m fired clay platform with four walls forming three channels (0.20–0.25m in width, 0.25–0.30m in height) (Burdo & Videiko 2016, Figs. 4–6) (here: Fig. 4.58). The walls were protected by fire-proof plaster and the whole complex was covered by destruction daub fired to a green colour mixed with soil, pottery and bones. The green colour indicates the presence of ferrous oxide (Fe_2O) in the clay (see below, Section 4.9), which had been fired to a high temperature. Near the feature were found fragments of fire-hardened clay which have been interpreted as the mobile covers for the channels. Currently unexplained daub lines projected to the NW and SW from the main feature.

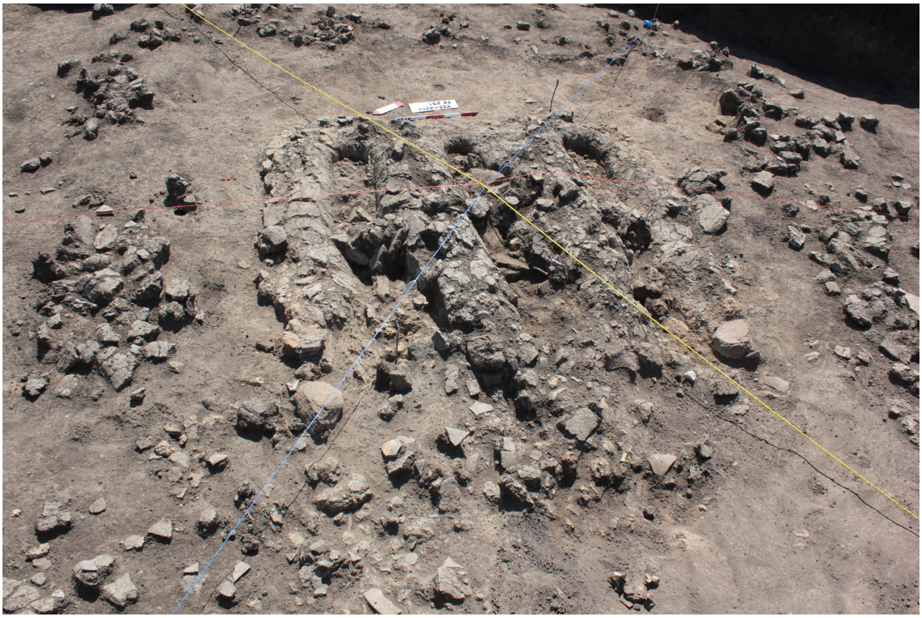

Figure 4.58: General view of Industrial feature, Nebelivka (by M. Videiko).

The daub feature was sub-rectangular, with some granite lumps built into the outside edges of the corners. Three channels some 25–30cm in depth and width were cut into this feature. Many of the daub fragments had a greenish tinge, marking the greatest concentration of greenish daub on the whole megasite (e.g., one or two greenish daub fragments have been encountered on test pits). In the post-abandonment phase of this feature, many small sherds were found on the upper surface of the feature – perhaps the kind of placed deposit found sometimes on the *ploshchadka* of the Mega-structure.

There has been a difference in the interpretation of this feature, with the Ukrainians proposing that this was indeed a pottery kiln (Burdo & Videiko 2016) and the Durham team suggesting that there was no signs of a separation of fuel from pots and that this feature was more likely to be the remains of a communal food preparation area. By analogy with excavated features at Taljanki and Majdanetske (cf. Korvin-Piotrovskiy et al. 2016, Figs. 17 and 32), the three channels have been interpreted as a three-chambered firebox or combustion chamber under a firing chamber with a dome. Burdo & Videiko (2016) interpret this feature as the poorly-preserved remains of an updraught kiln. Several metres to the North of the 'kiln' was a 5m × 4m pit whose total depth was not established. The pit was cut from a depth 0.40–0.60m below the current ground surface. Mixed into all of the four layers, which sometimes contained charcoal lenses, were sherds, figurines, animal bones, stone, a few flints and fragments of 'channel cover'.

The strongest argument for the interpretation of the Nebelivka feature as a kiln comes from the Majdanetske and Taljanki analogies. However, the Nebelivka channels were far shallower than the other examples, showing that there was little space for fuel for a kiln. Moreover, there was a striking absence of vitrified daub or secondarily burnt pottery at Nebelivka, as was found at the kilns of the other megasites. On this basis, there remains the possibility that the 'industrial' feature at Nebelivka was not so much a pottery kiln as a communal cooking place for the provisioning of the periodic feasts whose animal bone remains were often discarded in adjacent pits (e.g., the Pits near House B17 and in Sondazh 1). The channel covers would have functioned just as well in a communal oven as in a kiln and the former interpretation would explain the absence of vitrification and pottery 'wasters'. The closest analogy found so far comes from Hungarian Mediaeval brick ovens with their triple flues (Jakab 2011) (Fig. 4.59). However, these ovens have two essential elements both missing at Nebelivka – a floor separating fuel from bricks and a domed superstructure. A second structural parallel for the Nebelivka feature is the integrated set of three corn-drying ovens excavated at the Keston Romano-British villa in Kent, UK (Philp et al. 1991, pp. 87–88, Figs. 21 & 22 & Plates XI–XIV) (here Fig. 4.60). The best-preserved – the South Oven – was dug into the chalk and had three parallel-sided channels, with a stoke-pit outside the oven providing hot air to the central channel from which it passed to the side channels by means of lateral vents. The surface area of the platform above the ovens of

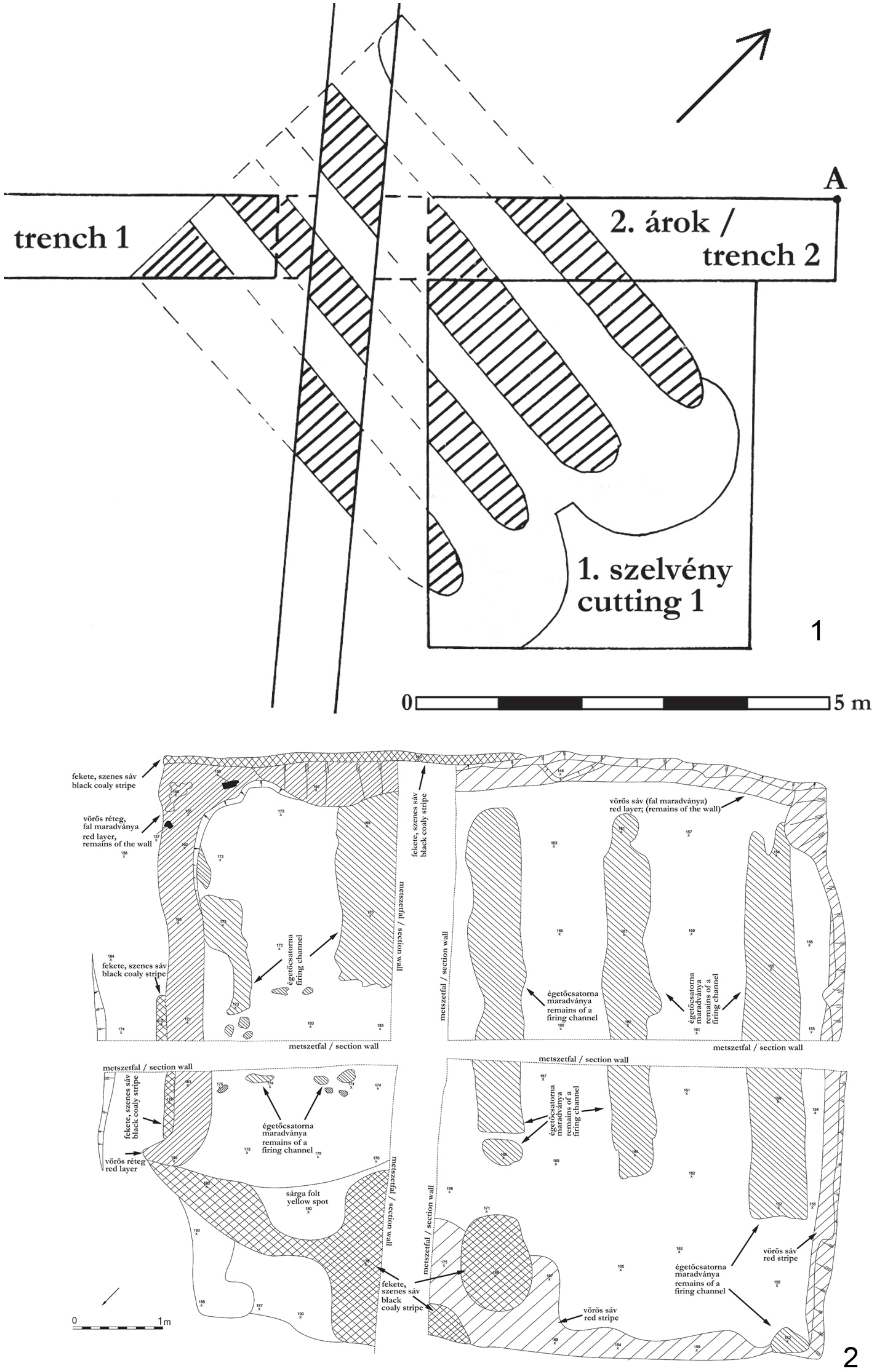

Figure 4.59: Hungarian Mediaeval brick kilns as analogies for Nebelivka 'industrial' feature; (1) Békéscsaba–Mezőmegyer; (2) Debrecen–Józsa Pláza (by B. Gaydarska, based upon Jakab 2011).

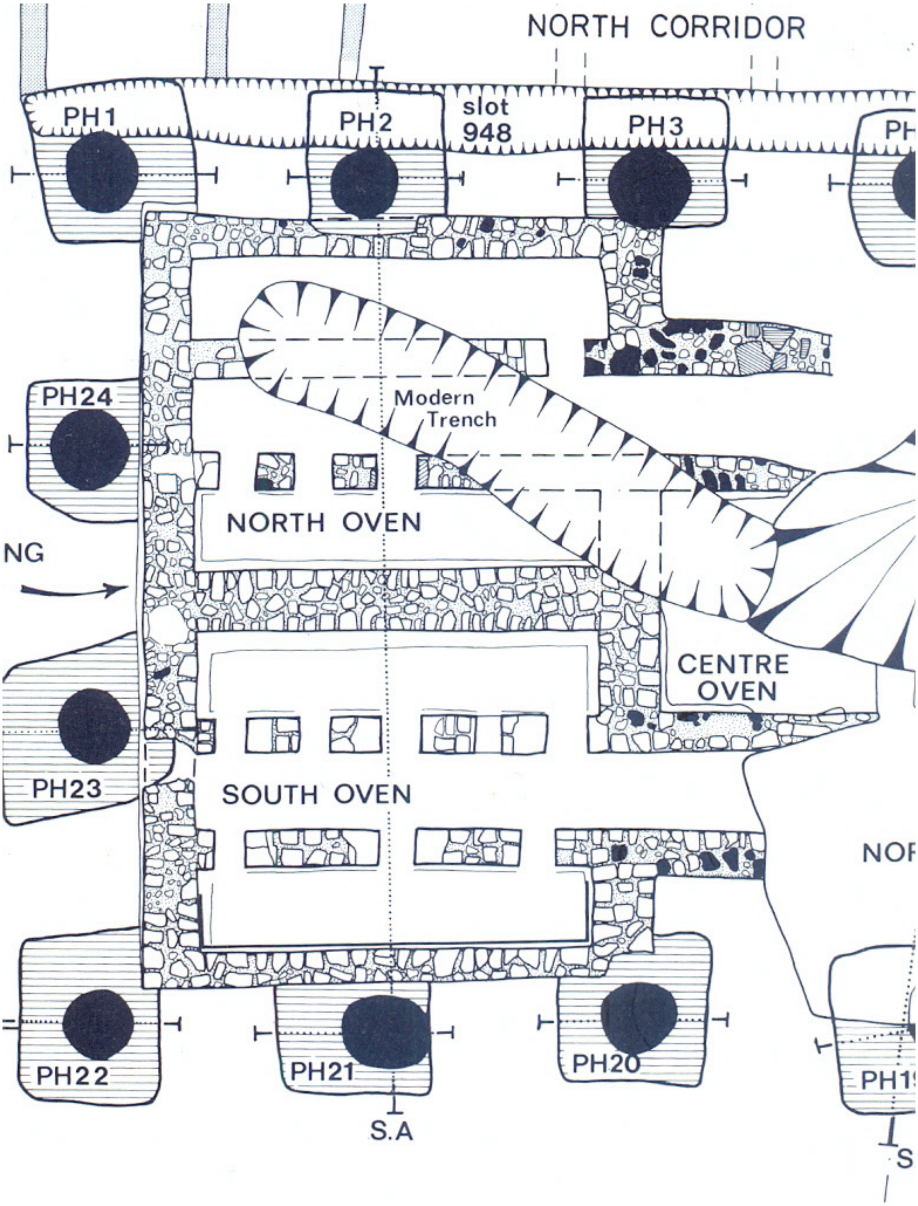

Figure 4.60: Corn-drying ovens, Keston Roman villa (internal width of South Oven – 4.15m) (by B. Gaydarska, adapted from Philp et al. 1991, Fig. 22).

ca. 20m^2 enabled the 'processing of fairly large quantities of grain' (Philp et al. 1991, p. 88). A structural feature essential to the process – in this case, a covered platform separating fuel from grain – was missing from the corn-drying ovens, as it was from the Nebelivka example.

We are still some way from a proper understanding of one of the most enigmatic features found at Nebelivka.

Andrew Millard

4.8 The AMS Dates

4.8.1 Aims

This part of the project at Nebelivka aimed:
1. to develop an internal chronological sequence for the Trypillia BII megasite using a programme of radiocarbon dating and Bayesian modelling; and
2. to use the chronology to estimate the number of coevally occupied houses at any one stage of the megasite's occupation.

Specifically, the four key questions were:
1. how long was the occupation of an individual segment of a circuit?
2. were adjacent houses and segments constructed, occupied, and destroyed sequentially or coevally?
3. how many houses, and segments/groups were constructed, occupied, and destroyed coevally across the whole site? and
4. how do the houses inside and outside the circuit relate chronologically to the circuits?

4.8.2 Initial Dating

Twenty-five radiocarbon dates were obtained from the Kyiv (conventional) and Poznań (AMS) Laboratories on material collected from the excavation of Nebelivka House A9 in 2009 (17 dates), and other burnt houses (8 dates). The use of conventional radiocarbon techniques on daub and pottery containing small quantities of organic material, and on bone led to very poor results. Ten bone dates ranged from 4130±60 BP to 4710±80 BP, seven daub dates from 2740±60 BP to 5970±70 BP and three pottery dates from 3720±180 BP to 4430±180 BP. Only three AMS dates – on bone (5010±40 BP), cereal (5030±40 BP) and daub (5180±60 BP) respectively – fell within the expected date range of 5300 to 4900 BP, while AMS dates on pottery were much younger (3310±35 BP and 4040±35 BP). Even if the expected range for Trypillia BII is incorrect, the occupation of the site falls entirely within a single stage in the ceramic relative chronological scheme (Ryzhov 2012) and must have been relatively short. These results show the importance of using AMS dating of carefully selected material for accurate and consistent results.

4.8.3 Simulations

Prior to sampling, simulations were undertaken to establish the number of dates likely to be required to resolve the chronological questions. The approach is to consider the widest possible range of chronologies, simulating possible combinations of radiocarbon dates and then calculating the parameters of the chronology, such as start and end dates, using a Bayesian model of the same type as was intended for the actual dataset. This allows an assessment of the efficacy of the proposed programme of dating before any expenditure on dates. The efficacy of the sampling process and the number of dates to be obtained can be optimised to resolve the chronological questions to hand (Bayliss 2013).

The range of possibilities was based on prior radiocarbon dating, previously published geophysical plans of other sites (e.g., Glybochok: Videiko 2007), and expert judgements about the nature of the site. Four zones were expected: the inner house circuit, the outer house circuit, the area internal to the inner circuit and the area external to the outer circuit. Three possible sequences of occupation of zones were simulated: (1) consecutive occupation of the four zones, (2) parallel occupation of all four zones for the entire duration, (3) a mixture of parallel and consecutive occupation. For each sequence, three possible chronologies were simulated: minimal (A: 160 years, 3980–3820 BC), medium (B: 300 years, 4050–3750 BC) and maximal (C: 600 years, 4250–3650 BC). For each of these nine sequence and duration scenarios, a dating effort of (i) 52, (ii) 100 or (iii) 200 dates distributed equally between the zones was considered. These 27 scenarios, with multiple possible orderings within sequence scenarios (1) and (3), capture the range of chronological and sequence possibilities. For each scenario, simulated dates were analysed in an OxCal model with independent bounded phases for each zone, to yield posterior estimates of zone start and end dates, the order of the zone start dates and the overall duration of occupation at the site.

The results showed that 52 dates would be inadequate; they would neither resolve the order of zones with a 160-year chronology nor distinguish between 160- and 300-year chronologies. The length of the 95.4% highest posterior density (hpd) region for the duration was used as an index of the precision of the calculations. This averaged 212 years (range 138–329) for 52 dates, 155 (115–213) for 100 dates and 112 (81–168) for 200 dates. These results show that at least 100 dates were needed to be able to estimate the duration within ±100 years at 95% probability, though, as will be seen below, issues with sampling led to the modification of this strategy.

4.8.4 Sample Collection

In order to obtain reliable dates, dating of short-lived single-entity samples (Ashmore 1999) is widely recognised as necessary. From previous excavations, it was known that burnt house floors on Trypillia sites lie at less than 1m depth and do not overlap (Videiko 2004). The daub used in construction contained significant quantities of seeds (Pashkevich 2005) which therefore have an unambiguous association with the construction. Within destruction layers, animal bones offer greater certainty of association than charcoal or charred grain, as they are less likely to be reworked by bioturbation.

The initial strategy was, therefore, to target burnt seeds for dating the construction of houses, and bones for their destruction. Using the geophysical survey (see above, Chapter 4.2) to locate burnt structures, mechanical coring to about 1m would be used to recover burnt daub samples from which charred seeds would be extracted for dating, and test pits on a subset of houses would verify the coring stratigraphy and recover samples from destruction deposits. Although coring during the 2012 season was successful in recovering 130 samples of burnt daub from 91 houses, the almost total absence of charred material within the daub meant that an alternative strategy was required (see above, p. 50). The new strategy adopted was to excavate test pits in order to recover stratified samples of animal bone or charred plant macrofossils.

To tackle the questions about association between chronology and spatial structure, sampling followed the identified components of the arrangement of houses based on the geophysical survey results (Figs. 4.3–4.4). This comprised:

- Two transects from outside the outer circuit to the innermost part of a radial street including an Assembly House (Test Pit groups 26, 29–30, and in part 27–28).
- Rows of three to six consecutive or near consecutive houses along the circuits distributed around the whole site (Groups 1, 23, 22, 24, 25 and 13; Group 15 with House A9)
- Groups of four houses, two on either side of a radial street or the two circuits (Groups 21, 20, 19, 18 and 16)
- A group of houses arranged in a square rather than a street (Groups 32–34).

In total, test pits were excavated on 82 houses over the 2013–2014 seasons (Fig. 4.61), recovering over 500 bones and six charcoal samples from houses[63]. In addition, 45 animal bone samples were recovered from excavations in pits and structures. To aid selection of samples for dating, all the bone samples were subject to zooarchaeological identification (see below, Chapter 5.3) and then screened for collagen preservation.

63 We are grateful to Charlotte O'Brien for the species identification of the charcoal samples.

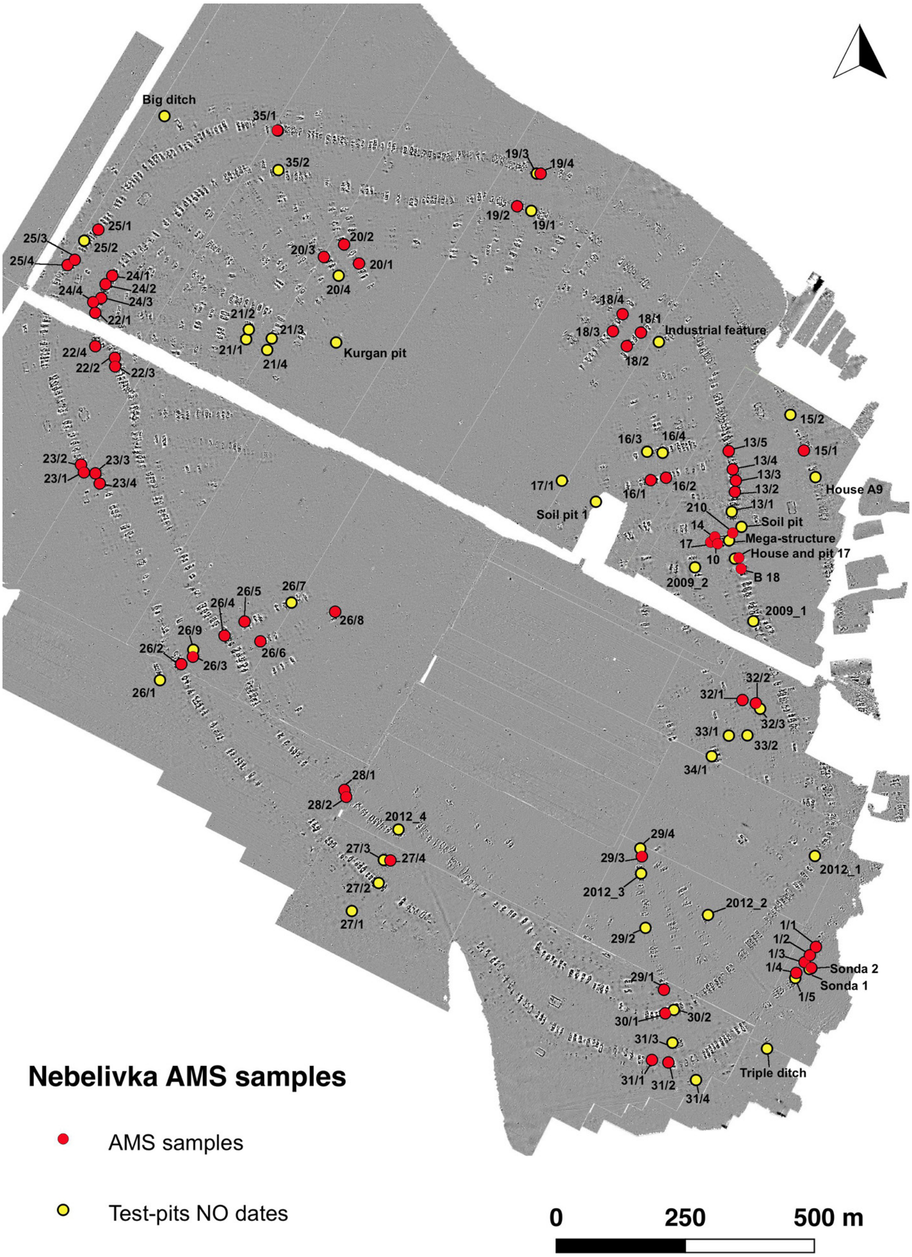

Figure 4.61: Site plan showing Test Pits with(out) AMS dates, Nebelivka (by M. Nebbia).

Full excavation of two houses (see above, Chapter 4.7.2 & 4.7.3) and the test pits (Chapter 4.6.1) demonstrated that there was a consistent stratigraphic sequence for each house, consisting of pre-construction, house floor, destruction deposits, post-destruction deposits and topsoil. Samples were retrieved from all these levels in the test pits, yielding respectively 20, 23, 30, none and one samples. In total, there were 80 dates on bone samples and six on charcoal samples, measured at Oxford (80) and Poznań (6). The routine methods of both laboratories follow the same pretreatment procedures (Brock et al. 2016). This was reduced from the initial quota of 100 dates as it became clear from early results that the timespan of the site was short and that it lay on a wiggle in the calibration curve. In an attempt to resolve this, in the later batches fewer samples were measured but with longer counting times to give higher precision.

4.8.5 Radiocarbon Results

Of the 86 measurements, six were duplicated on the same sample at Oxford as a routine quality control measure and four were replicated between Oxford and Poznań. These duplicate dates were combined by the method of Ward and Wilson (1978). Three samples were rejected as unreliable: one Poznań bone yielded C:N ratios outside the acceptable range of 2.9–3.6 (DeNiro 1985) and failed a Ward and Wilson test for combination with its Oxford duplicate, one bone dated to AD 1962 or 1975, and one bone with a low collagen yield gave a date in the Bronze Age. All dates are reported in the site archive (see https://doi.org/10.5284/1047599 Section 4.9). Thus, there were 83 measurements on 74 samples for statistical analysis. The 83 measurements were all very similar and a subset of 71 were statistically indistinguishable using the Ward and Wilson test. All results reported here follow the conventions given by Millard (2014).

4.8.6 Results and Discussion of Modelling

The homogeneity of the dates and the fact that they fell on a wiggle in the calibration curve (Fig. 4.62/1) posed problems for statistical modelling, as did a lack of strong prior information. No two excavated structures had stratigraphic relationships between them and samples were recovered with stratigraphic ordering from only eight test pits. Consequently, the modelling strategy was based on testing and comparing models based on different hypotheses derived from the spatial structure of the site and on equating stratigraphic units between test pits. All modelling was performed in OxCal (Bronk Ramsey 2009).

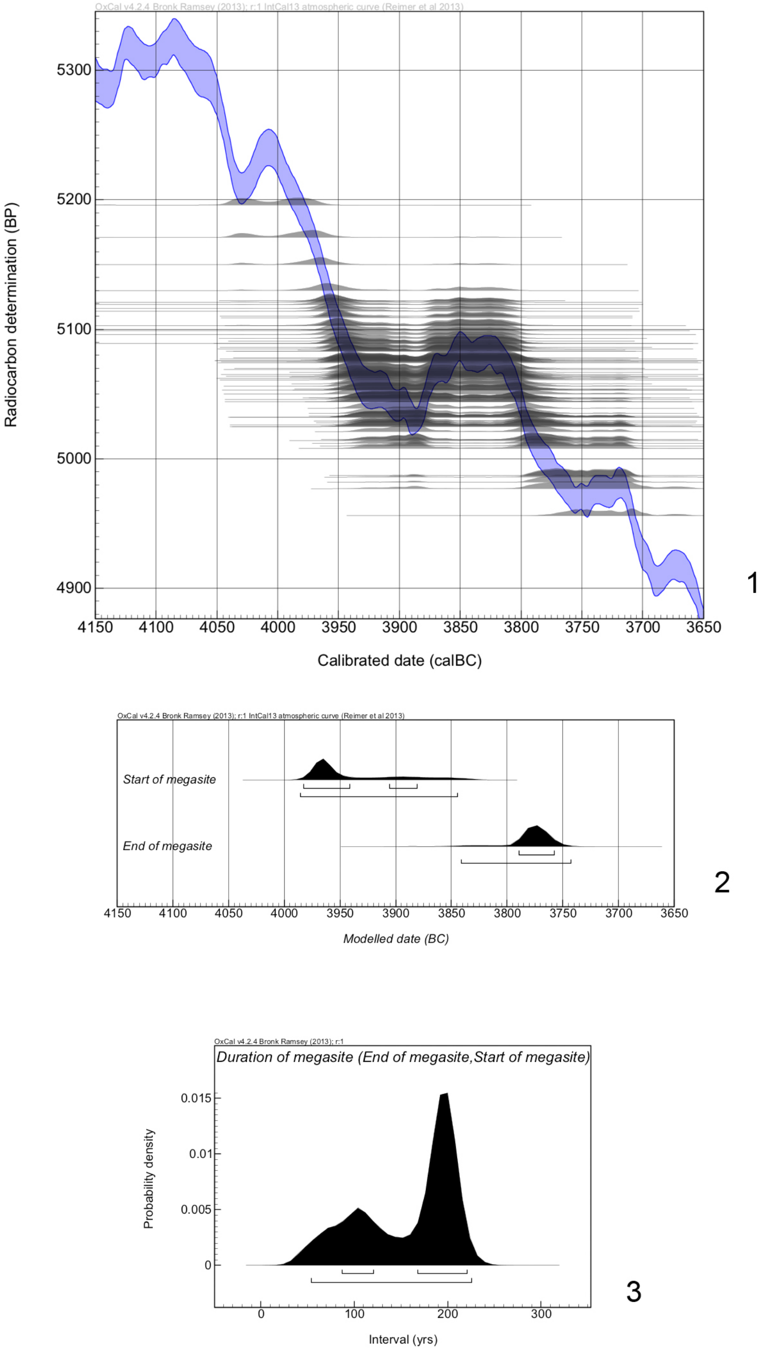

Figure 4.62: Bayesian plots of AMS dates, Nebelivka: (1) all AMS dates plotted on calibration curve; (2) start and end dates for occupation at Nebelivka; (3) duration of occupation at Nebelivka (by A. Millard).

4.8.6.1 Circuits and Streets

The large-scale spatial structure of the site is into the inner and outer circuits and the radial streets. Dates were assigned to these three groups and all six possible orderings of these three groups were modelled. The range of OxCal agreement indexes, A_{model}, was 6% to 44%; since acceptable A_{model} values are over 60%, none of these models gives an acceptable fit to the data. A model where these three groups are allowed to overlap and the ordering of their start and end dates is investigated is more revealing. Figure 4.63/1 shows that the start dates cannot be distinguished, but the end date for the outer circuit is later than the other two groups. The duration of the inner circuit comes at 0–145 years at 95% and 0–50, 70–120 years at 68%, and none of the dates can be ordered. So although the houses in the inner circuit could have been built over a century, they could also all have been built simultaneously.

As noted above, in each test pit a similar stratigraphic sequence was observed. However, only one reliable sample was recovered and dated from a pre-construction context and none from a topsoil context, so these contexts were not modelled. A model grouping dates as house floor, destruction deposits, and post-destruction deposits yielded A_{model} of 20%. Re-running the model with outlier analysis did not identify any samples with posterior outlier probabilities exceeding 50%. A model treating the destruction deposits and post-destruction deposits as a single stratigraphic unit produced similar results, though with some possible outliers identified.

4.8.6.2 Ordering Within and Between Quarters

Analysis of the layout of the site has identified a series of Quarters labelled A–N (see above, Chapter 4.2.2 and Fig. 4.5). Grouping dates by Quarter and treating each Quarter as a separate phase with a start and end date, we investigated whether the Quarters can be ordered in time, and whether there is any discernible chronological structure within Quarters. Ideally such a model would also have an overall start and end date for the site but, with this structure, OxCal failed to initialise the model. Quarters F and K were omitted as they had no dates. The posterior distributions for the start and end dates of the Quarters (Fig. 4.63/2) only yield probabilities of ordering greater than 90% for (a) Quarter E starting before Quarters A, B, C, G, H, I, L and M, (b) Quarter E ending after Quarter B, and (c) Quarter G ending after Quarters A and B. Quarter E therefore seems to predate most of the rest of the site and to continue after some parts of it.

Within each Quarter, the ordering of dates was also tested. Probabilities greater than 90% were obtained only in two Quarters. In Quarter E, Test Pit 20/1 is earlier than Test Pit 20/3 and 35/1. In Quarter G, the sample from Test Pit 25/3 post-dates all other samples excepting that from 25/1 which itself predates most other samples, and has probabilities of 87–89% for the others (Test Pit 24/1, Test Pit 24/4, and Test Pit 25/4 OxA 31665). These sequences suggest variations on the order of several decades in the construction dates for houses in the same Quarter – perhaps an indication of the temporal duration of Quarters across multiple human generations.

Quarter E therefore stands out as the earliest Quarter, and Quarters E and G as likely to be the latest Quarters to be occupied. It is probably their longevity which allows the detection of ordering of events within them. This sequence suggests that not all of the Quarters were built at the same time but that there were multi-decadal differences in not only their starting date but also their duration.

4.8.6.3 Ordering Within Rows

At the more local geographical scale within the site, there are clearly Neighbourhoods, some of which are separated from each other by kinks or gaps. Models were constructed considering both (a) possible orderings along a row and (b) differences in date between houses grouped either side of a kink or gap. Continuous rows were explored for Test Pit Groups 1, 24 with 22, and 12, and rows with breaks for Test Pit Group 13 with houses B17 and B18, and groups 22, 23, and 31. In all but one case, no ordering was distinctively better than another and the duration of any break had its highest probability at zero years. The exception concerned the three dates in Test Pit Group 12, which suggest a clockwise order around the circuit. Given the number of models tested, this is likely to be a chance finding. The absence of a sequence in any of these Neighbourhoods suggests that the houses were built as an integrated group within a short period of time.

4.8.6.4 Radial Structure

Some of the test pits were deliberately located to investigate any radial structure to the dating of houses. Using similar models to the rows of houses, this possible structure was investigated for Test Pit Group 26, Groups 29, 30 and 31, and for 15, 13 and 16. Only the first group produced any possible evidence for structure, primarily because the date from test pits 26/2 is earlier than several others in the group, and therefore an inner to outer ordering is consistent with the dates. This counterfactual finding is currently hard to explain.

4.8.6.5 Overall Occupation

The timing and overall duration of the entire occupation at Nebelivka is a key question. A series of models was used to investigate this and to check the sensitivity of the answer to possible variations in the approach used. Models were constructed with an overall start and end for the site, using the eight stratigraphic sequences of dates and omitting them, and with and without outlier analysis. Figures 4.62/2 and 4.62/3 show the results for the least precise model, without the stratigraphic sequences and with outlier analysis. This is the most conservative estimate, though the other models all produced similar results. The site is estimated, with 95% probabilities, to have started in the range 3990–3840 BC and to have ended 3850–3740 BC, having lasted 50–230 years; all models agree the most likely dates are ca. 3970 to ca. 3770 BC with a duration of ca. 200 years.

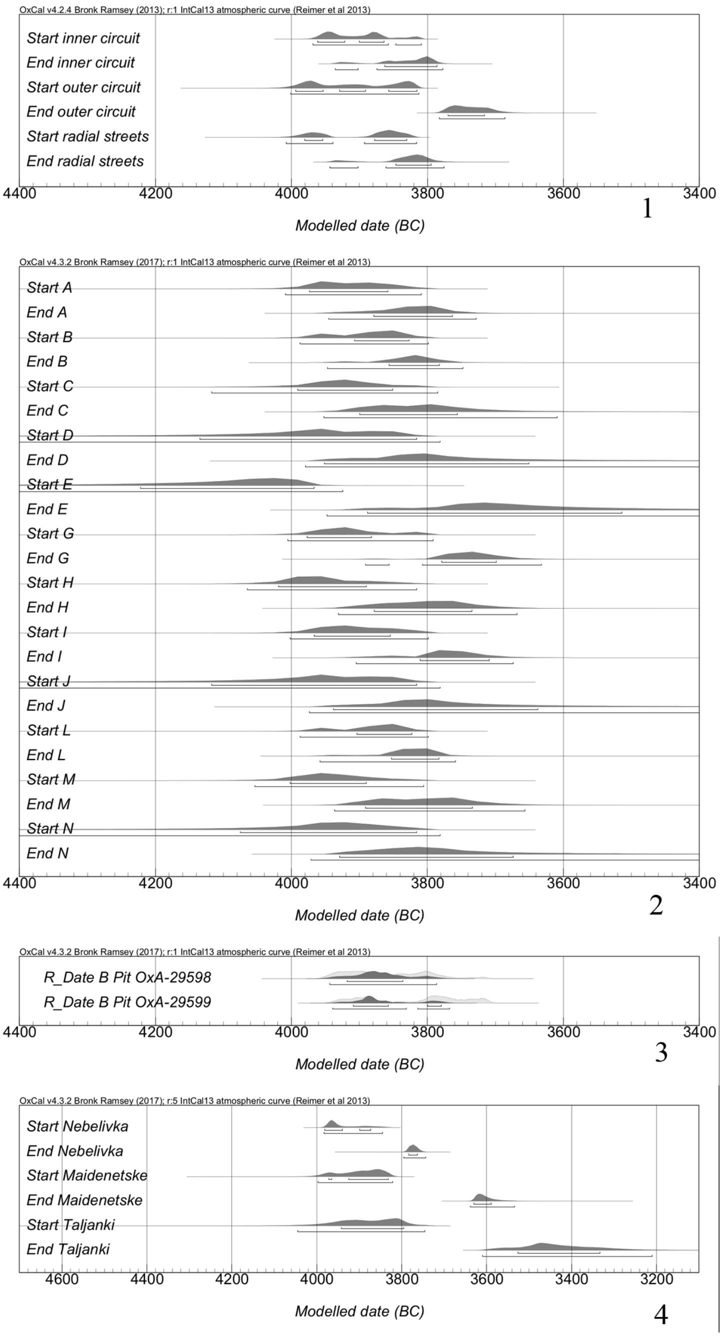

Figure 4.63: Bayesian plots of AMS dates, Nebelivka: (1) start and end dates for circuits and streets modelled independently; (2) start and end dates for Quarters; (3) AMS dates from the Pit, Sondazh 1; (4) start and end dates for three megasites (by A. Millard).

4.8.6.6 Comparison with Other Sites

In addition to Nebelivka, two other similar sites have significant numbers of radiocarbon dates, Majdanetske (n = 86: Müller et al. 2017, p. 75; Dal Corso et al. 2019, Fig. 2) and Taljanki (n = 11; Rassamakin & Menotti 2011)[64]. Modelling the overall sequence of these dates and comparing the start and end allows investigation of whether these three large sites were occupied simultaneously or consecutively, which is an important question when considering regional population sizes. Based on ceramic typology, Nebelivka is assigned to Phase BII while the others are assigned to the succeeding Phase CI, with Taljanki preceding Majdanetske (Müller et al. 2016). Despite the pottery typology, Diachenko & Menotti (2012) proposed that the occupations of Nebelivka and Taljanki overlapped by 100 years.

The results (Nebbia et al. 2018) show that occupation at Majdanetske started before the end of occupation at Nebelivka (Fig. 4.63/4).[65] Occupation at Taljanki probably started before the end of occupation at Nebelivka, and certainly before the end of occupation at Majdanetske. The uncertainties in the radiocarbon dating do not allow us to determine which of the three sites was occupied first. This implies that two out of the three largest megasites were partially coeval, and all three may briefly have been coeval. Testing a more constrained model in which the typological ordering is used as a constraint showed that this is not consistent with the radiocarbon dates.

4.8.6.7 Coeval Houses

The estimate of overall duration can be used to investigate the likely number of coeval structures. Figure 4.62/3 shows two peaks of probability for the duration of around 100 and 200 years, which provide convenient round values to explore the likely range of possibilities. A very simple model posits a constant rate of house-building, with each house having a defined average use-life, followed by cessation of building. This leads to a linear growth of the number of houses with time, a period with the maximum number of coeval houses followed by a gradual decline after building ceases, and a total of 1,500 houses built and destroyed. If the use-life of a house was 25 years, then a 100-year duration would require 20 houses to be built *per annum* with a maximum of 500 coeval houses, but a 200-year duration would reduce those figures to a rate of 8.6 *per annum* and a maximum of 210 coeval structures. If houses were used for an average 50 years, then these figures increase to 30 *per annum* and 1,500 coeval for a 100-year duration, and 10 *per annum* and 500 coeval for a 200-year duration. A short

64 It should be noted that the set of AMS dates from Taljanki is much smaller than those from Nebelivka and Majdanetske, with several of the dates based upon long-lived species and some dates based upon samples from insecure contexts.

65 Bayesian modelling of the overall dwelling period at Majdanetske, at 3935–3640BC (Dal Corso et al. 2019, p. 3 & Fig. 2), confirms the results of this modelling.

use for a house of only 10 years reduces the figures to 17 *per annum* and 170 coeval or 7.9 *per annum* and 79 coeval structures.

Although the model is simple and the approach is broad-brush, it can nonetheless indicate the scale of occupation. As it is most likely that the duration of the site was 200 years and the lifetime of a house constructed of timber is likely to be a few decades[66], we should probably envisage between one-sixth and one-third of the houses at Nebelivka being occupied simultaneously. Simultaneous occupation of the whole site could only have occurred if the houses were long-lived and the building rate was very high.

4.8.7 Conclusions

The study of the chronology of Nebelivka is hampered by the short occupation of the site, especially as the relevant period falls on a wiggle in the calibration curve that limits the precision that can be obtained and the possibility of ordering events in time, whatever Bayesian models are used. The preservation of charred material was poor and thus investigation of the duration of occupation of individual houses was not possible. Nevertheless, some robust conclusions may be drawn. It is clear that Nebelivka was a relatively short-lived site occupied for between 50 and 230 years between 3990–3840 BC and 3850–3740 BC (all at 95.4% probability). Most likely this was ca. 3970 to ca. 3770 BC with a duration of ca. 200 years. Quarter E started earlier and ended later than other parts of the site. It is unlikely that all the houses were occupied simultaneously but, quite probably, one-sixth to one-third of them were in coeval use.

Natalia Shevchenko & Bisserka Gaydarska

4.9 Analyses of Building Materials

4.9.1 Introduction

The building of houses with timber, clay and reeds has been at the centre of Trypillia archaeology since the earliest excavations (Khvoika 1904; for summary, see Videiko 2013). However, it is surprising to note that very few results of *ploshchadka* research after more than a century have so far focussed on physical-chemical analyses of the building materials (Kulska & Dubitska 1940; Shevchenko & Ovchinnikov 2003;

66 The TOTL Project has investigated the duration of many Neolithic houses and their overall finding is that the duration of houses varied between 15 and 80 years (e.g., the Uivar tell: Draşovean et al. 2017, Fig. 7).

Shevchenko 2015, pp. 61–68; Diachenko & Harat-Strotsen 2016), This is presumably because of poor preservation thanks to the effects of burning and ploughing. Thus, no ‘original’ template has been preserved from which to derive past practices. It can be queried whether house-models (Shatilo 2005) combined artistic license with impressions of actual houses or faithfully replicated original house forms and building techniques.

The burning of a Trypillia house preserves the burnt daub mass (the ‘*ploshchadka*’) in plan form but has destroyed much, often leaving only shapeless daub remains. However, close attention to this building material allows the recovery of much useful technological information. The reasons for house-burning are multiple and should be separately investigated, in part through emphasis on taphonomy (e.g., the surface deposits on building materials and pottery: see Chapter 5.1). It is important to recall that the nature of the clay affects the secondary changes to these materials during house-burning.

For these reasons, this analysis begins with the most important task – the technical-typological analysis of the Mega-structure. The full analysis is available online (https://doi.org/10.5284/1047599 Section 5.1.5). Here, we summarise the general implications of the results for an appreciation of the way that Trypillia builders created their own world of clay.

4.9.2 Methods and Materials

A preliminary study of the building materials from House A9 (excavated in 2009) enabled the design of a broad research framework for the analysis of building samples from the Mega-structure. Laboratory methods were designed to fulfill three goals: (1) the establishment of the technical – typological characteristics of the samples, including their physical-chemical properties, their composition, their structure, their context and their recipes; (2) the determination of the function of the different building materials; and (3) the classification of building materials based on Goal (1).

A combination of macro- and micro-level methods was used, including morphological analyses, qualitative analyses (composition), quantitative analyses (ratios between different elements in clay mixture), metric analysis (fractions of content, thickness of layers of building material) and textural-structural analyses. A total of 155 samples was collected, comprising building material (n = 91 samples), pottery (n = 22 samples) and grinding stones and unworked stone (n = 15 samples), as well as materials from clay sources (n = 16 samples) and rock sources (n = 11 samples).[67] A total of 89 photographs was taken of these samples[68]. A total of the

67 The full list of samples appears in https://doi.org/10.5284/1047599 Section 5.1.5.3.
68 For a selection of key photographs, see https://doi.org/10.5284/1047599 Section 5.1.5.2.

80 most characteristic samples was selected for further laboratory analysis. Visual inspection by magnifying glass, supplemented by stereo-microscopic investigation, confirmed the preliminary field classifications of morphology, mineral content and stratigraphic structure. Thin-sections were made for polarising microscopy to recover more specific information on mineral contents, structural traits, ratios of elements in the clay mixture and mineral temper. Further, micro-probe analysis was used for the clay minerals in some of the samples. Polished sections (Russian: *Anschliff*) were studied in reflected side light to gain further stratigraphic information.

4.9.3 Clay Materials Used in Building

Five different clays were used at Nebelivka. During preliminary fieldwork in the village territory, the project team was able to identify four sources of clay, indicating that the distances required to bring clay to the megasite rarely exceeded 2km. The five clay types could be distinguished initially by colour and, later, by physical-chemical analysis. The colour of the greenish clays was due to ferrous oxide (Fe_20), while red clays have a strong component of ferric oxide (Fe_20_3). Colour variation in the clays is due to the ratio of ferrous oxide to ferric oxide. It was the iron elements that were predominant in determining firing temperatures. At temperatures of 700^{0}C in an oxidising atmosphere, Fe_20 is oxidised to Fe_2O_3, with consequent colour changes (e.g., the range 'greenish-brown–pale yellow' changes to the range 'bright orange–red–dark reddish-brown') without visible changes towards vitrification. These colours show the temperature range of 700^{0}C–900^{0}C (Fig. 4.64/6).

The building materials at Nebelivka were often made by mixing different clays, sometimes forming lumpy mixtures of uneven colour and many cracks and pores, caused by uneven shrinking with drying. By contrast, high-quality mixtures led to uniform surface colours and consistent textures, with an even distribution of cracks. Three types of daub mixture were observed: (a) chaff-free clay made of a mixture of two clays (Podium, Platforms); (b) red clay or marl with chaff, turning red or yellow after firing (smoothing layers); and (c) a mixture of two clays and chaff, turning pink after firing (smoothing layer). The daubs contained natural minerals, including (a) clastic quartz-feldspar; (b) calcium carbonate, making the clay more plastic; and (c) ferrous minerals. The main artificial temper was chaff (40–60%), leading to different size of porosities in the daub as burnt-out chaff. However, gaps between minerals formed in drying and expansion of minerals through high firing and subsequent cooling also led to porosities in the daub. All of these types of porosity can be found in one daub sample. It was striking that sand-grade temper was absent; it may have been removed in clay purification.

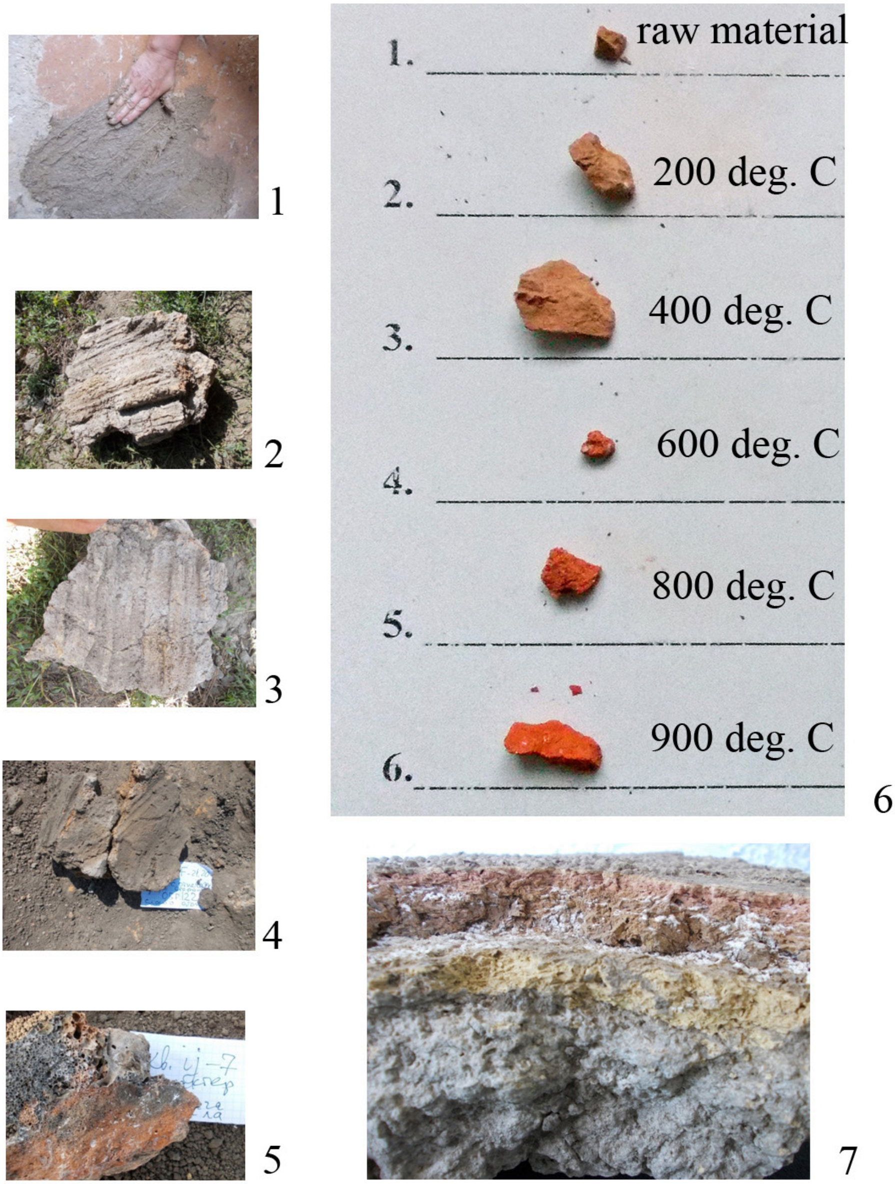

Figure 4.64: Building materials analysis: (1) finger action; (2) squared timber-impression; (3) withy-impression; (4) finger-impression; (5) vitrified daub; (6) thermal plot, daub, Context 117; (7) cross-section of daub showing clay layers, Nebelivka (by N. Shevchenko).

4.9.4 Daub and Daub Impressions

Impressions of the following materials were found on daub samples: (1) wood; (2) wood shavings; (3) straw; (4) chaff; (5) grain; (6) steppe grasses such as *Stipa*; (7) woven stems (? twine); and (8) leaves. There were no obvious examples of reed impressions[69]. The commonest impressions on the underside of daub were regularly-cut, flat wooden beams with fibres (Fig. 4.64/2). There were fewer samples with smooth impressions of thin, circular rods of diameter 7–10cm (perhaps hazel withies), probably because of the filing of timber or the process of de-barking (Fig. 4.64/3). Even more rare are impressions of branches of diameter 3–5cm. Some multi-layered impressions were found, some with finger impressions producing 'barbotine'-like roughening, especially on examples of highly plastic clays (Fig. 4.64/1 & 4). Cereal grain, chaff and straw impressions were very common throughout the daub samples. The wide range of impressions underlines the Trypillia practice of incorporating many aspects of their everyday landscape into their Assembly Houses (for the incorporation of fragmentary objects into house daub, see below, p. 414).

4.9.5 Building the Mega-Structure Walls

Samples were investigated from two parts of the Mega-structure walls – the South wall and the South-Eastern wall. One daub block from the South wall was formed by the application of the three layers of different clays, each with 60% chaff temper by volume and showing a red–white–pink cross-section (cf. Fig. 4.64/7). These clays show a firing temperature of 850–900^{0}C. A second sample from the South wall shows the beginning of the vitrification, at 1000^{0}C, of poorly mixed polymineral clays (cf. Fig. 4.64/5). A similar practice – mixing two different clays with contrasting properties – was used to make the daub for the South-East wall, which was fired at 800^{0}C. The likelihood of the clays mixed for wall-building deriving from different clay sources may indicate the 'presencing' of different parts of the landscape in the same stretch of wall.

4.9.6 Constructing the Podium and the Platforms

The most significant features inside the Mega-structure were made of different clays with different tempering practices in comparison with the wall daub. No chaff was used in the application of clay to the horizontal surfaces of Platforms; these were dense clays, stronger than chaff-tempered daub. The surface smoothing layer

69 This observation does not wholly fit with the molluscan evidence presented in Section 4.1.2.

was usually applied in several coats, with chaff temper in the lower part only. The uppermost layer was a light, carbonate-rich clay layer applied in a 1-mm-thick layer as a basis for painted decoration and with red ochre used as paint. The clay materials of the podium and the lower level of platform 257 were not only the same but they were fired at similar temperatures (800–850^{0}C). However, different clay materials were used to construct the different layers of Platform 257, suggesting either different times of making, the practice of repairing the feature or its use for different functions.

4.9.7 The Production of a Storage-Jar

A single sample of the thick-walled storage vessel termed a 'pithos' showed that the vessel had been built up using two layers of clay – a lower level of faster-drying olivritic clay marl with 50% chaff and an upper level consisting of a mixture of two clays – a polymineral clay and a marly clay with 30% chaff to reduce shrinkage/ cracking during drying. A slip was applied to smooth the outside surface, perhaps to achieve a decorative effect. The vessel was fired at 800–850^{0}C.

4.9.8 The Destruction of the Mega-Structure: The Evidence from Daub Firing Temperatures

There were two problems for those engaged in the deliberate burning of the Mega-structure at the end of its active life: the extreme size of the built part of the Mega-structure – at 36m x 20m the largest known structure in the Trypillia world – and the large central open area which would have hindered the spread of the fire from either end to the other side. For this reason, daub samples from a wide range of contexts were selected for daub re-firing temperature analysis. Each sample was re-fired until its colour was replicated in the kiln atmosphere, with its increase of 100^{0}C every hour or with five 8-hour firings, each producing a temperature change of 200^{0}C (for details, see https://doi.org/10.5284/1047599 Section 5.1.5) (Fig. 4.64/6).

The results showed that the firing temperature of most daub blocks was found to be no more than 800–850^{0}C, with three very low temperatures (200–300^{0}C) and one vitrified sample, fired at over 1000^{0}C. All samples showed similar tendencies in colour change based upon increases in firing temperature. Very different firing temperatures were reached in different parts of the Mega-structure. These temperatures can be grouped into low (200–400^{0}C), medium (400–900^{0}C) and high (>900^{0}C). Concentrations of vitrified daub ('high') may indicate the starting-point for the fires, given the optimal draught conditions; concentrations of unburnt daub ('low') may have been the most remote from the fire or were 'protected' under collapsed walls and/or as lowest parts of the design (e.g., the podium and the Platforms). In the case of four contexts (the platform Context 6; the podium Context 29); and two daub scatters Contexts 107 and 112), contrasting daub temperatures were recorded for different samples from the same context. The higher (highest) of the temperatures is taken to represent the principal impact of the fire, while the lower (lowest) indicates areas protected from the main conflagration. ‘High’ temperatures were found in only three Contexts (the platform Context 6 and the daub scatters Contexts 107 and 112). ‘Medium’ temperatures were found in four contexts (the podium Context 29; the platform Context 257; the West wall Context 118 and the pithos (Context 149) above podium Context 29). Finally, ‘low’ temperatures were found in five contexts (the fired clay wall slots Context 159; the North wall Context 173; and daub scatters Contexts 45, 110 and 120).

The spatial distribution of the daub firing temperature evidence by Phase (Fig. 4.41) shows markedly different distributions in Phase 3 Upper and Lower. In Phase 3 Upper, the principal clustering of vitrified daub was in the South-West corner, with a spread along the podium and the South wall; there were hardly any clusters of vitrified daub in the Eastern rooms. However, in Phase 3 Lower, much more vitrified daub was found in the Eastern rooms, with less in the Western wall and less still in the South-West corner. The combined picture suggests at least two starting-points for the fires that were lit to burn down the Mega-structure: a dominant cluster in the South-West corner and a less marked concentration in the North-East corner, both taking advantage of good draught conditions for burning. Such a conclusion makes sense in terms of the two problems for those burning the Mega-structure – its size and the central open area which resisted the spread of the fire.

Bisserka Gaydarska & John Chapman

4.10 Summary

The site investigations at Nebelivka followed the multi-disciplinary scatter-gun approach now standard in many modern projects, by which a multiplicity of approaches and methods is used to understand a site through the integration of huge quantities of disparate, specialist information[70]. The diversity of approaches selected is not simply a function of the total number of available approaches, since some approaches were considered and rejected[71]. Rather, the variety of approaches was

70 Consider Alasdair Whittle and István Zalai-Gaál’s exemplary Ecsegfalva 23 project, in which 31 specialist reports show the variety of approaches to a single, small Early Neolithic Körös settlement (Whittle 2007).

71 The study of soil aDNA was considered and rejected for an understanding of the central open space at Nebelivka because there was no way in which to identify the depth of the occupation surface of such a large open space.

related to the diversity of research questions posed about Nebelivka in particular and megasites in general (for Project aims and objectives, see above, Chapter 2.2).

The central problem for the Project team was the difficulty of researching such a massive site of 238ha. We were fully aware that our Ukrainian colleagues put the strategy of the excavation of burnt houses at the heart of their decades-long investigations at the two nearby megasites of Taljanki and Majdanetske (Kruts et al. 2001, 2005, 2008, 2010, 2011, 2013; Shmaglij & Videiko 2001–2). While the excavation-centred approach has produced remarkable insights into the architecture of megasite houses and their burning, as well as an unparalleled series of 'burnt-house assemblages', only one of the Project objectives (Objective 6, on Trypillia house architecture) could have been answered by a small-scale emulation of this approach. The Project response was to develop a targeted series of complementary investigations to answer the two overarching aims and each objective. It soon became apparent that geophysical prospection was to play a fundamental role in the Nebelivka study.

The geophysical plan of the 238ha settlement at Nebelivka was the first such complete plan for any Trypillia megasite. Moreover, the advances in the new geophysical devices meant an improvement in the quality of the plot, with a greater differentiation of anomalies and hence the detection of new kinds of anomalies, as well as the potential to define new combinations of features new and old (Chapman et al. 2014b). These breakthroughs led to the setting of a new agenda for Trypillia megasite studies, which we estimate will engage archaeologists and kindred specialists for at least two decades.

A vital first step in tackling the new research agenda was the ground-truthing of a wide range of new and old features through trial and larger-scale excavations. The Project excavated five types of new feature, including the largest Assembly House known in the Trypillia world (the so-called 'Mega-structure'), an unburnt house, the largest form of pit, an industrial feature (perhaps a 'pottery kiln') and the perimeter ditch. The most complex operation was the excavation of the Mega-structure, in which a high proportion of the finds was recorded by Total Station and almost all daub features were drawn, scanned and integrated into Phase plans. While the primary goal of test pit excavation was the recovery of stratified organic samples for AMS dating, the large number of test pits, though small in size at 2–4% of a house area, produced a cumulatively impressive quantity of architectural information, enabling spatial comparisons of house architecture that have not been possible before.

The interpretation of excavated remains relies heavily on a good understanding of taphonomic processes, which have been neglected in past investigations of Trypillia sites. The Project focussed on two types of feature – burnt structures and pits. Natalia Shevchenko's innovative analysis of the Mega-structure building materials provided a framework for the construction of the walls and internal features as well as a daub firing temperature-based consideration of its deliberate destruction by fire. The late introduction of an experimental house-building and -burning programme led by Stuart Johnston was augmented by the excavation of the experimental burnt house in 2017. The production of a genuine '*ploshchadka*' for the second time, and vitrified daub for the first time, in Cucuteni-Trypillia house-burning experiments underlines the importance not only of deliberate burning but also the unsuspected quantities of firewood required to burn a house – perhaps as much as 10 times the timber required to build the house.

The predominantly dry conditions of the South Ukrainian forest-steppe made it particularly difficult to understand the landscape in which the megasite was created. Bruce Albert and Konstantin Krementski were able to locate a small alluvial basin within 250m of the edge of the megasite, from which they recovered a sediment core dating to before, during and after the megasite occupation. Two fundamental conclusions emerged from this research: the discovery of a pre-megasite agricultural signal, including a massive fire event, indicating an Early Trypillia population in the area which has not been detected through fieldwalking; and the extraordinarily low level of human impact found in the sediments coeval with the megasite, emphasising the limited number of people dwelling at Nebelivka at any one time in this massive site. Both of these findings are crucial for our understanding of the growth and development of Nebelivka.

The only objective which the Project failed to meet was the derivation of an internal sequencing for the 1,445 structures at Nebelivka. The pioneering use of a large number of 2m × 1m test pits placed in the geophysical anomalies interpreted as dwelling houses or Assembly Houses[72] enabled the collection of over 500 AMS samples, from which over 100 were submitted for dating in the ORADS (Oxford) and Poznań labs. Despite the successful production of 83 AMS dates, a wiggle on the radiocarbon calibration curve has complicated even the most basic chronological differentiation – whether the Outer Circuit was built in different decades from the Inner Circuit and how the Inner Radial Streets related in time to the two Circuits. This stumbling-block opens up the interpretation of the Nebelivka plan to a variety of models, from the coeval occupation of all houses to the sequential occupation of a fraction of houses in any generation and several others (for an evaluation of the three developmental models, see Chapter 6.1). But whichever the preferred scenario, the model must conform to the limitations of the basic settlement footprint of 1,445 houses, including 1,077 burnt houses, to be built and burnt within seven or eight generations or 200 years, without any peaks in human impact as shown in deforestation or charcoal peaks.

72 The strategy of widely spaced test pits for the collection of AMS samples has now been adopted by other research teams in Ukraine (e.g., Müller et al. 2017; A. Diachenko, pers. comm.; A. Korvin-Piotrovskiy, pers. comm).