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Vlasac revisited: formation processes, stratigraphy and dating

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ABSTRACT – *Since 2006, new excavations of the Mesolithic-Neolithic site of Vlasac in the Danube Gorges of the north-central Balkans have been under way. Excavations made across the surviving preserved portion of the site provide a unique opportunity for a re-evaluation of previous conclusions about the stratigraphy, chronology and the character of occupation at this classic site of the Lepenski Vir culture. Our revision work is contributing to new knowledge about formation processes at the site, its absolute dating, complex interplay of different mortuary practices and the nature of Mesolithic-Neolithic transformation in the region as a whole. Some aspects of these research efforts are presented in the paper.*

IZVLEČEK – *Od leta 2006 potekajo nova izkopavanja na mezolitsko-neolitskem najdišču Vlasac v donavski soteski v severnem delu centralnega Balkana. Izkopavanja, omejena so na ohranjeni del najdišča, omogočajo ponovno presojo in reinterpretacijo stratigrafije, kronologije in poselitve klasičnega naselja kulture Lepenskega Vira. Naše delo omogoča nove pojasnitve procesov formiranja naselja, njegovo absolutno datiranje ter predstavitev kompleksnosti pogrebnih praks v kontekstu mezolitsko-neolitske transformacije v regiji. V članku predstavljamo nekatere vidike in zaključke raziskovalnega dela.*

KEY WORDS – *Vlasac; Mesolithic; Danube; Lepenski Vir; geoarchaeology; chronology*

Introduction

A series of settlements along the narrows of the Danube River on the Serbian-Romanian border provide a rich settlement and intramural mortuary dataset. The archaeological record indicates largely unbroken continuity of occupation during the Mesolithic and Early/Middle Neolithic periods (*c.* 10 000–5500 cal BC) (*e.g. Borić 2002a; Borić and Dimitrijević 2007 in press; Borić and Miracle 2004; Radovanović 1996; Srejović 1972;* but *cf. Bonsall et al. 2002*). This long continuity is marked by important changes throughout the sequence, the most important one being the transition from the Mesolithic to the Neolithic from around 6200 to 5900 cal BC. Early Neolithic pottery appears in the central Balkans around 6300 cal BC (*Whittle et al. 2002; 2005*). Significantly, this dating seems to coincide with architectural changes in the Danube Gorges: the transition from the use of rectangular open-air stone hearths to the construction of elaborate trapezoidal buildings with limestone floors. At the type-site of Lepenski Vir this new form of architecture is most elaborately expressed. However, it seems that these features in their basic form, including trapezoidal floor outline with central rectangular hearths and red limestone flooring, appear already in the Mesolithic sequence at the neighbouring site of Vlasac for the first time (*Borić 2007a; Srejović and Letica 1978*). Moreover, at Lepenski Vir, there seems to exist a gap between the Early Mesolithic occupation and the later phase with trapezoidal buildings. This gap coincides with the duration of the regional Late Mesolithic, *c.* 7300–6200 cal BC. In contrast, at Vlasac, this period saw the most intense activity on the basis of existing radiometric evidence (see below). Hence these two neighbouring sites provide complementary sequences for studying diachronic changes among the Danube Gorges fisher-foragers.

In this paper, we revisit the dating, stratigraphy and phasing of the site of Vlasac. Such a discussion is partly facilitated with the results of new fieldwork at this site (*Borić 2006; 2007b*) that enabled a re-examination of formation processes, among other things. In addition, a series of new AMS dates from Vlasac, most of which are published here for the first time, encompass samples from both the 1970s excavations as well as the most recent excavations and help us ground our observations about site's stratigraphy in the temporal framework. These new results are then compared with and discussed in relation to observations made by the first excavators of the site.

Geological setting

The Danube Gorges region of eastern Serbia/western Romania (Fig. 1) is a complicated but well studied region geologically (*Banu 1972; Grubić 1972; Marković-Marjanović 1978; Rabrenović and Vasić 1997; Stevanović 1997*). By the late glacial period there was a very large meandering and fast flowing river confined within the limestone/granitic/sedimentary rock dominated gorge, with narrows, cataracts and terrace remnants on the floodplain edge. These often occurred as promontories on the valley floor, composed of riverine sand, wind-blown loessic silt and/or scree off the adjacent steep slopes, often re-cut and re-carved by channel avulsion processes. It was on these 'tongues' of land projecting at near right angles to the adjacent valley slopes that the Mesolithic peoples established themselves with settlement and burial sites, with Lepenski Vir on finely laminated riverine sands, and Vlasac on granitic and limestone derived scree. These floodplain edge 'terrace remnants' could be seen as more accessible – just above the river's influence and not being covered to the same extent with the thick and developing woodland that gradually blanketed the adjacent slopes in the early Holocene.

Previous research at Vlasac

The first excavations at Vlasac (44° 32' N, 22° 02' E; *c.* 62–78 m asl) were made in 1970 and 1971 across the area of 640m² (*Srejović and Letica 1978*) (Fig. 2). The site was excavated along the riverbank section that would be submerged and only selected areas of the river terrace were excavated. There were five dwelling structures with floors and 26 possible open-air (?) hearths as well as 17 stone constructions of different shapes and extent whose function remains undetermined. There are also 87 graves containing either 119 individuals (*Nemeskéri 1978*) or 164 individuals (*Roksandić 1999; 2000*). The excavation area was divided into three sectors: western (176m² excavated), central (224m² excavated) and eastern (240m² excavated) sectors. It was suggested that one could separate three main cultural horizons across the site: Vlasac I with subphases a and b, Vlasac II and Vlasac III. The excavators described the sequence at each of these sectors separately. The cultural and physical characteristics of these layers are mixed in these descriptions that come from Srejović and Letica (*1978.11–14*) and we shall later try to connect these first observations about the stratigraphy of the site with our own observations about the stratigraphic sequence at the southernmost extent of its spread investigated in the course of renewed work in 2006 to 2008 (see below). Stratigraphic descriptions of each sector follow.

Fig. 1. Vlasac – location map (1 : 25 000).

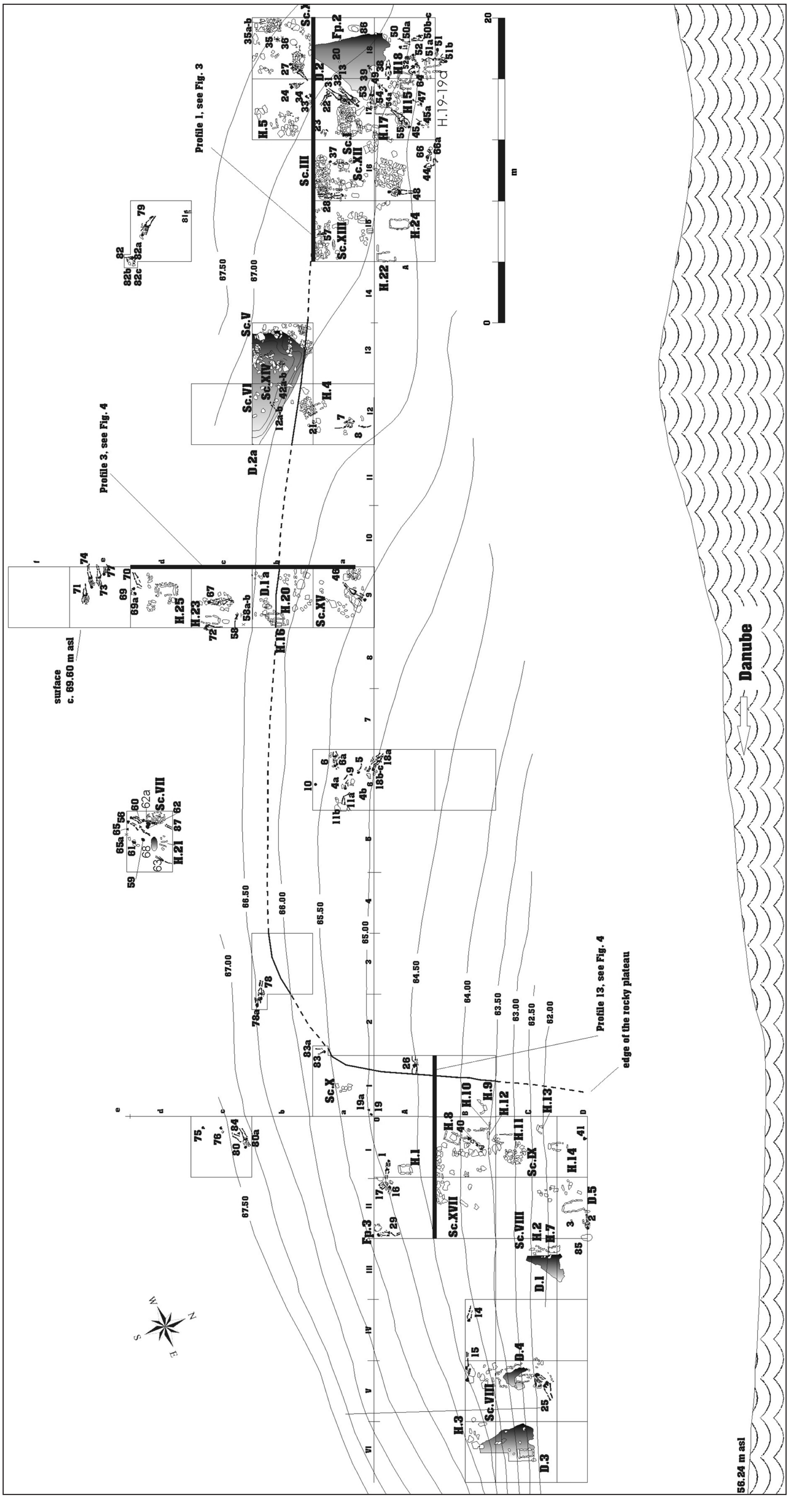

Fig. 2. Areas excavated in 1970–1971 at Vlasac with the location of some section drawings marked (adopted after Srejović and Letica 1979*).*

Western sector

At this sector the terrain slopes gently from the SW to the NE (approximately 50cm over a distance of 8m). The most representative section of the stratigraphic sequence at this sector and possibly the whole site, as stressed by Srejović and Letica (*1978.11*), is reproduced in Fig. 3. The stratigraphic sequence at this sector as seen by the excavators is as follows:

- Humus (20 to 25cm);
- Younger scree (15 to 30cm);
- Older scree (30 to 60cm);
- Eneolithic layer only in square a/18 (10cm);
- Vlasac III (40 to 80cm): brown to black soil containing gravels and large stones;
- Vlasac II (30 to 100cm): brown soil with large quantities of smaller scree;
- Vlasac Ib (10 to 60cm): dark yellow soil with larger gravels;
- Vlasac Ia (20 to 60cm): only in squares a/17, a/18, A/17 and A/18): a large number of fish bones, gravels and clay-like soil;
- Natural: clay-like soil, culturally sterile, with brown soil and gravels (virgin soil I) or the oldest yellow scree with smaller gravels (virgin soil II).

Central sector

The surface at this sector slopes from the S to the N relatively more abruptly than at the western sector (approximately 1.5m over a distance of 16m). Interestingly, at this sector the bedrock slopes in the opposite direction: from N to S, by 1.8m. Due to the specifics of the terrain in this part of the site, in square B/6 under the level of humus, the bedrock was hit with no cultural levels, while in squares A/6 and a/6, a homogenous cultural level was only 60cm thick, with burial remains only and rare finds of animal bones and other materials. This is due to the existence of an elevated rocky plateau (bedrock formed of large stones) that was forming a half-circle in the central part of the terrace (see Fig. 2; *Radovanović 1996.Fig. 4.7*). This feature must be a relict of the Danube's palaeo-channel, which in the past had cut through less resistant sediments behind the rocky plateau, which remained unaffected. The first inhabitants of Vlasac appropriated the depression left here for their first settlements (*Srejović and Letica 1978.10*). This feature of the site topography is important for understanding both the specificity of formation processes in certain areas of the site as well as for the organization of the initial settlement activities as reflected in the settlement layout. This feature can best be observed on the published sections that run from point d9 to x9 or c12 to x12 (*Srejović and Letica 1978.profiles 3, 7*). Similarly, at the eastern sector, this is observable on sections that run through points ay to a1 and from point AII to A1 with the rocky base dipping from the NW to

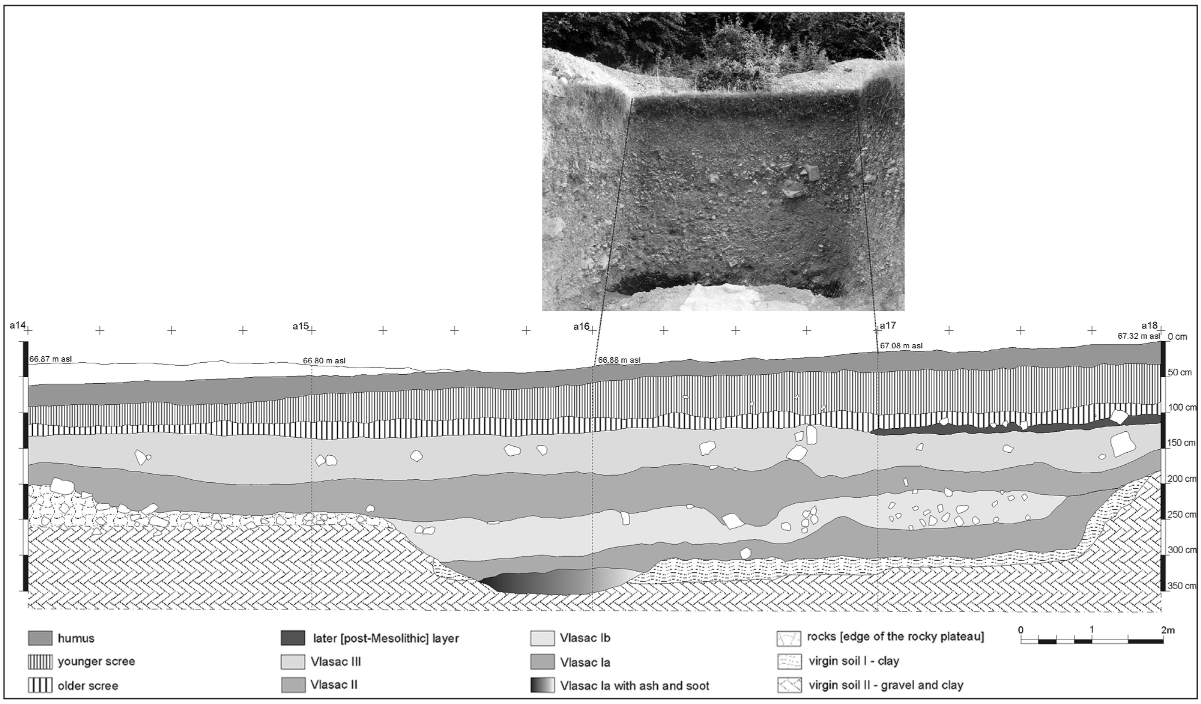

Fig. 3. Section from 1970–1971 excavations running through points a14 to a18 (adopted after **Srejović and Letica 1978.profile 1*****) compared to the photo of the section from 1970–1971 excavations running through points a16 to a17 in the background and parts of squares A/17 and a/17 with Hearth 17 (at 64.55 m asl) in the foreground (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).***

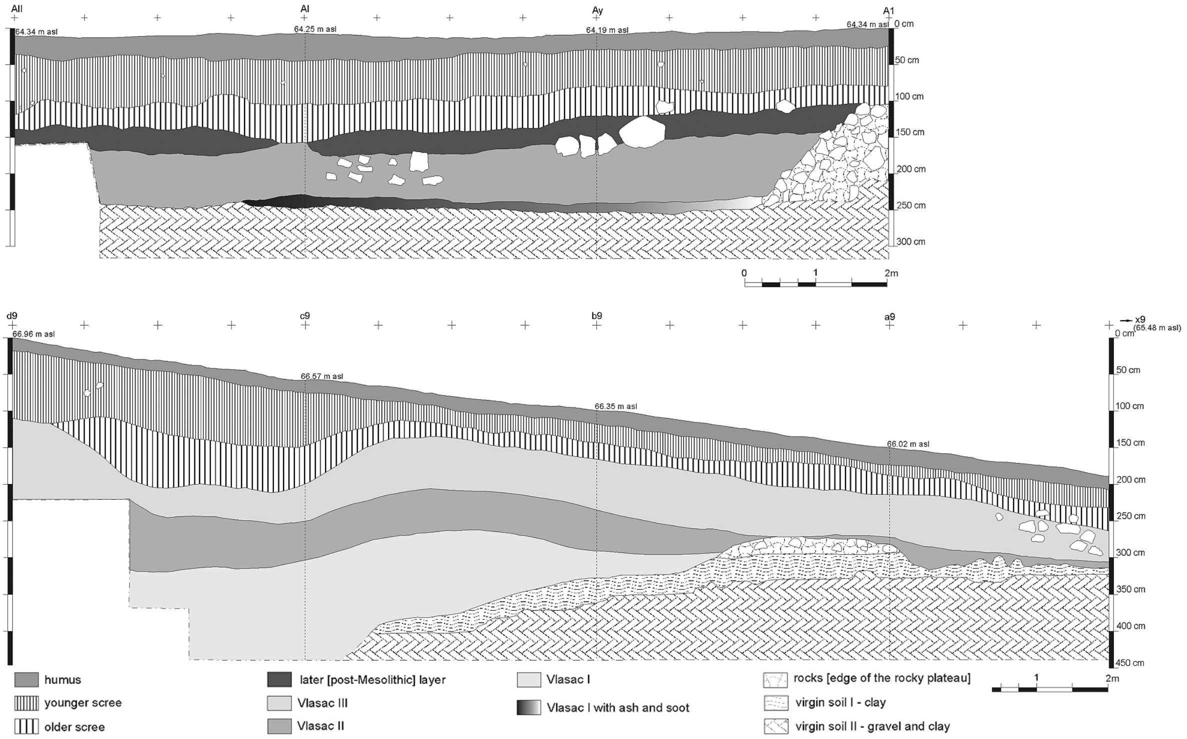

Fig. 4. Cross-sections of the stratigraphy of the Vlasac terrace with the rocky plateau indicated on the basis of published sections (a) d/9 to x/9 and (b) A/II to A/1 (adopted from* Srejović and Letica 1978.profile 3, profile 13*).

the SE. At these latter sections one catches the limit of this rocky, elevated plateau on the eastern side of the Vlasac terrace (*Srejović and Letica 1978.profile 10*). In Fig. 4a–b, we reproduce published cross-sections of the terrace showing the rocky plateau as documented on the central and eastern sectors. The limit of the rocky plateau in the central sector can also be established in square b/3 where the bedrock is reached below 20cm of surface humus. The bedrock here also slopes from the NW to the SE.

In the central sector the thickness of identified layers is somewhat different from the western sector:

- Humus (20cm);
- Scree (30 to 180cm);
- Vlasac III (40 to 100cm);
- Vlasac II (average thickness 50cm; present in squares d/9 and c/9 only);
- Vlasac I (150cm; present in squares d/9 and c/d only with a sudden dip of layers behind the zone of the rocky plateau);
- Natural.

Eastern sector

The observed stratigraphic sequence behind the rocky plateau (see Fig. 4b) is divided in two zones: Western zone in squares A/1, A/I, B/1, B/I, B/II, C/I, C/II, C/III, D/I, D/II and D/III):

- Humus (25cm);
- Younger scree (average thickness 20cm);
- Older scree (average thickness 40cm);
- Early/Middle Neolithic horizon (80cm, only in squares C/III, C/II and C/I).
- Vlasac III (average thickness 50cm; in square A/1, only 20cm due to the intrusion of an Early/Middle Neolithic pit, or completely damaged in squares A/I, B/I and C/I);
- Vlasac II (average thickness 40 to 90cm);
- Vlasac Ib (30 to 180cm, only in squares C/III, C/II and C/I);
- Vlasac Ia (10 to 40cm, only in squares C/III, C/II and C/I);
- Natural.

According to the excavators, the eastern zone of the eastern sector in squares B/IV, B/V, B/VI, C/IV, C/V and C/VI differs from the rest of the site both on the basis of layers' physical characteristics (consistency, inclusions, colour) as well as in terms of their archaeological content. The excavators observe that the pre-Neolithic levels are rather homogenous, largely containing clays and smaller pebbles (*Srejović and*

Letica 1978.13). The terrain here also is rather steep with the inclination the S–N and the height difference is 2m at the distance of 4m. The base of the sequence also has an abrupt dip from the SE to the NW at point BV (*Srejović and Letica 1978.profile 16*) forming a deeply buried sequence in squares B/V, B/IV, C/V and C/IV.

- Humus (30cm);
- Homogenous layer of scree (average thickness 80cm);
- Vlasac III (40 to 70cm);
- Vlasac II (50 to 140cm);
- Vlasac Ib (20 to 100cm over a small area);
- Vlasac Ia (average thickness 30cm over a small area);
- Natural.

The observations at this sector are added with the mention of test square c/I (see Fig. 1), where the base of the sequence has an abrupt dip from the SE to the NW, which forms a deeply stratified sequence in the NW corner of this square. This is probably similar to the situation in the central sector (see above) with the existence of a deep natural 'gully' behind the rocky plateau, before the base starts to rise again toward the south. In square c/I one observes the following stratification:

- Humus;
- Homogenous layer of scree (100cm);
- Younger cultural levels (70cm): yellow-brown soil containing large stones and charcoal;
- Older cultural levels (60cm): reddish-brown deposit with lots of charcoal and ash at its bottom;
- Natural.

Summary and discussion

Above given detailed descriptions provide very illuminating insights about the original topography of Vlasac and point out significant variations of archaeological deposits across the site. For the adequate understanding of formation processes at this site, it is important to comprehend the existence of the central rocky plateau that approximately forms a half-circle with a natural 'gully' behind this rocky plateau where one seems to find the most deeply stratified zone. Also, here, the excavators observed the existence of the earliest levels, which they attribute to their phase Ia–b. However, their descriptions of the physical characteristics of all three main horizons (phases Vlasac I–III) are limited to the western sector and are not very detailed. These observations are then assumed for other areas of the site. The excavators seem to take for granted the existence of layers that possess the same physical characteristics and the same type of cultural material at approximately the same level across the site. Yet, it is obvious from their descriptions of the site's topography that this sloping terrace has a fairly complex sequence and that it is unlikely that the cultural levels would be formed continuously across the site as is often the case when cultural layers are laid on a flat terrain, for instance, in tell type of archaeological sites. Hence the excavators' basic assumption that at the complex erosive-accumulative terrace such as Vlasac, with varying inclinations of slopes, one could distinguish and recognize Holocene layers of the same date, with the same physical characteristics (consistency, colour, etc.), at approximately the same level, was problematic. Moreover, Srejović and Letica's phases Vlasac I–III, marked on published section drawings as separate entities, lack detailed descriptions of their physical characteristics.

By comparing one of these published sections with a previously unpublished photo of a part of the same section (Fig. 3), one could check the decisions made by the excavators to attribute a particular zone to a particular level. In this example, the humus layer is clearly distinguished, while it is more difficult to make a distinction between the so-called 'younger' and 'older' scree as marked by the excavators. On this photograph, instead, one notices a homogenous zone beneath surface humus that contains smaller scree. This likely represents the subhumic level and the archaeologically sterile hillwash (see below). Larger stones and significant amounts of gravel can be distinguished as layer Vlasac III, which seems clearly defined on the photograph, particularly in comparison to the layer below it. A difference between layers marked as Vlasac II and Ib on the published section is less recognizable on the photograph although one may notice differences in the concentration and size of gravels in particular zones of this rather homogenous deposit. On the photograph, one can also notice an intense dark layer at the bottom of the stratigraphic sequence that would correspond to layer Vlasac Ib as drawn on the published section. This markedly different colour on the section may partly be due to a different degree of moisture in this part of the section in comparison to the rest of the exposed section as its bottom portion must have been excavated last, but could perhaps also relate to a concentration of charcoal in this particular layer as indicated on this part of the published section (see Fig. 3). We are missing the base of the section on the

Fig. 5. North-facing section in Trench 3/2006 before the start of excavation works in 2006 (© D. Borić).

photo and cannot compare the cultural layers with the sterile layer beneath that the excavators on the section drawing distinguish into two different zones: a thin layer of clay virgin soil directly beneath cultural levels and gravel and clay deposits that mark the base of the whole terrace.

In the following section, we will describe the stratigraphic sequence as seen through our renewed work at the upper portion of the terrace, trying to make connections between what we can observe and the characteristics of the stratigraphic sequence described by the excavators in the 1970s at the lower portion of the Vlasac terrace.

Geoarchaeology and the stratigraphic sequence at Vlasac in 2006–2008

A large part of Vlasac closer to the original river terrace was excavated during the 1970 and 1971 rescue excavation campaigns (see above) while unexcavated parts were submerged under waters of the modern Danube. For over 35 years since the end of the first excavations at Vlasac, the Danube at this location was slowly eroding away sediments, creating a new riverbank section (Fig. 5). During the 2005 field season in the Danube Gorges hinterlands[1], there were reports from local fishermen about washed out bones at this place. Checking these reports at the start of the 2006 field season, it was confirmed that certain portions of this site were still preserved and accessible for research (*Borić 2006; 2007b*).

At the break of slope just above the water's edge, which fluctuates depending on the accumulation of water in the artificial lake (*i.e.* the Danube in this part of its course in front of the hydroelectric dam), there is a *c.* 10m wide linear zone of Holocene archaeological survival (Figs. 6–7) associated with a complicated erosion sequence. From the field observation of the open section profiles and some selected micromorphological analyses, the aims were to investigate the nature of any buried land surfaces present and the colluvial sequence, and any potential structural surfaces.

The composite hillslope sequence of deposits as seen on the north-facing, exposed riverbank section

Fig. 6. Excavated areas at Vlasac in 2007 seen from the Danube (© D. Borić).

1 New fieldwork in the Danube Gorges started in 2004 as part of a collaborative project entitled "*Prehistory of north-east Serbia*" between the Department of Archaeology of the University of Belgrade, Serbia, and the Department of Archaeology, University of Cambridge, UK, and with Miloš Jevtić and Dušan Borić as principal investigators. A part of this wider project relating to the Stone Ages has been designed to test the notion of the Mesolithic-Neolithic frontier as a general model as well as its applicability in this regional example by reference to known Mesolithic settlements on the Danube and largely uninvestigated hinterland areas on the Serbian side of the Danube.

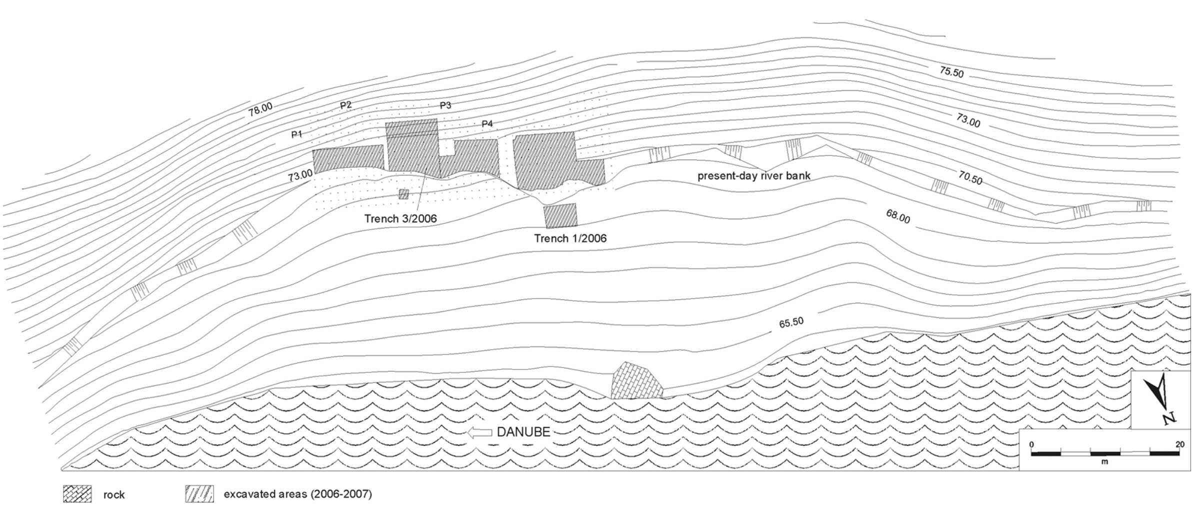

Fig. 7. Excavated areas at Vlasac in the course of 2006–2007 excavation campaigns (© D. Borić).

of Trench 3/2006 at Vlasac (Figs. 8–11) is described as follows.

Above the bedrock at the base of the slope is a 20+ cm thick gray limestone scree deposit, which is probably a solifluction type of deposit of the late glacial period (*cf. Marković-Marjanović 1978*).

It has a slightly undulating boundary with a *c.* 15–40cm thick, reddish brown, calcitic clay with common to occasional fine (<3cm), angular to sub-rounded limestone fragments. From the micromorphological analysis (*French 2008*), this horizon exhibits some pedogenic features, notably a well defined, fine (<5mm), sub-angular blocky ped structure, some bioturbation through soil faunal action and evidence of a once greater organic content in the form of fragmentary amorphous iron-replaced plant tissues. This horizon undoubtedly represents a soil with some degree of soil formation and stability, but which is probably also influenced by additions of hillwash-type material in the form of calcium carbonate and fine limestone pebbles. The upper organic A horizon has been truncated, presumably through subsequent slope erosion processes. But this palaeosol contains no evidence of any loessic component, contrary to initial impressions in the field (*French 2007*).

The early Holocene buried soil is present by at least the Late Mesolithic, from *c.* 7300 cal BC. It is certainly possible that there was a substantial degree of woodland cover immediately upslope from the occupation and burial site at this time which allowed relative stability at the base of the slope where the current excavations are taking place, and therefore the formation of this soil. The longevity of this soil is impossible to ascertain on soil features alone, but as there is now a suite of radiocarbon dates indicating the continuous use of this site throughout the late Mesolithic for at least several centuries (see below), indicating by implication that the soil is of a similar age range.

Importantly in the upper half of the palaeosol (contexts 145 and 149) and immediately associated with a possible trapezoidal structure, there is a distinct line of horizontally oriented small limestone frag-

Fig. 8. North-facing section in Trench 3/2006 through burial sequence and possible dwelling floor after initial cleaning (© D. Borić).

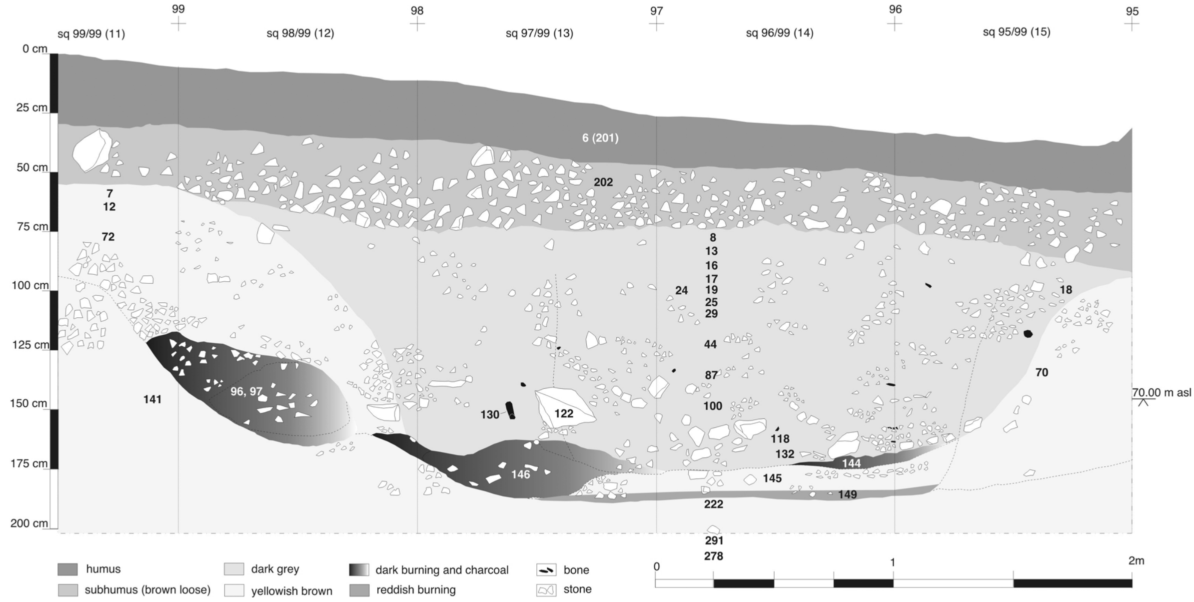

Fig. 9. Drawing of the north-facing section in Trench 3/2006 through burial sequence and possible dwelling floor after initial cleaning (© D. Borić).

ments which strongly suggest that this is a surface (Fig. 12). It is probably not a prepared surface *per se*, but it has either been truncated at this level, or trampled and compacted through human use. On balance, it is suggested that this level represents an exposed surface, and this is corroborated by the few fragmentary anthropogenic inclusions of fish bone, both burnt and unburnt, bone and charcoal with much amorphous iron impregnation (Fig. 13). This reflects anthropogenic activity during the Mesolithic use and occupation of this hillslope. There are a number of Mesolithic burials uncovered in the course of the renewed work at Vlasac that are also cut into this 'red soil.'

The remainder of the profile succession then consists of hillwash material composed largely of angular limestone rubble of <5cm across in all orientations. This occurs in thick horizons located extensively across the hillslope over depths of *c.* 1–3m. There is also hillwash material infilling either large tree-throw pits and/or small gullies, that bisect the base of the slope. These pits are up to *c.* 1.5m in depth and 8m in width. The hillwash material sometimes exhibits discontinuous bedding lenses of limestone rubble fragments of up to 10cm in size as well as more undifferentiated zones with smaller limestone fragments in all orientations. It is suggested that this indicates overland flow mechanics of deposition as well as deflation through slope run-off and the stop/start nature of deposition. There are also units of browner, more organic and soil-rich hillwash, which are indicative of some temporary stabilisation or at least a slowing in colluvial depositional processes. These variations are probably as much associated with the nature of the vegetative growth and cover on the hillside as human activities. Also, there may be differential colluvial deposition occurring around *in situ* trees on the slope; there is certainly differential infilling with coarser/more abundant limestone fragments within large tree-throw pits.

Above and upstream from the trapezoidal structure, this level is characterised by a mixture of fine limestone rubble, colluvially derived, and a greyish brown calcitic silt in which both occupation material and burials are found. Elsewhere and downstream, this same level in the stratigraphy is essentially free of cultural material and is dominated by limestone rubble hillwash deposits. The greater soil and organic component of this post-structure horizon suggests that this area represents a much slower aggradational dynamic. It may well represent a series of temporary or standstill soil surfaces alternating with minor, intermittent colluvial episodes, which have subsequently become mixed through bioturbation and some fine soil wash. Giving a temporal dimension to this is very difficult, but it could be envisaged in terms of 100 years or so if you consider turf development taking a few years in such a context.

Finally, the sequence is capped with the modern woodland floor on a *c.* 45 degree slope. It is composed of *c.* 20–25cm of dark brown silt loam with leaf litter matt and oxidised organic component and much modern rooting, with small angular limestone pebbles increasing in frequency with depth.

Fig. 10. North-facing section in Trench 3/2006 through burial sequence and possible dwelling floor with the last inhumation Burial context 53 exposed (© D. Borić).

Slope processes

The whole area under excavation and the complete profile represents the episodic deposition of variable mixtures of soil and chalk hillwash occurring around *in situ* trees in greater or lesser degrees of open woodland. This had the result of leaving some areas of the hillside more intact and stable than others, with other adjacent areas being severely affected by overland flow hillwash processes. Certainly there is much tree throw activity in evidence, areas of former root bowls and root disturbed areas, which are often associated with concentrations of Mesolithic artefacts.

The hillwash activity was essentially occurring on the bare, devegetated slopes by overland flow. This colluvial slumping may have led to some folding over of existing deposits on the hillside, such as in the upper/uphill fills of the inhumation burials, and even inversion of sediments.

The main archaeological levels, even though they occur at different levels on the hillside, are probably indicative of the same stabilised soil surface level in the Late Mesolithic, from *c.* 7300 cal BC. Nonetheless, there is little doubt that this relative stability was broken from time to time by some downslope soil movement. When the woodland on the slope above became seriously disturbed/exploited, hillwash events began in earnest, and may well have led to the abandonment of this part of the site at the base of the slope. On archaeological grounds this does not appear to have occurred before the end of the Middle Neolithic, *i.e.* sometime between 5700 and 5500 cal BC.

Comparison with the 1970s excavations

Our observations indicate the importance of an adequate understanding of the complexity of colluvial processes for the correct interpretation of the stratigraphic sequence at Vlasac. Although some elements of the stratigraphic sequence at the part of the site where new excavations are taking place must differ from those features observed at the part of the site excavated in the 1970s, it seems that we may suggest some revisions of the previous understandings of Vlasac's stratigraphy with the benefit of more detailed geoarchaeological and micromorphological observations that we have provided. First, the important role in this revision is played by the nature of depositional processes that depended on the dynamics of woodland clearance, creation of tree-throws and the intensity of hillwash downslope movement and its accumulation in particular depressions, which prevent any constancy in the deposition and formation of cultural levels across the site and, moreover, cause the movement and re-deposition of some cultural materials. From the descriptions provided by the excavators, it is clear that they also had difficulties in seeing their phases Vlasac Ia–b to III as clearly recognizable layers across the site, which is understandable bearing in mind the complex colluvial sequence just described.

From the bottom of the stratigraphic sequence we can equate Srejović and Letica's 'virgin soil II' (see Fig. 3) with our description of the bedrock consisting of gray limestone scree. What they describe as 'virgin soil I' is what we have identified as 15–40cm thick reddish brown calcitic clay. This is palaeosol with some stability, representing incipient soil formation with woodland cover in the early Holocene. In mid profile in this soil, one can recognize some anthropogenic activity, possibly related to the woodland clearance, which, with time, intensified with the downslope erosion of scree and its deposition in depressions and tree-throws. Cultural activities sometimes continued for more than a millennium (see below) even in those areas affected by the hillwash accumulation as witnessed in the case of the burial sequence discovered in Trench 3 in 2006. Such activities were often associated with larger depressions left after earlier Mesolithic use of particular locations. On the basis of our understanding of the colluvial sequence at Vlasac, it is difficult to justify the assumption that cultural levels Vlasac Ia–b to III identified by Srejović and Letica were laid continuously across the site since the deposition of cultural strata at Vlasac must have been taking place at different times in different areas of the site. Thus two related processes created the cultural stratigraphy at Vlasac: on the one hand, the dynamics of hillwash movement affected by woodland clearance, and, on the other hand, complex cultural practices of inter-cutting and re-depositing of older layers and materials. These inter-cuttings are often hardly visible in the type of hillwash deposits, which most of the stratigraphic sequence at Vlasac consists of, where one finds gravels of different sizes to be a significant component of the soil matrix.

Fig. 11. North-facing section of the base of the colluvial sequence with the palaeosol at about 20–55cm above the base of the profile developed on scree at Vlasac in squares 104/98 and 105/98, Extension Trench 1/2007 (© D. Borić).

These observations are further aided by radiometric dating that connects the previously described nature of formation processes with the absolute temporal framework by dating architectural features and articulated burials found in this complex stratigraphic matrix.

Radiometric dating

There are now 43 dates from Vlasac of which 17 dates were previously made on charcoal and 26 are AMS dates made on samples of human (13 dates) and animal (13 dates dating 12 contexts) bones (Tab. 1 – see Appendix). Most of the charcoal dates from Vlasac were reported in Srejović and Letica (*1978.129*) original publication as BC corrected ages while original results can be found in Quitta (*1975.283–284*) for Berlin (Bln-) dates and in Radiocarbon 17 (p. 151) for Zagreb (Z-) dates. Bonsall et al. (*1997; 2000*) published first 5 AMS dates (OxA-5822–5826) on human burials from Vlasac obtained through the Oxford Radiocarbon Accelerator Unit (ORAU). There are also 5 dates made on human burials from Vlasac obtained through the National Science Foundation Arizona AMS Facility at the University of Arizona (AA-), and the details of these will be published by Price and Borić (*forthcoming*).

Bonsall et al. (*1997; 2000*) were first to note the problem with the aquatic reservoir effect when dating human burials. A similar problem occurs when dating dog bones in the Danube Gorges due to the intake of 'old carbon' from a foodweb that is in this

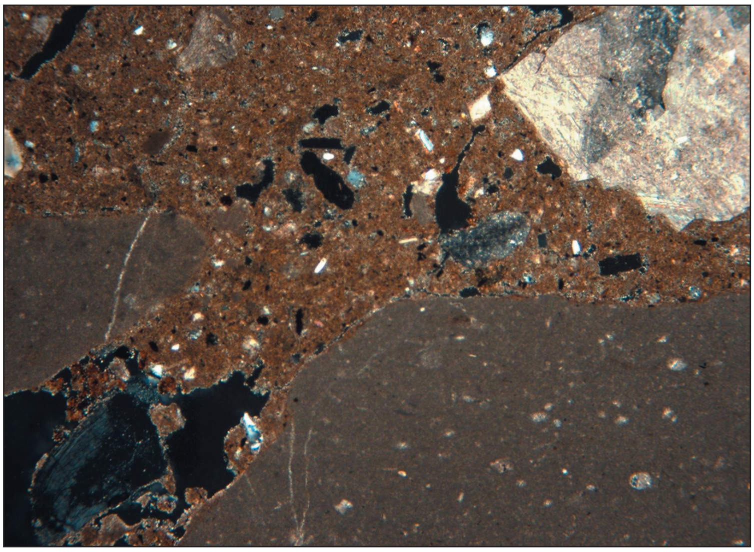

Fig. 12. Photomicrograph of horizontally oriented line of fine limestone fragments in context 145 of the possible trapezoidal structure (cross polarised light; frame width = 4.5 mm).

particular case dependent on freshwater sources (see also *Borić et al. 2004; Borić and Miracle 2004; Grupe et al. 2003*). Several methods were suggested for the correction of these dates that appear too old and require a correction before they are calibrated (*Cook et al. 2002*). For the correction of the results made on human burials we used method 2 suggested by Cook et al. (*2002*) (see Table 1 in Appendix).

Addressing this problem of correction of reservoir affected dates made on human and dog bones from Vlasac and other sites in the Danube Gorges, most recently, two of us (DB and VD) obtained 16 new AMS dates through the Oxford Radiocarbon Accelerator Dating Service (ORADS) funded by the Arts and Humanities Research Council (AHRC) and the Natural Environmental Research Council (NERC) of the UK. From this group of dates 13 dates were made on animal and three on human bones (Tab. 1 – in Appendix). There are six new AMS results that date features from new excavations at Vlasac and 10 dates were made on the material from old collections. This new dating programme was partly designed to establish the date for the occupation of trapezoidal dwellings, which in their rudimentary form occur at Vlasac for the first time. Trapezoidal structures had been assigned to Srejović and Letica's phase I and it was necessary to establish the exact date for the construction and occupation of these features bearing in mind that this architectural form plays an important part in chronologically later developments found at Lepenski Vir. Several other samples were chosen to test previous dates on charcoal or human bones that produced problematic dates, and, also, to date contexts from new excavations at Vlasac.

All available dates[2] from this site are presented in Table 1 (in Appendix), grouped by context or by their stratigraphic relations with one another where possible. In the following we discuss this dating evidence. We are aware of the necessity to provide adequate Bayesian modeling of these groups of dates and the given ranges are for the moment only coarse estimates.

Dwelling 1 (phase Ia) (see Figs. 2, 14)

There are three old, conventional dates from this building (Bln-1051, Bln-1051a and Z-262), dating samples that were allegedly collected from the floor of the building (spit 26). These dates give respective ranges 5988 to 5642, 5893 to 5522 and 6032 to 5720 cal BC at 95 per cent confidence. These rather Middle Neolithic dates do not correspond with two new AMS dates obtained on animal bones found on the dwelling floor (spit 25): OxA-16214 and OxA-16215 give ranges 7163 to 6818 and 7042 to 6699 cal BC at 95 per cent confidence. There are two other old charcoal dates (Bln-1050 and LJ-2047a) that come from the same excavation square C/III where Dwelling 1 is located but from upper levels (spits 15 and 22) assigned by the excavators to phase Vlasac II. Surprisingly, these two dates are in a much better agreement with the two new AMS dates from the building floor and give ranges 7082 to 6574 and 7049 to 6642 cal BC at 95 per cent confidence. The explanation for these similar ranges of charcoal samples at higher levels (almost 1m in the case of Bln-1050) than the floor level of Dwelling 1 can perhaps be related to the fact that the trapezoidal dwellings at Vlasac were dug into the sloping terrace or placed into existing depressions in the terrain (Fig. 14). Hence these charcoal samples might have come from the area outside of the semi-subterranean dwelling (*i.e.* on the level from which the dwelling was dug, representing the level

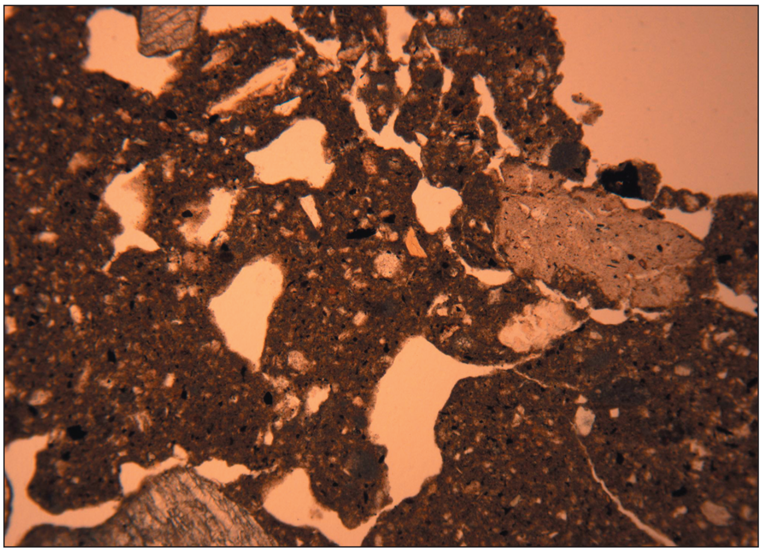

Fig. 13. Photomicrograph of very fine bone and charcoal inclusions in context 145 of the possible trapezoidal structure (plane polarised light; frame width = 4.5 mm).

2 One should note that the dating results of the nitrogen activation analysis of Vlasac burials (Butzko et al. 1978) cannot be accepted as reliable and are not listed here.

of the occupation horizon on the slope outside the dwelling). On the other hand, there are two ways to explain the inconsistency of the first three charcoal dates from Dwelling 1 with the rest of now existing dates in the area of this building. The first explanation is to reject the three charcoal dates as statistical outliers. The second explanation, given their consistent Middle Neolithic dates, is to assume some type of later intrusion from the level of the Middle Neolithic occupation of the site (see below) to which excavators assign a significantly thick layer (80cm) exactly in the area of squares C/I, C/II and C/III (*Srejović and Letica 1978.13*). This type of possible intrusions are seen on the published section from this area of the site, where phase Vlasac III is non-existent (*Srejović and Letica 1978.profil 14*). At present, we can only speculate how this charcoal of later date reached the floor of Dwelling 1 in spit 26 where it was allegedly collected. New AMS dates indicate the chronological framework for the construction and use of this dwelling sometime in the first century after 7000 cal BC.

Fig. 14. Dwelling 1 from Vlasac with reddish flooring (2.70m long and 1.20m wide) (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

Dwelling 2 (phase Ia) and Burial 31 (phase I) (see Figs. 2, 15)

There are two older dates on charcoal (Bln-1053 and Bln-1014) from this feature and both of these, similarly to charcoal samples from the floor of Dwelling 1, give Middle Neolithic dates in the range 5983 to 5618 and 5966 to 5534 cal BC at 95 per cent confidence. We may either reject these dates as outliers or suppose some sort of intrusion as the excavators mention a thin layer of Eneolithic occupation in square a/18 where Dwelling 2 is found (*Srejović and Letica 1978.11*). To check the dating of this feature, we have dated a roe deer skull with antlers that was found lying on the floor of the building (*Srejović and Letica 1978.22*). OxA-16216 dates this sample in the range of 7047 to 6699 cal BC at 95 per cent confidence. This date corresponds very well with the two dates obtained from the floor of Dwelling 1, and may indicate the overall contemporaneity of construction and use of these two dwellings. We have also dated a red deer tool that was marked as coming from the area beneath the floor of this

Fig. 15. Burials 31 (AA-57777) and 32, found next to Dwelling 1 (Burial 31 is 1.76m long) (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

dwelling. The obtained OxA-16217 gives the range 6900 to 6593 cal BC at 95 per cent confidence. This date is younger than expected and may indicate a later intrusion. It is likely that the date does not come directly from beneath the floor of the dwelling, what we initially assumed when choosing it for dating, but from the level on its side, *i.e.* lower than the floor of Dwelling 2 but next to it rather than directly beneath the floor. This possibility is perhaps also supported by the new date AA-57777 for Burial 31 (Fig. 15). After the correction for the freshwater reservoir effect, Burial 31 is dated in the similar range 6823 to 6436 cal BC at 95 per cent confidence. Srejović and Letica (*1978.21*) note that Dwelling 2 was damaged along its south-eastern side by interment of Burials 32 and 31 (see Fig. 2). Burial 31 was found 20cm below the floor level of Dwelling 2 and in the same spit 23 as the red deer antler tool dated by OxA-16217. Hence it is likely that Dwelling 2 was partly damaged by later Mesolithic intrusions.

Dwelling 3 (phase Ib) (see Fig. 2)

The new OxA-16218 date for a red deer antler found on the floor of Dwelling 3 is in the range 7028 to 6651 cal BC at 95 per cent confidence and confirms the contemporaneity of this feature with Dwellings 1 and 2 (see above).

Dwelling 4 (phase Ib) (Figs. 2, 16–17)

Earlier charcoal date Bln-1170 dates this dwelling in the range 7036 to 6496 cal BC at 95 per cent confidence and corresponds very well with the range of dates obtained for Dwellings 1 to 3. With new OxA-16219 we have now dated a modified red deer antler from the floor of Dwelling 4 that surprisingly gives the range 9756 to 9321 cal BC at 95 per cent confidence. It is very unlikely that this date represents the actual date for the construction/use of this feature and it is more likely that it represents residual materials that come from layers much older than the use of this dwelling. A similar phenomenon was observed at the site of Lepenski Vir (*Borić and Dimitrijević in press*). Due to the specificity of the process of construction of buildings at these sites by cutting into the sloping terrace, older occupation zones are turned over and re-deposited, which brings older, residual materials into stratigraphically and chronologically later contexts. However, this early date for the occupation of Vlasac is important as it indicates the existence of the earliest occupation zone at the site that can be attributed to the regional Early Mesolithic. With a similarly early date obtained for Burial 72 (see below), one may suggest that the site was used in the early phases of the regional Early Mesolithic. Traces of this Early Mesolithic occupation are preserved sporadically at Vlasac. There is one more date that can be connected to Dwelling 4: AA-58321 dates Burial 25 that was found some 90cm above the floor level of the building and thus gives a *terminus ante quem* for the occupation of Dwelling 4 in the range 7026 to 6481 cal BC at 95 per cent confidence (after the correction for the freshwater reservoir effect). This date overlaps with the occupation of Dwelling 4 and may indicate a quick infill of the dwelling cut over the floor area before Burial 25 was interred here. Yet, only modelling of these dates within the Bayesian statistical framework may indicate a more precise tempo of these processes.

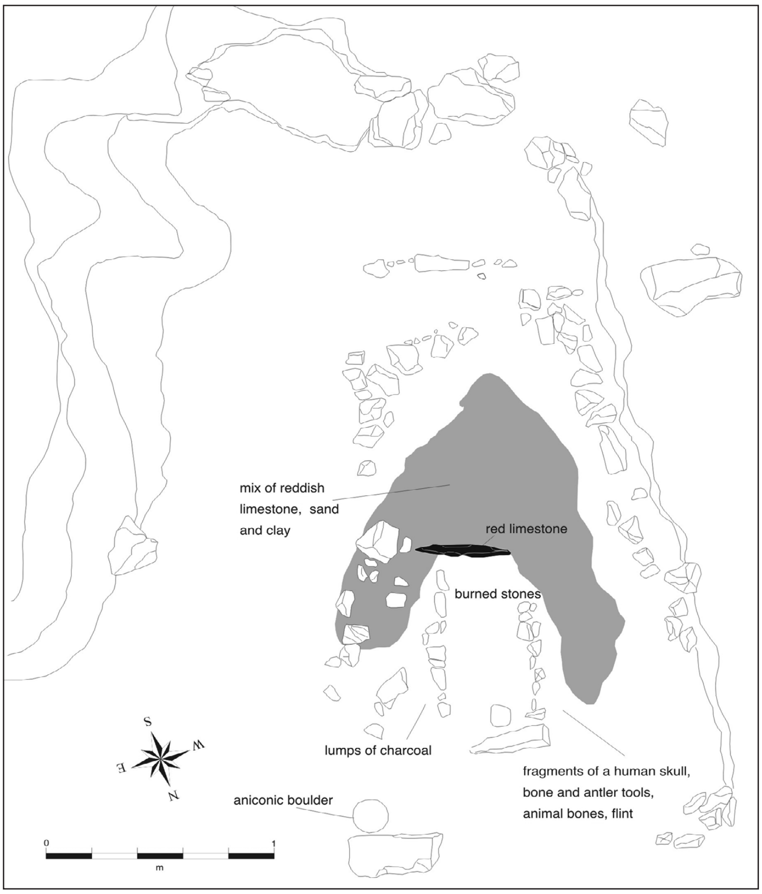

Fig. 16. Dwelling 4 from Vlasac (adopted after **Srejović and Letica 1978.Fig. 12*).***

Dwelling 5 (phase Ib) (see Fig. 2)

This dwelling is dated (OxA-16543) by a typologically characteristic bone chisel from an aurochs' metapodial (Fig. 18) found on the floor of this feature. The date is in the range 7034 to 6693 cal BC at 95 per cent confidence. This dating significantly overlaps with previous dates obtained for four other dwellings that all had traces of reddish limestone flooring around the rectangular stone-lined hearths (see above).

Hearths 20 (phase II) and 16 (phase III) (see Fig. 2)

The layer beneath Hearth 16 has previously been dated with Z-267 made on charcoal in the range 6592 to 6236 cal BC at 95 per cent confidence. There is another conventional ^{14}C date (Bln-1168) made on charcoal from this square, which gives a partly overlapping range 6496 to 6093 cal BC at 95 per cent confidence. In order to check previously obtained dates on charcoal, we have dated a red deer antler found beneath Hearth 16 with OxA-16080 and OxA-16220 (duplicate) which give almost identical ranges 6638 to 6479 and 6634 to 6474 cal BC at 95 per cent confidence. These new dates are in agreement with the previous charcoal dates from this area and suggest mid-7th millennium BC use of this part of the settlement. Almost exact overlap of Hearths 20 (at 64.81 m asl) and 16 (at 65.18 m asl) may indicate a relatively short period for the accumulation of deposits between them (see *Srejović and Letica 1978.T. XVII*). Assigning these two hearths to two different phases could be problematic. One is left to speculate whether the construction of a new hearth at the same place here related to the intensity of downslope movement and scree accumulation (see above), which slowly buried previously used features and the area around them, or to ideas about a symbolic renewal of a particular social place.

Burial 72 and Hearth 23 (both phase I) (see Fig. 2)

OxA-5824 dates Burial 72 and after the correction for the freshwater reservoir effect gives the range 9756 to 8804 cal BC at 95 per cent confidence. It is currently the oldest dated human burial from Vlasac. This burial is found 30cm below Hearth 23 along its eastern side. The excavators date this burial to the earliest phase Vlasac I (*Srejović and Letica 1978.57*). Radovanović (*1996.217*) rephases Burial 72 into her later phase burial. In order to check this surprisingly early date, we have dated a wild boar tusk tool found in association with Burial 72 (*Borić 2002b.Appendix 4*). The obtained OxA-16221 gives the range 7033 to 6686 cal BC at 95 per cent confidence. This Late Mesolithic date has not resolved the problem with this early date on Burial 72. The new AMS date on the wild boar tusk tool should probably be considered as representative for the dating of Hearth 23, which might have been contemporaneous with the construction/occupation of dwellings with floored areas around them since it was placed in the virgin soil. In the light of recently obtained OxA-16219 from Dwelling 4 that suggested the existence of Early Mesolithic levels at Vlasac (see above), the problematic OxA-5824 can be considered as certainly dating a human bone of an early Mesolithic age given its isotopic signature. What is not quite certain is whether the sample for this date came from Burial 72 or from a loose human bone fragment that might have been found in its vicinity and was collected as Burial 72, since no information is available on what skeletal part was dated. It is important to mention that in the area of the site where this burial was found, behind the rocky plateau (see above), one finds the most deeply stratified deposits, which may contain materials more than a millennium earlier than the phase of dwellings with floors that has now been dated to the beginning of the 7th millennium BC. In addition, an older charcoal date (Bln-1169) from this square, collected at the level of spit 14,

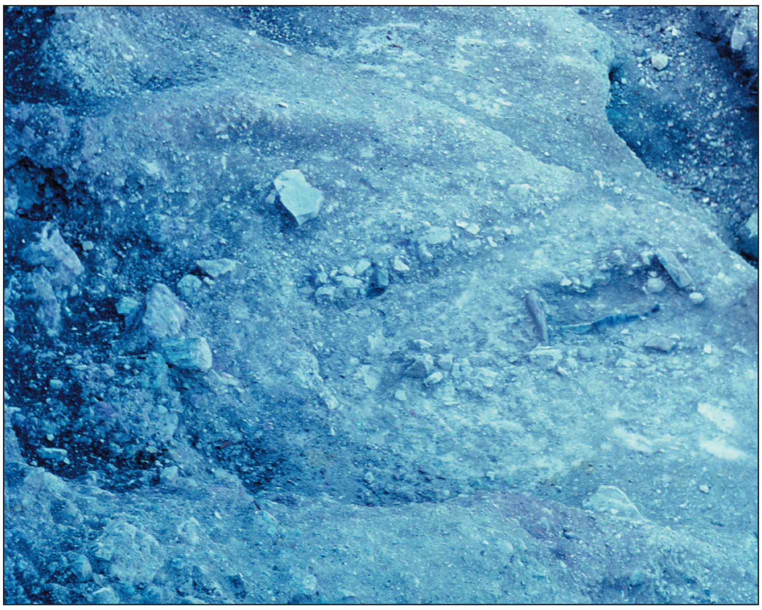

Fig. 17. Dwelling 4 from Vlasac, north-facing (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

gives a later Mesolithic date in the range 6744 to 6295 cal BC at 95 per cent confidence, indicating that the location remains in use throughout the Late Mesolithic.

Burial 17 (phase I) (Fig. 19) and phases II and III in square A/II

AA-57776 dates one of the most intriguing burials from Vlasac: Burial 17 was placed in a sitting position with crossed legs (Fig. 19). After the correction for the reservoir effect the date is in the range 8286 to 7749 cal BC at 95 per cent confidence. This early Mesolithic date has an overlapping range with the dates obtained for burials found in the same position at other sites (for Padina see *Borić and Miracle 2004* and for Lepenski Vir see *Bonsall et al. 2004; Radovanović 2006.Fig. 4*). At present, there are no other dates that overlap with the dating of Burial 17. In the same square A/II, from spit 14, comes a charcoal date LJ-2047 with the range 6438 to 6213 cal BC at 95 per cent confidence. This date indicates that the location continued to be used throughout the Late Mesolithic.

Fig. 18. Bone chisel (OxA-16543) made on an aurochs' metapodial (my inv. 1271) from the floor of Dwelling 5 (© D. Borić).

Burials 54, 45 and 51a (phase I) (see Figs. 2, 20, 21)

There is a complex sequence of overlapping and inter-cut features, such as hearths and burials, in squares A/17 and A/18. We have 3 dates from three burials in this zone. All three burials had to be corrected for the freshwater reservoir effect. AA-57778 dates Burial 45 in the range 6654 to 6411 cal BC at 95 per cent confidence. Only the skull and part of the right arm survived from this burial as it was cut by a later interment of Burial 55. Burial 55 was covered by Hearth 17. Burial 54 was found as a pile of disarticulated bones and was covering articulated inhumation Burial 53 found beneath it (Fig. 20). OxA-5823 for Burial 54 is in the range 7024 to 6394 cal BC at 95 per cent confidence after the correction for the reservoir effect. This date predates Hearth 17 and postdates child Burial 53. These ranges overlap and may indicate that this complex sequence was formed over a relatively short period of time in the mid-7th millennium BC. There is an older charcoal date (Z-264) from Burial 54 in the range 5480 to 5062 cal BC at 95 per cent confidence. It must represent a later intrusion in this burial zone that brought the remains of younger charcoal in association with Burial 54. In the vicinity of this sequence, closer to the river edge, there are several burials that were covered by later stone-lined rectangular Hearths 19 and 19a (Fig. 21). One of these burials, Burial 51a, is dated with OxA-5822 in the range 7572 to 7082 cal BC at 95 per cent confidence. This is the oldest date for the Late Mesolithic sequence of burials at Vlasac and likely predates the construction of dwellings with floors, which are built only after 7000 cal BC. Although all three burials were assigned to phase I, it is clear now that they can be confined to the Late Mesolithic development, with Burial 51 relating to an earlier phase of the Late Mesolithic, in the second half of the 8th millennium BC, while Burials 45 and 54 can be assigned to a later part of this

Fig. 19. Burial 17 (AA-57776) in sitting position with crossed legs (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

likely continuous development throughout the 7th millennium cal BC.

Burial 6 (phase III) and square a/6

Dates from this part of Vlasac somewhat help us understand the stratigraphic sequence in this central part of the settlement. A previous charcoal date Z–268 that was associated with Burial 11 gives the range of 5762 to 5480 cal BC at 95 per cent confidence, which is a Middle Neolithic date and is likely an intrusion from upper levels. This is not surprising in this central part of the settlement, just behind the rocky plateau, as archaeological levels here have an average thickness of only 50cm and the excavators mention a single, homogenous horizon with burials and very little other material (*Srejović and Letica 1978.12*). AA–57775 dates Burial 6, found in this zone, in the range 6600 to 6235 cal BC at 95 per cent confidence, and we may assume that most of other burials in this square can be connected with this later phase of the Late Mesolithic use of Vlasac as a burial ground.

Other Late Mesolithic dates from Vlasac

There are several other dates from Vlasac that have also given mid-7th millennium dates for the use of the site for burial interments. OxA–5825 and OxA–5826 date Burials 24 and 83 respectively (see Fig. 2) in the ranges 6640 to 6220 and 7024 to 6430 cal BC at 95 per cent confidence after the correction for the reservoir effect. There is also a date in the similar range for the first discovered burial in the course of new excavation work at Vlasac (*Borić 2006*): OxA–16541 dates burial context 2 in the range 6775 to 6470 cal BC at 95 per cent confidence. Three more charcoal dates (Bln–1171 Bln–1052, and Bln–1054) from two different zones of the settlement give partly overlapping ranges 7030 to 6478, 6644 to 6250 and 6460 to 6085 cal BC at 95 per cent confidence, confirming the intensity of inhabiting and/or using this locale for burial purposes in the course of the Late Mesolithic, and especially in the course of the 7th millennium BC.

Sequence with the dwelling floor and burials in Trench 3/2006

There are several new dates for the sequence of burials above the possible dwelling floor level excavated in the course of renewed work at Vlasac. This is an important feature as it provides well-stratified contexts that indicate the continuity in the use of this location throughout the Late Mesolithic, transformational/Early Neolithic and Middle Neolithic phases in the Danube Gorges. The transformational/Early Neolithic phase is best represented at the site of Lepenski Vir with the phase of trapezoidal buildings (*Borić and Dimitrijević 2007; in press*). The newly discovered burial sequence at Vlasac for the first time indicates the existence of this transformational phase at this site too, while associated items of material culture indicate the process of cultural transformation that was taking place at the time. Here is the brief description of the sequence with associated AMS dates and their stratigraphic positions.

At the bottom of the sequence, the reddish burned flooring (context 149) (Fig. 10) of a possible semi-subterranean dwelling had only a partly preserved rear area and one is left to speculate whether it might have had a trapezoidal shape since the Danube waters eroded away the front part of this feature. It seems that upon the abandonment of this feature a layer of sterile soil (context 145) was intentionally placed over the floor, while there are several cremation pits found around this dwelling floor with traces of intense burning and containing burned human remains. These pits must have been dug at a later date around the abandoned depression. From this area comes the AMS dated projectile point (OxA–16540), which gives the range 6654 to 6484 cal BC at 95 per cent confidence and thus likely postdates the

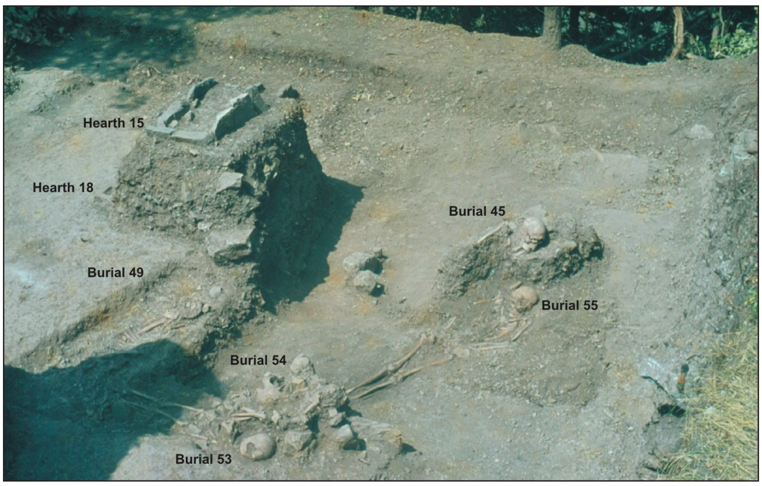

Fig. 20. Burials 55 (176cm long), 45 (AA–57778), 53, 54 (OxA–5823) and 49, after lifting Hearth 17; Hearths 15 and 18 in the background (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

occupation at the dwelling floor. Assuming that this dwelling floor was similar to other dwellings found during the first excavations at the site and now dated sometime in the first century after 7000 BC, we may expect a similar date for the construction/occupation of this floored feature. The first burial interred in this area could have been either adult disarticulated Burial context 136, child Burial context 297 or adult Burial context 232, which was placed over an oval cremation pit containing burned human remains and bone projectile points (Feature 26). Burial context 136 was damaged by one of the cremation pits and only its right leg below knees and feet survived in the articulated position. This burial is now dated with OxA-18865 in the range 6775 to 6473 cal BC at 95 per cent confidence after the correction for the reservoir effect. At a higher level along the same axis and with the same position and orientation Burial context 81 was found, again damaged by the interment of headless adult inhumation Burial context 63, found cutting through it. Burial context 63 is after the correction for the freshwater reservoir effect dated with OxA-16542 in the range 6232 to 6018 cal BC at 95 per cent confidence. This is presently the youngest date for a burial at Vlasac found buried according to the typical Mesolithic burial rite. Here, finds of Spondylus beads as well as red and white limestone beads, identical to those found in several burials from Lepenski Vir (see *Borić 2006; 2007b*), indicate the effect of cultural changes in the region through the acceptance of new, Neolithic-looking ornaments, which sits very well with the obtained date. There was a partly burned child burial placed over the chests of Burial context 63. Burial context 63 was damaged on its left side by the interment of neonate Burial contexts 62 and 69, found one on top of the other. Another cremation pile was covering all these interments, while on the top of this cremation the last articulated burial, context 53 (Fig. 10), was placed along the same axis as previous burials, although with the head pointing in the opposite direction from other burials, *i.e.* upstream. It was covered with stone plaques over the head and the pelvis, and a red deer skull with antlers (context 19) was placed on top of it. OxA-16544 dates this red deer skull in the range 6006 to 5838 cal BC at 95 per cent confidence and this is currently the youngest AMS date from Vlasac, which corresponds very well with the stratigraphic position of older, dated Burial contexts 63 and 136. This date is also a *terminus post quem* for the layer with Starčevo pottery found on top of large stones that were covering this burial location. This pottery level is dated to the regional Middle Neolithic. OxA-16539 which was chosen to date this level of Middle Neolithic occupation in Trench 3/2006 has given a slightly earlier range than expected: 6393 to 6229 cal BC at 95 per cent confidence. It could be either that the Starčevo-type pottery found in the dated context is thus present at Vlasac already around this time, or, more likely, that with this date we dated slightly older, residual material found in a later stratigraphic context.

Fig. 21. Burial 51a (OxA-5822) and Hearth 19 (1.05m long) (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

Summary of the dating evidence

The sequence of all available radiometric dates is shown in Fig. 22. At present, the radiometric evidence suggests that Vlasac might have been sporadically inhabited with possible burial interments (Burial 72) very early in the Holocene sequence, some time in the mid-10th millennium BC. A more secure date for the use of the site as a burial ground comes from the end of the 9th millennium BC or the beginning of the 8th millennium on the basis of the date for the only sitting burial with crossed legs found at Vlasac (Burial 17). The practice of burying selected individuals in a sitting position with crossed legs is found at several other sites in the region and has so far been dated at two other sites with an overlapping time range, suggesting of the same cultural phenomenon across this region even at this early date. A more intensive occupation/use of the site follows from the mid-8th millennium, which can be considered the start date of the Late Mesolithic in the region, and continues, most likely without interrup-

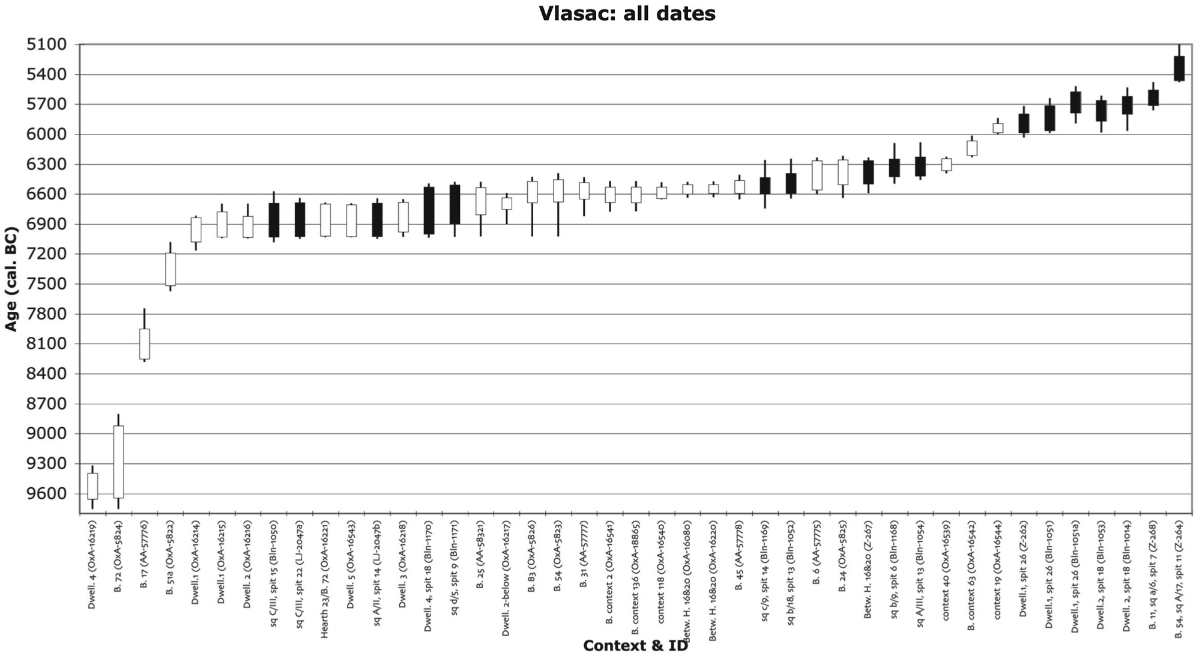

Fig. 22. Calibration ranges at 1 and 2 standard deviations (cal BC) of all dates from Vlasac. Dates calibrated with OxCal v. 4.0 (*Bronk Ramsey 1995; 2001*). Solid bars show 1 s.d.; lines show 2 s.d.. Black fill: charcoal/conventional dates; white fill: AMS dates.

tions, for more than two millennia. First trapezoidal dwellings with experiments in providing a reddish limestone floor are built around or after 7000 BC and might have been contemporaneously occupied. It seems that this practice of flooring features dies out in the course of the 7th millennium. Only rectangular stone-lined hearths are built in the course of the 7th millennium, sometimes overlapping with each other. Whether this practice of building new hearths at the place of older similar features is only related to the symbolic renewal of these features (*cf. Borić 2003; 2007a*) or, also, to the pressing reality of downslope erosion of scree, which quickly accumulated over occupation areas after episodes of woodland clearance, remains an open question. There is now evidence, coming from new excavations at the site, that Vlasac remained in use, at least as a burial ground, throughout the period that saw the flourishing of the phase with trapezoidal buildings at Lepenski Vir, *i.e.* the period of transformational/Early Neolithic phase, *c.* 6200 to 5900 cal BC. There is also clear evidence for the Middle Neolithic use of the site, from both old as well as new excavations. A number of charcoal dates from Vlasac that were accidentally associated with older Mesolithic features and that gave the Middle Neolithic time spans could be connected with the use of the site during this later period. One should also add that the dating evidence does not support a scenario as suggested by Bonsall et al. (*2002*) that this site, along with some other sites in the Danube Gorges, might have been abandoned due to floods of large magnitude related to the 8.2 k BP event, *i.e.* from 6300–5950 cal BC (*cf. Borić and Miracle 2004*). Future Bayesian modelling should add greater chronological sharpness to these main trends that the current dating evidence offers.

Conclusions

The complex stratigraphic sequence at the Mesolithic-Neolithic site of Vlasac was examined by comparing details of stratigraphic relations established in the course of the first excavations at this site in the 1970s with the observations made in the course of renewed work at the site that started in 2006. It has also added new geoarchaeological and micromorphological examinations of these colluvial deposits. We suggest that the complexity of colluvial process, dependent on woodland clearance and downslope movement of scree, must be incorporated in an adequate understanding of formation processes at this site. The stratigraphy of Vlasac largely consists of hillwash deposits formed above a palaeosol found at the base of the stratigraphic sequence. Minor colluvial episodes continued to affect this soil, alternating with periods of stability and incipient soil development, and together led to slow soil aggradation and thickening throughout the later Mesolithic and into the Early and Middle Neolithic. This early Holocene soil is essentially a 'cumulative colluvial soil.'

Furthermore, cultural practices of cutting through older features and the complexity of placing features on the sloping terrace complicate any attempts to assign the same cultural horizon to features found on the same level. For example, due to the nature of placing trapezoidal, horizontally levelled areas on these slopes, similar to other sites in this region, such as Lepenski Vir and Padina, the phenomenon of residual materials ending up in later, secondary stratigraphic contexts is a serious potential danger when attempting to assign cultural materials to a particular feature without the help of absolute dating.

Previous and new radiometric dates to a great extent clarify stratigraphic matters. The current dating evidence does not correspond very well with the phasing of the site into phases Vlasac I(a–b), II and III as suggested by the first excavators of the site. The inconsistencies are clearly shown by comparing obtained dates with phases that excavators assigned to particular features (Tab. 1 – Appendix). These phases can have a heuristic value only at particular locations to distinguish the sheer verticality of deposited layers one on top of the other. However, it is impossible to use them as meaningful chronological entities across the site, and the combination of new field research and continuing radiometric dating of particular contexts along with the re-examination of archaeological collections from the old excavations can be the way forward in sketching a more reliable cultural stratigraphy of Vlasac.

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APPENDIX

Tab. 1. Radiometric dates from Vlasac on charcoal (17 dates), human (13 dates from 13 contexts) and animal (13 dates from 12 contexts) bones. Dates are calibrated with OxCal v. 4.0 (*Bronk Ramsey 1995; 2001*). Ages are corrected for those that have $\delta^{15}N$ values >+10‰ (affected by the aquatic reservoir effect), using Method 2 as suggested by Cook et al. (*2002*). The $\delta^{15}N$ values used to estimate percentage of aquatic diet; a = 100% reservoir correction applied (440 ± 45 years); b = 50% reservoir correction applied (220 ± 23 years).

Laboratory code	Sample no. and material	Radiocarbon age (BP)	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	Calibrated date (68% and 95% confidence)
Dwelling 1 (phase Ia)					
Bln–1050	1/70, charcoal from square C/III (Sonda A), spit 15 (phase II)	7935 ± 100	–	–	68.2% probability 7028 BC (21.8%) 6931 BC 6920 BC (9.8%) 6878 BC 6848 BC (36.6%) 6691 BC 95.4% probability 7082 BC (95.3%) 6590 BC 6578 BC (0.1%) 6574 BC
LJ–2047a	charcoal from square C/III, spit 22 (phase II)	7925 ± 77	–	–	68.2% probability 7025 BC (14.4%) 6966 BC 6948 BC (3.3%) 6934 BC 6916 BC (9.0%) 6880 BC 6840 BC (41.5%) 6686 BC 95.4% probability 7049 BC (95.4%) 6642 BC
Z–262	charcoal from Dwelling 1 in square C/III (Sonda A), spit 26 (4.1 m below the surface)	7000 ± 90	–	–	68.2% probability 5984 BC (68.2%) 5798 BC 95.4% probability 6032 BC (95.4%) 5720 BC
Bln–1051	2/70, charcoal from Dwelling 1, C/III (Sonda A), spit 26	6915 ± 100	–	–	68.2% probability 5964 BC (1.6%) 5958 BC 5901 BC (66.6%) 5715 BC 95.4% probability 5988 BC (95.4%) 5642 BC
Bln–1051a		6790 ± 100	–	–	68.2% probability 5786 BC (66.9%) 5616 BC 5581 BC (1.3%) 5575 BC 95.4% probability 5893 BC (95.4%) 5522 BC

Laboratory code	Sample no. and material	Radiocarbon age (BP)	δ13C (‰)	δ15N (‰)	Calibrated date (68% and 95% confidence)
OxA–16214	VL40, brown bear canine from the floor of Dwelling 1 in square C/IV, spit 25, my inv. 1797	8055 ± 45	–19.5	8.4	68.2% probability 7080 BC (37.4%) 7023 BC 6968 BC (6.6%) 6946 BC 6936 BC (7.4%) 6914 BC 6882 BC (16.8%) 6836 BC 95.4% probability 7163 BC (0.2%) 7160 BC 7142 BC (95.2%) 6818 BC
OxA–16215	VL41, red deer antler tool from the floor of Dwelling 1 in square C/IV[3], spit 25, my inv. 1793	7960 ± 39	–21.3	7.8	68.2% probability 7028 BC (33.0%) 6930 BC 6922 BC (15.3%) 6876 BC 6860 BC (17.1%) 6804 BC 6788 BC (2.8%) 6778 BC 95.4% probability 7042 BC (90.3%) 6735 BC 6726 BC (5.1%) 6699 BC
Dwelling 2 (phase Ia) and Burial 31 (phase I)					
Bln–1053	4/70, charcoal from Dwelling 2 in square a/18, spit 18	6865 ± 100	–	–	68.2% probability 5868 BC (0.8%) 5866 BC 5846 BC (67.4%) 5660 BC 95.4% probability 5983 BC (4.9%) 5939 BC 5931 BC (90.5%) 5618 BC
Bln–1014	charcoal from Dwelling 2 in square a/18, spit 18	6805 ± 100	–	–	68.2% probability 5799 BC (68.2%) 5622 BC 95.4% probability 5966 BC (0.5%) 5957 BC 5902 BC (94.9%) 5534 BC
OxA–16216	VL43, roe deer skull from the floor of Dwelling 2 in square a/18, my inv. 1250	7970 ± 45	–22.1	5.8	68.2% probability 7033 BC (68.2%) 6821 BC 95.4% probability 7047 BC (90.4%) 6744 BC 6738 BC (0.5%) 6735 BC 6726 BC (4.5%) 6699 BC
AA–57777	Burial 31, cranial fragment of young adult male, extended, NE–SW, in square a/17, 2.64 m from the surface, spit 23 (64.04 m asl, 29/10/1970), next to the east side of Dwelling 2 and 20 cm below the floor level; on the right shoulder a large bone awl; Cyprinidae and *Cyclope neritea* beads	Uncorrected 8196 ± 69 Corrected 7756 ± 82[a]	–20.7	16.1	68.2% probability 6649 BC (68.2%) 6483 BC 95.4% probability 6823 BC (95.4%) 6436 BC
OxA–16217	LV44, red deer antler tool from the area below the floor of Dwelling 2 in square a/17, spit 23, my inv. 1265	7850 ± 40	–22.4	6.5	68.2% probability 6752 BC (13.3%) 6720 BC 6710 BC (54.9%) 6636 BC 95.4% probability 6900 BC (0.6%) 6890 BC 6826 BC (94.8%) 6593 BC

3 There seems to be a mistake in the labelling of the antler tool that we dated here. The labels on the antler tool indicate that they come from Dwelling 1 and square here should be C/III and not C/IV.

Laboratory code	Sample no. and material	Radiocarbon age (BP)	δ13C (‰)	δ15N (‰)	Calibrated date (68% and 95% confidence)
Dwelling 4 (phase Ib) and Burial 25 (phase II) – stratified					
AA–58321	Burial 25, cranial fragment of old adult male, extended W–E, in square C/V, 1.95 m from the surface (61.61 m asl); fragmented dog mandible on his chests	Uncorrected 8267 ± 56 Corrected 7827 ± 72[a]	–20.0	16.2	68.2% probability 6804 BC (3.0%) 6788 BC 6778 BC (62.0%) 6588 BC 6581 BC (1.9%) 6570 BC 6541 BC (1.2%) 6534 BC 95.4% probability 7026 BC (5.0%) 6964 BC 6949 BC (1.1%) 6934 BC 6917 BC (3.6%) 6880 BC 6842 BC (85.7%) 6481 BC
Bln–1170	3/71, charcoal from Dwelling 4[4] in square BC/V, spit 18	7840 ± 100	–	–	68.2% probability 7000 BC (1.2%) 6992 BC 6985 BC (1.9%) 6972 BC 6912 BC (4.2%) 6884 BC 6830 BC (59.0%) 6568 BC 6544 BC (1.9%) 6531 BC 95.4% probability 7036 BC (95.4%) 6496 BC
OxA–16219	VL47, red deer antler from the floor (60.7 m asl) of Dwelling 4 in square BC/V, my inv. 1808	10 000 ± 45	–21.1	6.7	68.2% probability 9655 BC (23.8%) 9576 BC 9552 BC (44.4%) 9394 BC 95.4% probability 9756 BC (4.5%) 9717 BC 9698 BC (90.9%) 9321 BC
Layer between Hearths 20 (phase II) and 16 (phase III)					
Bln–1168	1/71, charcoal from square b/9, spit 6 (phase II)	7475 ± 100	–	–	68.2% probability 6427 BC (68.2%) 6248 BC 95.4% probability 6496 BC (95.4%) 6093 BC
Z–267	beneath Hearth 16 in square b/9	7559 ± 93	–	–	68.2% probability 6497 BC (56.7%) 6352 BC 6310 BC (11.5%) 6264 BC 95.4% probability 6592 BC (95.4%) 6236 BC
OxA–16080	VL49, red deer antler tip fragment found beneath Hearth 16, in dark, burned soil (my inv. 1328)	7731 ± 39	–20.6	6.6	68.2% probability 6598 BC (68.2%) 6504 BC 95.4% probability 6638 BC (95.4%) 6479 BC
OxA–16220		7720 ± 38	–20.8	6.6	68.2% probability 6593 BC (68.2%) 6504 BC 95.4% probability 6634 BC (95.4%) 6474 BC
Burial 72 and Hearth 23 (phase I)					
Bln–1169	2/71, charcoal from square c/9, spit 14	7665 ± 100	–	–	68.2% probability 6601 BC (68.2%) 6434 BC 95.4% probability 6744 BC (0.6%) 6726 BC 6700 BC (92.7%) 6345 BC 6312 BC (2.1%) 6259 BC

4 In the listing of charcoal dates that Srejović and Letica (*1978.129*) provided, this sample is connected with Dwelling 5, while quadrants BC/V are given for Dwelling 4. There was some re-labeling of these features in the course of excavations and post-excavation analyses that must have caused this confusion, and it is almost certain that this sample comes from Dwelling 4 and not Dwelling 5.

Laboratory code	Sample no. and material	Radiocarbon age (BP)	δ13C (‰)	δ15N (‰)	Calibrated date (68% and 95% confidence)
OxA–16221	VL51, wild boar tusk tool found in association with Burial 72, on the same level and next to Hearth 23	7936 ± 40	−20.7	7.0	68.2% probability 7022 BC (2.5%) 7012 BC 7005 BC (10.2%) 6970 BC 6944 BC (1.6%) 6938 BC 6914 BC (9.8%) 6882 BC 6832 BC (44.1%) 6698 BC 95.4% probability 7033 BC (95.4%) 6686 BC
OxA–5824	Burial 72, adult female extended, perpendicular to the Danube-head upslope in square c/9, 2.57 m from the surface (64.23 m asl), along the longer side of Hearth 23, 30 cm below the level of the hearth	Uncorrected 10 240 ± 120 Corrected 9800 ± 130[a]	−19.3	14.5	68.2% probability 9643 BC (2.2%) 9615 BC 9514 BC (0.3%) 9510 BC 9455 BC (57.7%) 9122 BC 9000 BC (8.0%) 8920 BC 95.4% probability 9756 BC (1.4%) 9716 BC 9700 BC (94.0%) 8804 BC
Burial 17 (phase I) and square A/II (phases II and III)					
LJ–2047b	charcoal from square A/II, spit 14 (phase II)	7930 ± 77	–	–	68.2% probability 7025 BC (14.9%) 6966 BC 6948 BC (3.4%) 6934 BC 6916 BC (9.3%) 6880 BC 6840 BC (40.6%) 6690 BC 95.4% probability 7048 BC (95.4%) 6646 BC
AA–57776	Burial 17, scapula fragment of young adult male in sitting position with crossed legs in square A/II, 0.72 m from the surface (63.67 m asl), in the bedrock	Uncorrected 9353 ± 86 Corrected 8913 ± 97[a]	−20.7	15.1	68.2% probability 8250 BC (68.2%) 7951 BC 95.4% probability 8286 BC (95.4%) 7749 BC
Burials 54, 45 and 51a (phase I)					
Z–264	charcoal from Burial 54 in square A/17, spit 11	6335 ± 92	–	–	68.2% probability 5465 BC (6.5%) 5442 BC 5423 BC (4.3%) 5406 BC 5382 BC (57.4%) 5218 BC 95.4% probability 5480 BC (84.0%) 5196 BC 5180 BC (11.4%) 5062 BC
OxA–5823	Burial 54, adult male, disturbed and disarticulated pile of bones in square A/17, 1.92 m from the surface (64.27 m asl); beneath Hearth 17 and covering child Burial 53	Uncorrected 8170 ± 100 Corrected 7730 ± 110[a]	−19.1	14.9	68.2% probability 6678 BC (1.3%) 6671 BC 6659 BC (66.9%) 6454 BC 95.4% probability 7024 BC (2.4%) 6966 BC 6948 BC (0.5%) 6934 BC 6916 BC (1.6%) 6880 BC 6841 BC (90.9%) 6394 BC
AA–57778	Burial 45 (possible phase I), cranial fragment of possible old adult male, postcranial skeleton, extended perpendicular to the Danube, NE–SW, disturbed by Burial 55, in square A/17, 2 m from the surface (64.32 m asl)	Uncorrected 8117 ± 62 Corrected 7677 ± 77[a]	−19.5	15.6	68.2% probability 6591 BC (68.2%) 6462 BC 95.4% probability 6654 BC (95.4%) 6411 BC

Laboratory code	Sample no. and material	Radiocarbon age (BP)	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	Calibrated date (68% and 95% confidence)
OxA–5822	Burial 51a (phase I), adult female, extended, NE–SW, perpendicular to the Danube in square A/18, 2.73 from the surface (63.83 m asl), buried in the virgin soil, beneath Hearth 19	Uncorrected 8760 ± 110 Corrected 8320 ± 120[a]	–19.1	14.4	68.2% probability 7518 BC (56.6%) 7290 BC 7273 BC (3.7%) 7254 BC 7228 BC (7.9%) 7190 BC 95.4% probability 7572 BC (95.4%) 7082 BC
Burial 6 (phase III) and square a/6					
Z–268	charcoal from Burial 11 in square a/6, spit 7	6713 ± 90	–	–	68.2% probability 5711 BC (51.1%) 5604 BC 5596 BC (17.1%) 5559 BC 95.4% probability 5762 BC (95.4%) 5480 BC
AA–57775	Burial 6, cranial fragment of possible old adult male, extended, parallel to the Danube, head pointing downstream in square a/6, 1.77 m from the surface (63.96 m asl); neonate Burial 6a on its right shoulder; graphite in burial	Uncorrected 8012 ± 84 Corrected 7572 ± 95[a]	–19.8	16.4	68.2% probability 6558 BC (1.6%) 6550 BC 6506 BC (59.2%) 6354 BC 6307 BC (0.8%) 6303 BC 6294 BC (6.5%) 6266 BC 95.4% probability 6600 BC (95.4%) 6235 BC
Burial sequence and dwelling floor in Trench 3/2006					
OxA–16539	VL18, large mammal bone fragment in context 40, x.8, Trench 3/2006, square 95/96 (20) (30/05/2006)	7425 ± 39	–21.7	6.8	68.2% probability 6362 BC (50.9%) 6286 BC 6272 BC (17.3%) 6246 BC 95.4% probability 6393 BC (95.4%) 6229 BC
OxA–16544	VL50, red deer skull from context 19 placed over the burial sequence in Trench 3/2006 (22/04/2006)	7035 ± 40	–21.3	6.8	68.2% probability 5984 BC (68.2%) 5891 BC 95.4% probability 6006 BC (95.4%) 5838 BC
OxA–16542	VL45, rib of adult headless female Burial context 63; extended parallel to the Danube, head downstream (08/07/2006)	Uncorrected 7701 ± 39 Corrected 7261 ± 60[a]	–17.7	17.0	68.2% probability 6212 BC (41.1%) 6136 BC 6116 BC (27.1%) 6066 BC 95.4% probability 6232 BC (95.4%) 6018 BC
OxA–18865	VL1/2008, right tibia of human adult Burial context 136; extended, parallel to the Danube, head downstream; partially preserved – only right leg below knees and feet (20/07/2006)	Uncorrected 8231 ± 36 Corrected 7791 ± 58[a]	–18.5	16.2	68.2% probability 6684 BC (62.5%) 6566 BC 6546 BC (5.7%) 6530 BC 95.4% probability 6774 BC (95.4%) 6472 BC
OxA–16540	VL21, bone projectile point from context 118, x.1, above the floor (context 149) of Feature 12 in Trench 3/2006 (18/07/2006)	7764 ± 38	–22.1	7.7	68.2% probability 6644 BC (60.5%) 6567 BC 6544 BC (7.7%) 6531 BC 95.4% probability 6654 BC (94.7%) 6494 BC 6490 BC (0.7%) 6484 BC
Contexts with one sample per context					
Bln–1054	5/70, charcoal from square A/III, spit 13 (phase III)	7440 ± 100	–	–	68.2% probability 6416 BC (68.2%) 6229 BC 95.4% probability 6460 BC (95.4%) 6085 BC

Laboratory code	Sample no. and material	Radiocarbon age (BP)	δ^{13}C (‰)	δ^{15}N (‰)	Calibrated date (68% and 95% confidence)
Bln–1052	3/70, charcoal from square b/18, spit 13 (phase II)	7610 ± 100	–	–	68.2% probability 6590 BC (68.2%) 6394 BC 95.4% probability 6644 BC (87.3%) 6326 BC 6320 BC (8.1%) 6250 BC
Bln–1171	4/71, charcoal from square d/5, spit 9 (phase Ib)	7830 ± 100	–	–	68.2% probability 6899 BC (1.3%) 6890 BC 6826 BC (60.8%) 6560 BC 6550 BC (6.1%) 6508 BC 95.4% probability 7030 BC (18.7%) 6874 BC 6866 BC (76.7%) 6478 BC
OxA–16218	VL46, red deer antler from the floor of Dwelling 3 in square C/VI, B/VI, my inv. 1802	7912 ± 39	–22.5	5.9	68.2% probability 6981 BC (1.4%) 6975 BC 6908 BC (6.1%) 6886 BC 6828 BC (60.7%) 6681 BC 95.4% probability 7028 BC (16.6%) 6931 BC 6920 BC (9.4%) 6877 BC 6859 BC (69.4%) 6651 BC
OxA–16543	VL48, bone chisel made on an aurochs' metapodial from Dwelling 5 in square D/I, II, C/II, my inv. 1271	7945 ± 40	–21.9	7.2	68.2% probability 7026 BC (18.8%) 6965 BC 6948 BC (4.2%) 6934 BC 6916 BC (12.0%) 6880 BC 6841 BC (29.4%) 6750 BC 6721 BC (3.9%) 6708 BC 95.4% probability 7034 BC (95.4%) 6693 BC
OxA–5825	Burial 24 (phase III), adult female, extended, S–N, head upslope in square b/17, 1.7 m from the surface (65.74 m asl)	Uncorrected 8000 ± 100 Corrected 7560 ± 110[a]	–18.6	14.7	68.2% probability 6504 BC (53.9%) 6338 BC 6315 BC (14.3%) 6256 BC 95.4% probability 6640 BC (95.4%) 6220 BC
OxA–5826	Burial 83 (phase III), possible adult female, extended, perpendicular to the Danube, N–S, in square a/1, 1.07 m from the surface (64.72 m); on the right shoulder a detached human mandible Burial 83a	Uncorrected 8200 ± 90 Corrected 7760 ± 100[a]	–19.1	14.6	68.2% probability 6685 BC (68.2%) 6470 BC 95.4% probability 7024 BC (2.8%) 6967 BC 6947 BC (0.6%) 6935 BC 6916 BC (2.0%) 6880 BC 6840 BC (90.0%) 6430 BC
OxA–16541	VL42, rib fragment from Burial context 2, extended parallel to the Danube, head downstream in Trench 1/2006 (10/04/2006)	Uncorrected 8228 ± 40 Corrected 7788 ± 60[a]	–18.2	16.3	68.2% probability 6681 BC (62.0%) 6566 BC 6546 BC (6.2%) 6530 BC 95.4% probability 6775 BC (95.4%) 6470 BC

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