The Rise of Metallurgy in Eurasia

Evolution, Organisation and Consumption of Early Metal in the Balkans

Edited by Miljana Radivojević, Benjamin W. Roberts, Miroslav Marić, Julka Kuzmanović Cvetković and Thilo Rehren

The Rise of Metallurgy in Eurasia is a landmark study in the origins of metallurgy. The project aimed to trace the invention and innovation of metallurgy in the Balkans. It combined targeted excavations and surveys with extensive scientific analyses at two Neolithic-Chalcolithic copper production and consumption sites, Belovode and Pločnik, in Serbia. At Belovode, the project revealed chronologically and contextually secure evidence for copper smelting in the 49th century BC. This confirms the earlier interpretation of c. 7000-year-old metallurgy at the site, making it the earliest record of fully developed metallurgical activity in the world. However, far from being a rare and elite practice, metallurgy at both Belovode and Pločnik is demonstrated to have been a common and communal craft activity.

This monograph reviews the pre-existing scholarship on early metallurgy in the Balkans. It subsequently presents detailed results from the excavations, surveys and scientific analyses conducted at Belovode and Pločnik. These are followed by new and up-to-date regional syntheses by leading specialists on the Neolithic-Chalcolithic material culture, technologies, settlement and subsistence practices in the Central Balkans. Finally, the monograph places the project results in the context of major debates surrounding early metallurgy in Eurasia before proposing a new agenda for global early metallurgy studies.
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To the memory of Borislav Jovanović, our colleague, friend and inspiration

(1930 – 2015)
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Chapter 37

Relative and absolute chronology of Belovode and Pločnik

Miroslav Marić, Miljana Radivojević, Benjamin W. Roberts and David C. Orton

The chronology of the sites of Belovode and Pločnik has been discussed several times in the past two decades since excavations were renewed at each site (Arsenijević and Živković 1998; Šljivar 1996; Šljivar and Jacanović 1996a; Šljivar and Kuzmanović Cvetković 1997a), though not in detail and rarely integrating the relative and the absolute chronological sequences. Chronologies from both sites have been published (Whittle et al. 2016), drawing upon eight radiocarbon dates from the two trenches then existing for Belovode (Trenches 7 and 8) and nine radiocarbon dates from three trenches for Pločnik (Trenches 14, 15 and 16). These dates were allegedly focussing on the dating of metallurgical finds, however, the nature of those finds was not known at the time, so the best guess was to date materials from the spits, which only adds to the doubt on the chronological precision achieved.

The seriation and ceramic sequences of both sites resulting from this project are discussed in detail elsewhere in this volume (see Chapters 12, 13, 27 and 28) and in this chapter will be used only to illustrate relative chronology compared to other chronologies used for Vinča culture (see Chapter 4). The identical spit and context excavation methodology employed on both sites enables us to compare chronologically sensitive pottery forms to other relevant sites of the period.

This chapter presents 29 new radiocarbon dates from throughout the excavated sequences: 17 from Trench 18 at Belovode and 12 from Trench 24 at Pločnik. The systematic excavations, relative ceramic sequences and the intensity of radiocarbon dating enables a far more precise modelling of dates for the identifiable activity horizons at both sites.

Stratigraphy

A detailed discussion of features and the stratigraphic situation in each excavated trench is provided in Chapters 10 and 25 of this volume; a short summary is given here to facilitate understanding of the chronology. Both sites were excavated using 10 cm spits, with definable features being recorded and excavated separately but within a framework of relative stratigraphy, providing secure units for selecting samples and dating the sites.

Trench 18 at Belovode comprised approximately 2.2 m of cultural deposits starting directly from the modern plough zone just 10 cm bellow the present-day surface. Based on stratigraphic observations of defined contexts, five activity horizons (labelled Horizons 1 to 5 from surface to bottom) were defined within the trench, with four possible sub-horizons (Horizons 1a and 1b, and 4a and 4b). The general thickness of anthropogenic deposits is similar to that of previous partially published trenches, e.g. Trench 2 (2.4 m) and Trench 5 (2.3 m), but the thickness of deposits can reach up to 4 m when pits are present at the bottom of a trench (e.g. Šljivar and Jacanović 1996a: 55). As no detailed analysis of the ceramic forms in their stratigraphic sequence was published by the previous excavator, with only bowls and goblets featuring in Arsenijević and Živković (1998), it is difficult to compare the finds from Trench 18 with other excavated trenches. We can, however, claim with certainty that the site of Belovode contains the whole sequence of the so-called Vinča ‘culture’.

Trench 24 at Pločnik yielded somewhat thicker anthropogenic deposits than Belovode, ending in archaeologically sterile soil at about 3.7 m below the present surface in the excavated portion of the trench. It should be noted that approximately 80 cm before the occurrence of the yellow clayish subsoil at the bottom of the trench, an infill of a single feature (F38) was detected, which is most likely an early phase pit-dwelling dug into the natural soil and subsequently re-used as a refuse pit. Since the last feature of Trench 24 at Pločnik belongs to an early habitation phase, the thickness of the cultural deposits in the trenches at both sites can be broadly equated, especially if we acknowledge about 60 cm of archaeologically sterile soil between the modern surface and Feature 1.

The detailed study of the finds from the cultural deposits at both sites shows that they correspond with the established phases of the Vinča culture and its gradual transformation from the Neolithic towards the Chalcolithic, as known from other sites of the central Balkan region (see Garašanin and Garašanin 1979; Jovanović 1994; Stalio 1972). In our limited area of excavations, we were able to gather enough archaeological information to reconstruct the entire Late Neolithic occupation sequences at both Belovode and Pločnik.
Relative and absolute chronology of Vinča culture

The basis for the relative chronology of the Vinča culture is the rich and diverse evidence for the production and consumption of pottery. Ceramic vessel fragments are found in vast numbers as refuse in pits or as in situ assemblages within destroyed wattle and daub structures throughout the settlements of the period. The reference assemblage used for the creation of the Vinča culture ceramic chronology sequence is that of Belo Brdo in Vinča, excavated by Miloje Vasić for more than 20 years and published largely in the last of his four-volume ‘Prehistoric Vinča’ books (Vasić 1936c). However, it was not Vasić but rather the German archaeologist Friedrich Holste who first tried to develop a relative chronology of the Late Neolithic period in the central Balkans based on Vasić’s finds from Belo Brdo (Holste 1939). Holste correctly suggested a four-part division of the Vinča culture, a framework that was further supported a decade later by Vladimir Milojić (1949) and Milutin Garašanin (1951). The latter would become a crucial contributor to the Late Neolithic relative chronology of the central Balkan area, dedicating much of his fruitful scientific career to the matter. He divided the Vinča culture into two major periods, early and late (the so-called Tordoš and Pločnik Phases respectively) and defined a finer sub-division of both the early and late phases (Garašanin 1951). Over the following decades, he further refined the principal chronological divisions with the addition of the transitional Gradac Phase (Garašanin 1979), which marked the end of Neolithic Vinča culture and the beginning of copper processing in the region. Towards the end of his career, he made one more revision to the chronological system (Garašanin 1993) by further sub-dividing the early (Tordoš) phases of the culture.

Influenced by Garašanin’s work, other authors established their own relative chronological systems for the period. The best-known examples include the work of Stojan Dimitrijević on the chronology of Late Neolithic Croatia (Dimitrijević 1968) and Berciu and Lazarovici for the Late Neolithic relative chronology of Romania (Berciu 1961; Lazarovici 1979, 1981). An all-encompassing chronology for the whole of the territory of Vinča culture was proposed by Chapman in his seminal work on the southeast European Late Neolithic (Chapman 1981) but was not widely used or accepted by authors in the region. Further schemes were made at the beginning of 1990s, but were more specific site cases, rather than all-encompassing pottery-based relative chronology sequences (Bogdanović 1990; Vukmanović and Radojičić 1990). The work of Bora Jovanović on the southern, Pločnik variant of the Vinča culture led to a refinement of the pottery sequence and instigated the notion of the longer lasting Vinča sites in the south of Serbia, indicated by discernible differences in the pottery assemblages of the late phases (Jovanović 1994). Finally, with the broader application of absolute dating based on radiocarbon samples, a new wave of papers on the Vinča culture started to appear from the late 1980s (Breunig 1987; Schier 1996; Tasić et al. 2015; Tasić et al. 2016b; Whittle et al. 2016) further refining existing divisions and periodisation. No radical change has occurred, however, demonstrating that the old periodisation system based on relative chronology devised from pottery sequences remains fundamentally correct despite all the adjustments made over the decades.

Incorporating the relative chronology of two archaeological sites found over a hundred kilometres away from the type site was somewhat challenging. Regional variations (as established by Chapman 1981: 19–31) tend to increase with distance from the type assemblage, necessitating revision of the examined site assemblage, including the comparison and analysis of pottery types common to both. We therefore propose a relative chronological system (Figure 1) adapted to provide both a relative chronology based purely on pottery types and their relative depths (Garašanin 1979) and a second based on pottery seriation and absolute dates (Schier 1996), both based upon the type site of Belo Brdo. The proposed relative chronological framework is an attempt to draw upon the strengths of both research traditions, i.e. the long-established chronological scheme of Garašanin (1979) and the 14C dates underpinning the chronology of Schier (1996) that lacks the analysis of the final four metres of the Belo Brdo pottery. In order to accommodate the slight differences in the phasing of the two systems, we introduce transition boundaries (denoted as blurred white regions in the Belovode/Pločnik column in Figure 1). These boundaries nullify the slight relative depth differences between the Garašanin and Schier phases and represent the short time difference between the appearance of certain types of pots in the reference assemblage based on pure pottery observation and the pottery seriation combined with absolute dating. A note of caution is required here. Although we accept Schier’s sub-division of certain phases, we found it difficult to identify such minute differences in the limited assemblage excavated from the trenches of Belovode and Pločnik during just two seasons of excavations. The reference assemblage from Belo Brdo, however, consists of a significantly larger collection of pottery sherds that were collected over 11 excavation campaigns, covering a large area and spanning 20 years of field research.
Radiocarbon dates from Belovode and Pločnik

A total of 37 samples taken from trenches at both sites were collected for \(^{14}C\) dating, including 22 from Belovode and 15 from Pločnik (Table 1). In order to minimise the residual effect of samples, a strategy was adopted of selecting short-lived samples such as grains and animal bone where possible, although this proved difficult to achieve in the field. Whenever possible, samples were also taken from secure contexts in order to minimise the risk of residual or intrusive measurements. The samples chosen from spits were associated with confirmed metallurgical finds in order to help date them by proxy. More detailed descriptions of the individual features from Table 1 can be found in Chapters 10 and 25 of this volume.

From the 37 samples chosen, four (MAMS 22072, 22080, 22085 and 22094) were withheld as reserves in case the original samples failed. The extracted collagen from animal bones was purified by ultrafiltration and freeze dried, then combusted in an Elemental Analyzer. The resulting carbon dioxide was converted catalytically to graphite. Sampled charcoal was pre-treated using an Acid-Base-Acid sequence, whilst the seeds were washed in HCl (hydrochloric acid) before analysis. Only two samples of animal bones (out of 19) failed to produce enough collagen for dating.

The dating results were initially calibrated using IntCal13 (Reimer et al. 2013) and SwissCal 1.0 by the Manheim Laboratory, whilst the \(^{14}C\) ages were normalised to \(\delta^{13}C=-25\) (Stuiver and Pollach 1977). The \(\delta^{13}C\) value was obtained from the isotope determination in the AMS system with a typical uncertainty of 0.2%.

Discussion

The integration of relative and absolute chronologies was performed after the \(^{14}C\) results were obtained from the Curt-Engelhorn-Centre of Archaeometry in Mannheim. As the archaeological excavations were conducted using a hybrid single context recording, the relative chronology of each excavated site is best illustrated by a diagram showing relationships between individual contexts found within the trenches (Figures 2 and 3). These were supplemented with absolute dates to illustrate the absolute age. The relative phasing based on pottery finds was subsequently compared to the absolute dating in order to establish phasing at both sites.

Belovode

At Belovode, five horizons were established during the excavations, marked 1–5 from the surface down. To obtain absolute chronological ranges for the horizons, several Bayesian models were created from the available dates.

A total of 17 radiocarbon results were available for the whole Belovode sequence (Table 1). This allowed a formal estimation of the site chronology using an explicit statistical method, combining both the radiocarbon dates and the relative stratigraphy recorded during the
Figure 2. Schematic diagram of stratigraphic relations between features in Belovode Trench 18.
Figure 3. Schematic diagram of stratigraphic relations between features in Pločnik Trench 24.
Figure 4. Stratigraphic model with corrected residual samples for Belovode Trench 18.
excavation. Such an approach, combining two types of chronological information, provides date estimates which can be more precise and more robust than the individual chronological data that generates the model.

Modelling was performed in OxCal v4.2 using IntCal13 calibration curve (Bronk Ramsey 2009; Reimer et al. 2013). All absolute date measurements were placed into the first model based on their spit numbers (i.e. relative depths). When more than one sample existed from the infill of the same cut feature, the same principle was applied, on the presumption that deeper samples represent earlier deposits. Using such an approach, four dates were identified as statistically inconsistent with the rest of the Trench 18 sequence and were partially removed from the modelling, using the ‘After’ function of OxCal. These four dates (MAMS-22071, MAMS-22073, MAMS-22074 and MAMS-23379) are assumed to represent residual samples and cannot be included fully in the model. Two of the excluded dates originate from charcoal samples, which could indicate an old wood effect (Ward and Wilson 1978), whilst the others, measured on animal bone samples, could indicate reused or residual bone which was found out of its original context (articulated bone specimens having unfortunately not been available). The final relational model is presented in Figure 4. Upon the removal of these problematic samples the overall agreement of the model was Aoverall: 65.5.

In addition to modelling individual dates, our model contained the dating of the span of each horizon, in an attempt to establish the transitional periods between relative phases as well as the beginning and the end of the Neolithic occupation of the site (cf. Tasić et al. 2015). In order to achieve this, the dates of each horizon were modelled separately and a value for the start and the end of the horizon was obtained (Figure 5).

The start of Horizon 5 can be modelled at 5648–5338 cal. BC (95.4% prob.), which corresponds with the use span of ossuary pit Z on Belo Brdo in Vinča (Tasić et al. 2016b: 128, Table 4), i.e. the end of Starčevo burials, which corresponds with the 68% probability modelled at 5491–5375 cal. BC. It must be noted that the sole dating sample from Horizon 5 in Trench 18 originates from a hearth and is a charcoal fragment. This could imply old wood effect, as the ceramic finds in the spit surrounding the feature show trademarks of Vinča A pottery style, but examples with chaff found in inclusions, indicative of Starčevo pottery technology, were also recovered from the same spit (Chapters 12 and 13, this volume). The hearth itself yielded three non-distinct ceramic fragments, which cannot be dated more precisely. It is our belief that the hearth itself is probably linked with the end of Starčevo occupation, whilst the spit immediately above it may be linked with the Vinča A Phase of the settlement. The transition boundary to Horizon 4b is modelled at 5452–5318 cal. BC (95.4% probability), which would correspond to very early Vinča A found in the Pannonian plain (Whittle et al. 2016: 12). The ceramic finds from this sub-horizon, although limited in numbers, show clear analogies with Vinča A pottery and the number of pot fragments containing chaff is negligible. At Belo Brdo, this date corresponds to the very end of the Starčevo occupation of the site. Horizon 4a, comprising a series of discarded kiln floors, is dated with one sample from the immediate vicinity of Feature 36 (MAMS-22076). The modelled boundary between Horizons 4b and 4a is at 5366–5054 cal. BC (95.4%) which corresponds with the start of Vinča occupation at Belo Brdo itself, defined by pits at around 9.3 m relative depth (Tasić et al. 2016b: 136–7, Table 8). The subsequent boundary between the end of Horizon 4a and Horizon 3 start is modelled at 5139–4860 cal. BC (95.0%) which compares to layers between 7.5 and 6.5 m relative depth at Belo Brdo in Vinča (Tasić et al. 2016b: 136–7, Table 8), i.e. the Vinča B1–B2 period (Figure 1). The modelled transition of Horizon 3 to Horizon 2 is at 4951–4760 cal. BC (95.4%), corresponding to layers between 6.2 and 5.6 m at Belo Brdo (Figure 1), or the Vinča Gradac–Vinča C period (Tasić et al. 2016b: 136–7, Table 8). The end of Horizon 2 and the start of Horizon 1b boundary in Belovode Trench 18 is modelled at 4818–4692 cal. BC (95.4%) and directly corresponds to layers between 4.9 and 4 m, or the Vinča C–D1 period (Figure 1). The transition to the last phase of Neolithic life on the site, and the boundary between Horizon 1b and 1a, is modelled at 4701–4540 cal. BC (95.4%) corresponding to layers below 4.0 m relative depth at Belo Brdo, or the Vinča D2 period. It should be stated that although the sub-division of Horizon 1 was not clearly detectable in the trench while excavating due to the lack of overlapping features, the modelling strongly suggests its existence as visible in Figure 4, when compared to the type site of Belo Brdo in Vinča (Schier 1996). Thus, Horizon 1a would comprise Features 1 and 9 whilst Horizon 1b would contain Features 3, 6 and 19. Finally, the end of Neolithic life in Trench 18 at Belovode is modelled to 4601–4383 cal. BC (95.4% probability) or 4571–4482 cal. BC (68.2%), which corresponds to modelled results from Belo Brdo itself at 4570–4460 cal. BC (Tasić et al. 2015: Figure 8; Tasić et al. 2016b: 128, Table 4), but also on a wider scale to the majority of the Vinča world (Whittle et al. 2016: 38, Figure 35), especially in the Danube–Sava–Tisza region.

The model also clearly illustrates that the whole span of the Late Neolithic Vinča culture is present at Belovode (Table 2), although specific phases may be absent for certain areas of the site that may not have been permanently occupied during all periods of the Late Neolithic settlement. It seems that the Late Neolithic settlement of Belo Brdo (Schier 1996: 160, Figure 11)
Figure 5. Final Bayesian model for Belovode Trench 18 (green distributions represent horizon boundaries).
in Vinča begins earlier than Belovode but not by very much. The occasional find of Late Starčevo pottery in some of the earlier trenches at Belovode (Šljivar et al. 2015) indicates that the location was not unknown in the Early Neolithic, which is typical of many sites occupied by Vinča communities (Belo Brdo being the best known). Based on the absolute dates presented here, but also compared to the pottery typology, the earliest Vinča settlement in Belovode was established early in Vinča A1 Phase (Figure 5). The horizon, defined by a series of small, elliptical hearths and discarded kiln floors in Trench 18, is (like the previous Horizon 5) dated by a single sample, preventing us from undertaking more detailed modelling of this phase, though still providing an insight into continuous occupation of this part of the settlement in the Late Neolithic. The Vinča B Phase at Belovode (Horizon 3) shows evidence of an increase in activity in Trench 18, with numerous pottery fragments recovered, a large refuse pit (Feature 32), a hearth with an ash deposit immediately next to it, indicating economic activity, although it is unclear whether this was connected with food preparation or raw material resource preparation and transformation.

The transitional, traditionally non-metallic to metallic Vinča Gradac Phase at Belovode, and the beginning of the Vinča C period, are contained within Horizon 2, defined by several pits, one of which (Feature 21) shows strong traces of fire use and contains multiple lumps of malachite ore in its infill.

The beginning of the subsequent Vinča D1 Phase at Belovode (Horizon 1b) is defined by the appearance of a wattle and daub structure (Feature 3), surrounded by a pit to the south (Feature 19) and a hearth installation with metallic copper droplets (Feature 6) to the east. Unfortunately, Schier’s study, although comprehensive, does not include the last phase of the settlement in Vinča (Schier was forced to leave Serbia in 1992 due to UN sanctions before he could finish his work), but a recent study (Tasić et al. 2016b: 136–7, Table 8) fills

<table>
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<tr>
<th>Lab No. MAMS</th>
<th>Site</th>
<th>EDM No.</th>
<th>Feature / Spit</th>
<th>Horizon</th>
<th>Sample type</th>
<th>14C age</th>
<th>± 13C</th>
<th>Cal. 1σ (cal BC)</th>
<th>Cal. 2σ (cal BC)</th>
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<td>25</td>
<td>-24.0</td>
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<td>26</td>
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Table 1. Radiocarbon dates from Belovode and Pločnik

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<th>EDM No.</th>
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<th>Horizon</th>
<th>Sample type</th>
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<th>±</th>
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Table 2. Absolute dates of Belovode settlement phases based on final model (Figure 5).

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<th>Posterior density interval (2σ)</th>
<th>Posterior density interval (1σ)</th>
<th>Horizon</th>
<th>Relative Chronology (Belo Brdo)</th>
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<td>End Vinča D2</td>
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<tr>
<td>4702-4540 cal BC</td>
<td>4689-4669 cal BC (10.6%) or 4634-4549 cal BC (57.6%)</td>
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<td>Start Vinča D2</td>
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<td>Vinča C-D1</td>
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<td>4951-4762 cal BC</td>
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<td>Gradac-Vinča C</td>
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<td>5140-4859 cal BC</td>
<td>5139-4859 cal BC</td>
<td>Horizon 3 start</td>
<td>Vinča B1-B2</td>
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<td>5366-5054 cal BC</td>
<td>5351-5185 cal BC</td>
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<td>Start Vinča A</td>
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<td>5452-5318 cal BC</td>
<td>5404-5335 cal BC</td>
<td>Horizon 4b Start</td>
<td>End Starčevo</td>
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<td>5648-5338 cal BC</td>
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Figure 6. Stratigraphic model without corrected residual or intrusive samples for Pločnik Trench 24.
Figure 7. Stratigraphic model with corrected residual or intrusive samples for Pločnik Trench 24.
this gap with new dates. The Vinča D1 Phase at Belo Brdo in this study has absolute dating values similar to those obtained on Belovode samples, which is not surprising due to the proximity of the two sites. Finally, the modelled date for the Vinča D2 period in Belovode is equivalent to that for the Belo Brdo type site in Vinča, as is the end of Neolithic occupation on both sites (Tasić et al. 2015: 1077), indicating a larger occurrence that engulfed the whole of the Danubian Vinča at the turn of the 46th century BC, resulting in a complete abandonment of well established, permanently occupied settlements.

**Pločnik**

Like Trench 18 at Belovode, Trench 24 at Pločnik comprised five activity horizons, numbered 1 to 5 from the topsoil to the bottom of the trench (Figure 3). The sample list contained 17 samples in total, but one (MAMS-22082) did not yield collagen and two additional samples (MAMS-22085 and MAMS-22094) were kept in reserve and were not dated (Table 1). The same method used to model the absolute dates from Trench 18 at Belovode was used for Trench 24 at Pločnik. The 14 samples were first modelled stratigraphically based on their spit number in order to identify residual or contaminated samples. In the process, two samples (MAMS-22088 and MAMS-22092) were identified as intrusive and residual respectively (Figure 6, upper portion). The remaining 12 samples were built into a slightly altered model (Figure 7) using the 'After' and 'Before' functions of OxCal to identify the residual and intrusive samples for further modelling, and to keep them distinct (red coloured). The altered model (Figure 7) with high agreement (Amodel:104), corroborates the relative stratigraphy recorded during the excavations in the trench.

The stratigraphic model was then enhanced by adding boundaries between identified horizons in order to define the start and the end of each horizon, i.e. its duration. The final model (Amodel:90), presented in Figure 8, indicates that the start of Neolithic occupation of the southern part of Pločnik settlement occurred in 5389–5003 cal. BC (95.4% prob.), perhaps in 5180–5028 cal. BC (67.4% prob.) or 5189–5186 cal. BC (0.8% prob.), which corresponds to layers between 9.3 and 7.0 m relative depth in Vinča, or the Vinča A–Vinča B2 period (Tasić et al. 2016b: 136–7, Table 8). If the 67.4% probability posterior density estimate is considered, it could narrow the starting period to between 8 and 7 m at Belo Brdo, coinciding with the end of Vinča A and the beginning of the Vinča B1 Phase (Figure 1). The boundary at the end of Horizon 5 and the beginning of Horizon 4 is modelled at 5121–4976 cal. BC (95.4%), which corresponds to the layers between 7.05 and 6.55 metres at Vinča, or the Vinča B2 period in relative chronology (Figure 1). The end of Horizon 4 and beginning of the subsequent Horizon 3 (Figure 8) is modelled at 5036–4951 cal. BC (95.4% prob.). This period corresponds to the Vinča B2–C transition, or the so-called Gradac Phase (Garašanin 1979) at Belo Brdo (Tasić et al. 2016b: 136–7, Table 8). A single sample (MAMS-22086) dates the span of Horizon 2. The end of Horizon 3 and the beginning of Horizon 2 in Pločnik is modelled at 4927–4621 (95.4% prob.), which would correspond to the layers between relative depths of 6.0 and 4.0 m at Belo Brdo (Tasić et al. 2016b: 136–7, Table 8), or the Vinča C–D1 span in relative chronology (Figure 1). Taking into account the 68.2% probability for the posterior density estimate of this boundary, modelled at 4894–4746 cal. BC, the start of Horizon 2 would fall between 6.05 and 4.95 m relative depth at Belo Brdo (Tasić et al. 2016b: 136–7, Table 8), or the Vinča C Phase. The end of the penultimate horizon in Pločnik, and the beginning of Horizon 1 is modelled at 4631–4462 cal. BC (95.4% prob.), corresponding to the layers between 3.4 and 1.3 m at Belo Brdo (Tasić et al. 2016b: 136–7, Table 8), or the latter half Vinča D2 Phase and beyond. Although it may seem so, this is not surprising for the southern variant of the Late Vinča (the metallic Vinča) culture, as some authors have hypothesised that it has a prolonged duration compared to the Danubian Vinča (Jovanović 1994) and even direct contact and overlap with the early Bubanj–Salçuta–Krivodol (BSK) communities in the Central and Eastern Balkans area (Tasić 1979; Tasić 1995) which, in its earliest phase, contains pottery types closely resembling those of the Late Vinča. Other authors (Srejović 1984b) have claimed that Vinča communities of the southern variant disintegrated under the influence of the BSK complex, melting into the new societies that started occupying the Balkans area from the 45th century BC. It appears that the new dates presented here, extrapolated from a strict and constrained Bayesian statistical framework can further corroborate the hypotheses of the previous researchers regarding the transition from ‘metallic’ Vinča to the Middle Chalcolithic proper. They also illustrate that, in Trench 24 at Pločnik, there appears to be no activity linked with the Vinča D1 period, either because this part of the site was temporarily abandoned during that specific period, or because the limited scope of the trench prevented us from detecting such features.

Finally, the end of the Neolithic occupation of Pločnik and the end of Horizon 1 is modelled at 4446–4231 cal. BC (95.4% prob.) or 4430–4326 cal. BC (68.2% prob.). This posterior density interval, obtained on two dates (MAMS-22083 and MAMS-23373) originating from the burnt daub structure discovered in situ in Trench 24 has no direct comparison at either Belovode or Belo Brdo in Vinča, as by this period both these sites were long abandoned after a fiery end that occurred towards the end of the 46th and the beginning of the 45th century BC and enveloped a host of Late Neolithic sites in the wider
Figure 8. Final Bayesian model for Pločnik Trench 24 (green distributions represent horizon boundaries).
area of the Danube and its tributaries (Tasić et al. 2015). However, in Belo Brdo itself, there is evidence for Middle Chalcolithic (or Early Copper Age in the terminology of the original scholarship) occupation, with four burials identified as belonging to Bodrogierező phase of the Middle Chalcolithic (Jevtić 1986: Figure 2). Of the four burials discovered, two were dated: Burial 1 at 4354–4244 cal. BC (95.4% prob.) and Burial 2 at 4314–4084 cal. BC (95.4% prob.). These postdate the modelled abandonment of Late Neolithic Belo Brdo by about 150–250 years (Tasić et al. 2015: 1077) but are significantly less distant when compared to the modelled dates of Trench 24 in Pločnik, where this margin is between 80 and 100 years.

Another, albeit single, AMS date from the Middle Chalcolithic site of Bodnjik, located about 160 km northwest of Pločnik in western Serbia, is a much better illustration of the possibility— and probability—of contemporaneity between late Vinča culture in the south of Serbia and the emerging BSK communities. The site of Bodnjik, located on a hilltop near the town of Koceljeva in western Serbia, was researched over several campaigns in the mid-1990s (Palavestra et al. 1993; Palavestra et al. 1996), yielding two rectangular burnt daub structures with pottery material typical of early BSK complex in a single layered settlement. Of four samples submitted for AMS dating, only one had sufficient collagen (OxA-26309, 5579BP, +/-35), calibrating to 4466–4347 cal. BC at 95% probability, or 4448–4369 cal. BC at 68.3% probability (Živanović 2013: 54). This value overlaps with the modelled values obtained from dates for the end of Horizon 1 in Trench 24 at Pločnik (Table 3), indicating a strong possibility of contemporaneous life of late Vinča and early BSK communities in the central Balkans.

A similar set of early radiocarbon dates was obtained in northeast Bulgaria, at the site of Lîga (about 180 km northeast of Pločnik). Located 1 km north of the modern village of Telish in the Cherven Briag municipality of Bulgaria (Merkyte 2005: 9), this site has three horizons, two of which (Lîga 2 and 3) are comparable to the Bubanj-

<table>
<thead>
<tr>
<th>Posterior density interval (2σ)</th>
<th>Posterior density interval (1σ)</th>
<th>Horizon</th>
<th>Relative Chronology (Belo Brdo)</th>
<th>Relative Chronology (Jovanović 1994)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4446–4231 cal BC</td>
<td>4431–4324 cal BC</td>
<td>Horizon 1 end</td>
<td>-</td>
<td>Gradac III</td>
</tr>
<tr>
<td>4631–4462 cal BC</td>
<td>4576–4491 cal BC</td>
<td>Horizon 1 start</td>
<td>Vinča D2</td>
<td>Gradac II</td>
</tr>
<tr>
<td>4927–4621 cal BC</td>
<td>4894–4747 cal BC</td>
<td>Horizon 2 start</td>
<td>Vinča C–D1</td>
<td>Gradac I</td>
</tr>
<tr>
<td>5036–4951 cal BC</td>
<td>5013–4968 cal BC</td>
<td>Horizon 3 start</td>
<td>Gradac phase</td>
<td></td>
</tr>
<tr>
<td>5389–5003 cal BC</td>
<td>5199–5190 cal BC (2.5%) or 5182–5028 cal BC (65.7%)</td>
<td>Horizon 5 start</td>
<td>Start Vinča A2–B1</td>
<td>Start Vinča A2–B1</td>
</tr>
</tbody>
</table>

From the final Pločnik Trench 24 model (Figure 8) it is easily discernible that the Late Neolithic occupation begins later than at Belovode and Belo Brdo, midway through the Vinča A2 Phase. Trench 24 was located towards the southern edge of the Late Neolithic settlement, so that this need not be the case for the central part but the contemporary village of Pločnik prevents us from large scale excavation in this area (see Chapter 24). A noticeable increase in activity is present in the following Horizon 4, dated to the Vinča B2 Phase, with several notable features, most distinct being the rectangular ash deposit (Feature 34). The transitional Gradac Phase of Horizon 3 has an abundance of activity, including the edge of a burnt daub structure (Feature 17) opposite a dismantled kiln surrounded by a large ash deposit originating from its use (Features 14/15). The latter two indicate a longer lasting economic activity. Unfortunately, they were...
located next to the eastern profile of the trench, so it was not possible to establish the exact nature of the activity as the kiln was only partially excavated. Horizon 2, defined by another dismantled kiln next to the western profile and a partially excavated pit in the northeast corner of the trench, seems to mimic the economic activity of the previous horizon. The Late Vinča C and Early D1 Phase of Horizon 2 indicates that the area was still not exclusively residential, but rather had a mixed role in the late settlement. In the final horizon of the Neolithic occupation of Pločnik, well past the onset of the Middle Chalcolithic in the rest of the Balkans and Pannonian plain, the residents of the settlement erected a large rectangular daub structure, which was completely burnt at the end of the settlement occupation, well into the second half of the 45th or the first half of the 44th century cal. BC. This abrupt change in the nature of the space may signify a new purpose given to the previously predominately economic area, but also some other changing aspect, such as an increase in the number of households due to yet unexplained reasons, or similar. However, these questions extend far beyond the limits of both this chapter and this volume.

The bibliographic reference for this chapter is:

![Bayesian model for Liga 2 and 3 radiocarbon dates](adapted from Merkyte 2005: 33–36).

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Y


Z


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The Rise of Metallurgy in Eurasia is a landmark study in the origins of metallurgy. The project aimed to trace the invention and innovation of metallurgy in the Balkans. It combined targeted excavations and surveys with extensive scientific analyses at two Neolithic-Chalcolithic copper production and consumption sites, Belovode and Pločnik, in Serbia. At Belovode, the project revealed chronologically and contextually secure evidence for copper smelting in the 49th century BC. This confirms the earlier interpretation of c. 7000-year-old metallurgy at the site, making it the earliest record of fully developed metallurgical activity in the world. However, far from being a rare and elite practice, metallurgy at both Belovode and Pločnik is demonstrated to have been a common and communal craft activity.

This monograph reviews the pre-existing scholarship on early metallurgy in the Balkans. It subsequently presents detailed results from the excavations, surveys and scientific analyses conducted at Belovode and Pločnik. These are followed by new and up-to-date regional syntheses by leading specialists on the Neolithic-Chalcolithic material culture, technologies, settlement and subsistence practices in the Central Balkans. Finally, the monograph places the project results in the context of major debates surrounding early metallurgy in Eurasia before proposing a new agenda for global early metallurgy studies.