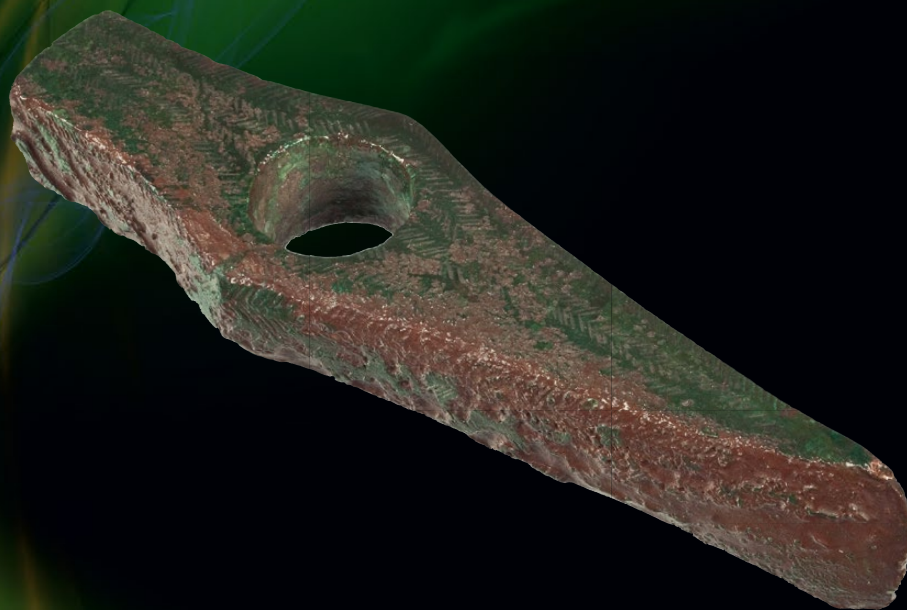




# The Rise of Metallurgy in Eurasia

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



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Inner back cover: Reconstruction of the world's earliest copper smelting. Green flames come from the extraction of metal from malachite. Experiments at Pločnik, Serbia (2013) - Marko Djurica

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*To the memory of Borislav Jovanović, our colleague, friend and inspiration*

*(1930 - 2015)*



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## Chapter 2

# The Rise of Metallurgy in Eurasia: Evolution, organisation and consumption of early metal in the Balkans: an introduction to the project

Thilo Rehren, Miljana Radivojević and Benjamin W. Roberts

The study of early metallurgy has many aspects and has, accordingly, taken many forms and foci (Rehren and Pernicka 2008 and literature therein). Some scholars have documented the morpho-typological evolution of artefact types and some have explored the role of metals in creating social hierarchies, in storing and displaying wealth, or the more transcendent role of metals in a variety of rituals. Other researchers are fascinated by the skills and technical achievements of the metalworkers and their intangible heritage as expressed in intricate castings, ingenious manufacturing methods and elaborate surface decorations. Yet others study the transformation of rocks and ores to metal as documented in the slags and furnace fragments or try to trace the geological origins of metal objects, as a proxy for the movement of people, materials, and ideas. The investigation of ancient mining extends well beyond the field of archaeometallurgy, with mines for flint, pigments, precious stones and salt all pre-dating metal smelting, and quarrying for building stone exceeding metal mining both in scale and value generation (e.g. Schauer *et al.* 2020). This range of interests inevitably implies the application of a multitude of methods, borrowed from a host of mother disciplines, adjusted and refined to form the interdisciplinary field of archaeometallurgy. It also makes any holistic project both a daunting prospect and an exercise in interdisciplinary diplomacy.

*The Rise of Metallurgy in Eurasia* project did not, of course, spring into existence in a vacuum. The subject of early metallurgy in the Balkans has attracted scholarly attention for almost a century and was closely associated with early 20th century investigations of Vinča-Belo Brdo, the eponymous settlement of the Vinča culture (c. 5400 – 4600 BC) (Vasić 1932-1936), the discovery of metal artefacts at the tell settlement of Pločnik (south Serbia) (Grbić 1929), and the excavation of Vinča-style pottery in copper mining shafts at Jarmovac in southwestern Serbia (Davies 1937). The Balkan Peninsula, and specifically its northern part, subsequently became a major focus for scholarship concentrating on early mining and metallurgy, as manifest, for instance, in:

- The excavation of the copper mining sites of Rudna Glava in Serbia and Ai Bunar in Bulgaria (Chernykh 1978a; Jovanović 1971, 1980, 1982), which were the subject of pioneering provenance studies (Pernicka *et al.* 1993; 1997). These two sites were identified as the central nuclei of the Carpatho-Balkan Metallurgical Province (CBMP), which has served as a highly influential model in understanding community inter-connections across the Balkans and the Eurasian Steppes (Chernykh 1978b, 1992, 2013; Chernykh and Kuzminykh 1989; Chernykh *et al.* 2004; Kohl 2007; Koryakova and Epimakhov 2007; Kuzmina 2008; Yang *et al.* 2020). The abundance of copper deposits and the general richness of polymetallic veins across the Balkans has been discussed at length as crucial for early access to minerals and experimentation (e.g. Bogdanov 1982; Janković 1967, 1977, 1982; Jelenković 1999; Montheil *et al.* 2002; Neubauer and Heinrich 2003; Pernicka *et al.* 1993, 1997; Sillitoe 1983) and it is worth noting that this rich metallogenic profile still supports a key industry in the modern era in the region.
- The application of radiocarbon dating and, subsequently, archaeometallurgical research, which together revealed both the earliest known dates and the characteristics of copper metallurgy, and accompanying evidence for the independent invention of this technology in the Balkans (Glumac 1991; Jovanović 1980; Jovanović and Ottaway 1976; Pernicka *et al.* 1997; Renfrew 1969; Ryndina and Ravich 2000, 2001; Todorova 1978). The recent analysis of copper slag at the eastern Serbian Vinča culture site of Belovode, dating to c. 5000 BC (Radivojević 2013; Radivojević and Kuzmanović Cvetković 2014; Radivojević and Rehren 2016; Radivojević *et al.* 2010a), subsequently reignited the debate around the multiple inventions of metallurgy across Eurasia (see Montero-Ruiz *et al.* 2021; Pearce 2015; Pernicka 2020; Radivojević 2015; Roberts and Radivojević 2015; Roberts *et al.* 2009; Rosenstock *et al.* 2016). Accordingly, the

Balkans now has the earliest known evidence for metallurgy with respect to:

1. *lead*, smelted probably from the end of the 6th millennium BC (Radivojević and Kuzmanović Cvetković 2014) but more regularly used from the mid-5th millennium BC in the central Balkans (Glumac and Todd 1987) and later in the eastern Balkans (Hansen *et al.* 2019);
  2. *copper*, smelted from *c.* 5000 BC onwards in eastern Serbia (Radivojević 2013; Radivojević and Kuzmanović Cvetković 2014; Radivojević and Rehren 2016; Radivojević *et al.* 2010a);
  3. *gold*, used from *c.* 4650 BC onwards in eastern Bulgaria (Higham *et al.* 2007, 2018; Krauss *et al.* 2014, 2017; Leusch *et al.* 2014, 2015);
  4. *bronze*, smelted as a natural alloy from *c.* 4650 BC in southern Serbia and found across Bulgaria (Chernykh 1978b; Radivojević *et al.* 2014a, 2014b; Radivojević *et al.* 2013);
  5. and, probably, *silver*, produced by cupellation rather than occurring naturally, by the end of the 5th/early 4th millennium BC in Greece (Maran 2000; Muhly 2002).
- The scholarly tradition—best exemplified by the *Prähistorische Bronzefunde* series—of constructing detailed typo-chronologies of the many early metal objects, primarily (*c.* 4300) copper implements, which were then placed at the core of archaeological narratives in the Balkans and the surrounding regions (e.g. Antonović 2014a; Chernykh 1992; Diaconescu 2014; Driehaus 1952–55; Govedarica 2001; Heeb 2014; Kuna 1981; Patay 1984; Ryndina 2009; Schubert 1965; Taylor 1999; Todorova 1981; Vulpe 1975; Žeravica 1993).
  - The discovery and excavation of the spectacular cemetery at Varna in Bulgaria, still unparalleled in metal volume, upon which major debates relating to the existence (or not) of elites and the dynamics of inequalities in the 5th and 4th millennium BC have since been played out (e.g. Biehl and Marciniak 2000; Chapman 1991, 2013; Chapman *et al.* 2006; Crnobrnja 2011; Fol and Lichardus 1988; Hansen 2013a; Higham *et al.* 2018; Ivanov 1978a; Klimscha 2014, 2020; Krauss *et al.* 2017; Leusch *et al.* 2017; Müller 2012; Porčić 2012a, 2019a; Reingruber 2014; Renfrew 1978a, 1986; Slavchev 2008).

It is still the case in Balkan prehistory that metallurgy is understood mostly through the lens of copper mining and the typology and distribution of metal (mainly copper and gold) artefacts, although this reflects only two ends of the metal production process. Production debris such as slags or crucibles, despite their rarity (and infrequent recovery in the field and subsequent

analysis) in the archaeological record during the Chalcolithic, provides far more information about the metal-making recipes, and the transmission of metallurgical knowledge or ore provenance than the morphology of the final products or their origins (cf. Hauptmann 2014; Killick 2014; Martín-Torres and Rehren 2008; Martín-Torres and Rehren 2014; Ottaway 1994, 2001; Rehren 2003, 2008; Rehren *et al.* 2007). Slag, a by-product of metal extraction, is a vitreous, usually amorphous and often magnetic material that typically contains traces of all components contributing to its formation, while remaining largely resistant to post-depositional processes and dislocation (Bachmann 1982). Slags can be found as free pieces but also attached to the walls of crucibles, furnaces, or ceramic fragments known as ‘slagged sherds’, as is the case for early metal production in the Balkans (Radivojević and Rehren 2016; Rehren *et al.* 2016).

Since the 1990s, the deteriorating political situation in the Balkans hugely disrupted many early metal-orientated archaeological and archaeometallurgical research projects in the region. The negative impact on fieldwork, publications and collaborations has only recently been reversed, as evidenced, for instance, by the success and growth of the *Balkan Early Metallurgy Symposia (BEMS)* meetings in London, UK (2007); Prokuplje, Serbia (2010); Sozopol, Bulgaria (2013); and Targu Jiu, Romania (2015). This upsurge can also be seen in the continued prominence of metallurgical research within the festschrifts of major Neolithic-Copper Age Balkan archaeologists whose students and colleagues now occupy prominent positions in archaeological museums, university departments and research institutes (e.g. Forțiu and Cîntar 2014; Stefanovich and Angelova 2007; Țerna and Govedarica 2016). Metal-orientated scholarship is also very evident, not only in the classic and still influential conference proceedings published as *Die Kupferzeit als Historische Epoche* (Lichardus 1991a), but also in more recent proceedings from three major international conferences published on the region: *The Neolithic and Eneolithic in Southeast Europe* (Schier and Drașovean 2014); *Neolithic and Copper Age between the Carpathians and the Aegean Sea: Chronologies and Technologies from the 6th to the 4th Millennium BC* (Hansen *et al.* 2015); and *Der Schwarzmeerraum vom Neolithikum bis in die Früheisenzeit (6000–600 V. Chr)* (Schier and Nikolov 2016). It is however less prevalent in the most recent conference *Formation and Transformation of Early Neolithic Lifestyles in Europe* (Krauss *et al.* 2020). All reflect the persistent depth and influence of German scholarship – and the increasing use of English in publications.

Narratives on the emergence and evolution of Balkan metallurgy have always been modelled against developments in the Near East (or more precisely Southwest Asia) following a much embraced trend in

scholarship from the late 19th century onwards that proclaimed ‘*Ex Oriente Lux*’ or ‘light from the east’ to explain the emergence of ‘European civilisation’, as argued influentially by Montelius (1899) and Childe (1930). The transmission of farming technologies, products and practices as well as new pyrotechnologies such as ceramics from the Near East to Anatolia and onwards to the Balkans in the mid-7th millennium BC is, indeed, very well evidenced and clearly established in both past and more recent scholarship (see de Groot 2019; Shennan 2018; Whittle 2018). This earlier confirmation of the ‘*Ex Oriente Lux*’ model has consistently created a strong intellectual paradigm for a Southwest Asian metallurgical origin that only a few individuals such as Renfrew (1969), Jovanović (1971), Ottaway (Jovanović and Ottaway 1976) and Todorova (1978) have challenged, arguing instead for the independent origins of Balkan metallurgy. Against this backdrop we appreciate immensely the resumption of the Belovode and Pločnik excavations with the clear agenda of Šljivar and Kuzmanović Cvetković (1998) to demystify the Vinča metallurgy debate despite scholarly resistance at the time. The decade-long, painstaking archaeological work of D. Šljivar and J. Kuzmanović Cvetković at Pločnik, and of D. Šljivar at Belovode with their *Archaeometallurgy in the Vinča Culture Project* provided the foundations for our project. Pločnik, in particular, had been known for almost a century as a major metal-yielding site (Grbić 1929), even though the majority of copper finds from the site stem from hoards rather than potential production contexts. However, it was D. Šljivar’s work at Belovode and his joint work with J. Kuzmanović Cvetković in Pločnik that eventually enabled the identification of the first real copper smelting slag from a Vinča culture site (Radivojević *et al.* 2010a). It was their joint early mentoring of one of us (MR) which ultimately led to the formation of the current research team. While J. Kuzmanović Cvetković fully participated in bringing this monograph to fruition, we deeply regret that for reasons beyond our control D. Šljivar felt unable to join us for writing up this project. His absence from the team was not for lack of trying from our side to integrate him, and we put on record here our debt of gratitude for his important early work at Belovode and beyond, his mentoring and full support of our early studies, and the essential role of the National Museum in Belgrade and its staff for the study of the early metallurgy in Serbia and the wider Balkans.

Our interdisciplinary research project, *The Rise of Metallurgy in Eurasia: Evolution, organisation and consumption of early metal in the Balkans*, funded by the UK’s Arts and Humanities Research Council (AHRC) connected Serbian, UK and German institutions in what was, at the time, the largest archaeometallurgical undertaking in the Balkans and beyond. It drew

together UCL Institute of Archaeology, Durham University (UK), National Museum in Belgrade, Homeland Museum of Toplica in Prokuplje, Homeland Museum of Priboj on Lim in Priboj (Serbia), Curt-Engelhorn Centre for Archaeometry in Mannheim, Roman-Germanic Commission in Frankfurt, and the German Mining Museum in Bochum. This was also an international team, intellectually and practically led by a Serbian scholar (MR). Three key debates were shaping our questions. Firstly, is there a single origin of metallurgy in Eurasia, or several? Then, how did pre-existing technical know-how influence and inspire the emergence of metallurgy? And lastly, how was this early metallurgy organised across the *chaîne opératoire* of metal production and use, and integrated across a range of metals and alloys? From these debates or research themes we developed six specific questions, aiming to understand how metallurgy was transmitted and adopted by different communities across the Balkans and beyond:

1. How did the mineralogical and technological basis for early metal production in the Balkans emerge and evolve during the 6th-5th millennia BC?
2. To what extent was metallurgy related to pottery technology and production, and how did pre-existing technological knowledge influence the emergence of metallurgy?
3. How were ore sources, smelting, and casting connected and organised?
4. Where did the smelted metals circulate?
5. What metal types were being made and how did these evolve?
6. Was there a close relationship between ore sources, metallurgical technology, and artefact types?

These research questions were prompted by new insights gained during the early work at Belovode. Having identified a smelting site within a settlement meant that we now knew what to look for, at least in broad terms. We also knew to look for complex networks of ores and metals moving across the wider Balkans, and not to limit ourselves to a single region. And we also understood how little evidence survived from a much larger picture, and the need to add more pieces to the jigsaw (Pernicka 1990; Rehren 2014; Taylor 1999). We aimed to integrate the smelting in its wider *chaîne opératoire*, by adding two precursor technologies: the mining for minerals, and the firing of black-burnished pottery, the latter long seen as having laid the foundation for metal smelting. We were constrained, as always, by the usual limitations of archaeological research: the nature of suitable, accessible archaeological sites; the financial and time limitations imposed by our (most generous!) funding body; the assembled expertise of

the team; and the unpredictable nature of luck (or lack thereof) that dominates so much fieldwork.

The resulting project fieldwork spanned two seasons of surveys and excavations at Belovode and Pločnik in 2012 and 2013 by the core project team, as well as extensive geophysical surveys at both sites by project partners from the Roman-Germanic Commission (RGK). There at the copper mining site of Jarmovac in 2013 by the core project team in collaboration with project partners at the Priboj on Lim Homeland-Museum (Savo Derikonjić) and the German Mining Museum Bochum, which will be published separately (Thomas *et al.* in preparation). Beyond the fieldwork, the processes involved in copper smelting were explored and evaluated in a series of experimental reconstructions at Pločnik conducted in 2013. Also, metal production debris from the earlier excavations of the site of Gornja Tuzla (Bosnia and Herzegovina) were included in the program of laboratory analysis and will be addressed in detail separately. Rather than simply focussing only on the metallurgical remains, the extensive post-excavation programme deliberately encompassed the analysis of all material and environmental remains by a wide range of specialists. At both Belovode and Pločnik, the entire stratified sequence of excavated activities was subject to radiocarbon dating. For the first time ever, we have directly dated metallurgical activities in a Vinča culture settlement.

*The Rise of Metallurgy in Eurasia* project also included a funded PhD to undertake the petrographic and compositional analysis of pottery from Belovode and

Pločnik as an integral part of research into pottery and metal technology. This doctoral thesis examined the selection of clays, tempers, and firing conditions with an emphasis on black burnished pottery pre-dating the emergence of metallurgy. The results of the PhD (Amicone 2017) are presented within this volume (Chapters 14, 29, and 43) and have also been published elsewhere (Amicone *et al.* 2020). The research also led to a workshop and edited volume (Amicone *et al.* 2019).

The long gestation period of this volume was partly the result of the changing professional circumstances and rapidly increasing responsibilities of the lead editors, but also due to the conscious expansion of its scope. We realised that the traditional format of the excavation monograph with only a limited discussion of the newly discovered evidence in the broader regional context was neither sufficient nor satisfactory. This was resolved by the addition of thematic surveys of specific phenomena from across the Balkans that also offered an international platform to a new generation of mainly Serbian specialist scholars.

This volume reports the outcomes of the project, the ways in which we arrived at them, and the further work we hope will be done, either by ourselves or by others. The outcomes differ from those we expected when we started and further questions arise as we reach a close. As such, this volume is a waymark on the winding road that is 'research'. We place it at the mercy of the reader and hope it will contribute to a better understanding of the archaeology of early metallurgy and society in the Balkans.

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## Y

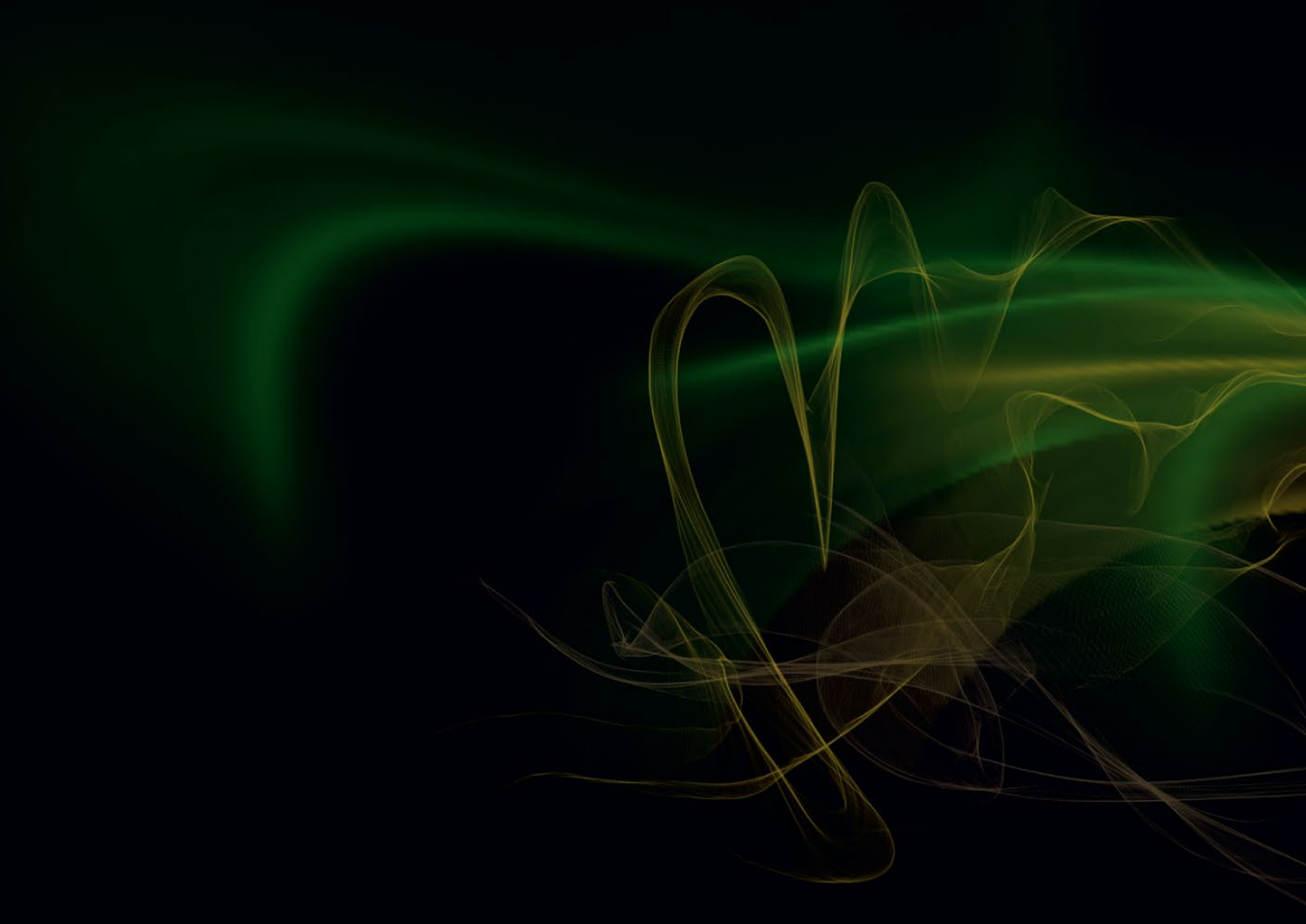
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The background of the page features a dark, almost black, field. Overlaid on this are several thin, glowing lines in shades of green and yellow. These lines are fluid and wavy, creating a sense of movement and depth. In the center-right area, there is a dark, semi-transparent sphere that appears to be part of the overall composition, possibly representing a globe or a specific archaeological site. The overall aesthetic is modern and scientific.

*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.