Journal scientific and applied research, vol. 24, 2023
International Journal

ISSN 1314-6289 (Print)
ISSN 2815-4622 (Online)

Original Contribution

ANCIENT METALLURGY IN THE BULGARIAN LANDS

Stella Doncheva

KONSTANTIN PRESLAVSKY UNIVERSITY OF SHUMEN, SHUMEN 9700, 115 UNIVERSITETSKA STR.

E-mail:s.doncheva@shu.bg

Abstract: *Ancient metallurgy is a broad concept and is associated both with mining and metalworking, and in many cases is evidence of their existence. Data on metalworking are indirect evidence of the development of mining. Metal implements, weapons, and ornaments were the most mobile material, and metal and its articles were one of the main objects of ancient barter. The development of metallurgy became one of the main drivers of economic life during different historical eras, and the territory of Bulgaria is no exception, but on the contrary, it is one of the places where this activity originated and developed for centuries.*

Key words: *ancient metallurgy, the Balkans and Middle East, Burgas region, cultural heritage*

Ancient metallurgy is a broad concept and is connected to mining and metalworking at the same time and in many cases is proof of their existence, outlining the cultural-historical heritage of different communities in time and space. Data on metalworking are indirect evidence of the development of mining. Where no metals are extracted (in the oreless areas) and only imported metal is processed, it is called metalworking. Metal implements, weapons, and ornaments were the most mobile material, and metal and its articles were one of the main objects of ancient barter. With the help of such finds, the copper ore zones and the distribution of the metal in the oreless areas are located, which is a prerequisite and a means for establishing the synchronization between the individual areas and the absolute chronology [1]. Many facts speak to the fact that the extraction and processing of metals is not carried out by everyone, but by people in this activity that have passed on their knowledge to a narrow circle of the community. There is also an essential question about the used ore deposits, and hence also about mining, which can hardly be solved without comparative analyzes of samples of the metal objects and the supposed raw material sources.

A large part of the territory of Bulgaria (over 50%) has a mountainous character with a diverse geological structure. Nature has created in many places in the earth's bowels accumulations of various minerals, many of which have been known to the local population since ancient times. The development of mining on our lands corresponds to the general world development in this industry. The proximity of our territory to the ancient cultural world is also important for this - Asia Minor, Egypt, the islands of the Aegean and Mediterranean seas and central Greece, where ancient human culture was born and the beginning of the use of metals for household needs and in art.

Studies show that the metallurgical processing of copper ores originated simultaneously in the Balkans and Eastern Asia. Familiarity with metal in the Middle East is known in the pre-ceramic Neolithic (8-6 millennium BC). The oldest copper finds and traces of copper mining were found in Çatal-Hüyük (Anatolia) and date from the 8-7 millennium BC. [2]. The metal became known in Dvurichye in the 6th millennium BC. (Tel-as-Savan settlement near Baghdad, Yaram-Tepe I), in Egypt - from the 5th millennium BC. (Badari culture). In Iran, the most ancient centers of copper metallurgy are from the end of the 6th - the beginning of the 5th millennium BC. (Sialk Settlement) [3].

Long before 6000 BC. in Southwest Asia, metalworkers shifted from using natural copper to extracting it from oxide and sulfide ores, which ushered in the production of metal by smelting. It is assumed that the process was adopted directly from the casting of natural ore. Natural copper mixed with small amounts of unwanted rock impurities formed from silicates or iron oxides, but containing copper oxides, was heated with the intention of separating the rock impurities from the pure metal. The carbon from the fuel extracted the oxygen from the copper oxide (reduction process), resulting in additional metallic copper. Silicates and iron oxides also had to be melted down and turned into slag. The observant craftsman noticed that most copper was produced when it was placed in the fire with the impurities from the rocks.

The appearance of copper metallurgy is also associated with the production of ceramics. The relationship between metallic copper and the green, copper-containing pigment malachite was noticed when natural copper naturally turned green with time, or when malachite, which was used as a pigment on the ceramic surface, was heated over a low heat, resulting in pure copper. This process requires a temperature of around 1100°C and its reaching is associated with charcoal. It is assumed that the knowledge of smelting natural copper also came from the processing of other rocks or ores [4].

In Syro-Mesopotamia, RBE produced high-quality metal products from sufficiently complex copper-based alloys. Tin bronze, for example, appeared in 3000 BC. in the Middle East. The production repertoire includes both utilitarian objects and symbolic objects indicating a high social status. In the 4th millennium BC a high level has been reached in metal production, based on

mastering the smelting of various types of ores, including polymetallic ores with impurities of arsenic, lead, nickel, antimony; the mass production of arsenical bronze; the making of various objects. The qualitative and quantitative flourishing of production occurred in the 3rd millennium BC [5]. Thus, the Erghani Maden deposits yielded metallurgically "pure" copper, while the Talmessi ores in Iran yielded both "pure" copper and natural compounds with arsenic, also smelting copper from oxide ores.

Copper-arsenic-nickel alloys are widely represented in Arslantepe, Hassek-Heyyuke and Habuba Kabire - settlements located on the trade route running along the Upper Euphrates in a north-south direction. Ores with a high content of antimony and arsenic are known from the southern slopes of the Caucasus, in Gorna Racha [6]. The presence of antimony in the Arslantepe wares suggests how far the Syro-Mesopotamia trade route may have reached - into the Kebana region of eastern Anatolia or even as far as the Caucasus. The series of objects of high-nickel bronzes from the Caucasus and the Prikubanite prove the presence in the North Caucasus of deposits of arsenic-nickel ores [7]. The export of the obtained copper to the southern metallurgical centers and the bronze to the north to the Eastern European steppes and forest-steppes and the North Caucasus proves that in the 4th millennium BC. 45% of all the copper obtained in the south went thousands of kilometers to the north, to the steppe peoples. By the 3rd millennium BC it increases to 60%, i.e. in the ore-free Eastern Europe, the predominant part of the obtained metal came [8].

In Egypt they received lead from 6000 BC, along with silver and gold. Archaeological excavations have established that in Rio Tinto (Spain) the Phoenicians processed lead-silver ores as early as 3000-2000 BC. Cupellation as a process has been known since about 2000 BC, as evidenced by finds found at Ur, Maikop, etc. places. Silver and lead ingots were found in Troy I and Troy II (2500-2000 BC). The lead content of the silver finds from the same site attests to the use of the cupellation process. The Greeks extracted lead from mines on the islands of Rhodes and Cyprus. Their silver, lead, zinc, copper mines in Lavrion are famous. The Romans extracted silver and lead (as a secondary product) from the silver-lead mines in Spain and Germany. Brass was produced during the Roman period by the addition of calamine ore ($ZnCO_3$) to copper, under the influence of reducing conditions in the crucible. In this process, some of the zinc was reduced by the fuel before the copper was melted. The zinc vapor entered the copper and lowered its melting temperature, which reached 900°C.

Copper and bronze ingots and molds for their casting have been found in these regions. The ingots are flat-convex or in the form of small regular rods. Mesopotamian texts mention ingots-rods of metal, as a convenient form of carrying it [9]. Apparently, the ingots served as an exchange metal form - standardized and adapted to the production of medium-sized objects. Their

production was mass-produced, judging by the presence of three or four nests on one mold.

The advent of the knowledge that metals could be melted down and easily given any desired shape was easier to accept for lead, with its low melting point of 327°C, than for copper, which melts at 1083° C. The earliest object produced by copper casting, the famous mace of Jan Hassan III, consists of a very pure copper nugget with traces of silver [10]; from the same time is the lead bracelet from Yaram Tepe I; while the earliest data on metallurgical processing of copper ores in the form of slags and furnaces date from the end of the 5th millennium BC. and originate from Norshuntepe, Tal-i-Iblis, Seh Gabi and Tepe Gabristan [11]. At that time, metals were already widespread in the Balkans and Central Europe.

The actual pyrometallurgy of copper, i.e. purposeful smelting of ores in a reducing atmosphere refers to the end of the 5th millennium BC. in the Uruk period. The earliest slag finds testify to metallurgical processing under relatively oxidizing conditions, without the use of additives. Towards the middle of the 5th millennium BC. a large number of objects appear in South-Eastern Europe, which is a testimony to the autonomous development of metallurgy in the Balkans. Later evidence shows two independent regions of metal use, Anatolia and the Balkans, which existed for a long time in parallel.

The earliest finds of malachite and copper from Bulgaria date back to the last phases of the Neolithic and Early Chalcolithic (VI-V millennia BC). One of the significant ore deposits is Ai Bunar, Stara Zagora municipality, on the southern slope of Sredna Gora. The extraction of copper ore from this place during the Chalcolithic (V-IV millennium BC) is estimated at 2000-3000 tons, of which over 500 tons of copper [12]. The ore paragenesis is polymetallic with a well-developed oxidation zone and variations in depth from 1 to 25 m. Malachite and azurite are recorded on the surface. 11 prehistoric mines were found with gallery lengths from 10 to 100 m. Research shows that the copper produced in Ai Bunar contains a low content of arsenic As and antimony Sb. The sulfur content is above 17% S, which does not change the results. Practically all oxide copper ores are necessarily obtained from sulphide minerals, so the amount of sulfur S depends on the degree of oxidation. This was probably known to the ancient miners, who determined the ores by color: green - malachite and blue - azurite. This is confirmed by the two prehistoric mines - at Rudna Glava and Ai-Bunar, developed from the middle of the 5th millennium BC. and the Kozlu copper deposit in northeastern Central Anatolia.

The functioning of the Balkan-Carpathian region covers the entire 5th millennium BC, with the culmination of development being between 4300-4000 BC. Research proves the presence of multiple sources of metal. It is possible that during this early stage a significant part of metallurgical production was fueled by the collection of native copper [13]. The main ore areas containing

copper mineralization are Malkotarnovsk, Burgas, Panagyur, Bor-Majdanpek (Serbia), Banat and Beica (Romania). During the early Eneolithic, the earliest specialized crafts were formed - mining, metallurgy and trade, and at the same time the separation of craft production from agriculture and animal husbandry occurred.

The works of metallurgy since the 5th millennium BC. in the Balkans proves the presence of polymetalism based on the aesthetic requirements of the elite at that time [14] Metallurgists mixed different ores and techniques to obtain different metals, which turned the Balkans into a field for the expression of different technological practices. A prerequisite for foundry practice is the mastery of high temperatures and the knowledge of a suitable refractory material from which crucibles can easily be made. During the excavations of the settlement mound in Karanovo, not only copper implements were found, but also the remains of copper processing, which proves the local roots of the industry on the Bulgarian lands. Copper ore in the III millennium was mined from the surface of the earth. The inhabitants of Karanovo collected the ore in the nearby area, in the area of the Ilia Heights, and melted it in clay pots. One such, filled with pure, powdered malachite ore, was found in a dwelling in the settlement. Similar pots were found in other settlement mounds in the vicinity of Aytos, Kazanlak, Plovdiv. The numerous tools of labor discovered from the Eneolithic period are proof of the wide spread of metal mining, which is the earliest metallurgy in Bulgaria.

The traditions of ore mining and ore processing in the Eastern Balkan lands in the 3-2 millennium BC. continue to exist later. In the Iliad, for example, the Thracians are described as good makers of bronze weapons and objects. The information about the Thracians refers to two eras - the end of the Mycenaean era (12-11th centuries BC) and the VI century BC. (the data on Rezos in the tenth song). In the minds of the Hellenes, Thrace was an area with rich ore deposits and opportunities for the exploitation and export of ores (especially gold, silver and copper) [15]. Late antique writers speak of the skilled Thracian miners, known as the Besi. Vegetic (5th century) mentions the Besi as a people who knew how to dig underground galleries, looking for gold and silver veins. Paulinus of Nola (end of the 4th century) states on the occasion of the conversion of the Bessians that one of their main occupations was gold mining. Clavianus (end of 4th - beginning of 5th century) especially emphasizes the dexterity of the demons in searching for underground ores. In the eulogy for the emperor Theodosius I (end of the 4th century), the demons are highlighted as skilled gold diggers in the mines and skilled in washing river sand.

In the 7-6th century BC. is the era when Greek colonists settled on the shores of the Black, Marmara and Aegean seas. Numerous colonies were established in these areas close to ore deposits (the gold and silver mines in Halkidiki and in the Pangean region). In the Black Sea, the Gulf of Burgas plays

a special role, where Ionian Apollonia and Dorian Mesambria arose, apparently attracted not only by the rich agricultural hinterland, but also by the ore wealth (especially copper) of Strandzha and the Burgas region. The discovered traces of intensive bronze casting in Mesambria from the 4-3td centuries BC. were unthinkable without the regular supplies of copper from the neighboring Thracian population, while Apollonia stood only 15 km from the rich copper deposits [16].

The archaeological and mining-engineering studies carried out so far allow us to determine that copper and iron ores were extracted and processed in Kraishteto, the Osogov mountain and Transko, and lead-silver ores near the village of Bosnek to the Skombros (Vitosha) mountain. During the Classical and Hellenistic eras, gold-bearing sand was washed in the Bistrishka River to Serdika, and during the Roman and Late Antiquity eras, iron mining flourished along the middle course of the Nestos River (Mesta) and around the Samokov River. Pyrite, chalcopyrite and lead-silver ores were mined and processed in the area of Belogradchishko, satisfying the growing needs of the Thracian tribes in today's Northwest Bulgaria. The Thracians mined and processed silver, copper and iron in the Central Balkans, in the lands between the present-day cities of Etropole and Troyan. The center for extraction and processing of ores in Southeast Thrace is located in Strandzha - Malko-Tarnovsko and in the region of Burgas, where copper and iron were mined.

The conquest of the Balkans by Rome introduced significant changes in the organization of ore mining. Under Roman law, all mines were owned by the state. This was strictly followed for the mining of gold and silver. During the Roman period, silver, lead, copper, iron and gold were extracted mainly from the mines of Mysia, Macedonia, Dacia Mediterranean and Dacia Ripensis. It is known that the first mines for the extraction of lead and silver were discovered by the Romans in the Yanevo and Kishnica region (Kosovo) in the 2nd century during the time of Emperor Trajan (53-117) [17].

Metallurgy developed continuously in Kratovo and Zletovo in the late Roman period and reached its greatest development in the 6th century. This is confirmed by the two large hoards of early Byzantine coins found in Sekuchko Gradishte. One of them contains nearly 500 folios from the time of Anastasius, Justin and Justinian. The second contains more than 1000 solidi and tremis of the same rulers. In Zletovo, metallurgical production continued to exist even during the Ottoman period. Studies show that during the Middle Ages intensive exploitation of ore wealth took place here. In addition to lead-zinc ores and copper deposits, especially in the "Plavitsa" area, they were discovered. Copper ore is mined in the Kosturino and Strumica regions. It is known that from the 5th century BC to 2th century AD silver, gold and iron are mined in the Etropolis mines. The operation was restored from the 9th century until 1689.

The ore extraction technique has reached a high level of development, which is evidenced by the low percentage of lead and iron in the slag.

The information shows that the area south of Burgas and the eastern parts of Strandzha were known mining areas throughout antiquity. At the time of K. Irecek, there are still visible remains of the ancient developments in the Burgas region. A large mining center was discovered near Malko Tarnovo: "Over this entire coast rises a trachyte hill with a flat top, which is called Bakarbair (Copper Peak, 380 m), Shkorpil also found layers of copper and iron (hematite) on its skirts, as and old rupees and cinders, and on the summit traces of a quadrangular fort. From here probably came the copper from which the neighboring cities of Apollonia, Deultum, Anchialo and Mesemvria struck their coins in ancient times. Many of the Roman mines continued to function throughout the Middle Ages and the Renaissance" [18].

The general features of the early Balkan metallurgy, which testify to the cultural and historical heritage of the Bulgarian lands, can be summarized as follows: gold-copper bimetallicity, in which pure, unalloyed metals are used [19]; heavy gun casting; practice of complex casting technologies; metallurgical and mining activities turned into specialized trades that are practiced separately from other activities. The development of metallurgy became one of the main drivers of economic life during different historical eras, and the territory of Bulgaria is no exception, but on the contrary, it is one of the places where this activity originated and developed for centuries.

References:

[1] Chernykh E. Metal-man-time. Moscow, 1972; Metal and ancient cultures: key research problems. – In: Natural scientific methods in archeology. Moscow, 1989, p. 14-30.

[2] Mellaart, J. Çatal Hüyük. A Neolithic Town in Anatolia. London, 1967.

[3] Forbes, R. Metallurgy in Antiquity. Leiden, 1950, pp. 24-25.

[4] Lambert, J. Traces of the Past. Unraveling the Secrets of Archaeology through Chemistry. 1997, Canada, pp. 173-175.

[5] Avilova, L. Metal exchange in the Middle East in the Early and Middle Bronze Age. – Russian Archaeology, 1, 2010, p. 5-14.

[6] Abesadze, Ts. Metal production in Transcaucasia in the 3rd millennium BC. Tbilisi, 1969.

[7] Ryndina, N., I. Ravich, S. Bystrov. On the origin and properties of arsenic-nickel bronzes of the Maikop culture of the North Caucasus (Early Bronze Age). – In: Archeology of the Caucasus and the Middle East. Moscow, 2008, p. 196-221.

[8] Chernykh, E. Ancient metal and symbols. – Soviet archeology, 1, 1991, p. 162-166.

[9] Moorey, P. Ancient Mesopotamian materials and industries. The archaeological evidence. Oxford, 1994, p. 245.
[10] French, D. Excavations at Can Hasan. First preliminary report. – Anatolian Studies, 12, 1962, pp. 27-40.
[11] Pernicka, E. Status of natural science research on the most ancient metals. – In: Problems of the Earliest Metallurgy. Ord. H. Todorova, P. Popov, Sofia, 1994, p. 30, tab. III, V.
[12] Pernicka, E., F. Begemann, S. Schmitt-Strecker, H. Todorova, I. Kuleff. Prehistoric copper in Bulgarisa. Its composition and provenance. – Eurasia Antiqua, Bd. 3, 1997, pp. 40-181.
[13] Todorova, H. The earliest metallurgy in Bulgaria. – In: Problems of the Earliest Metallurgy. Collection of articles. Proceedings of the University of Mining and Geology, No. 4. Sofia, 1994, p. 6.
[14] Radivojević, M., T. Rehren, J. Kuzmanović-Cvetković, M. Jovanović. Why are there tin bronzes in the 5th millennium BC Balkans? – In: Archaeoteghnology: studing technology from prehistory to the Middle Ages. (Eds. S. Vitezović, D. Antonocić). Belgrade, 2014, p. 249.
[15] Katsarov, I. Thrace in the Homeric epic. - IBID, XI-XII, 1931-1932, pp. 122-135.
[16] Vassilev, V. Bronze vessels from the necropolis near Trebenishte. – Excavations and studies, XIX, 1988, c. 7-27.
[17] Keramidchiev, A. Roman Affairs in Eastern Macedonia. – In: First Symposium on Mining in South East Europe. Varna, 1975, p. 58.
[18] Radoslavov, B. Mining in the development of human culture. Sofia, 1948, p. 21; Irechek, K. Travels in Bulgaria. Sofia, 1974, p. 831.
[19] Dimitrov, K., R. Stoychev. The East Balkan Region as a Source of Precious and Non-ferrous Metals from Prehistory to the Roman Period. – In: Gold and Bronze. Metals, Technologies and interregional Contacts in the Bronze Age. Sofia, 2018, p. 49.