THE OLDEST COPPER METALLURGY IN THE BALKANS

A Study of the Diffusion of Copper from Asia Minor to Southeastern Europe

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The flourishing of copper metallurgy during the Eneolithic or Chalcolithic period in the Balkans and Carpathian Basin has led to the problem of the sources of the raw material necessary for such rapid development. The question is all the more interesting as the geographic position of these parts of southeast Europe has played an important role in the interpretation of the origin of copper metallurgy in central and east Europe. Finally, the rapid development of the earliest copper and gold industry has required a more precise explanation for the origin of the new production, whose importance was equal to the stimulus provided by the first agriculture on sedentary life.

But until now there has been no reliable data concerning the earliest copper and gold mining. It has been rightly proposed that the oldest mines were destroyed by later, more intensive exploitation. The earliest miners exploited the richest ores, since at the time of their use no deposit had been touched, and there was no need to exploit greater depths. Such relatively simple works, one assumed, had little chance of preservation during later exploitation of the same locality. However, ore veins are an exception, as is confirmed by the excavations of the two oldest mines in southeast Europe, Rudna Glava in east Yugoslavia/northeast Servia, and Ai Bunar in south Bulgaria.

But these results which put an end to the traditional lack of data concerning primary mining, are not restricted to southeast Europe alone. Similar results are known from Anatolia and Iran, although they are less reliable chronologically and are restricted in the possible reconstruction of working techniques. For example, one can cite the old mining works in the region of Veshnoves, west-central Iran, and those near Kozlu, in the province of Tokat, north Anatolia.

Thus some prerequisites are known for the comparison of primary mining in the Near East and southeast Europe albeit with limitations and restrictions. This relation seems even more important as it coincides in the geographical sense with the proposed direction of the diffusion of the first metallurgical knowledge from Asia Minor to southeast Europe. When one takes into consideration the chronological priority of the knowledge of metal in the Near East in relation to Europe, this explanation of the diffusion of early metallurgy implies a certain chronological distance.

The oldest metal objects discovered so far in southwest Iran, Anatolia and Syria have been dated from the 9th millennium B.C. onwards into the first half of the 6th millennium at, for example, Zawi Chemi Shanidar, Tell Ramad, Ali Kosh and Catal Hüyük.

In the opposite direction, in southeast Europe, the first metal objects occur as single finds in the cultural groups of the Early Neolithic with absolute dates falling in the 6th millennium B.C. In both cases the phenomenon suggests the first knowledge of metal rather than the organization of a massive production of such objects. If, nevertheless, one thinks of the utilization of native copper as the first step in the evolution of copper metallurgy then one can, at the same time, propose that copper mining did not exist in this phase. Considerable quantities of native copper probably existed in the earliest exploited deposits, implying that the primary raw material for the beginning of copper metallurgy was

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Geographical position of the investigated prehistoric copper mines in the Balkans. (Copied from *Bollettino del Centro Camuno di Studi Preistorica* 13-14, p. 78, Fig. 16)

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very easily obtained. If such a view-point is accepted, the initial phase of copper mining could be identified as a series of gathering and exploratory operations without any large-scale mining of the ores.

These and similar questions, often discussed in the former explanations or theories on the origin and development of the primary copper metallurgy of the Old World, may now be generally compared with the data provided by investigations of the earliest mining sites. In this connection one may emphasize that the chronology of those Anatolian mines known so far is not clear. In the same way it is not certain whether the mining works preserved to date in these sites belonged only to the oldest period of exploitation. As those sites have not been systematically excavated, one may expect new data after more far-reaching investigations.

With regard to southeast Europe knowledge of primary mining is somewhat more advanced. Widespread activity has been dated to the Early Eneolithic at Rudna Glava and to the Late Eneolithic at Ai Bunar.

EARLY MINING IN THE NEAR EAST

The oldest copper mines in the Near East known so far have been discovered in the course of geological reconnaissance. As no major investigations have been carried out on these sites, but only small trial excavations, only preliminary reports exist.

One such copper mine is that in the Veshnoveh area in the Qom highland in west-central Iran. During economic-geological investigation of the copper deposits, old workings have been discovered with the first exploitation dated as early as the Early Bronze Age, about 3200 B.C. The works consisted of underground galleries or drifts, nearly 30-40 m. in length. It is important that in those drifts no traces of working with metal implements have been discovered, implying the applications of techniques of strong heating and smashing of ores with simple tools. Here mauls of volcanic stone have been found, placed at the entrance of pits or in the drifts. The mauls were rounded, up to 18 cm. in length and in fact were pebbles with a central groove. On the basis of the available data, it has been assumed that the exploitation of the mine corresponds generally to the Early Bronze Age.

A similar investigation of sources of raw materials has been carried out in central Anatolia at Kozlu, Tokat province. Limited exploratory work pointed to the existence of underground prehistoric works, more

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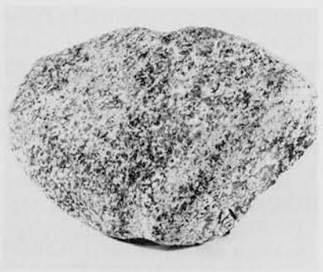

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Note
All of the illustrations are from Rudna Glava

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Pebble: maul of rectangular form

3
Pebble: maul of spherical form

4
Pebble: maul of oval form

5
Pebble: maul of wedge-shaped form

exactly from the Early Bronze Age or about 2800 B.C. It has been suggested that the depth of the workings exceeded 50 m., but more precise data on the character of those workings and the technology utilized have not been established.

These are, for the present, the most important examples of mining in Asia Minor, belonging to the developed phase of copper and bronze metallurgy. But according to the present evidence there is a complete lack of data for mining in the Chalcolithic period, when the earliest metallurgy of Anatolia and Iran had in fact already been developed.

In this respect, the old mines investigated in southeast Europe have a relatively higher chronological age, belonging as they do to the initial stage of Balkan copper metallurgy especially at Rudna Glava. Both Ai Bunar and Rudna Glava have been systematically excavated, yielding a wide range of new data on the beginning of copper metallurgy. However, a comparison of mines in southeast Europe, Anatolia and Iran shows a rather closely related technology used in the early mining of copper in all of them. Such common characteristics can be generally expressed as follows:

A widespread intensive exploitation that exhausted nearly all the deposit of its richest part in the same period in which exploitation of the site had begun, i.e. in southeast Europe the Eneolithic period, in the Near East the Early Bronze Age. Exhaustion of the ore bed was accomplished not only by continuous work, but also by a technology which included a good knowledge of the basic features of the oxide ores of copper.

In both areas the exploitation began and ended within the framework of a single period as, for example, that in the Near East in the Veshnoveh area. It seems that exploitation was directly related to the wealth of the selected ore beds. During the primary exploitation of copper ores, a number of such deposits existed. Selected sites, according to present data, contained a low quantity of ore by modern criteria yet with a high percentage of copper. Proportional to the needs of early copper metallurgy, such ore deposits yielded rather large amounts of copper. Therefore the choice of copper ore beds—especially oxide but also sulphide ores with secondary enrichment of the carbonate minerals—was based on knowledge acquired through former mining experience. Besides, those mining sites, though few in number, confirm the use of malachite, azurite and cuprite as the earliest raw material for winning copper. Such a conclusion was already known on the basis of analyses of the content of the earliest copper objects; similarly, finely-ground carbonate minerals prepared for further processing have been discovered in some Eneolithic sites in southeast Europe, namely the settlements of the final Eneolithic in south Bulgaria. At Fafos, a Vinca site on the Kosova plain in south Serbia, a similar mixture consisted of malachite, azurite and cuprite.

Similarities between old copper mines in southeast Europe and Asia Minor are also noticeable in the application of techniques of ore extraction. At none of those mining sites were metal implements used. It seems that the lack of metal tools in those mines is related not only to their higher value, but also to the technology of primary mining adapted to the local conditions of each deposit. It is probable that copper implements were not sufficiently hard and durable for effective and continuous use in mining works. The quality of smelted copper, in particular its hardness and resistance to heavy action, did not allow for the manufacture of satisfactory metal tools in contemporary mining. It seems that during the oldest mining production the need for a hard copper alloy was ever present.

On the other hand, this common phenomenon in the mines discussed previously may have a chronological significance; there are just two copper axe-adzes at Ai Bunar, but they are chance finds. We would be quite justified in supposing that all the old mining works without traces of wear from metal tools were established during the Eneolithic and Early Bronze Age.

Of course this conclusion lacks precision in that stone tools also appeared in mining works of the Early Iron Age, but in such sites they differed in shape. Finds from Asia, Tuve for example, show well-formed stone hammers dated to the 8th century B.C.

In the chronological determination of ancient mining works, the typology of stone and bone tools is, therefore, of no little significance. In this way the similarity between old mining works in Iran and southeast Europe is clearly expressed. Stone hammers or mauls, large quantities of which are found on sites such as Rudna Glava, had the same purpose and showed the same damage from heavy usage. They are, as a rule, large volcanic pebbles of various shapes and sizes with a shallow medial groove. Their typological variants clearly expressed at Rudna Glava point to different functions, more specifically for various operations during ore extraction from underground workings. This implies a certain degree of specialization of tools,

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Shaft 6a. Antler tool *in situ*

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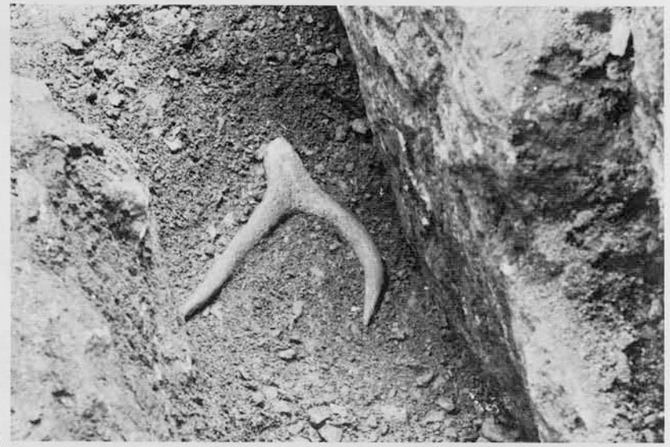
Detail of antler tool



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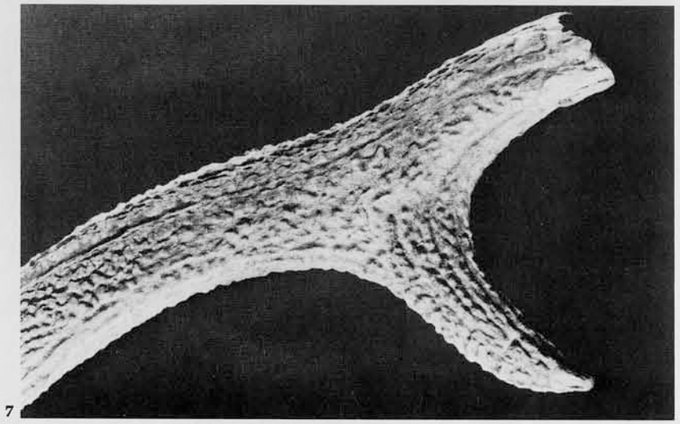

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represented at Rudna Glava by rectangular, spherical, oval and wedge-shaped forms.

The most likely conclusion to be drawn from these facts—a mine with no traces of working by metal tools and a plethora of stone tools, especially massive mauls—is that the mine could be dated to the Eneolithic or Bronze Age. Following are some other characteristics, mostly confirmed by the investigation of Rudna Glava.

The presence of the remains of hearths or burnt areas in the shafts points to use of the technique of alternate heating and cooling of the ores to break up compact blocks. Further, the use of antler tools, mainly wedges and scrapers, is typical of mines of this age. Finally, current data do not favor the smelting of ores during this period at the mine itself, or in the immediate vicinity. An exception is the mining works from the Bronze Age of the Austrian Alps, where ore smelting was carried out in the vicinity of the shafts, so that the whole process of obtaining the metal was organized at the same place.

The distribution of massive stone tools connected with old mining works is so vast that one could hardly suppose their diffusion from a single center or region. For example, their appearance could be followed in various chronological phases from the Far East to the west coast of Europe and the central regions of Asia Minor. In addition to the examples from Rudna Glava, mauls of this type are known from old mining works in central Europe at Spania Dolina, in central Italy at Cornacchino, province de Grosseto, and on the southwest shores of Ireland at Mount Gabriel.

At all of these sites, as probably at many others still undiscovered, such implements are nearly identical in form as well as in purpose and treatment. Therefore it seems reasonable to regard their origin and appearance as a consequence of the same or a similar technological level of primary metallurgy and mining of copper in the Old

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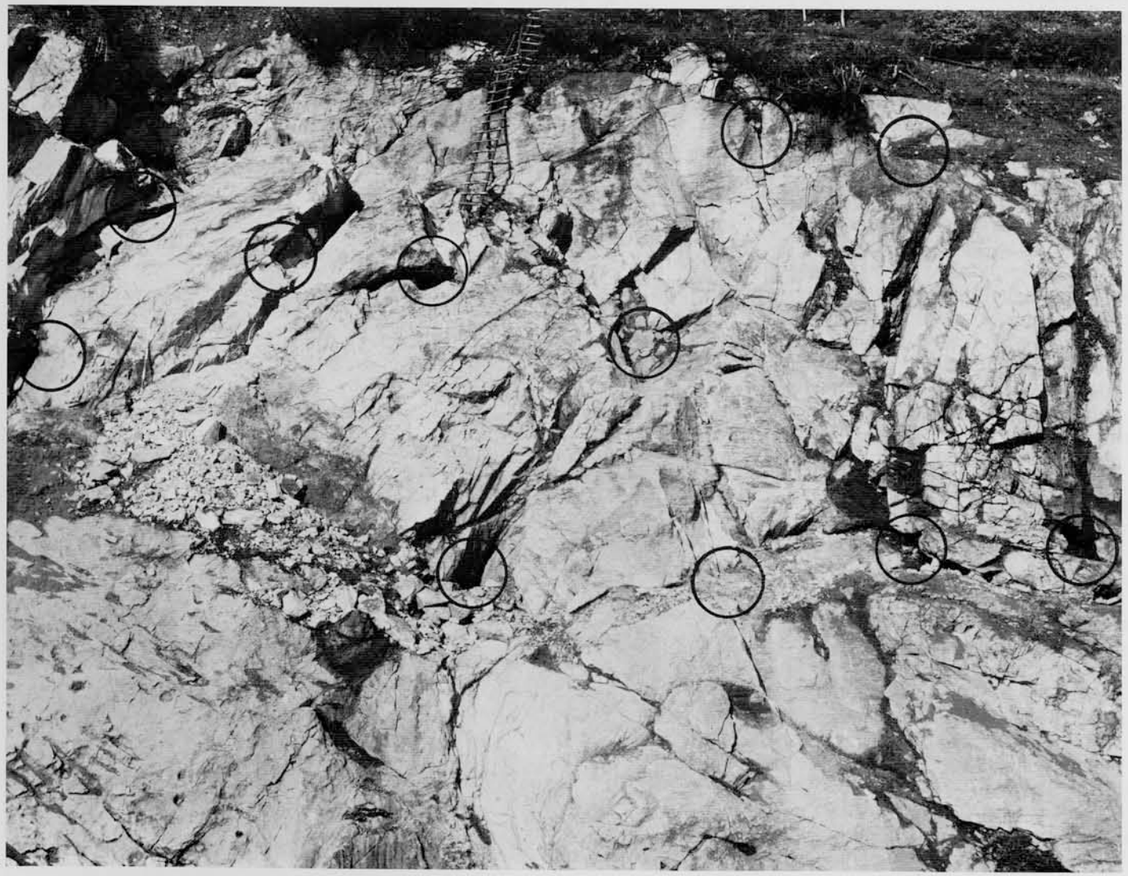
Northwest side of the open cast iron mine. Early Neolithic shafts partially destroyed by the exploitation of the modern iron mine



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World. The utilization of the copper ore deposits was carried out therefore by a common technology oriented to the use of the same tool types.

FLINT AND COPPER MINING COMPARED

It is understandable also that the broad distribution of the technology of copper mining must be based on previous experience in the mining of other minerals. Copper mining was not the first mining: before the appearance of the oldest copper mines in Europe, flint mines were already in existence. There is evidence that the quarrying of flint was as old as the Late Palaeolithic in central Europe. There is also no reason for the origin of the mining of flint to be connected with any priority center. It is obvious that all developed cultures of the Mesolithic and Neolithic had to use local sources of raw material for the contemporaneous industry of chipped and polished stone tools, including here some local differences in the working techniques. In this connection it is clear that over the whole of the Old World the mining of flint and other minerals preceded copper mining, because the first had been developed as a response to the permanent demand for such raw material inherent in the Neolithic economy.

A number of flint mines have been discovered in west, east and central Europe. Some of them were investigated by systematic excavations giving reliable evidence on methods of exploitation. At the site of Krasnoe Selo in White Russia, zones with vertical shafts, which were dug for the utilization of flint veins, occupied a large area, with more than a thousand shafts. The shafts had a diameter of 1.5-2 m. and reached a depth of 6 m. cutting through layers of chalk to find the rich deposits of flint. Abandoned shafts were filled by the material from other, active shafts, or transformed into some sort of workshop for the rough fashioning of flint. Developed patterns of mining technology are seen at the flint mine at Jandrain-Jandranouille, Brabant, in Belgium. Horizontal galleries branched out from the base of vertical shafts, similar to examples from the well-known flint mines of Grimes Graves in England. Vertical shafts which were dug to obtain flint are also known from Mauer, near Vienna, dated to the Late Neolithic or the beginning of the Early Eneolithic.

Passages between galleries, interlinking shafts, supporting posts that protected the galleries from subsidence or landslip are some of the characteristics represented at those flint mines. All of them confirm the use of developed mining techniques for obtaining flint in the time preceding, but also contemporaneous with, the formative phase of earliest copper metallurgy. The vast scale of flint exploitation during the non-metal periods of European prehistory is so clear that, until now, little discussion has referred to separate centers where flint mining may have originated. Therefore it is a commonly accepted idea that the mining of flint or other minerals has had independent origins and has supplied the local needs of every Neolithic population in the Old World. It is understandable that regions exceptionally rich in flint or other raw materials—for example obsidian—may have become exporters of finished or semi-finished articles over varying distances. But the export of the technology of the mining has not, as a rule, been taken into consideration in any discussion of basic mining activity in prehistoric Europe.

On the basis of the simple relation between the mining of flint and the chipped stone industry, it is clear that detailed knowledge of copper preceded the developed phase of its primary mining. In this sense, the proposed stage of the use of native copper may have served as an introduction to more intensive utilization of the oxide ores. Since the appearance of native copper was as a rule connected with rich deposits of carbonate minerals of that metal, whose veins come directly to the surface, the utilization of native copper led, as is already known, to the exploitation of oxide ores of copper.

If such a view is correct, and it has been mostly accepted in the present explanation of the origin of copper metallurgy, one would expect the appearance of the larger mining works later, in the Late Eneolithic period or Early Bronze Age. The mines from the Near East mentioned above confirm such a dating in the Early Bronze Age. The examples from southeast Europe introduce some new elements in the investigations of the origin of copper mining or initial copper metallurgy.

The data from Rudna Glava point to large-scale exploitation of copper carbonate minerals. In the course of former excavations, nearly 25 vertical shafts were discovered as emptied channels of ore veins of various dimensions. The depth of some of them reached 20 m.; sometimes the veins ran into each other, or branched into sloping channels. The most important shafts, within the zone which has been explored so far, were concentrated along large fissures or broad cracks, e.g. shafts 5b, 4 and 3. Excavations in the area outside the

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Entrance of shaft 5b

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Altar with deer's head terminal from hoard No. 3

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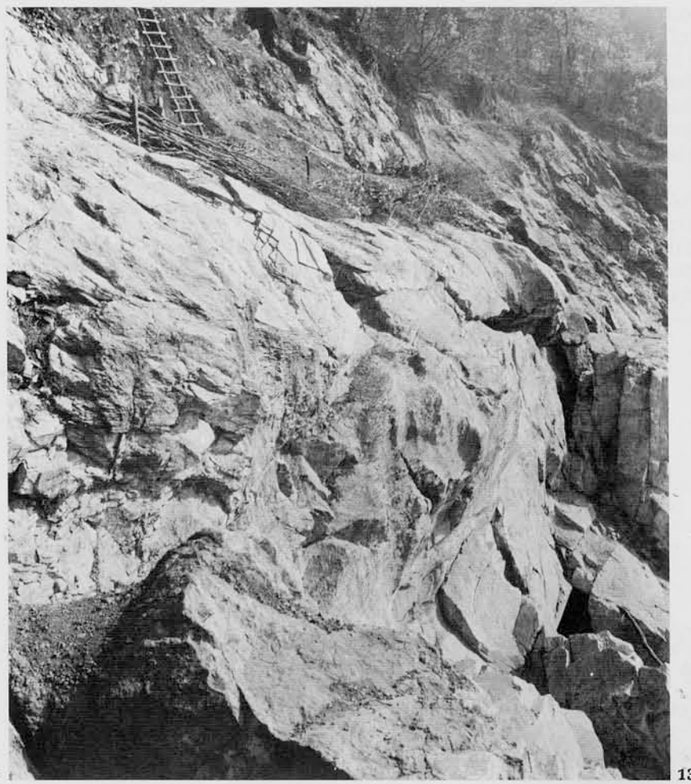

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Access platforms and upper part of shafts 3 and 4

12
Hoard No. 3 *in situ*

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Profile of the material accumulated during the exploitation of the Early Eneolithic shafts

modern open-cast iron mine were carried out by the Museum of Mining and Metallurgy at Bor and the Institute of Archaeology in Belgrade. These discovered new, important stratigraphic data consisting of massive levels of material dug from the shafts and accumulated during their exploitation.

On the south side of the massif of Rudna Glava, this reliable stratigraphy shows a relatively long duration of ancient mining activity. Three different levels accumulated in the course of the same cultural period—the Early Eneolithic—indicate individual

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Black burnished amphorae: left, hoard No. 1; right, hoard No. 3

15
Amphorae from hoard No. 2 (the two at the left) and from hoard No. 3 (the two at the right)

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stages of mining work in this area. This stratigraphic division has been confirmed by finds of stone tools and ceramics. But the most significant find was ceramic hoard No. 3, important not only chronologically, but also for what it tells us about the technology used by the Eneolithic miners.

This hoard, discovered *in situ* in the oldest stratigraphic horizon, consisted of three amphorae, an altar with deer's head terminal, stone and bone tools. One of the amphorae, of black burnished ware decorated with shallow channelled spiral motifs, was closely related to a vessel from ceramic hoard No. 1. Both amphorae can be used, together with other altars, as reliable relative chronological indicators for the dating of Rudna Glava. Taking into further consideration other vessels from all three ceramic hoards and the numerous fragments from the shafts or access platforms, Rudna Glava can be closely dated to the beginning of the Early Eneolithic of the Balkans and Danube Basin—the end of the early or initial phase of the Late Vinča group. The absolute date of this copper mine falls in the middle or second half of the 4th millennium B.C., or much earlier if calibrated radio-carbon dates are used.

With such dating Rudna Glava belongs clearly to the earliest phase of copper mining, in both the diachronic and technological sense. The mine was exploited at the very initial stage of copper metallurgy in the Balkans and Carpathian Basin, so, in this respect, it could be taken as the starting point for the investigation of the mining of metal in southeast Europe. Similiar evidence is provided by the old mining works at Ai Bunar, belonging to a slightly later stage, that is to the final phase of the Eneolithic period of the southeast Balkans.

Mining technology of Rudna Glava showed also a developed degree of knowledge in the separation of useful copper oxide ore, in the preparation of access platforms for every shaft and in underground works.

But all of these elements, or at least the most important ones, were represented also in the contemporaneous or older mining of flint and other minerals; here one may mention the use of the pigment cinnabar from the Avala mountain near Belgrade, already worked in the Early Vinča group. It is understandable that parallels of such a kind perhaps do not need special proofs; identical technology of copper mining and winning of non-metals within the same period and by the same population of southeast and central Europe could be based simply on the same, local technical knowledge. It has been already mentioned that nobody looks for the origin of flint mining in one or more centers; one quite justifiably turns to the local technology, which supplied permanent demands for certain materials. Copper mining at the initial stage of the Early Eneolithic indicates a steadily rising demand for this metal. As a concrete example, Rudna Glava is the answer to such demands in the Late Vinča population.

In view of the production relations between mining and a copper industry, it is obvious that mining represents a secondary, subsequent development of copper metallurgy. In other words, the demand for a certain raw material increases with concomitant technological processing of that raw material. Judging by the large quantities of copper ore obtained at Ai Bunar and Rudna Glava, the general amount of copper provided by these two sites ought also to be considerable. It may be regarded as proof of the well-developed technology of processing copper in the metallurgy of southeast Europe even in its initial Eneolithic phase.

Therefore the importance of the earliest mining of copper was not merely in more exact knowledge of its technology and date, but even more in the precise evaluation of the economic progress caused by the introduction of metal and by the circulation of this new raw material. One may take into consideration that Rudna Glava and Ai Bunar represent, for the present, only two preserved examples of many other local copper mines in the metalliferous regions of southeast Europe. It follows that the quantity of copper concentrated in the economy of the Eneolithic period ought to be correspondingly large. Thus we are justified in assuming that the phase of the utilization of native copper in the Early Eneolithic of southeast Europe was very short and that the production of copper was documented by the utilization of oxide ores. It is possible, therefore, that the technique of casting tools in open moulds was already known in the very early stage of copper metallurgy in southeast Europe.

According to this data, the origin and evolution of the early copper metallurgy in southeast Europe were based on local mining experience and the use of local sources of raw material. This early copper metallurgy, with the use of considerable quantities of copper, is just part of the common development of the production base in the Aegean, the Balkans and the Carpathian Basin at the transition between the Late Neolithic and the Eneolithic periods.