Ancient Mining in Turkey and The Eastern Mediterranean

Edited by: Ü. Yalçın, H. Özbal, A. G. Paşamehmetoğlu

1996
ATILIM UNIVERSITY

International Conference AMITEM 2008
Ancient Mining in Turkey and The Eastern Mediterranean
June 15-22. 2008 Ankara, Turkey

ANCIENT MINING IN TURKEY AND THE EASTERN MEDITERRANEAN

Edited by

Ünsal Yalçın
Deutsches Bergbau Museum, Bochum, Germany

Hadi Özbal
Boğaziçi University, Istanbul, Turkey

A. Günhan Paşamehmetoğlu
Atılım University, Ankara, Turkey

ATILIM UNIVERSITY

Atılım University
Turkey Historical Research Applications and
Research Center Publications 2

ISBN 978-975-6707-20-3

Yapım
Remark İletişim ve Tanıtım Hizmetleri
Kuleli Sokak No: 57/4 GOP - ANKARA
Tel: 0312.436 27 28 Faks: 0312.436 27 00
remark@remarkreklam.com

Baskı: Desen Ofset A.Ş.
Birlik Mahallesi 7. Cadde 67. Sokak No: 2 Çankaya - Ankara

ATILIM UNIVERSITY

Ancient mining in Turkey and the Eastern Mediterranean (2008:Ankara)
International conference AMITEM 2008. Ancient mining in Turkey and the Eastern Mediterranean, June 15-22 2008, Ankara, Turkey / Ed. by Ünsal Yalçın, Hadi Özbal, A. Günhan Paşamehmetoğlu.
Ankara Atılım University, 2008
480 s., 24 cm.
Atılım University Turkey Historical Research Applications and Research Center Publications, 2.
ISBN 978-975-6707-20-3
1. Mining Engineering. History. Turkey
2. Mining Engineering. History. Eastern Mediterranean.
I. Yalçın, Ünal
II. Özbal, Hadi
III. Paşamehmetoğlu, Günhan A.

TABLE OF CONTENTS

International Conference AMITEM 2008
Ancient Mining in Turkey and The Eastern Mediterranean
June 15-22. 2008 Ankara, Turkey

ARCHAEOMETALLURGICAL SURVEYS IN THE EASTERN RHODOPES 2004-2006 RESULTS AND PERSPECTIVES FOR DEVELOPMENT

ALBRECHT JOCKENHÖVEL
Westfälische Wilhelms-Universität Münster, Germany

HIRSTO POPOV
Bulgarian Academy of Sciences, Sofia, Bulgaria

The view that there was a highly specialised and functional metallurgy in Ancient Thrace is endorsed by several Bulgarian archaeologists and historians (Velkov 1972: 23,27-29; Panayotov & Yordanov 1976: 30-34). Most of them have found support for this assumption in ancient historical sources. However, if we take a closer look at these texts we will find only few facts supporting this opinion (Hom. II, 844-850; VI, 5-11; X, 434-440; XIII, 560-576; Hdt. I, 64; Hdt. VI, 46; Hdt. VII, 112; Thuc. I, 101; Thuc. IV, 105). The evidence provided by these sources is somewhat scarce and unavailing, and all conclusions based on their information should be considered secondary. In the often-cited passages from Homer, Herodotus, Thucydides and other later authors, we solely find information about the wealth of the Thracian kings or of some Thracian tribes, including descriptions of particular artefacts made of precious metals. The authors speak with awe about the great quantities of precious metals extracted in Thrace (or received as annual tax, which of course is another matter), but they do not provide concrete information which could be helpful for the modern field survey and the localisation of the Thracians´ raw-material sources. The only notable exception is of course the Pangaeus (today in northern Greece), which is explicitly mentioned in the ancient sources as a centre of ore-mining.

There is a great discrepancy in the scientific publications concerning the topic of ore-mining and metallurgy during the Iron Age. We can distinguish two main groups which we shall call 'archaeological' and 'geological' (Popov 2004:

34-37). At first glance they share a common aim - archeometallurgical research, but in fact, they focus on different types of finds and structures. Their methodological approach, purpose and level of analysis are also different. The problem is that there is no communication between these two groups. The 'archaeological' group usually tries to localize metallurgical and artistic workshops by concentrating on the end products. The analysis tries to draw conclusions from existent end-products or semi-manufactured materials to a general hypothesis about the possible origin of the metal. They study the last segments of the archeometallurgical technological chain. The hypothesis about the raw material sources used is secondary.

The 'geological' group includes publications based on primary field researches by geologists and mining engineers on the traces of ancient ore-mining and metallurgy. The difference from the 'archaeological' group of publications is the authors´ focus on the structures of the first segments of the production chain. These are the characteristics of the terrain – mines, traces of ore-extraction and smelting processes and occasional finds of movable artefacts related to this process. The field surveys adduced a number of places, where signs of ancient ore-mining and metallurgy were found. (Georgiev 1978; 1987; Konyarov 1953; Kraev 1976; Maximov 1974) However, there is no systematic research, rather based on occasional data registrations. This group of publications includes a large number of primary information which is not archaeologically verified.

Current Status of Research

The first steps toward archaeometallurgical research were taken in 2004, thus filling the gap in the exploration of the ore-mining and metallurgy during the Iron Age. A small team of scientists from the National Institute of Archaeology and Museum and the Regional Historical Museum of Haskovo conducted a field survey in the Lyubimets municipality. The results confirmed the existence of ancient ore-mining activity in the region (Popov & Iliev 2006b: 53-54).. During the following two archaeological campaigns the group developed a research project about ancient ore-mining and metallurgy in the eastern Rhodope Mountains. The field practice and the review of the sources suggest that we should not exclusively rely on the ancient authors and the evidence of the well-known archaeological sites to obtain primary data. We should rather use information collected with a specific practical purpose.

1. We should note the results from contemporary geological explorations of

the metallogenic zones in the Eastern Rhodope Mountains. Traces of ancient ore-mining are often registered during geological prospection. The reports that contain this information are stored in the National Geological Databank of the Ministry of Environment and Water of Bulgaria. Examples of registered ancient mines are found in the area of Kamilski Dol village, close to the border with Greece (Nakov *et al.* 2001: 55). The ancient mines near Stremci (Fig. 1) are also known from the geological exploration of the area (Atanasov 2002: 90-94). The mapping of the mines and the discovery of movable artefacts used as primary chronological markers (Roman period and Middle Ages) was conducted by a team of geologists in the 1980s. The newest regional geological mapping of the geological structure of the eastern Rhodope Mountains was realised in the 1990s and is important for the collection of up-to-date field information.

2. During the past decades a number of ancient mines and movable artefacts related to their exploitation were found as a result of modern ore-mining. Examples are known from the area of the mines at Madan and Rudozem, mine 'Strashimir', mine 'Sedefche', Madzharovo, etc. (Kraev 1976: 169-174, 178; Avdev 2005: 38) Unfortunately, the movable artefacts mentioned in the reports (mining tools, ladders, wooden pans, parts from wooden fortifications of the galleries, bags for carrying ore) got lost later. Nevertheless, this primary information is sufficient for the commencement of systematic archeometallurgical research.

3. The archaeological stray finds currently stored at the depot of the Regional Historical Museum of Haskovo also provide important information for future research. For example, the mining pickaxe and lamp dated to the 3rd-4th century AD found in the old course in the area of Mechkovets peak near the Mineral Baths of Haskovo (Fig. 2) and the moulds and metal artefacts occasionally found near Brenitsa village (Fig. 3) can also be used as indicators for ancient mining activity in the area.

The archeometallurgical exploration and research performed between 2004 and 2006 can be distinguished into two major groups:

1. Field surveys and a few test-trench excavations of already registered archaeological structures.

2. Rescue excavations in areas affected by contemporary mining.

The field surveys were conducted in two campaigns in the area of the villages of Valche Pole, Kamilski Dol and Lambuh. According to its metallogenic structure, this region is part of the East Rhodope Metallogenic Zone, which is characterized mainly by Pb-Zn specialization. During the 1980s this microregi-

on was suggested to be of high potential for Au-specialization (Breskovska & Gergelchev 1988; Nackov *et al.* 2001). The area is distinguished by the development of three major ore fields: Lozensko (Pb-Zn), Madzharovsko (Pb-Zn-Au) and Kamildolsko (Au).

The results of our research in the territory of the villages of Valche Pole and Kamilski Dol suggest that the ore mineralization is represented mainly by Fe oxides and hydroxides including magnetite, hematite, maghematite, goethite, etc. In 2005 an opencast mine was registered in the territory of Valche Pole on the left bank of the river Cutela (Tsintsov *et al.* 2006: 81-83). The ore deposit where the mine is located is of placer type. Its exploitation was made easier by the initial extraction of the material, which was done by collecting and sorting the pieces of ore by hand. There was no need of breaking the rocks during this process to follow the ore mineralization, which, however, is required for the exploitation of the main deposits. As another reason for the suggestion that the exploration of this mine was profitable we should mention the high concentration of iron in some pieces of ore, which is almost about 65-70 %. The concentration of iron in the majority of pieces probed is over about 40 % (Table 1). The traces of anthropogenic activity in the terrain are compassing a large segment on the left riverbank (about 80-100 meters from the present river bed). The digging was done on a large scale although we cannot say whether this was a result of long term activity or short, but very intensive exploitation. The slope starting from the dry terrace of the river is cut by ditches, whose purposes were to allow access to the ore deposits lying immediately under the humus stratum. A large number of piles of inspected and sorted sterile rock mass were found on the field (Fig. 4). After extensive surveys we identified the borders of the opencast. The area covered by the mine is approximately 2-2.5 ha and with a length in North-South direction of 280-300 m and in East-West direction of 50-100 m.

Basing the local ore mineralization characteristics, we can securely conclude that the mine was used for the extraction of iron. At this stage we still have no definite answer to questions concerning the chronology of the mine or the location of the sites for processing and smelting the ore. There are at least two possible sites in the eastern periphery of the mine for the location of the furnaces. In the process of registration and narrowing the exploration area we used a fluxgate magnetometer (Grad 601-1 Bartington).

The analyses of the collected geological and slag samples were conducted by Dr. Zdravko Tsintsov from the Central Laboratory for Mineralogy and Crystallographiy of the Bulgarian Academy of Sciences. The petrographical analysis was performed using an Amplival Microscope. The ore mineralization

has been with a Leitz Orthoplan-Pol Optical Microscope. The morphological analysis of the specimens surfaces was realized with a binocular stereomicroscope (binocular magnifier) and an electronic microscope Philips SEM-515. X-ray diffraction analysis (XRD) was performed on the ore mineralization and the slag samples. The chemical analysis was based on the method of atomic emission spectroscopy with inductive coupled plasma (AES ICP).

A particular feature of the ore mineralization registered in the area of Kara Kol'ov Bunar is that has its origin in a metallogenic zone with Pb-Zn and _u specialisation. Apparently, the placer iron-rich blocks found in the sediments of the water basins in the territory of Valche Pole were of interest for the ancient miners. Although the iron-rich blocks are hard they can easily be crushed into pieces and grinded allowing the ancient miners to treat the blocks with some basic tools.

Iron

The field survey in the north of the village of Kamilski Dol adduced traces of ancient metallurgical activity. A number of blocked-up entrances to mine galleries were registered in the Dyado Vanjov Bunar locality near the border zone with Greece. On the banks of the small river which runs from southeast to northwest, we found traces of small surface workings. Half-filled vaults of mining galleries are visible on the right bank of the river, about 30 m from the river basin, under a steep slope. If we consider the curve of the vaults, there will be probably 2 or 3 galleries. In front of the entrances a small platform could be located, which is connected to the river.

The entrances were filled up by the sliding of a large mass of earth, which at some places has reached a considerable thickness (Fig. 5). Due to this current condition we can establish the height of the vaults up to 1.2 m. The curve of both vaults descends towards the ground at angle of 20-25. The inaccessibility of the site prevented us from measuring the depth of the mines exactly. One of them must be at least 4.5 m deep. A draught can be felt from the inside, which suggests a much greater depth. On the left side of the vaults, about 6-7 m away, there are traces of a third vault – probably an entrance to another mining gallery.

The analysis of the geological samples from the area (cf. below) showed a high concentration of iron in the ore mineralization (hematite). It follows that the site was exploited by the ancient miners for the extraction of iron. However, in this case the main deposit must have been mined by underground-workings. The

preliminary exploration of the area has shown that in the Dyado Vanjov Bunar locality traces of opencast mines can be found, too. The use of both methods of mining was, apparently resulted from the different exposure of ore and the need for exploitation of deposits with high rates of iron.

The extraction of iron in the area of the villages of Valche Pole and Kamilski Dol in antiquity can be proven by the localisation of furnaces at least three areas (Fig. 6, 7). The furnaces in the places of Kutela and Baj Manjova field show were dug into the slopes of high dry river terraces. The excavation of another furnace near a small Roman farm showed that it had a truncated cone form and was dug into the steep slope. The closest parallels of same type furnaces dating in the Late Iron Age and the Roman period have been found in Rumania. (Iaroslavshi 2000: 98-100, Fig.1; Dimitriu & Dobrescu 2003: 72).

The forthcoming excavations of some registered furnaces will help to gain more specific info. At this stage our knowledge from field work is preliminary and it can only be used for the nomination of auspicious sites for archaeological excavations (Fig.). There are no certain chronological markers for dating the registered ancient mining and metallurgical sites in the area. The parallel exploration, of non-metallurgical archaeological sites reveals that the region was intensely populated during two main periods:

1. The Iron Age, with a peak in the late phases of the Early Iron Age (8th-7th century BC) and the early phases of the Late Iron Age (5th-4th century BC);

2. The period of the Early Roman Empire (2nd-3rd century AD). A number of the sites dated to these periods and registered by field surveys are located near to the ore exploitations mentioned above.

Gold

As an astonishing note there is no evidence for ancient extraction of precious metals in the area, despite the geological data for the Au-potential in the ore mineralization. However, the possibility of ancient gold mining should not be ignored. Some preliminary prospections in the valley of Middle Arda, in the area of Lambuh village, give a hint at the possibility of large scale gold placer mining in this part of the river basin (Fig. 7).

The most important results of the team's field research were achieved in 2005 during rescue excavations in the territory of the gold deposit field 'Han

Krum', Ada Tepe section, which is located at the south-western environs of Krumovgrad. The excavations were conducted on the western slopes of the Ada Tepe height following the decision for investment in the exploitation of the ore field by Balkan Mineral and Mining EAD (Popov & Iliev 2006a: 154-155). The main auriferous mineralization is located in the region of contact between metamorphic rocks and Palaeogene sediments. The formed quartz-metasomatic body was named 'The Wall' by the research team of geologists on the site. The body's width is approximately 150 m, length 350 m and average thickness approximately 17 m. The average concentration of Au is 7.3 g/t (Zhelev 2006a: 30). In some segments of the body, the samples show a much higher concentration of gold – 134.7 g/t (Zhelev 2006b, 28). Traces of ancient mining were found right at the beginning of the geological exploration of the Ada Tepe height (Zhelev 2006a: 27). Unfortunately, the west slopes of the Ada Tepe height were prepared for open-pit mining before the start of the archaeological rescue excavations. This compromised the former terrain of the site (Fig. 8). The archaeological sections provided concrete information about the chronology of the site and the technologies applied for its exploitation. After clearing the mounds of earth from the modern day earthworks we investigated a small gallery (length of the main gallery: 14 m; length of the gallery branch: 2.8 m). During the excavations we found some materials of anthropogenic origin – sherds of ceramic vessels. In fact the artefacts were found at the deepest end of the main gallery and in front of the northern entrance. They were mixed with a layer of stones, probably used for mining the deposit, which leads to the conclusion that these objects were synchronous to the exploitation. The stratigraphy of the site suggests that after the end of mining this place was left. The workings were gradually filled with masses of earth. The ceramic found at the site was exclusively hand made and is datable to the Late Bronze age (15th-11th century BC). Thus, we can date the exploitation of the gold mine to the same period (Fig. 9, 10).

We made three further archaeological sections during the exploration of Ada Tepe. Two of these sections were situated on mounds of rock debris (Fig.11) located to the South and North of the gallery. In section _ 2 we found a large number of fragmented mortar stones and pestles, which were used for crushing and grinding the extracted ore (Fig. 12). The ceramic found here is comparable to the material from the gallery. Despite the fact that most of the vessels are coarsely made and the abrasive effect of the rock blocks in the mound there are certain characteristics of forms that allow us to date the material to the Late Bronze Age (15th-11th century BC) and Early Iron Age 10th-6th century BC). There are no founds from later periods. The material from the archaeological section at the foot of the peak is synchronous to the material from the west slope of

the height. A number of fragmented mortar stones and pestles were found in this section, too. Traces of early mining were localized on the western slopes of Ada Tepe. All of them are situated at or near the contact zone 'The Wall' close to the mineralization with the highest concentration of gold. It is quite possible that in this case the ancient miners used the close-pit mining method localizing and following the richest ore veins with the help of small galleries. Further, the general context of the archaeological monuments related to Ada Tepe must be implied. At the very top of the height there is a sanctuary from the Late Bronze Age, which was investigated in multiple archaeological campaigns by Dr. Georgi Nekrizov from the National Archaeological Institute (Nekhrizov & Tzvetkova, in print). The consultations with the geological team working on the site showed that the sanctuary was built over a terrain, which was partly taken away during the mining process. The exploitation of the gold deposit started at an earlier stage during the Late Bronze Age and later a small sanctuary was built on the top of the height. Among the findings at the sanctuary there was a large number of mortar stones . The excavations on the slopes of Ada Tepe brought no traces of building structures. At this point we can assume that the ore extraction was seasonal and the area was not frequented during the whole year. We also made some important observations concerning the end of the exploitation and the existence of the sanctuary. The ore-mining supposably continued during the first phases of the Late Iron Age. The hoard of coins found in the great mounds on the eastern slopes gives the end of 4th century BC as a *terminus ante quem* for the exploitation of the mines in this sector. The investigation of the small gallery on the western slopes and the big sections on the east side of the height, where the terrain is changed by human activity, suggest the use of both open and close pit mining. The stratigraphy of the sanctuary implies that it functioned until the 1st century BC – the end of the Iron Age. Probably, by the end of the 1st millennium BC the gold mines weren´t in use anymore.

Conclusions and perspectives

The information acquired from the archaeometallurgical field surveys having taken place between 2004 and 2006 in the Eastern Rhodope Mountains has a preliminary character. Chronologically the registered traces of ancient metallurgical activity date from the late Bronze Age until the beginning of the 1st millennium AD – a period of approximately 1500 years. We provided evidence for early extraction of gold and iron. The results of our research provide a good potential to establish a base for future interdisciplinary studies. For this very reason a joint Bulgarian-German archaeometallurgical project, called 'Iron and gold. Tracing

the metallurgy in ancient Thrace', was initiated in 2008. The main academic sponsors of the project are the ´National Institute of Archaeology and Museum - Sofia´, the ´Bulgarian Academy of Sciences´, and the ´Department for Pre- and Protohistoric Archaeology at the University of Münster´, Germany. The financial sponsorship for three years is made by the ´Alexander von Humboldt Foundation´, Germany, as part of interinstitutional partnership. We aim to continue and broad our field survey and to concentrate on a number of predefined microregions. At this stage we have four microregions: Valche Pole, Krumovgrad, Baylovo and the Ihtiman Middle range (Fig.13). The main aim of the project is to acquire current, evidence for the extraction and processing of precious metals and iron in the 1st millennium BC. For this reason our efforts are concentrated on the investigation of microregions with different characteristics. They can be seen as an representative excerpt from the geology of the area, the traces of ancient mining and metallurgy and the intensive habitation during the different phases of the Iron Age in ancient Thracia. The project will start with field surveys and small archaeometallurgical excavations on localized sites with mining and metallurgical structures. The results of the field surveys will set the priorities for our research in the second and third year. At the same time the excavations of already localized archaeological sites (Ada Tepe, Kutela) with high potential will be expanded. In the past several finished projects concerning ancient mining and metallurgy showed the basic necessity of specialized research and interdisciplinary cooperation. (Jockenhövel 1995: 4-13; Jöns 1999: 249-252; Wischenbarth 2001: 9-42; Goldenberg 1990: 85-113; Jockenhövel 2005: 2-4). Specialists from the ´Central Laboratory for Mineralogy and Crystallography of the Bulgarian Academy of Sciences´ and the ´University of Mining and Geology 'St Ivan Rilski' – Sofia´ are taking a part in the project. The chemical analyses and electronic microscoping will be done as far as possible by the institutions mentioned above. Our hope is that the three-year research of our team will result in the successful exploration of key archaeological sites and will present some major characteristics of the ore-mining and metallurgy of the Thracians during the Iron Age.

References

AVDEV, S.
2005 Istoriya na zlatodobiva po balgarskite zemi. Sofia, 2005 (in Bulgarian).

ATANASOV, V.
2002 Drevniyat rudnik za zlato Perperikon krai selo Stremtsi, Kardjaliisko. Godishnik na minno-geolojkiya universitet "Sv. Ivan Rilski", 45, svitak I, Geologiya, Sofia, 2002, 89-96 (in Bulgarian).

TSINTSOV, Z., POPOV, H. & BANUSHEV, B.
2006 Arkheometalurgichni prouchvaniya v rayona na s. Valche pole, Haskovsko. Godishnik na minno-geolojkiya universitet "Sv. Ivan Rilski", t. 49, Sv. I, Geologiya I geofizika, 2006, 79-84 (in Bulgarian).

BRESKOVSKA, V. & GERGELCHEV, V.
1988 Madzharovo and Lozen Ore Fields. In: Dimitrov, R. (ed.), The lead and zinc deposits in Bulgaria. Tekhnika, Sofia, 114-134 (in Bulgarian).

DIMITRIU, S. & DOBRESCU, M.
2003 The beginning of iron metallurgy in Romania. – Archaeometallurgy in Europe. 24-26 September 2003, Milan Italy, Proceedings of International Conference, vol. I, Milano, 2003, 71-76.

GEORGIEV, G.
1978 Starata jelezodobivna industriya v Balgaria – Sofia, 1978 (in Bulgarian).
1987 Poleznite izkopaemi ot vremeto na trakite. Sofia, 1987 (in Bulgarian).

GOLDENBERG, G.
1990 Die montanarchäologische Prospektion – Methoden und Ergebnisse. In: H. Steuer et.al. (Eds.), Erze, Schlacken und Metalle. Früher Bergbau im Schwarzwald, Freiburg, 1990, 85-113.

HARKOVSKA, A., STOYKOVA, K. & MILAKOVSKA, Z.
2005 "Vulche pole molasse" (Eastern Rhodopes) – facts and problems. - In: Proceedings of anniversary International scientific conference "80th years Bulgarian geological society" 17-18, November, 2005, 11-13.

IAROSLAVSHI, E.
2000 Les fournaces de réduction du minerai fer chez les Daces. – In: M. Feugère, M. Gu_tin (eds.). Iron, Blacksmiths and Tools. Ancient European Crafts. Acts of the Instrumentum Conference at Podsreda (Slovenia) in April 1999, Monographies Instrumentum, 12, 2000, 96-102.

JOCKENHÖVEL, A.
1995 Archäometallurgische Forschungen an der oberen Dill und Dietzhölze (Lahn-Dill-Kreis). In: B. Pinsker (Hrsg.). Eisenland. Zu den Wurzeln der nassauischen Eisenindustrie, Wiesbaden, 1995, 1-14.
2005 Projektansatz und Projektdurchführung. In: A. Jockenhövel & Ch. Willms (Hrsg.), Das Diethölzetal-Projekt. Archäometallurgische Untersuchungen zur Geschichte und Struktur der mittelalterlichen Eisengewinnung im Lahn-Dill-Gebiet (Hessen). Münstersche Beiträge zur Ur-und Frühgeschichtlichen Archäologie, 1, 2005, 1-7.

JÖNS, H.
1999 Iron Production in Northern Germany during the Iron Age. In: Ch. Fabech & J. Ringtveg (Hrsg.), Settlement and Landscape. Proceedings of a conference in Aarchus 4.-7.05.1997 (Aarhus 1999) 249-260.

KOJUHAROV, D., KANURKOV, G. & KOJUHAROVA, E.
1988 Jelezonosni kvartsiti w dokambria ot Todopskia masiv. Godishnik na Komiteta po geologiya, 1988, t. 27, 19-39 (in Bulgarian).

KONYAROV, G.
1953 Prinos kam istoriyata na rudarstvoto I metalurgiyata v Balgaria. Sofia, 1953 (in Bulgarian).

KRAEV, D.
1976 Nahodki v starite raboti na minite "Rosen", "Plakalnitsa", "Rakovitsa" I "Spahievo", Haskovsko. I symposium za istoriya na minnoto delo v Yugoiztochna Evropa, Varna, 3-6.11.1975, Varna, 1976, 1, 166-178 (in Bulgarian).

MAXIMOV, E.
1974 Der Erzbergbau der Bessen. Thracia, 3, 1974, 397-398.

NAKOV, R., KERESTEDJIAN, T., KUNOV, A., ARNAUDOV, V. & AMOV, B.
2001 New data for a Paleogene epithermal origin of the gold mineralization in Kamilski dol area, Eastern Rhodopes, Bulgaria. – Rev. Bulg. Geol. Society, 2001, 62, 1-3, 55-64.

NEKHRIZOV, G. & TZVETKOVA, J. (eds.)
in print Ada Tepe. Thracian sanctuary near Krumovgrad.

PANAYOTOV, I. & YORDANOV, K.
1976 Po vaprosa za minnoto delo I metalurgiyata v Trakia prez bronzovata I jelyaznata epohi. I symposium za istoriya na minnoto delo v Yugoiztochna Evropa, Varna, 3-6.11.1975, Varna, 1976, 1, 24-39 (in Bulgarian).

POPOV, H.
2004 Arkheometalurgiya na jelyaznata epoha v balgarskite zemi – sastoyaniya I perspektivi. Arkheologiya, XLV, 2004, 1-2, 33-41 (in Bulgarian).

POPOV, H. & ILIEV, S.
2006a Antichni rudni razrabotki, zapaden sklon na Ada tepe. Arkheologicheski otkritiya I razkopki prez 2005., Sofia, 2006, 154-156 (in Bulgarian).
2006b Terenni obhojdaniya na teritoriyata na obshtina Lyubimets. Izvestiya na Haskovskiya mizey, t. 3, Stara Zagora, 2006, 46-63 (in Bulgarian).

TSINTSOV, Z., POPOV, H. & BANUSHEV, B.
2006 Arkheometalurgichni prouchvaniya v rayona na s. Valche pole, Haskovsko. Godishnik na minno-geolojkiya universitet "Sv. Ivan Rilski", t. 49, Sv. I, Geologiya I geofizika, 2006, 79-84 (in Bulgarian).

VELKOV, V.
1972 Rudodobivane I minno delo v Drevna Trakiya. Godishnik na Natsionalniya politehnicheski muzey, 2, 1972, 23-39 (in Bulgarian).

WISCHENBARTH, P.
2001 Eisenschlackenplätze im Rothtal. In: Keltische Stahl- und Eisenproduktion im Rothtal (Bayerisch-Schwaben). Berichte zur Archäologie im Landkreis Neu-Ulm und in den angrenzenden Gebieten, Bd. 2, Neu-Ulm, 2001, 9-54.

ZHELEV, D.
2006a Zlatno nahodishte "Khan Krum", uchastak Ada tepe. Geologiya I mineralni resursi, 2006, 7-8, 27-33 (in Bulgarian).
2006b Zlatno nahodishte "Khan Krum", uchastak Ada tepe. Geologiya I mineralni resursi, 2006, 9, 27-32 (in Bulgarian).

Assay No	Oxides , wt.											% Elements			
												wt%	g/t (ppm)		
	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SO_3	SiO_2	TiO_2	Fe	Cu	Pb	Zn
KKB-I_1	0,59	1,02	68,74	0,07	0,26	0,12	0,22	0,05	0,61	25,21	0,02	48	516	171	344
KKB-I_2	0,62	1,49	91,43	0,04	0,23	0,09	0,21	0,05	0,74	3,16	0,02	64	486	531	362
KKB-2_1	0,47	1,40	40,05	0,07	0,26	0,07	0,23	003	0,63	56,02	0,02	28	205	74	234
KKB-2_II	0,77	1,21	38,86	0,08	0,29	0,06	0,25	<0,03	0,82	57,02	0,03	27	366	103	224
KKB-5	7,16	1,45	2,46	0,13	0,20	0,03	3,48	<0,03	0,54	83,97	0,09	2	165	<10	275
KKB-7	16,39	4,26	2,09	0,25	0,96	0,05	7,04	0,15	0,79	64,52	0,45	1	162	132	208
KKB-8	0,59	1,04	51,04	0,09	0,23	0,13	0,60	0,05	0,78	44,49	0,02	36	300	169	263
KKB-9	0,64	1,05	92,41	0,07	0,22	0,06	0,21	<0,03	0,90	2,47	0,02	65	288	307	324

Note:
$Fe=Fe^{2+} + Fe^{3+}$
KKB - Kara Kol'ov Bunar and Kutela

Table 1: Comparisons chemical analyses (AES ICP) of the assays from the ores mineralization from the placer deposit, found in the places Kara Kol'ov Bunar and Kutela, in the area of the village of Valche pole.

Figure 1: An antique mine in the region of Village Stremci, Kardzhali district.

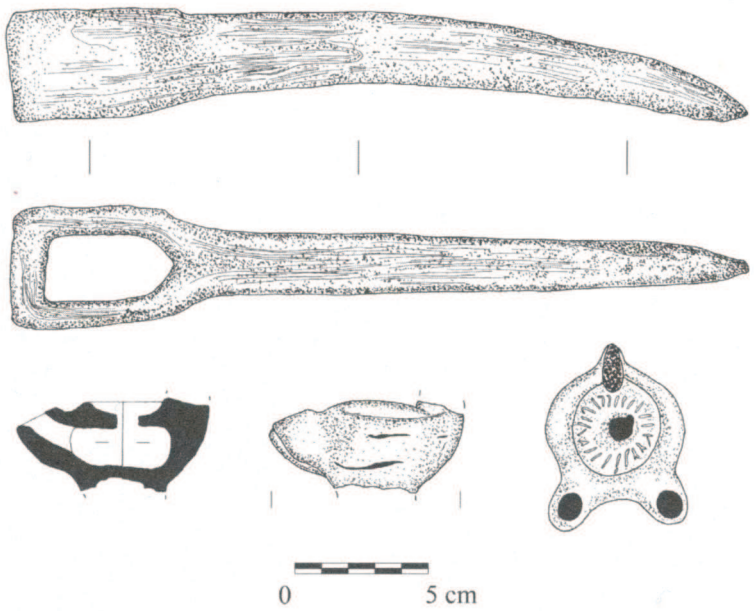

Figure 2: A mining pickaxe and lamp, 2nd-3rd centuries AD. Finds from a course in the region of the Mechkovets peak, Haskovo district.

Figure 3: Moulds from different periods. Finds from the region of Brenica, Haskovo district.

Figure 4: An opencast mine in the Kutela place, on the land of Valche Pole village.

Figure 5: A filling up enter of the course in the place Diado Vanio Bunar, on the land of Kamilski dol Village.

Figure 6: Registration of a metallurgy furnace in the place Kutela.

Figure 7: Archaeometallurgical sites, registered by field survey in the region of Middle Arda, on the land of Valche pole village, Kamilski dol village and Huhla. 1. Kutela, 2. Diado Vaniov Bunar, 3. Lambuh.

Figure 8: The Ada Tepe hill, after the preliminary works in preparation for using as an open mine.

Figure 9: An enter of course for gold-ore, west slopes of the Ada Tepe. Late Bronze Age.

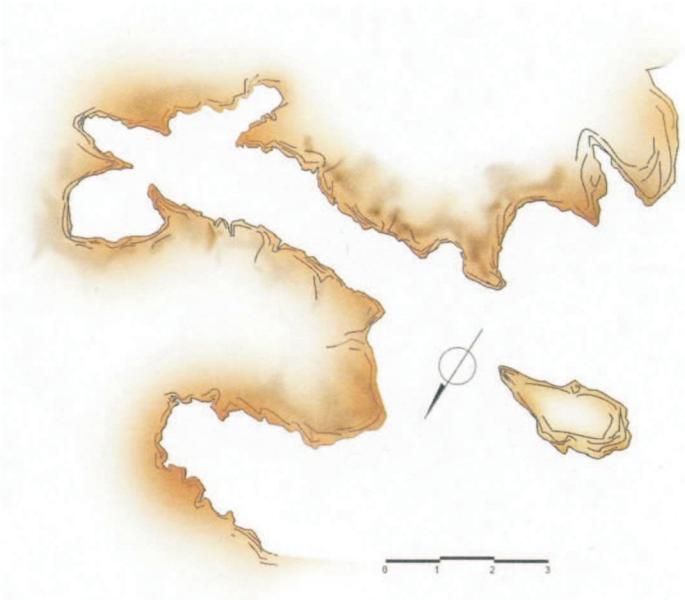

Figure 10: A general plate of the course.

Figure 11: Stone remains of ancient mining on the west slopes of Ada Tepe.

Figure 12: Mortar stones from Trench 2, used for grinding the ore.

Figure 13: The microregion of the forthcoming Bulgarian-German field excavations. 1. Ada Tepe, Krumovgrad; 2. Valche pole, Kamilski dol; 3. Bailovo; 4. Ihtimanska Sredna gora, Ihtiman, Vakarel.