NEW FINDINGS ON THE MINING HISTORY OF TURKEY AROUND TOKAT REGION

Ergun KAPTAN

Mineral Research and Exploration Institute of Turkey

ABSTRACT.— The city of Tokat and its surroundings in the central Black Sea region are the important localities which provide various materials revailing the subsurface mining and the mineral processing techniques of the times of B.C. up to the recent.

The first locality, having the indicators of Early Bronze Age, is the Almus, Tokat region. Nevertheless the age of the prehistoric subsurface mining in the Erbaa-Kozlu region, has been determined by utilizing the C-14 method. This is the only finding pertaining of the Anatolia.

These findings are very important discoveries for the History of the Turkish Mining.

I. INTRODUCTION

It goes back to thousands of years ago that the early settlers exploited the copper mines of Anatolia, which has rich and different ore deposits. They exploited copper mines; and smelted them to obtain copper ingots which were used for the production of materials for their technical needs of that time, and by casting or mixing with other metals they produced various alloys.

The first use of the native copper in Anatolia dates back about 9000 years from the present. The city of Tokat and its surroundings, located in the central part of the Black Sea region, are known from the ages before the Christ up to the recent times as a mining region.

A general investigation at the Tokat region provided various materials of subsurface mining and old metallurgy. Some of those materials are new discoveries and important for the «Turkish Mining History» (Kaptan, 1976; U.N.D.P., 1974).

The only location, known up to now, where the copper of Early Bronze Age has been smelted, is in Almus, Tokat region outside- of the old habitation centers of Anatolia.

In addition to that, the discovery of materials dating 2100 B.C., at Horoztepe region of the town of Erbaa, Tokat Indicate some metallic materials of the very advanced technology of old metallurgy worked generally on bronze and electrons (gold+silver) (Özgüç and Akok, 1958).

Another important point here is in Tokat and particularly in the Erbaa, Tokat region, how is tin mineral which is the main constituent of bronze had been obtained and how? This,question, related to the history of ancient Anatolian mining has not been answered yet. Because the present tin mines of Anatoli,a has not been revealed yet.

Also, it is identified that the copper mineralisation of Erbaa-Kozlu region has been known since 6000 years, and deposits with sulfur, and the copper deposits with sulfur had been successfully exploited by the old miners of Anatolia.

II. FINDINGS OF ALMUS, TOKAT REGION

A. Findings at Bakımlı village

1. Location and description of the findings. — The findings in the propertie of Mr. AH Karaca is located at the 1 km northwest of the Bakımlı (Mamo) village, Almus, Tokat (Fig. 1).

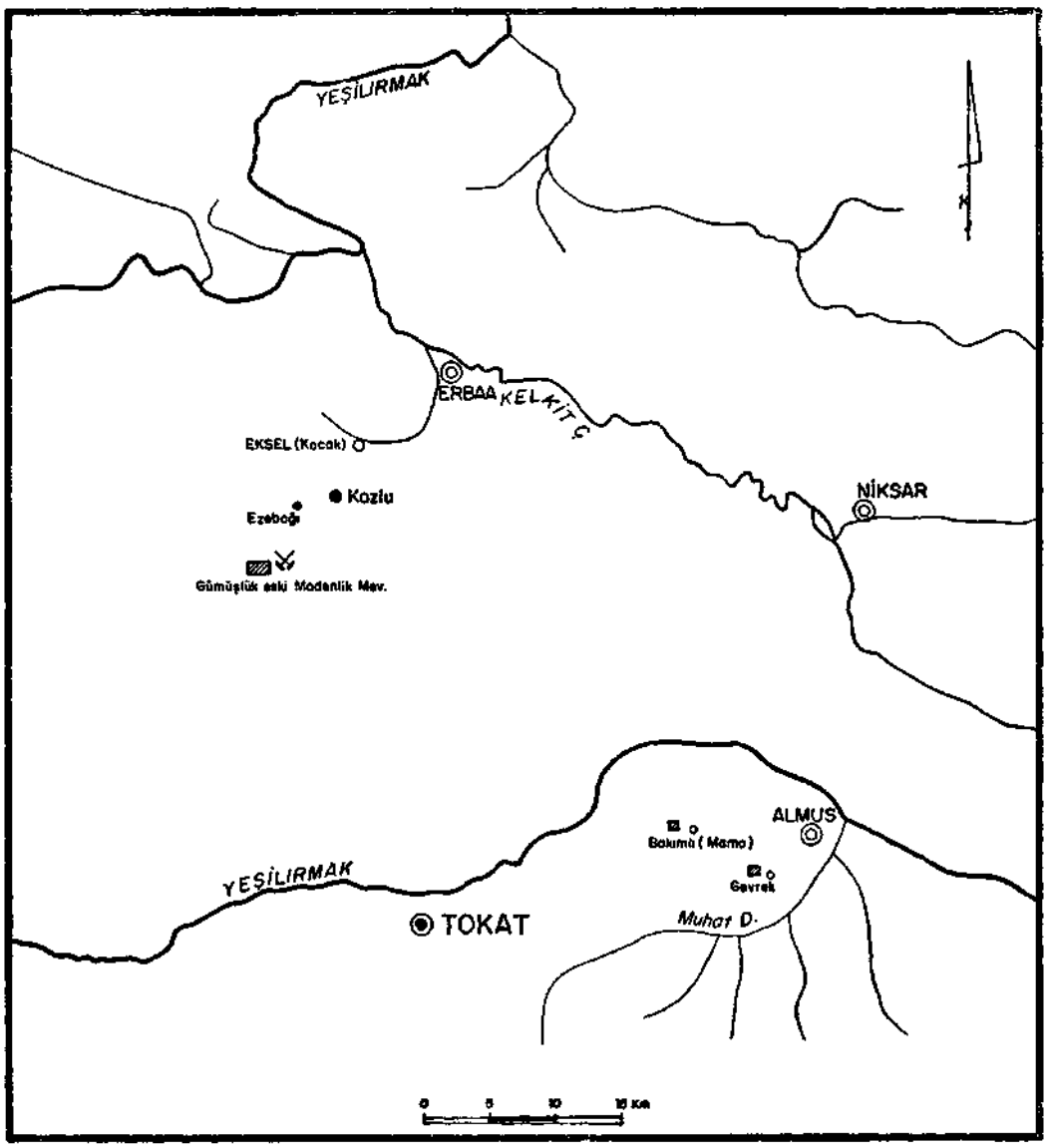

Fig. - 1

In a small slag deposition formed by the smelting of the copper ore, terra-cotta pieces of the melting furnace and also the ceramic pieces used by the old metallurgists have been found. There are important similarities between the terra-cotta pieces belong the lateral walls of smelting furnace of Bakımlı and the pieces found at the locality of Sarıcakız, Hisarcıkkayı village, Çankırı in 1973

(Jesus, 1978). Some pieces of terra-cotta were found stuck on some big slags prove that during the smelting of copper ore, the slags were stuck on the walls of the furnace.

By the examination of a ceramic piece, belonging to the old metallurgists with the measurements of 12 cm long and 1 cm thick, made of sandy clay being polished outside with reddish color and inside having attached small pieces of slag, that this slag deposit belongs to Early Bronze Age.

2. General characteristics of the slags. — The slags are generally coarse grained, light, porous and mat black colored. The pores of honey-comb shaped on these slags are the results of various gases coming out during the smelting processes. On some slags there are green colored prints of copper oxide. The optical spectrographic semi-quantitative analyses of these light slags give 0.004 % of copper which prove that how these old metallurgists were so successful on the smelting process of copper ore. The mentioned copper slag deposits which covers a small area indicates that the smelting had been made only once in this place.

This copper slag deposition is the only finding proving us that in Anatolia the copper ore has been smelted successfully and with great capability at Early Bronze Age (3000-2000 B.C.).

B. Findings at Gevrek village

1. Location and the description of the findings. — Of small slag deposit where the findings were found is in the field of Mr. Muharrem Denli is located in the Gevrek village of Almus, Tokat (Fig. 1).

In this small slag deposition we could not find any pieces of smelting furnace but a mould piece, made of terra-cotta, was found within the slags (Photo 1). This piece is an important finding for the history of Anatolian Mining. Because it is a piece of a mould which make it possible to obtain copper ingots in certain size and weight. Generally it indicates a great similarity with the slags where it was found.-

2. General description of the material. — General description of the mould is, kept at the Mineralogy Section of the Natural History Museum of the Mineral Research and Exploration Institute (MTA) of Turkey, with the registration number of 20, as follows;

Location : Slag deposits in the field of Mr. M. Denli, in the Gevrek village of Almus, Tokat.

Age : Bronze Age (probably).

Called : Mould (Fig. 2).

Dimentions : The original dimentions are unknown. Dimentions of the piece;

a. Length : 6.5 cm

b. Width : 4.5 cm

c. Highth : 4 cm

d. Depth : 2 cm

Properties : It is made of terra-cotta with rectangular surface and mat black colored. Due to high heat and having a sort of soil rich in ifon, the piece is deformed structurally by keeping its general shape.

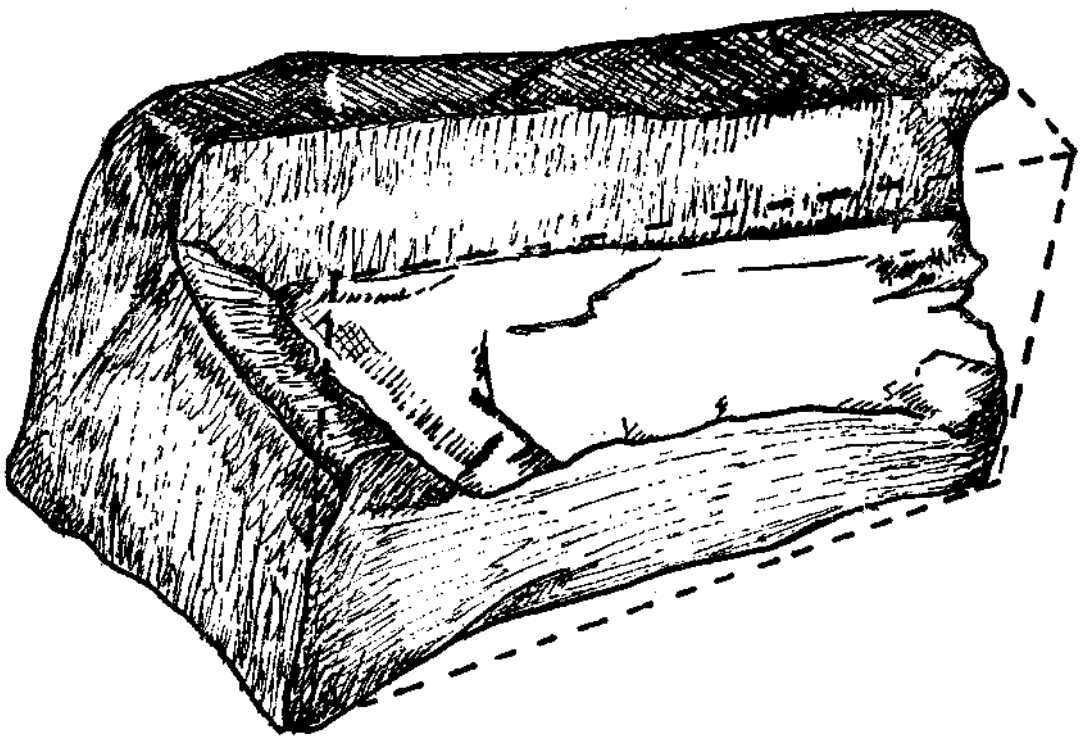

Fig. - 2

3. Comparison with other similarfindings. — The moulds, made ofterra-cotfa and carved stones, found in an old workshop at Kültepe-Kaniş Karum, Kayseri demonstrate similar properties with the mould of Almus-Gevrek village by their general shapes (Özgüç, 1955). But these moulds of Kültepe had been used for the production of the needed materials after remelting of ingots. For this reason they are differentiated from the mould of Almus-Gevrek.

Another mould, made of steatite and having rectangular prism shape, has been found on a field near Kültepe-Kaniş, Kayseri and it was used for the production of some figurines (Emre, 1969). This mould, being made of steatite and used for the reforming of smelted ingot as figurines, is differentiated from the mould found within the slag deposit at Almus-Gevrek, Tokat.

Thirtynine copper ingots and their pieces, taken out from a sunken antique ship near the Cape Gelidonya, Finike, Antalya, belong to the end of the Bronze Age (1200 B.C.) an their shape is in the shape of stretch bufallo skin (Maddin and Muhly, 1974; Wheeler, Maddin and Muhly, 1975). The moulds of these ingots have not been found. However the molds they were made had to be differentiated from the one found in Almus-Gevrek, Tokat. Probably this is one of the peculiarities of the moulds of the South and Southwest Anatolia.

It is impossible to establish the true dimentions of the material from Almus-Gevrek village. However, we can mention that the people of Anatolia who engaged in copper ingot trade in Bronze Age, have been reached to a standardization in the copper ingots by using the moulds with rectangular surface and 2 cm depth. The mould of Almus-Gevrek village is an interesting example which also has a great value for the ancient Anatolian metallurgy.

4. General characteristics of the slags. — The slags of the Gevrek area are mat black colored inside and outside. They are more rigid than the slags found in other localities. As they are broken, the undifferantiated limestone pieces of 5-6 mm are found within the slag which are used as an additive during the smelting process to obtain the fluidity of the slags. The success of smelting process has been proved by the light weight of the slags and by the determination of a little copper (0.015 %) by means of the optical spectrographic semi-quantitative analyse.

III. FINDINGS AT ERBAA-KOZLU REGION

A. Findings at Kozlu

1. Location and description of the findings. — Gümüşlük, known as old mining area where the findings obtained, is located 28 km away from Erbaa which is at south of Erbaa (Fig. 1). It is also in the north flank of the Tokat massive which is at 15 km south of the North Anatolian Fault.

The main part of this area including Gümüşlük the old mining area is generally covered by hornbeam and partly by beech trees. Tight brushwood and the plant called forest rose *(Rhododendron ponticum)* which is known as a rich flora growing understory make the investigations extremely difficult. From north to the south the slight inclination of the topography can be followed up to the great depression. The other section is depleted of forest flora in the east-west direction and found as a depressed talus and waste area (Fig. 3).

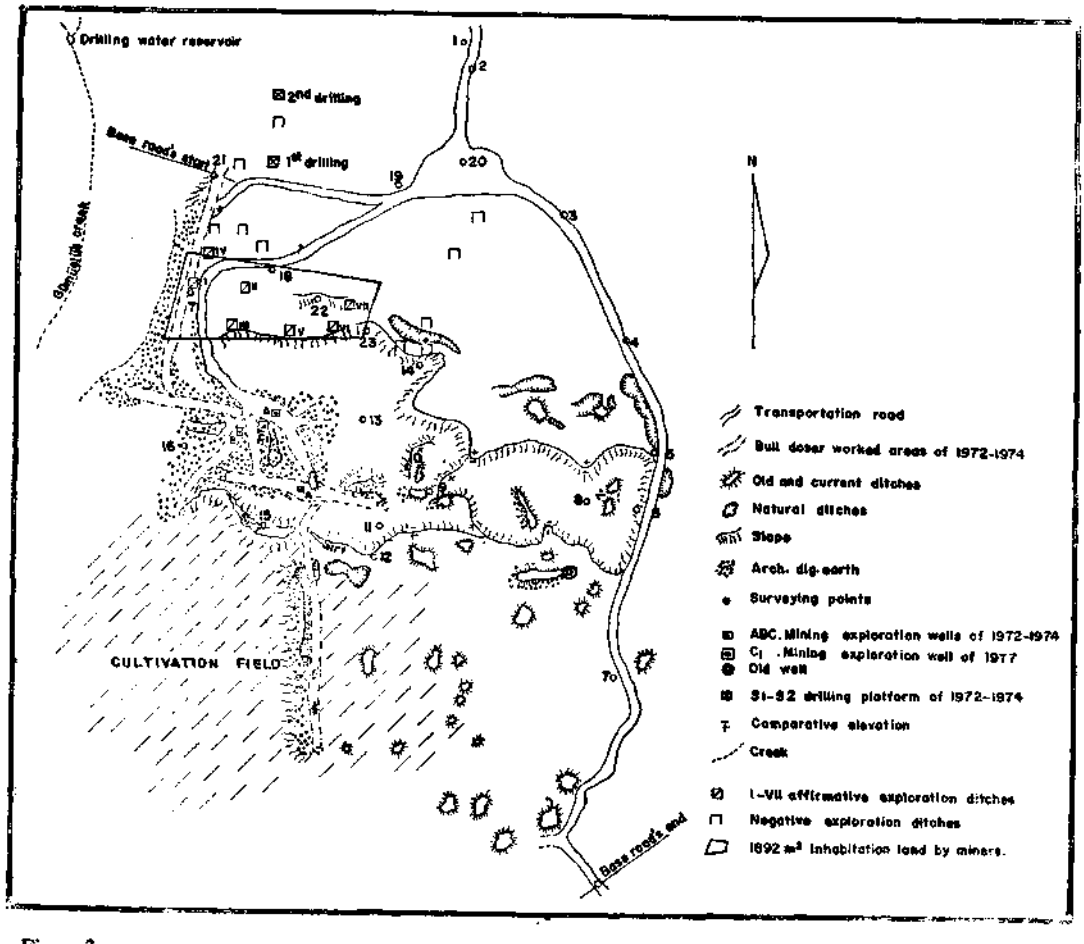

Fig. - 3

The United Nations team working for the Mineral Research and Exploration Institute of Turkey were searching for new ore deposites in North Anatolia in the years of 1972-1974, also worked in the Gümüşlük old mining area. Some tracks of an old mining gallery in a copper deposits with sulfur at a depth of approximately 45-50 m has run across as a drilling was taking place. In addition to that during the excavation of three mine research wells at the area called «the great depression» some antique pitwood pieces have been collected at a depth of 7.m. The results of the C-14 analyses of these pitwoods at the laboratories of the Finland Geological Survey, gave the age of. 2800 B.C. Both the research report of U.N. (U.N.D.P., 1974) and the article written on this subject (Giles and Kuijpers, 1974) don't light us either in detail or where the materials are now. On the contrary, the copper mineralization in this area gives some clues of the oldest underground copper mining ever done in this area.

Under the aim of exploring this antique mine gallery which is a very important discovery for the mining history of Turkey and of the world, and to determine the time interval between the first and last production period, the Mineral Research and Exploration Institute of Turkey has initiated a research programme in 1977, and has obtained some significant data. The first important results of the general investigations were obtained through the material foundin an unearthed mine research well, in the area called «the great depression».

2. Mine research well C 1. — In the great depression area, called «the great depression, talus and waste area» after the 1977 investigations (Kaptan, 1979) the mine research well C 1 was excavated which was advanced up to 8.20 m from surface. Excavated rock material was mostly green schists. On all layers the green schist with quartz veins and metadiabase are common.

Near surface, at 2.10 m depth, three ceramic pieces with copped oxide prints on belonging to the old miners were found. These materials, are the samples of 400 A.D. and dately correspond to the findings of the old miners located about 50-60 m north of the mine research well C 1 in the wood where the last production stage took place.

For this reason, the section of three meters downward from surface of the mine research well C 1 represents a deposition period from the beginning up to now.

Particularly at 5-6 m depth, the violet and brown colors of the schists probably was in the influence of hematite and limonite minerals. Some of the samples have broken and fissured structure due to tectonism and later they were altered and partly dyed by oxidation.

The ore slag, found at 7 th. m is the most interesting finding in this level.

Generally, after 5 th. meter, in limonitic clayey soil down to the bedrock at 8.20 m the pieces of charcoal are frequent.

Near bedrock there are materials consisting of metamorphosed schists, which are generally in the phyllitic character and have pyrite in it.

As excavations carried on in all layers, formations of secondary copper minerals of malachite and of little azurite has been observed.

The most interesting finding of the mine research well C 1 is the antique pitwood pieces.

3. Pieces of the antique pitwood. — Two pieces of pitwood, completing each other, have been found on the bedrock at 8.20 meters in the mine research well C 1 (Photo 2).

The microscopic studies of these materials at the laboratories of the Evaluation Department of Forestry Faculty of Istanbul University indicated that they are sort of pine species and under the high pressure the original form of the cell texture has been changed.

On this manner, by the determination of original species of these pitwood pieces not only helped us to have an idea on the original vegetation cover and also description of paleoclimatology of the area.

Currently, the pinewood as being generally more resistant is selected as pitwoods. This situation give more importance to the old subsurface mining of Anatolia. To prove that these old miners had consciously used the pinewood as pitwood in their mines, we need more similar findings from other mines which could be discovered in the future.

4. General description of the pieces of antique pitwood

Locality : Old mining area of Gümüşlük, Erbaa-Kozlu.

Called : Pieces of antique pitwood.

Age : Beginning of the ± 4000 B.C.

Dimentions : The pitwood (a) is composed of two pieces (Photo 2). One piece is 36 cm in length and the other one is 15 cm. Total length is 51 cm. The pitwood (b) is also composed of two pieces (Photo 2). One is 37 cm in length and the other one is 18 cm. Total length is 55 cm. All the measurements had been taken in in-situ position. The pitwood (a) was extracted in two pieces and the pitwood (b) in three pieces. The 36 cm long piece of the pitwood (a) has been exhibited in a good condition at the Mineralogy Section of the Natural History Museum of the Mineral Research and Exploration Institute of Turkey.

Properties : They are found at 8.20 m depth. These materials have been well preserved against the natural weathering agents and the underground water containing copper sulfate. However, copperoxide covered the materials had left struck-marks on these pitwoods. For example, on the pitwood (a) of 35 cm long, two struck marks of 2-2.5 cm long of a sharp tool have been observed (Photo 3). We can say that the struck-marks have been formed by prototype form of an axe. Of 26.5 cm part of the same pitwood had been chipped in the direction of its length to make it thinner (Photo 4).

5. Determined age of the pieces of antique pitwoods. — They were found in excellent condition for the age determination by C-14 method due to being under the influence of ground water containing copper sulfate.

The age analyses of these samples were performed at the laboratories of Physics Department of the Middle East Technical University by utilizing 5568 radioactive half-life C-14 method. Results are as indicated below;

Before present (before 1950).....: 5739 ± 109

At B.C.....: 3789 ± 109

These dates, determined by the C-14 method, probably indicates the beginning of ± 4000 B.C., and the first production of the mine which is also one of the first findings defining the old Anatolian subsurface mining.

6. Comparison. — It shortly mentioned in the UN report (U.N.D.P., 1974) that several material had been extracted from three mine research wells (Fig. 3) each reaching at a depth of 7 m and during the search, performed by UN experts between 1972-1974, some pieces of pitwoods were run across. The age of these lost pitwoods has been determined as ± 2800 B.C. by the C-14 method (Giles and Kuijpers, 1973; U.N.D.P., 1974). The pitwood, collected from the top of the bedrock in 1977, indicated 3789 ± 109 RC. as age determined by C-14 method (Kaptan,

1979). There is a difference of thousand years between these two results of C-14 method. This difference comes from depth where these pitwobds were collected. Thus, they may probably belong to different periods.

The date, determined on the materials of Gümüşlük old mine area probably reveals the first mine production period of mining works in the area.

7. The great depression-talus and waste area. — The place called the great depression-talus and waste area is an area of 350-400 m long lying in east-west direction and without forestal flora. This depression was filled by sidements of generally 8 m thick. By the studies of materials collected from the mine research well C 1 it is established that this sedimentation is a talus formed within thousands of years (Kaptan, 1979).

At the place an excavation of 7 m long, 2 m wide and 2.5 m deep has also been made. On within first 1-2 meters bodies of trees and at 2.5 m depth roots have been noted. The studies of these materials at the laboratories of the Evolution Department of Forestry Faculty of Istanbul University revealed that these materials comes from oak tree species and they have stayed for a long time under pressure. Thus, it is proved that the oak tree pieces found near surface, don't represent the near past. After this period the mining processes-we do not know why-were stopped for several hundred years. Probably this was the last period for the mine working. The near surface part of sediment filling of 8 m great depression area had been covered by a thin soil mantle with humus in this period and the tree cover was mostly oak species. To trenches and superficial excavations made indicates that this formation was located in the east of the area.

At the northern border of the investigation area, the woody and inclined area was inhabit place for the old miners of the last mine production period. The miners of this period, with the natural agents, were helped to speed up the sedimentation process which filled the mentioned area up to 2.5-3 meters thick. The ceramic pieces at the age of 400 A.D. found at 2.10 m depth in the mine research well C 1, are the proof of this idea. In addition to that this place is also posses some daily living materials of old miners and in the state of a mixed dumping area. These slags also helped to reach this 2.5-3 m thickness of filling between the third meter up to the 8.20 m where the pitwoods were found, there is no sign of antique materials which were utilized by old miners. But from the fifth meter down to bedrock of mine research well C 1, some pieces of charcoal were found in limonitic-clayey soil. This is a very important datum because, in every place where charcoals are found; it is the proof of the presence of inhabitants there.

There must be more antique pitwood in this area on the bedrock or near to it. For instance the findings of 1972-1974 found at 7 m depth is the proof of this thought.

According to all of these data, we can say that fillings of 8 m thick don't present the first mine production period. We can also add that this fillings was deposited by natural way and was accelerated by the old miners actions in the area.

8. The dwelling place of the miners. — The superficial investigation in 1977, performed on the area covered with beach and hornbeam trees, located at the northern border of the research area, provided us poorkinds of materials belong to old miners and a Roman bronze coin of 308-324 A.C. old. According to these data we supposed that this area was a dwelling place of the miners. To determine the borders of this place, 17 shallow treches had been performed. 7 of them gave us important date support this opinion. The results of measurements indicated that the dwelling place covers approximately 1892 m^2 (Fig. 3).

Generally green schist pieces, milky quarts pieces, secondary copper minerals of malachite-azurite samples, very few amount of hematite-limonite, an iron hat nodules, big pieces of charcoal of pinewood and various antique ceramic pieces were the materials collected from these shallow excavations.

Among the common characteristics of these excavations, burned soil layer of 5-6 cm thick located at 40-50 cm depth have not found at the excavations of VI and VII.

At the excavation of V, the marks of an intense fire has been observed. The soil has been burned intensely. Of mine slags and ceramic pieces have been found right on this burned layer. The milky quartz pieces and the pinewood charcoal pieces of 3-5 cm long were the materials used for smelting processes. As in other places, the milky quartz pieces have been used as an additive to smelting process by old metalurgists. However, it is difficult to explain the existance of the larger amount of charcoal depris than the amount of slags. Probably there was a small smelting workshop in that place. However, the tools and the enough quantity of slags to run a smelting workshop were not found. We can presume here an experimental smelting process has been done or a smelting expert made his own show off, with the characteristics of burned soil and ceramic pieces and big pieces of charcoal with small quantity of slag could be interpreted as a wide fire starting from the excavation V, spreading all over the dwelling place.

The slags were together with antique materials found only in the excavations of II, V and VII. The slags, in the excavation of II were with few hematite-limonite and in the excavations of V, VII were found with iron hat nodules. The quantity of the slags were little as compared to places where the ore smelted. This can prove that, here, the smelting process was not continious. The various slags collected from the areas could be classified as follows:

1. Porous and very light slags
2. Vitriferous slags
3. Poreless mat black colored slags
4. Classic type slags. Externally mat black colored internally with small shiny pores. That kind of slags are common in the most old slag deposits of Anatolia.

The pieces of charcoal were found in the porous and light slags and copper prints in the classic type slags. The absence of metallic residues in the vitriferous and light porous slags prove us that the smelting process was successful. On the other hand the milky quartz pieces, used as additional materials while the smelting process, were found unchanged in the slags. But, some of them, contain iron residue in quantity enough to affect a magnet. The optical spectiographic semi-quantitave analyses of the slags have been made and in the slags of the excavation of II and revealed that Fe more than 10 %, and Cu 0.7 %. On the slags of the excavation of V, the Fe more than 10 % and the Cu 0.4 %. The results of analyses also prove that the smelting process was successful.

The iron hat nodules with some antique findings were collected at the excavations of V and VII. The miners of the century were easily collected those nodules from the mining area, to make the experiences if they could smelt those nodules with their knowledge and technology. We could have this idea because, on these nodules there are prints of an unsuccessful smelting experience or of a fire.

In the seven excavations which gave us important data, at the dwelling place we reached to main soil level after a 1 m excavation of rigid clay which is without antique material. We could not find any foundation stone or other stones of the houses belonging to the miners down to the 2 m depth in the excavations of II, III and V.

On the burned soil layer, generally we found ceramic pieces of roughly-shaped plates which were made of sandy clay containing schist and muscovite pieces, those are the findings belonging to a forest village culture interested in the subsurface mining between the dates of ± 200 B.C. and ± 300-400 A.D. and not being a seasonal settlement.

The age of these materials found at this dwelling place would be dated as the last mine production period. According to existing data, this dwelling place was destructed by a big fire and never been an inhabitable place again.

9. *Antique mine gallery.* — The presence of a antique mine gallery at Gümüşlük old mine area was mentioned above. During the investigations with drilling on the north-south direction, one of the two drillings the S 1 was drilled with a dip of 45° southward and reached to a mine gallery at 80.9 m (Giles and Kuijpers, 1974; U.N.D.P., 1974). The depth of the gallery from the topography was 45-50 m. This might be the deepest depth that could be reached by following the mineralization zone. With a great probability this antique mine gallery starts with a rounded floor enterance than to reach the ore bearing layers miners used the step like method than they opened a gallery to reach the ore. As the modern miners, those miners should have used the pitwoods against the stone and soil sliding or falling while excavating to reach a 45-50 m depth. The findings of pitwoods in the great depression area at 8.20 m depth is a proof of this thought. The topographic projection of this antique gallery extends till bottom of the dwelling place mentioned above (Fig. 3). Due to natural and technical obstacles it disabled researchers to unearth this antique mine gallery at 45-50 m depth. In spite of the all investigations ever made, it was not found that the materials of old mining technique and remnants of life at dwelling place other than antique pitwood remnants found at the great depression area.

10. Similarfindings. — The first finding aged as B.C., has been found in the Anayatak stripe mine of «Murgul mine», Artvin. This gallery, which was destroyed, is dated at first half of 1000 B.C. by examination of a miner's showel made of wood has been found in oxidized ore (Kaptan, 1977). The other findings are more younger and are generally located in the Eastern Black Sea region. For example, antique mine pits found in Espiye, Bulancak town regions of Giresun have been dated as 1100-1300 A.D. (Kaptan, 1978). During the reserve development surveys of various mining operations in Anatolia with drillings and other investigation methods, more old galleries of subsurface mining belonging to historical times were found in these locations of Kurşunlu village, Koyulhisar, Sivas; Çanakçı region, Potürge, Malatya; Çiftlikköy, Maden, Elazığ and Hazine cave region of the Keban silver-lead working, Elazığ, Maden, Ergani; Çamardı region, Niğde; zinc-lead mine of Denizovası Kayseri; and Aşılık region of Saimbeyli, Adana. It is said that there must be similar samples in the West Anatolia region.

There are antique mines in Europe which are in the same age as the antique mine gallery of Gümüşlük old mining area. For example, the famous antique mine gallery of copper mine of Rudna Glava, East Serbia, Yugoslavia was supposed as the only unique antique mine gallery in present gives an age of 4000 B.C. and excavated at 25-30 m depth, known all over the world (Wertime, 1973). But, in the passing years, in Bulgaria, close to our border at Ayupınar region of Istranca forest, the experts of Archeological Institute of Moscow made a survey on the mentioned area to find antique remnants of subsurface mining operations. They have discovered a mine gallery and primative tools of miners made of bones and deer horns at a depth of 20 m. The discovery was dated as 5000 B.C. In the same region, approximately 300 ancient mining gallery were discovered and dated as 1000-3000 B.C. In the light of these discoveries it is reported that in the same region there is more than 1 000 000 tons of copper reserve.

In Italy, the 200 m long slope gallery of Sebastini Pb-Zn mine located at Moute Re mound at Cave Del Predil near the cities of Udine and Tarvisio known as old as 1000 B.C.

Another example is from Austria. Those ancient mines are located in Zeiring region of Graz state and exploited for silver. There are reports in archives that in the years of 1265-1361 these mines had been exploited continiously for iron (Haditsch, 1967).

The mines, known in Europe and in Anatolia have been mentioned in chronological order. All of these examples indicate the importance of the antique mine gallery of the Gümüşlük old mine area which represents the prehistorical subsurface mining in Anatolia.

IV. CONCLUSION

The findings of Tokat region reveals that in this region the mining activity was extremely advanced.

The mining activity from + 4000 B.C. up to the historical times at Gümüşlük old mine area, is a unique discovery in Anatolia where the mining activity had continued thousands of years. The absence of the comparasion materials for the C-14 method of the materials belonging to the first production period, could not stop us to have an idea that copper mineralization in this region is the proof of the oldest copper mining which was mined in this region. It is an interesting example for the Turkish mining history and also for the world mining history.

The slag deposition, formed by the successful smelting of the copper ore under the technical conditions of the Early Bronze Age (3000-2000 B.C.) at Almus-Bakımlı (Mamo) village, is the oldest and the first finding in Anatolia. The mould, found in the Almus-Gevrek village copper slag deposition is a special sample because of its unique form and the material from what it was made. With a great probability, this material indicates that the Bronze Age merchants have standart sizes for ingots trading. By the general investigations in Tokat region, we could observe that between the ore production centers and the localities where the smelting processes have been done, were in different and apart regions from each others. Thus, we can conclude that the people who interested in mining operations and the trading of ingots, with a great possibility, were experts on their professions.

We accept the findings of copper sulfate deposits at Gümüşlük old mine area, the slag deposition at Almus-Bakımlı (Mamo) village and the mould found in the slag deposition of Almus-Gevrek village as valuable prehistoric materials for the regional subsurface mining and the old metallurgy (to some extend), which explains the Mining History of Turkey.

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Photo 1

Photo 2

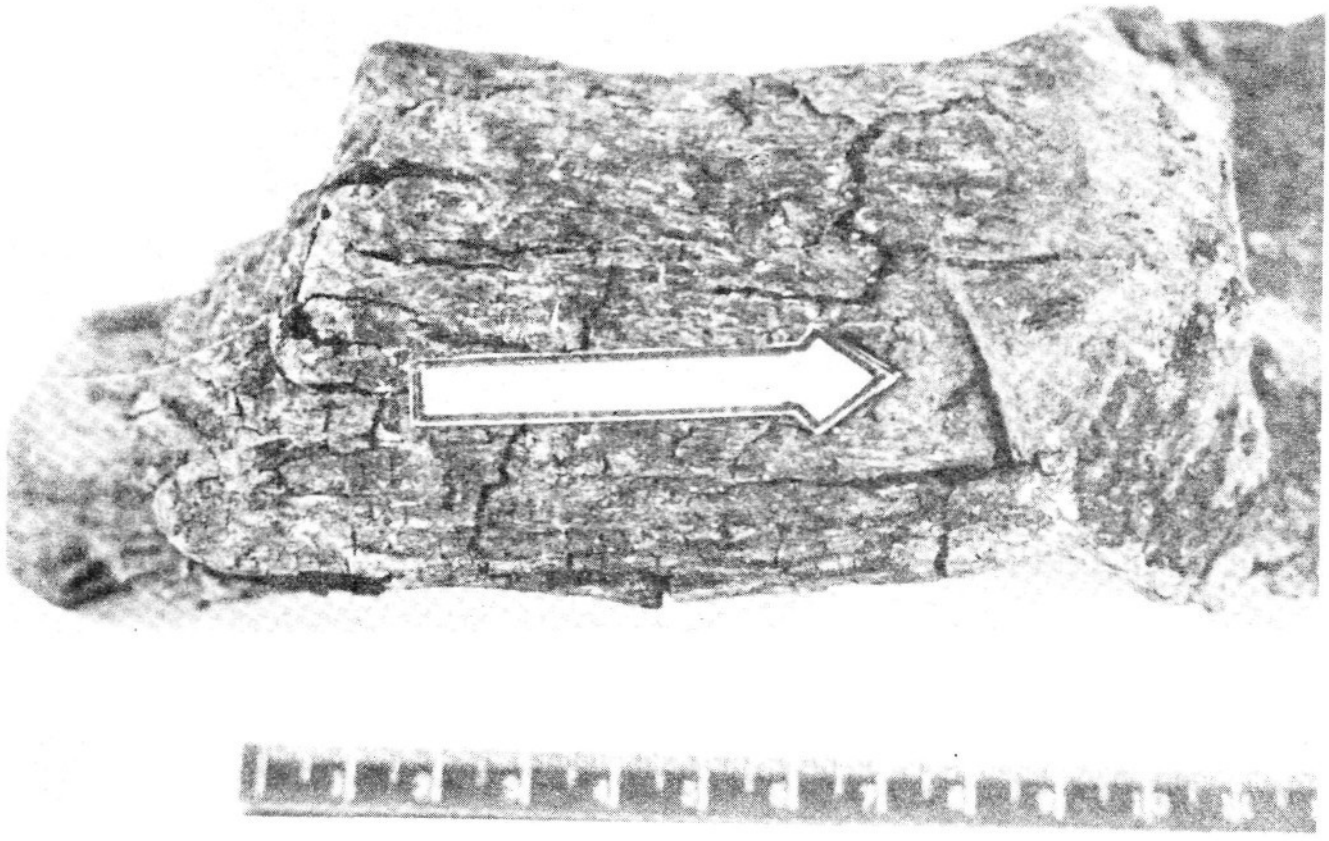

Photo 3

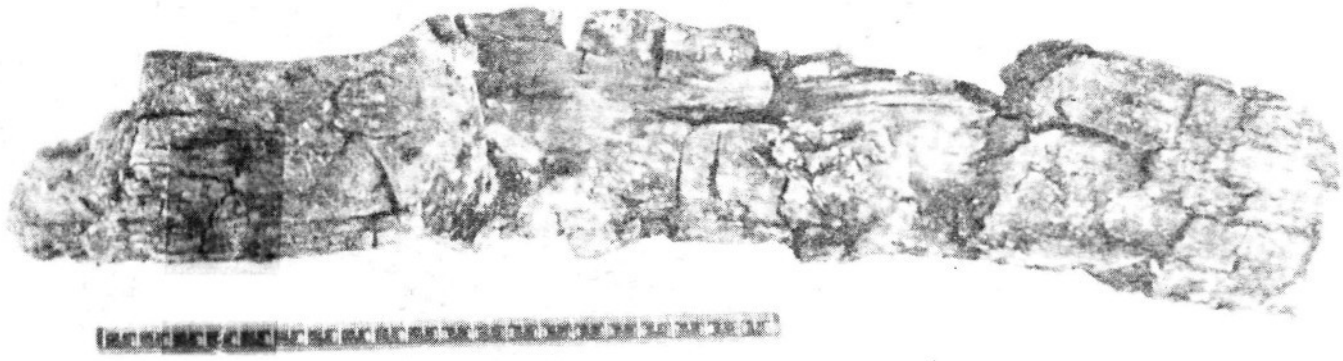

Photo 4