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FINDINGS RELATED TO THE HISTORY OF MINING IN TURKEY

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ABSTRACT . - The greatest innovation in the history of civilization is the use of minerals. Anatolia, owes its rich and long history, to the varied non-depleeting mineral wealth. Nine thousand years ago copper was the first metal the habitants of Anatolia made use of. The oldest underground mining in Anatolia has been discovered around Tokat-Erbaa, Kozlu which belongs to the beginning of 5 thousand years B.C. In this study, for the first time in Turkey, using archaeometric methods, in two locality around Niğde tin mineralizations have been discovered. This is an important discovery for the mining history of Turkey.

INTRODUCTION

Ancient man has worked metals and minerals distributed in the earths crust for thousands of years. The technological level achieved in todays world began with experimentation leading to a growing knowledge of metals and how they were worked. For this reason the greatest breakthrough in the history of civilization is the discovery of metals. Man began to take greater advantage of the metal resources around him through experience. Metals triggered the birth and growth of new cultures based on increasing needs. The evolution of these ancient metal industries has led to the high levels of todays civilizations.

From the Paleolithic period to the modern era, Anatolia has its place in world history as the home to inestimable cultural treasures. Anatolia's rich and well-rooted cultures and their variegated expressions are due in part to its many metal resources. Other ancient Near Eastern cultures exploited these metal resources throughout the millennia in part because of the Eurasian nature of Anatolia, that is, as being both a part of Asia as well as Europe. For this reason, Anatolia served as a bridge between the eastern and western civilizations for thousands of years. Trade between these areas rich with metal resources in Anatolia and ancient Near Eastern civilizations was thus bom four thousand years ago.

A GENERAL PERSPECTIVE OF ANATOLIAN METALLURGY

This chronological breakdown of the history of Anatolian metallurgy is based on years of research:

Chalcolithic period	**5000 - 3000 B.C.**
Early Bronze Age	**3000 - 2000 B.C.**
Middle Bronze Age	**2000 - 1550 B.C.**
Late Bronze Age	**1550 - 1200 B.C.**
Iron Age	**1200 - 550 B.C.**

The oldest worked metal made of metallic ore was found at the excavations of Çayönü tepesi mound near Diyarbakir-Ergani (Çambel and Braidwood 1970). These materials were made of native copper and malachite and were worked cold and shaped. These materials are the first finds proving ancient man in Anatolia had knowledge about and worked ores 9000 years ago.

The first finds signifying metallurgical work was found at the excavations of Çatalhöyük near Konya-Cumra (Mellaart, 1966). It is interesting and exciting to find such precocious evidence at Çatalhöyük in 6000 B.C. On the basis of these findings, this date should be noted as the beginning of Anatolian metallurgy.

Copper was the first metallic ore known to ancient man in Anatolia. However, aside from the knowledge that copper had better malleability than rocks, early experimentation never really reached high levels in technology. The Chalcolithic period (5000-3000 B.C.), which means the stone-metal era, is accepted as the transition and developmental phase between the Neolithic and the Early Bronze Age. Copper implements in this period are less evident than stone tools. Copper was a precious commodity in Anatolia in 5000 B.C. For this reason it was used only for important tools and weapons such as arrowheads, axes, adzes, and awls. Finds at Mersin-Yümüktepe indicate that casting was known during this period. In addition, objects that indicate tin was used as an alloying material, was found at Yümüktepe dating to 4300 B.C. (Esin, 1969). The tin content measures 2,9 % in these materials, however, this amount is very low for a true tin-bronze. If the ancient metallurgists knowingly, perhaps experimentally, were able to add 2,9 % tin to copper, then these can be considered the oldest, but most primitive bronzes in Anatolia.

The Bronze Age (3000-1200 B.C.) is a period when bronze has gained precedence over stone. In the third millennium B.C. Anatolian metallurgists and craftsmen were capable of casting metal and making alloys such as bronze and electrum (Koşay and Akok, 1966). In the Early Bronze Age (3000-2000 B.C.) metallurgists and craftsmen produced metals which indicate high levels achieved in casting. These are high quality examples of copper, lead, gold, silver, bronze (coppertin), electrum (gold-silver) objects. The best examples of these have been found in Alacahöyük (Çorum), Troy (Çanakkale), Horoztepe (Tokat-Erbaa), Eskiyapar (Çorum), Mahmatlar (Amasya), Karataş (Elmalı-Semayük). For example, at Alacahöyük, important finds include gold, silver electrum, bronze and copper objects. Analyses of these objects obtained at MTA Institute laboratories have yielded tin levels from 9-17 %. Since no other impurities were found in these metals, they are good examples of high quality tin bronze alloying (Koşay, 1938). In addition, latest analyses of Alacahöyük bronze objects, conducted at the Darmstad Technical University in Germany, indicated that tin content was 10 % (Koşay and Akok, 1966). The worlds oldest examples of the sword, which is the most efficient weapon known to man, was again found at Alacahöyük. All of these finds indicate, that by the third millennium B.C., Alacahöyük had achieved a high level of metallurgical skills and technology of manufacturing metal.

During the Early Bronze Age iron was a comparatively less known metal. It is assumed that the experimental techniques tried on other metals were also attempted with iron, with little success. This is due to the high temperatures needed for iron metallurgy. The product of this type of smelt, would have required new processing techniques, and for this reason, iron objects in this period are quite rare. The best example is a gold handled iron blade 18.5 cm. long from the second half of the third millennium B.C. found at Alacahöyük. MTA Institute analyses on group three materials from the 1937 season of this site yielded iron with 4-5 % nickel content (Koşay, 1938). It is highly possible that this was produced from meteoric iron. In the Early Bronze Age (3000-1200 B.C.) iron, which was considered the most precious metal, was probably manufactured out of meteoric iron. Research (Bjorkman, 1973) has indicated that meteoric iron was used in Anatolia and the Near East.

Research on tin sources is continuing to be an important topic in Turkey. It has always been recognized that tin was a crucial alloying metal for bronze, but its source was as-yet unknown. The source of the tin used first in the Early Bronze Age in Anatolia was not known. However, in the second millennium B.C., tin was imported as tubes into Anatolia as 300 kilogram weights from Mesopotamia (Bilgi9, 1943). During this period Anatolian cities had knowledge of its resources and had a well developed metal industry. Central and north central Anatolia especially are the earliest regions to develop underground mining and high levels of metallurgy (Kaplan, 1983). As a result, a metal trade belween Assur in Mesopolamia and Analolia conlinued for 200 years. Donkey caravans slarling from Mesopolamia would carry tin to the industrial centers of Anatolia, which had a high demand on this product. In relum they would oblain copper, argenliferous lead, silver and gold (Bilgiç, 1948).

Research into the sources of tin have continued in the present day. The first investigations were in 1899 with the permission of the Ottoman Imperial government (MTA report, 1900). After the birth of the Republic, tin was searched for beiwecn 1932-1939. Tin mineralizalion was first found in the Bursa-Keleş, Soğukpınar area (Çağatay el al, 1981). Ancient mines were also found in this area. In 1985 a tin-rich Pb-Zn ore was discovered al Bolkardağ-Sulucadere (Niğde-Ulukışla) (Yener and Özbal, 1986, 1987). This same investigation was exiended in 1987 to the Niğde-Çamardı area. An ancieni mining complex of galleries, which was mosl probably exploiting tin, was discovered in the Kestel-Sarıtuzla area of Celaller village (Kaplan, 1988; Yener, 1988; Yener el al., 1989).

Most of the metal objects made during the Old Hittite period (1750-1450 B.C.) were mostly copper and bronze. In addition to gold and silver objects, some rare iron objects were also found. The rarity of iron was due to the lack of melallurgical knowledge of iron working on the part of the Hittites. During the Hittite Empire period (1450-1200 B.C.), Anatolian melallurgy developed, became widespread, and took the characleristics of an industry. In spile of the fact that Anatolia had entered the Iron Age circa 1200 B.C., iron was less common than other metals.

The Urartians were highly successful in melallurgy in eastern Analolia. The success displayed by the metallurgical indusiry during the Urartian kingdom (900-600 B.C.) even influenced the Etruscans in northern Italy. During this period, malerials of bronze were exported from Anatolia to Greece and Italy (Akurgal, 1959). Anatolian melallurgy achieved great heights during the Phrygian period (700-550 B.C.). However, iron was less common than other metals. Sardis (Manisa), the capital of the Lydian kingdom (700-550 B.C.), is an imporlant industrial and metallurgical center located in westem Analolia. The splendor of the Lydian kingdom during this period was due to the exploitation of placer deposits of gold in the Pac-

tolus River (Sart Çayı), which flows nearby (Şükun, 1943). The Lydian people called the Pactolus the "river that flowed with golden waves".

Anatolia, which possessed these rich mineral sources, later came under the hegemony of the Achacmenid Persians, the Hellenistic, Roman and Byzantine Empires. The Great Selçuk and Otoman Empires continued working these metal sources, expanded upon the long accumulation of metallurgical skills and added new techniques, as fitting an old Anatolian tradition.

ANCIENT MINING SITES

The MTA Institute project on the "History of Metallurgy in Turkey" has yielded important and interesting results. New finds of ancient mining have especially placed Turkey into an important place in the history of metallurgy.

The oldest mining remains in Turkey were found in the Tokat-Erbaa (Kozlu Eski Gümüşlük) and were substantiated by soundings (Giles and Kuijpers, 1974). This mine is 50 meters deep. Excavations were conducted in the mine and in the tailings, which represent thousands of years of exploitation, and reached bedrock. Wood from an ancient gallery was found at 8.20 meters deep on bedrock (Kaptan, 1986). Radiocarbon dates obtained from the Physics Department of the Middle Eastern Technical University in Ankara gave a date of 3789±109(4650±109 B.C. calibrated date). This ancient mine was the source of copper for the region for thousands of years through a multitude of periods. The bronzes of Horoztepe (Erbaa), dated to the Early Bronze Age, display superior casting workmanship. Perhaps the source of the copper was this mine at Erbaa-Kozlu Eski Gümüşlük (Fig. 1).

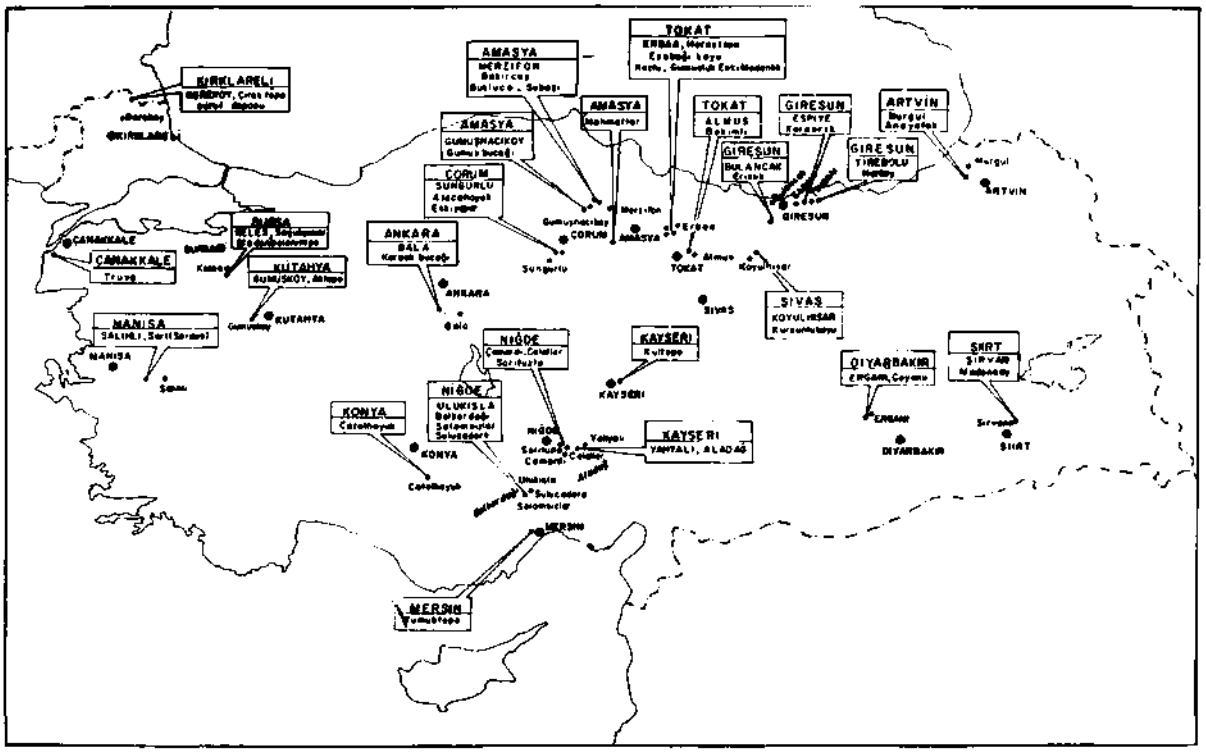

Fig. 1

The second oldest mine (Kaptan, 1988; Yener, 1988) was found in 1987 at the mining complex at the Niğde-Çamardı Celaller village al Kestel-Sarıtuzla mine (Fig. 1). The first workings were dated to the Early Bronze Age by pottery and radiocarbon dates. Four charcoal samples gave radiocarbon determinations from 40201880 to 3830±65 years B.P., calibrated to 2874-2133 B.C. (Yener et al., 1989). The mine continued in use into the Byzantine period. Research continues at this site.

The third oldesl mine was found in 1979 at Kütahya-Gümüşköy (Aktepe Mevkii). Torches were used for illumination by the ancient miners. Radiocarbon dales were obtained from burnt torch specimens at Aaechen University in Germany. The

C14 dates were 1950±85 B.C. (Kaptan; 1984). The calibrated dales are 2425±85. This mine is important not only for Anatolian metal history but for other areas as well.

The oldest remains as yet from the copper mines at Artvin-Murgul date to the second half of the fust millennium B.C. This dale was established with the help of an ancient mine found during open-pit mining in 1967 (Kaptan, 1977). This mine was destroyed due to the on-going mining operations. Another date abte ancient mine gallery was found at Sivas-Koyulhisar near Kusunlu village. The mine dates to the beginning of the first millennium B.C. (Kış and Güler, 1984). The date of the Siirt-Şirvan ancient mine was established by the wooden support beams in the mine during modem soundings at 66 meters deep. Radiocarbon dates yielded 590±45 A.D. (Kış and Güler. 1984). However. this does not represent the earliest and latest stages of the mine.

An ancient mine gallery found at Niğde-Ulukışla Madenköy Bulkardağ Şelamsızlar area al 2000 meters altitude was 190-200 meters long and dated to the 8 th century A.D. (Kaptan. 1988). Another mine a Bolkardağ Sulucadere was dated to the 9th century A.D. (Fig. 1).

Another mine was accidently exposed by Etibank at Giresun-Espiye Karaerik area. This mine was 100 meters long, is dated to the 11th century A.D. and yields chalcopyrite (Kaptan, 1980). Again at Giresun-Bulancak, Eriklik village area a mine gallery was found that was 17 meters long. This mine was dated to the 11 th century A.D. and was worked for copper (Kaplan, 1980). While soundings were being conducted by the MTA General Directorate to search for increased reserves of Cu-Pb-Zn. an ancient mine was discovered in 1980 al Giresun-Tirebolu Harköy. The mine is 28 meters deep. Radiocarbon dales from the gallery timbers yielded 1550±42 A.D. (Kış and Güler, 1984).

While investigating reserves at Kayseri-Yahyalı. Aladağ Pb-Zn veins, another ancient mine was discoveicd al 2645 meters altitude. Radiocarbon dates from the timbers gave 1050+73 A.D. (Kış, 1985). In addition to these examples, mines dating to the Roman-Byzanline and Otoman periods were found in a variety of areas, especially in eastern Black Sea regions.

ANCIENT MINING TOOLS AND EQUIPMENT

Ancient tools and equipment relating to underground mining aclivities arc rare in Anatolia. The first finds stem from the Murgul-Anayatak area. A mining shovel, carved from a tree trunk, was found in the galleries (Fig. 2). Radiocarbon dales based on 5730 half-life yielded 316±170 B.C. (Kaptan, 1977).

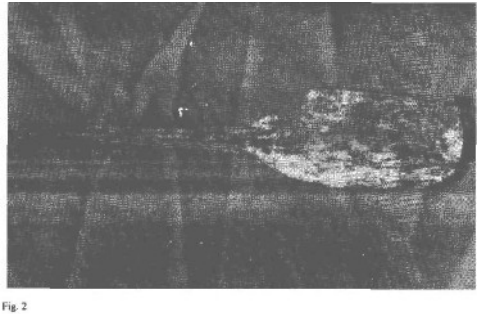

Fig. 2

Among the oldest mining finds was a wooden ladder which was from a gallery near Koyukhisar-Kurşunlu village. Radiocarbon dales yielded 948±56 B.C. (Kış and Güler, 1984). A second ladder was also found in the Kurşunlu village area and dated to 350±5G A.D. This example was maxle with more care than the ladders found in this area dating 10 earlier periods (Fig. 3). It was made by carving out steps on one face of the tree trunk and is unique in Anatolia.

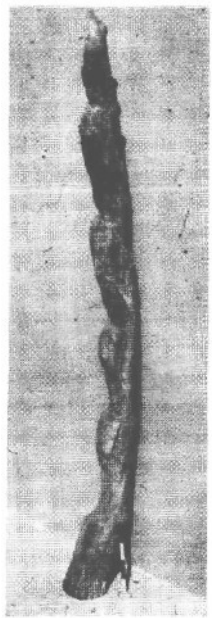

Fig. 3

A stationary ladder was found in the raise between lower levels in the Selamsızlar mine in Ulukışla-Madenköy at Bolkardağ (Fig. 1). Three separate ladders measuring 130-150 cm were found in the three raises. Three steps were carved on one face of one of the ladders which was made of black pine (Pinus nigra Arnold). The ladder was dated by C14 to 777±55 A.D. (Kaptan. 1988). Again at Bolkardağ Sulucadere, another ancient mine yielded a black pine shovel found 31 meters deep inside the gallery. Radiocarbon dates yielded 836±70 A.D. (Kış. 1985; Kaptan 1988).

C14 analyses yielded dates of 1161+74 A.D. (Kaptan, 1980). which calibrates to 1070+.74 A.D. An ore carrier, which is 17 cm. long was found in the galleries al Giresun-Bulancak, Eriklik village area (Fig. 1). Made from the trunk of a chestnut tree, radiocarbon dates it to 992±75 A.D. (Kaptan, 1980). which calibrates to 1050+75 A.D. It can be considered a prototype of mine wagons. This ore carrier is characteristic to Anatolia and is now unique in the world. (Fig. 4).

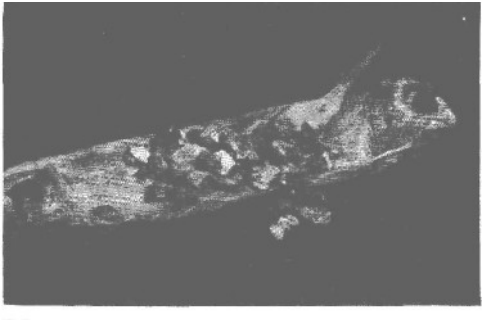

Fig. 4

ANCIENT ORE BENEFICIATION TOOLS

Tools used to process ores prior to smelling have been found, researched, and preserved in this country. The first time an ore beneficiation tool was identified was one found al the entrance of an ancient mine at Kütahya-Gümüşköy Aktepe mining area (Fig. 1). This ore processing tool was used for middle-to-fine pulverization. It dates to the second century A.D. (Kaptan. 1984).

The second find, a stone mortar used for breaking larger chunks of ore. was found al Merzifon-Bakırçay (Fig. 1). mortar with multiple depressions (Fig. 5). 28 holes for breaking the ore are on me surface. It was used in the phase of enriching ore between middle-sized chunks and fine powder. This ore enrichment tool from Bakırçay dates to the 1-2 centuries A.D.. the Roman period (Kaptan. 1987). Another multi-holed stone mortar was found in the copper slag mounds at Tokat-Erbaa near Ezebağı village. Made of andesite, both faces of this mortar were used. 33 depressions are on its obverse, and 9 on its reverse (Kaptan, 1986). A similar exasimple was found al Kırklareli-Dereköy (Fig. 1) at the Çitak tepe slag mound. The polygonal shaped find was used as a mortar, but its date has not been ascertained.

Similar mulli-holed mortars were found al the Rio Tinto mining region in Spain (Blanco and Luzon. 1969). Another complex (Kaptan. 1988, Yener. 1988). This open air workshop had 213 depressions on its marble surface (Fig. 6). The quantity of these depressions will probably increase as more work is done at this site. This is the first such mulli-holed-ore-beneficiation-workshop found in Turkey and is unique in the world. Ancient mining began here in the Bronze Age (3000-1200 B.C.) and continued through the Roman and Byzantine periods.

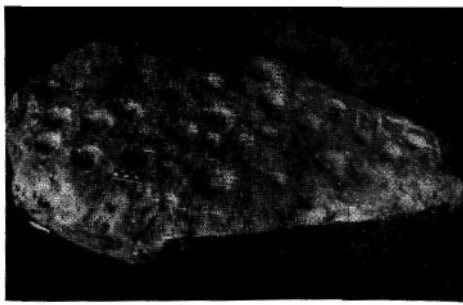

Fig. 5

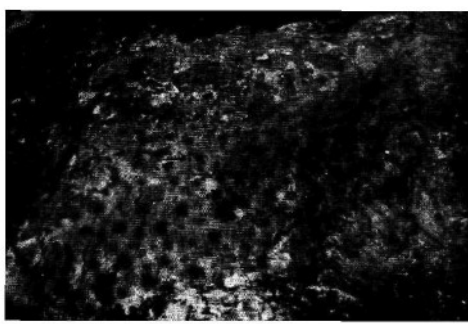

Fig. 6

ANCIENT METALLURGY FINDS

It is normal that ancient metallurgical tools, which are the continuation of the mining process, are found in Anatolia. The oldest find relating to ancient metallurgy was found *at* a small slag mound 1 kilometer to the north of Tokal-Almus Bakmlı village (Fig. 1), Furnace lining fragments were Found inside the slag heap. And arc a result of copper smelting. When the slag is light weight, it indicates that metallurgists were successful in their smelting. This slag mound (Kaptan. 1986) is

the only find so far of a successful and knowledgeable copper smelting process in Anatolia dating to the Early Bronze Age (3000-2000 B.C.).

The second oldest metallurgical finds are from the slag mound at Subaşı (Çesme başı) at Büklüce village, overlooking the Merzifon-Bakırçay valley. A large amount of tuyeres were found in the copper slag mounds (Fig. 7). In addition, wood charcoal used during smelling gave radiocarbon dates of 1887 B.C. (Ergin and Güler. 1985). Therefore, this find makes evident that the Anatolian metallurgists were successfully smelting copper at the beginning of the second millennium B.C.

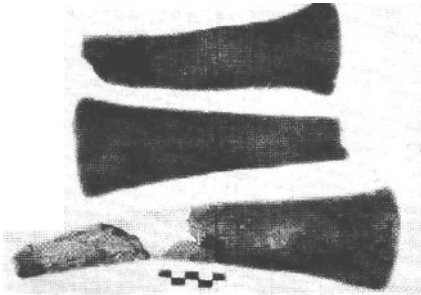

Fig. 7

Another copper slag mound at Ankara-Bala. Karaali village measure 70.000 tons and represents the Roman-Byzantine, Selçuk-Ottoman periods in the first millennium A.D. A 1.5 million ton slag deposit at Gümüş village near Amasya-Gumiyhacikoy represents the remains of ancient lead smelling. It is possible that metallurgical activities which began in the first millennium B.C. in this area, continued into the next millennia. These workings were continued in the Roman-Byzanline and Ottoman periods. In addition, smelting furnaces in Gümüş were used until 1886 (Kaptan. 1975).

There are more than 200 slag deposits in Turkey. 40 of these slag heaps in central and north central Anatolia have been established as belonging to the Roman-Byzantine periods. Eastern Black Sea slag heaps represent the smelling of the Cu-Pb mineralization and represent the Roman-Byzantine and Ottoman periods primarily.

CONCLUSION

The first metal that was recognized and smelted by ancient man in Anatolia was copper. The greatest find of Anatolian industry was the achievement of making bronze alloys by adding tin to copper. These are the developmental stages which led to modem high technology. Research into the history of metallurgy in Anatolia began in 1973. As a result, tools and equipment relating to mining, ore beneficiation and metallurgy have increased appreciably. These have conlribuled to the understanding of the history Anatolian metal industry and its developmental slages. In addition. due to the research into the history of metals, tin was discovered in two separate areas in Niğde. For this reason, the combination of the geological search for metals and archaeomelrical research, as it is in other countries, will yield important results.

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