The use of natural resources at Mentesh Tepe during the Late Chalcolithic period and the Early Bronze Age

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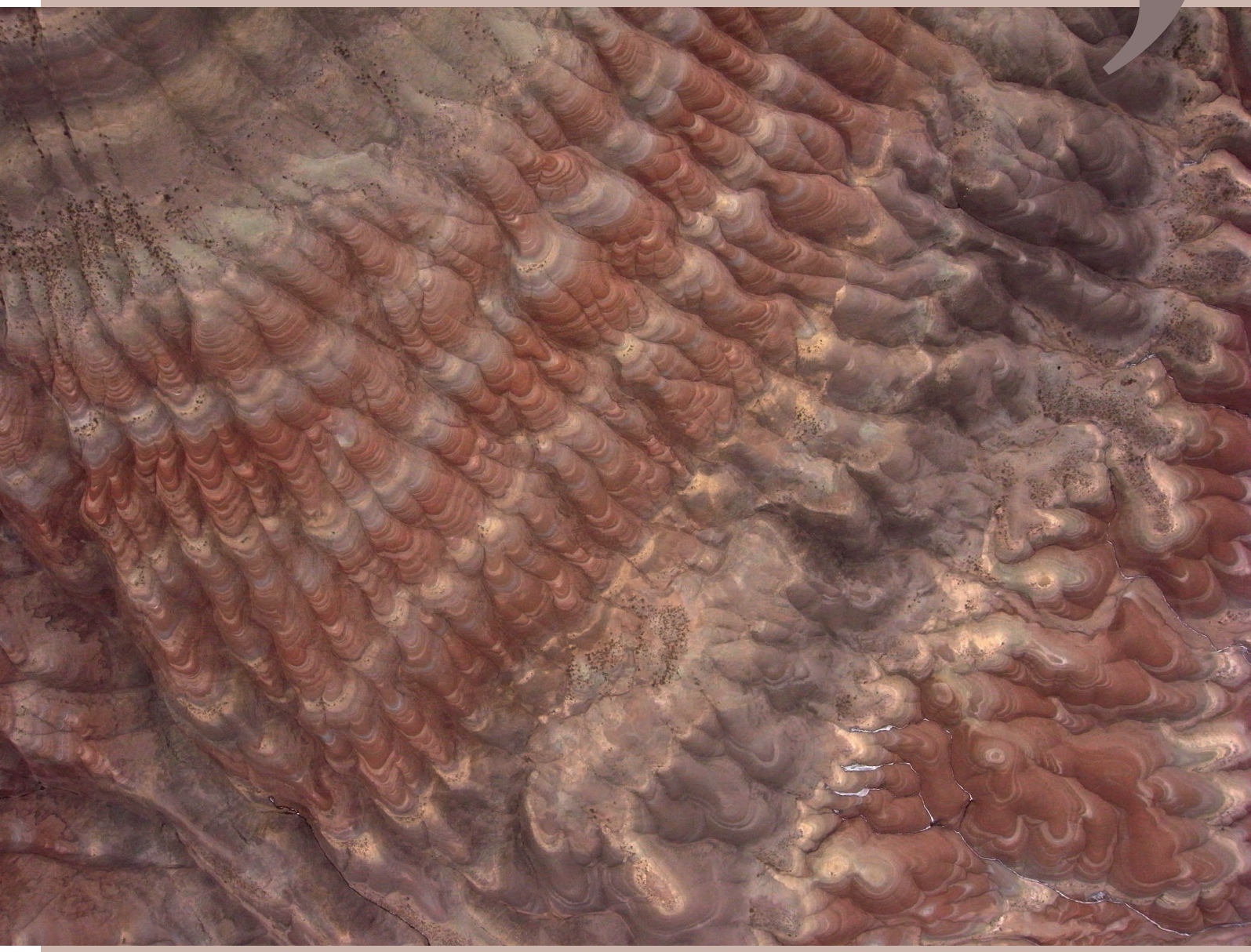

ON SALT, COPPER AND GOLD
THE ORIGINS OF EARLY MINING AND METALLURGY IN THE CAUCASUS

edited by Catherine Marro and Thomas Stöllner

MOM éDITIONS

ON SALT, COPPER AND GOLD: THE ORIGINS OF EARLY MINING AND METALLURGY IN THE CAUCASUS

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An international conference focused on the beginnings of mining and metallurgy in the Caucasus was organised in Tbilisi in June 16th-19th 2016 under the auspices of the National Museum of Georgia. This conference, which was funded by the Agence nationale de la recherche (France) and the Deutsche Forschungsgemeinschaft (Germany), aimed at discussing the intricate relationships between the emergence of mining and metallurgy, and the shaping of late prehistoric societies in south-western Asia.

The Caucasus is renowned in Near Eastern archaeology for its wealth in natural resources, in particular in metal ores: for decades, scholars have surmised a specific causal relationships between the rise of complex, hierarchical societies in the Near-East and the development of extractive metallurgy. Metallurgy, however, is only the most visible part of the story that accounts for the dramatic changes perceptible in south-western Asia in the course of the 5th millennium BCE. Early mining, which is not restricted to metal-ore mining, certainly also had an impact in terms of economic networks, social dynamics, settlement patterns and regional integration, not only across the Caucasus, but also in the ancient Near and Middle East.

Drawing on these fundamental questions, this book explores the socio-economic, technological and environmental background that favoured the rise of systematic mining and extractive metallurgy in the Caucasus at the end of the Chalcolithic. How far was early mining linked to the spread of specific subsistence strategies such as pastoral herding? Were mined resources mainly intended for local consumption or distributed throughout the Near East, towards Anatolia, Iran or Mesopotamia? Here are some of the issues that are discussed in the present volume, which contains 21 articles written by some of the most eminent specialists in Caucasian archaeology.

Un colloque international axé sur les origines de l'extraction minière et de la métallurgie dans le Caucase s'est déroulé à Tbilisi du 16 au 19 juin 2016, sous les auspices du Musée national de Géorgie. Ce colloque, financé par l'Agence nationale de la recherche (France) et la Deutsche Forschungsgemeinschaft (Allemagne), avait pour objectif d'aborder les relations entre la naissance des mines et de la métallurgie, et l'évolution des sociétés protohistoriques en Asie du Sud-Ouest.

Le Caucase est connu en archéologie orientale pour sa richesse en matières premières, en particulier pour ses ressources métallifères ; pendant des décennies, les chercheurs ont présupposé l'existence d'un lien de causalité particulier entre l'émergence de sociétés complexes hiérarchisées au Proche et Moyen-Orient et le développement de la métallurgie extractive. Pourtant, la métallurgie n'est que la partie émergée d'une histoire marquée par des changements spectaculaires tout au long du V^e millénaire avant notre ère. L'extraction minière, par exemple, qui ne se réduit d'ailleurs pas à l'exploitation des minerais métallifères, a certainement eu aussi un impact sur les dynamiques sociales, les structures de peuplement, l'organisation des réseaux économiques et les processus d'intégration régionale, en Orient comme dans le Caucase.

Partant de ces questions fondamentales, cet ouvrage explore le contexte socioéconomique, technologique et environnemental dans lequel se sont développées la métallurgie et l'extraction minière à la fin du Chalcolithique dans le Caucase. Ainsi, dans quelle mesure les premières exploitations minières sont-elles liées à des stratégies de subsistance spécifiques, tel le pastoralisme ? Les ressources exploitées étaient-elles destinées à la seule consommation locale ? Ou bien étaient-elles aussi distribuées à travers le Proche-Orient, l'Anatolie, l'Iran ou la Mésopotamie ? Tels sont les thèmes abordés dans ce volume, qui contient 21 articles rédigés par quelques-uns des plus éminents spécialistes de l'archéologie du Caucase.

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This volume is dedicated to the memory of our dear colleague Antonio Sagona † (1956-2017).

Tony Sagona in the field, region of Sveli, Georgia (courtesy of C. Sagona).

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The use of natural resources at Mentesh Tepe during the Late Chalcolithic period and the Early Bronze Age

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This article gives the results of the analyses made by several specialists on some of the raw materials (metal, obsidian and semi-precious stones) found at Mentesh Tepe (Middle Kura Valley, Azerbaijan) during the Late Chalcolithic and Early Bronze Age periods. They show that the procurement zone extends between 30 to 300 km away from the site. The copper and arsenic sources used during the Late Chalcolithic period are confined to the volcanogenic massif sulfide deposits (VMS) in the Lesser Caucasus to the south of Mentesh Tepe. Questions are still raised on their origins during the Early Bronze Age, with gold and tin during the same period yet of unknown provenance. Obsidian analyses show that various sources were used, some being very far (actual Turkey). Gegham, in Armenia, was by far the most important one during the Late Chalcolithic period, while Chikiani, in Georgia, has possibly played this role during the EBA. Finally, the raw material used for the beads come from ophiolitic series and volcanic contexts in the Lesser Caucasus, at a short distance from Mentesh Tepe.

Cet article présente les résultats d'analyses faites par plusieurs spécialistes sur une partie des matières premières (métal, obsidienne et pierres semi-précieuses) trouvées à Mentesh Tepe (moyenne vallée de la Kura, Azerbaïdjan) et datant des périodes du Chalcolithique récent et du début de l'âge du Bronze. Ils montrent que la zone d'approvisionnement se situe à une distance de 30 à 300 km du site. Les sources de cuivre et d'arsenic utilisées pendant le Chalcolithique récent se trouvent dans les « gisements de sulfures massifs volcanogènes » (VMS) qui s'étirent au sud du site dans le Petit Caucase. La question de leur origine pendant le début de l'âge du

Bronze reste posée, de même que celle de l'or et de l'étain à la même époque. Les analyses de provenance de l'obsidienne montrent que plusieurs sources ont été utilisées, dont certaines, situées en Turquie actuelle, étaient très éloignées. Gegham, en Arménie, a été de loin la zone d'approvisionnement la plus importante au Chalcolithique récent, tandis qu'il est possible que Chikiani, en Géorgie, ait joué ce rôle au début de l'âge du Bronze. Enfin, les matières premières utilisées pour les perles viennent de couches ophiolitiques et de contextes volcaniques du Petit Caucase situés non loin de Mentesh Tepe.

Mentesh Tepe, in the middle Kura Valley (Azerbaijan) (*fig. 1*), stands as an exceptional proto-historic settlement with several successive occupations, from the Neolithic to the Early Bronze Age interrupted by two main hiatus (Lyonnet et al. 2012, 2016, 2017).[1]

During the Late Chalcolithic period, in the second half of the 5th millennium (between 4360 and 4115 in median radiocarbon dates), remains of one or several buildings made of unbaked mud-bricks as well as courtyards have been brought to light (*fig. 2*). Excavations have shown that different craftsmanship activities took place both inside and outside the buildings, including metallurgy, lithic and pottery production. Several features of this period have been interpreted as related with northern Mesopotamia.

During the Early Bronze Age, the place seems to have had only a funerary character with the implantation of two successive kurgans with multiple burials and several individual burials. A great number of pits have also been related to this period (*fig. 3*). The first kurgan (ST 4) is linked with the beginning of the Kura-Araxes culture and dated to the end of the 4th millennium (between 3155 and 2986 in median radiocarbon dates); it contained at least 39 individuals but gave only little

Fig. 1 – Location of Mentesh Tepe in Azerbaijan (basemap available on Internet).

1. This article was first submitted to the editors in spring 2017. Only references have been completed when necessary.

funerary material – among which mainly stone beads – and was ritually destroyed by fire at the end of its use (Lyonnet et al. 2015). The second kurgan (ST 54) is related to the Martkopi phase of the Early Kurgan culture/end of the Kura-Araxes culture and dated between 2495 and 2408 in median radiocarbon dates; it contained three individuals and was fairly rich in jewelry (metal and stone) (Pecqueur, Decaix, Lyonnet 2017).

Fig. 2 – Mentesh Tepe, period III (Late Chalcolithic 1), plan of the structures (Mission Mentesh Tepe; É. Degorre, Eveha).

In this article, we intend to give an overview of some of the various mineral resources found at the site in order to trace back the procurement zones. We will concentrate chronologically on the Late Chalcolithic Period and the Early Bronze Age, and, as far as the material is concerned, on the metal ores, the obsidian, and the semi-precious stones. In so doing, our aim is to better understand the radius of action of the population at Mentesh Tepe for its procurement of these raw materials.

Fig. 3 – Mentesh Tepe, period IV (Early Bronze Age), plan of the structures (Mission Mentesh Tepe; É. Degorre, Eveha).

Metal

One among the most interesting discoveries made at Mentesh Tepe is the number of finds linked with metallurgy during the Late Chalcolithic period. Several articles have already been published (for instance Courcier 2012; Courcier forthcoming). Very few other sites dating to this period – except Değirmentepe in eastern Turkey, unfortunately inadequately published, and Ovçular Tepesi in Nakhchivan (Gailhard et al. 2017) – have yielded such abundant data on local metallurgy. Beside a great number of objects (69), mainly awls and rings (*fig. 4*), discovered in different places in and outside the buildings, all the different steps of the *chaîne opératoire* leading to them, have been brought to light: ores, crucibles, slags, moulds and ingots (Courcier forthcoming). Correcting an earlier theory (Chernykh 1992), this important discovery places the southern Caucasus on a level comparable with that of the Balkan "province" where metallurgy was already carried on during the second half of the 5th millennium.

Most of the manufactured objects are made from unalloyed copper with significant traces of lead and silver, but 13 are in arsenical copper (1.1-3.2%) (Courcier forthcoming). Archaeometallurgical studies have been made, including mineralogical investigations (thin-section, SEM-EDS, XRD, metallographies) and chemical ones (ICP-MS) at the Bochum Laboratory of the Deutsches Bergbau Museum under the direction of A. Hauptmann and M. Prange, as well as isotopic analyses

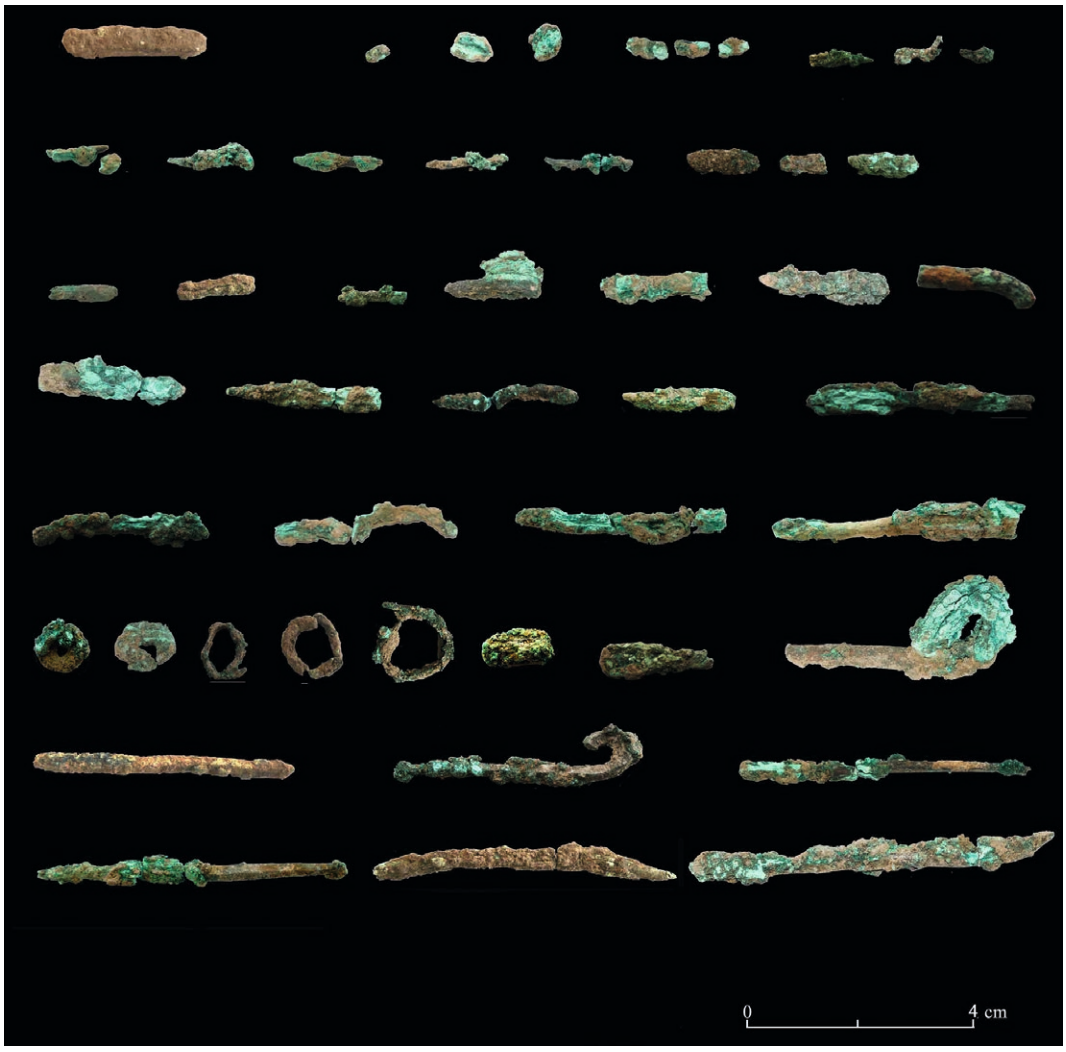

Fig. 4 – Mentesh Tepe, awls and rings from periods III and IV (Mission Mentesh Tepe; A. Courcier).

(HR-MC-ICP-MS) at the department of petrology and geochemistry of the Goethe University in Frankfurt under the direction of Prof. Dr Sabine Klein. The aim was to identify the possible sources for the metal ores. They have shown two possible areas for these procurements, west and south of Mentesh Tepe (*fig. 5*). The first possible one (west) includes three metallogenic zones: Bolnissi-Madneuli (Madneuli deposit), north of Alaverdi Kapan (Shamlug, Akhtala, Agvi, Ankadzor deposits) and north of Pambak-Zangezur (Fioletovo deposit). The second one (south) includes two metallogenic zones: Sotk-Gosha (Gosha) and Kedabek (Siny Yar, Kedabek).

These results point at three possible areas within the "volcanogenic massif sulfide deposits" (VMS) for the origin of the copper ores: eastern Armenia (districts of Alaverdi and Vanadzor), southern Georgia (district of Madneuli), or south-west Azerbaijan (districts of Gosha and Kedebek), i.e. in a radius varying between 40 and 180 km from Mentesh Tepe.

The Early Bronze Age period at Mentesh Tepe is devoid of traces of architecture except for two kurgans, several individual graves, and a great number of pits where the material is mixed with that of the earlier periods and therefore difficult to date with certainty. We will then only deal here with the metal found in secure contexts.

At the beginning of the Early Bronze Age, in kurgan ST 4, only a few items have been found, made either of fired clay (21 pots) or of stone (hundreds of beads, see below), but metal artefacts were singularly absent, possibly because they had been collected before the kurgan was set on fire for ritual reasons (Lyonnet et al. 2015).

The metal items we have from secure contexts come essentially from the second kurgan, ST 54, which is related to the Martkopi phase of the Early Kurgan Culture (or the end of the Kura-Araxes culture) (Pecqueur, Decaix, Lyonnet 2017). These items consist of spiral-shaped hair rings found near the skulls of two women skeletons. One of the women also wore two spiral bracelets and, probably sewn on her costume near the shoulder, a small umbo or mastos-shaped casket (*fig. 6*).

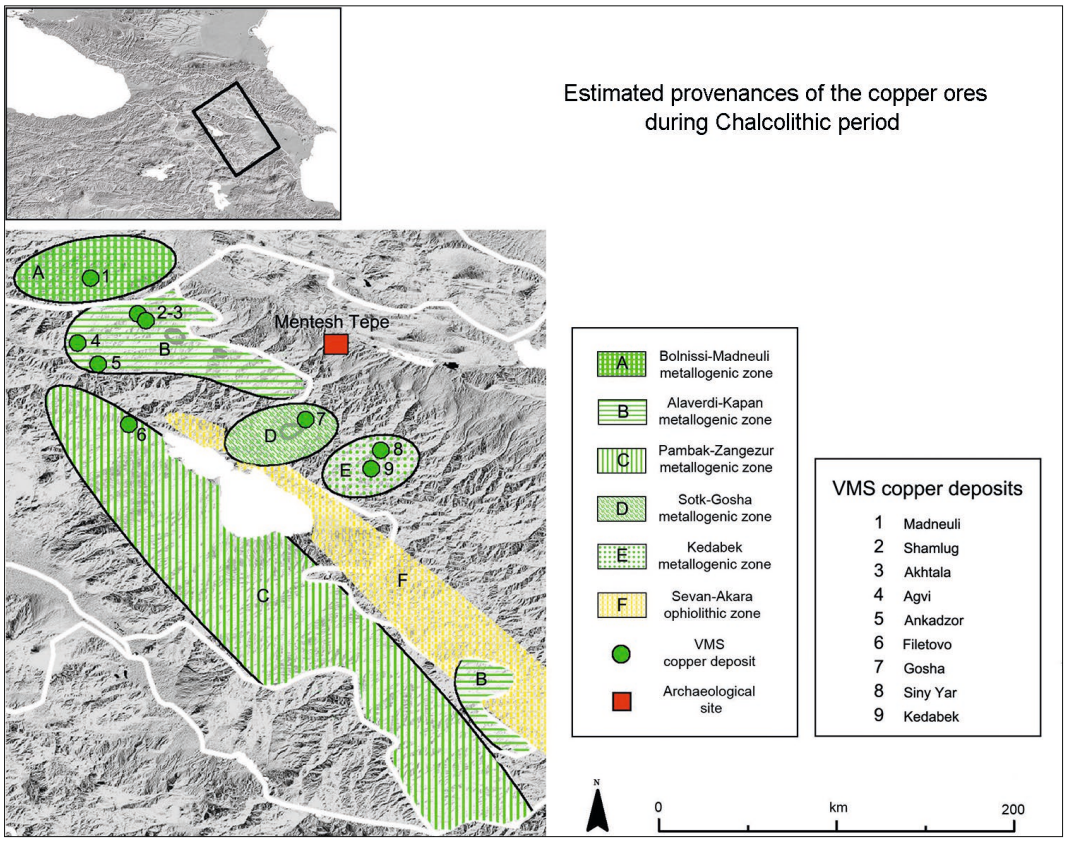

Fig. 5 – Mentesh Tepe, map showing the estimated provenance of the copper ores (Mission Mentesh Tepe; A. Courcier).

Analyses by ICP-MS have shown that the spiral-shaped hair-rings and the bracelets are made of bronze (from 2 to 11% Sn), with small amounts of arsenic (0.15 to 0.45% As) and significant traces of lead, while the umbolum-shaped casket is made of a silver-copper alloy (49.8% Ag, 42.9% Cu). We still have no clue as to the provenance of tin, but tin is rare in the Caucasus so that it probably comes from elsewhere. The provenance of the copper is still under question: either Alaverdi-Kapan or Gosha in the Lesser Caucasus, or with a foreign origin, like the tin.

Several gold beads, a gold hair-spiral and a gold ring have also been discovered in this kurgan and are related to a third person, an aged man (*fig. 7a, 7b-d*). At first, it seemed plausible that the gold came from Sakdrisi, an important gold mine in the Madneuli district of Georgia exploited during the Early Bronze Age (Gambashidze, Stöllner 2016), but the analysis made by M. Jansen at the Bochum Laboratory and at the Institute for Geosciences of the Goethe University (Frankfurt) has demonstrated that this is not the case. For both the ring and a bead, observation with a digital microscope has shown the presence of inclusions made of platinum group elements (PGE), i.e. natural alloys of osmium, iridium and ruthenium (Jansen et al., this volume). These cannot be found in primary gold deposits such as Sakdrisi, but they derive from chromite in ultrabasic rocks. These rocks eroded, and the PGE minerals have accumulated together with gold from a primary gold source in a secondary placer deposit. The PGE minerals were subsequently incorporated in the artefacts after panning and melting

Fig. 6 – Mentesh Tepe, kurgan 54 (Early Kurgan culture), individual no. 2 (in situ) together with her jewelry (Mission Mentesh Tepe; L. Pecqueur).

of the gold from this deposit. A XRF analysis has shown that the bead is an alloy mainly consisting of gold and silver, with some copper (*tab. 1*). Both the ring and the bead correlate together well in their tin and platinum content with most of the artefacts from the Lesser Caucasus that have been analyzed (Jansen et al., this volume). This, together with the presence of PGE inclusions, shows that the metal used is placer gold, i.e. from alluvial origin, but its exact provenance cannot be established for the moment.

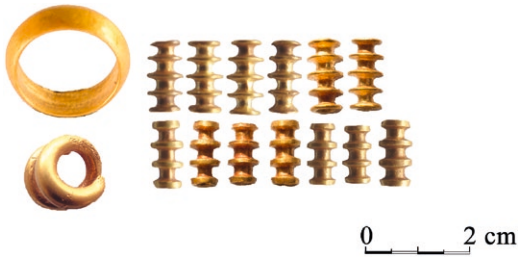

Fig. 7a – Mentesh Tepe, Kurgan 54 (Early Kurgan Culture), the gold jewelry of individual no. 1 (Mission Mentesh Tepe; A. Courcier).

Fig. 7b – Mentesh Tepe, Kurgan 54 (Early Kurgan Culture), detail of the analyzed gold bead (Mission Mentesh Tepe; M. Jansen).

Fig. 7c – Mentesh Tepe, Kurgan 54 (Early Kurgan Culture), detail of the analyzed gold bead (Mission Mentesh Tepe; M. Jansen).

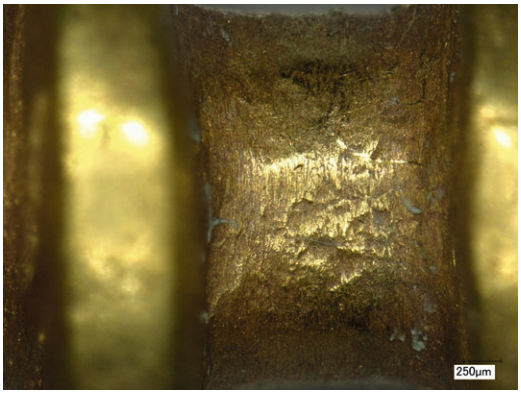

Fig. 7d – Mentesh Tepe, Kurgan 54 (Early Kurgan Culture), detail of the analyzed gold bead (Mission Mentesh Tepe; M. Jansen).

Sample	Au	2σ	Ag	2σ	Cu	2σ
Bead	81.9	0.5	17.5	0.2	0.52	0.05

Tab. 1 – Mentesh Tepe, results of the XRF analysis of the gold bead (Mission Mentesh Tepe; M. Jansen).

Obsidian

A large number of obsidian tools and flakes and a few nuclei have been discovered in all the levels of occupation at the site. The obsidian items present a wide range of colors and appearances. The technology used for the tool production is still under study by L. Astruc, D. Guilbeau and A. Samzun (for preliminary studies, see Astruc, Samzun, Gratuze 2012; Guilbeau, Astruc, Samzun 2017).

In order to trace the origin of the raw material, a great number of samples have been analyzed. In addition, samples of obsidian fragments used as a temper for some Late Chalcolithic pottery types – essentially cooking pots – have also been analyzed (Palumbi et al. 2018).

For the Chalcolithic period, the studied sample includes a total of 268 lithic elements (blade production and flakes) coming from well stratified contexts and 78 inclusions from 47 ceramic pots. We have less data for the Kura-Araxes chipped stone as this period is mainly represented on the site by two kurgans and pits, the context of which is often mixed with earlier material. Nevertheless, on a technological basis, four artefacts have been chosen and characterized by geochemistry.

Altogether, this represents, so far, the largest archaeological sample that has been geochemically characterized among the Caucasian and Near Eastern sites.

Methods

Two complementary analytical methods were used by B. Gratuze at the IRAMAT/Centre Ernest-Babelon Laboratory (Orléans). The first one is based on Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) and the second one on a non-destructive X-ray fluorescence approach (XRF). Among the 696 analyses, 42 were made exclusively by LA-ICP-MS, 342 by XRF, and 312 by both methods. In addition, 78 obsidian inclusions in clay pots were analyzed by LA-ICP-MS.

Given the specifications of the equipment, the LA-ICP-MS method offers several advantages (Chataigner, Gratuze 2014a, 2014b):

– it analyses 38 major, minor and traces elements in a single run, regardless of their concentrations and their isotopic abundance;
– the laser sampling (approximately 100 micrometres in diameter and 150 micrometres in depth) is invisible to the naked eye; this means that this method is virtually non-destructive and is particularly adapted to the characterization of obsidian inclusions present in ceramics;
– the measurement time (below one minute per samples) makes possible the characterization of a large number of artefacts per day.

A semi-quantitative X-ray fluorescence approach was developed to compare its potential for obsidian source identification to that of LA-ICP-MS. XRF gives the quantification of only 12 minor and trace elements present in obsidian: Al, K, Ca, Ti, Mn, Fe, Rb, Sr, Y, Zr, Nb and Ba. The instrumentation used was an ARTAX portable µ-XRF spectrometer from Bruker, equipped with a tungsten X-ray tube. The operating conditions for the X-ray tube were 45kV and 0.8 mA with an acquisition time of 1200 s. One of the main advantage of this technique is that it gives the measurement of large samples (blade superior to 15 cm in length or nucleus being more than 3 cm thick) that cannot fit in the LA-ICP-MS ablation chamber.

For both the XRF and LA-ICP-MS methods, geological samples from sources located in Armenia, Georgia and Turkey, and archaeological artefacts were analyzed together. Calibration of the XRF measurements were achieved by using the LA-ICP-MS data obtained on the artefacts analysed with both methods.

Comparison of the results obtained by both methods shows that a good discrimination of most of the main Caucasian obsidian sources can be achieved by XRF. However, this method is not precise enough to clearly distinguish between the sub-sources of the Sjunik area (Bazenk, Sevkar and Mets Satanakar) or the Sarıkamış area, or to identify with full confidence some obsidian flows originating from Arteni and Gutansar. Therefore, we developed an analytical protocol aiming at a systematic characterization of all the artefacts by XRF and used the LA-ICP-MS only to confirm the attribution of the sources through a limited number of artefacts selected among the different groups determined by the XRF results. However, for sources which present a systematic overlap, or for artefacts which are more difficult to characterize due to surface conditions or thickness, LA-ICP-MS analysis was systematically used.

As we mentioned above, we also analyzed the obsidian temper included in Chalcolithic ceramics. In contrast to the protocol described elsewhere (Palumbi et al. 2014), the inclusions were extracted from the clay before their analysis by LA-ICP-MS. The results obtained from this particular treatment of the obsidian have been compared with the data coming from the chipped stone industry.

Results

The very large sample studied from Mentesh Tepe – so far the largest archaeological sample among Caucasian and Near Eastern contexts for which a characterization has been searched for – has clearly enabled us to identify a larger amount of exploited sources than is usually the norm. Our understanding of the procurement is therefore more detailed and includes sources usually less visible.

During the Chalcolithic period, the lithic industry is oriented towards the production of blades. The *débitage* of unipolar blades is predominant. The production made using different kinds of pressure techniques is highly standardized (*fig. 8.1-2*). Among the 268 blanks that we had selected, the geological spectrum is wide (*fig. 9*) and shows that nine sources were used, located in Armenia, eastern Anatolia and Georgia. Following a decreasing numerical order, they point to: Gegham, Sarıkamış, Tsaghkunjats, Chikiani, Gutensar, Sjunik 3, Arteni, Hatis and Khoraphor (*fig. 10*). To sum up, a large variety of sources was then exploited, among which Gegham played a major role.

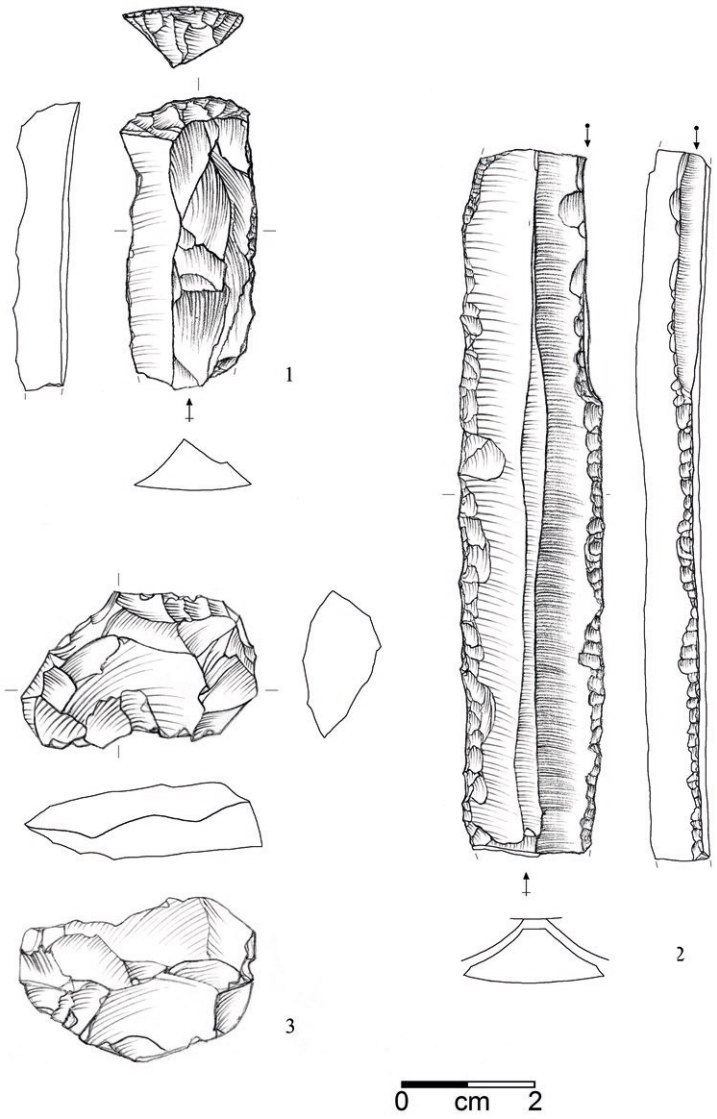

Fig. 8 – Mentesh Tepe; 1-2: examples of the Chalcolithic *débitage* technique; 3: example of the Kura-Araxes *débitage* technique (Mission Mentesh Tepe; D. Guilbeau).

The prevalence of Gegham during the Late Chalcolithic period is confirmed by the analyses performed on the 78 obsidian temper inclusions coming from 47 pots. There, six different sources have been identified: Gegham, Sjunik, Tsaghkunjats, Gutensar, Sarıkamış and Chikiani (*fig. 11*). Those located in Armenia are the most frequent, especially Gegham, with 52 inclusions. It is worth mentioning that remoter sources, like Chikiani, in Georgia, and Sarıkamış in eastern Turkey are also attested. These results, therefore, show the use of similar sources for temper in pottery and for the chipped stone industry.

There is an immense variation in the distances between Mentesh Tepe and the exploited sources during the Late Chalcolithic period. None is less than 100 kilometers away, most are between 100 and 150 kilometers, and Sarıkamış, the farthest one, is 270 km away.

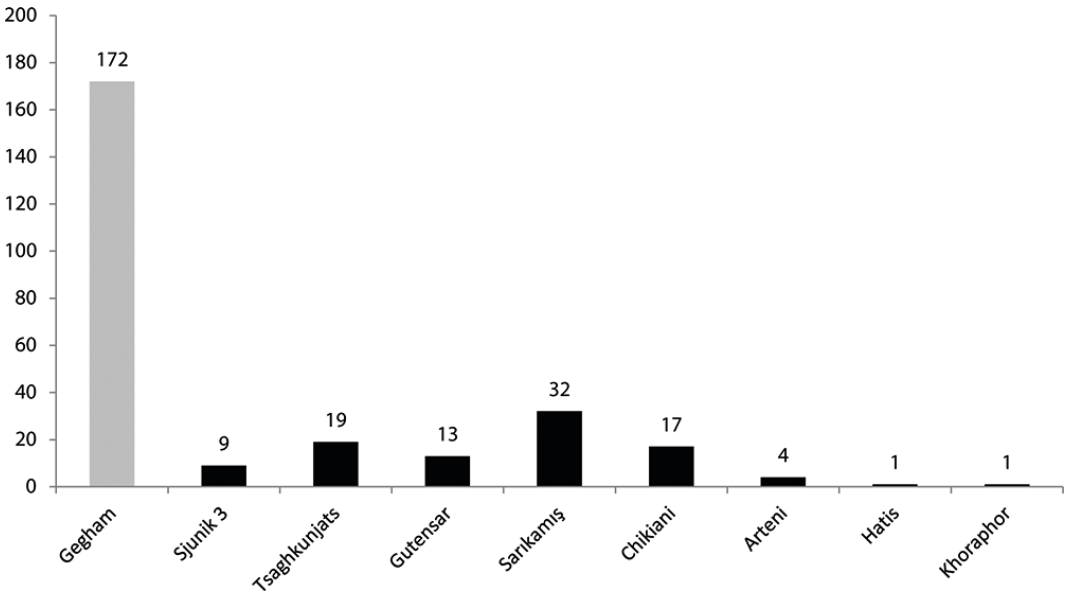

Fig. 9 – Mentesh Tepe, graph showing the repartition of the obsidian sources for the lithic industry during the Chalcolithic period (Mission Mentesh Tepe; B. Gratuze).

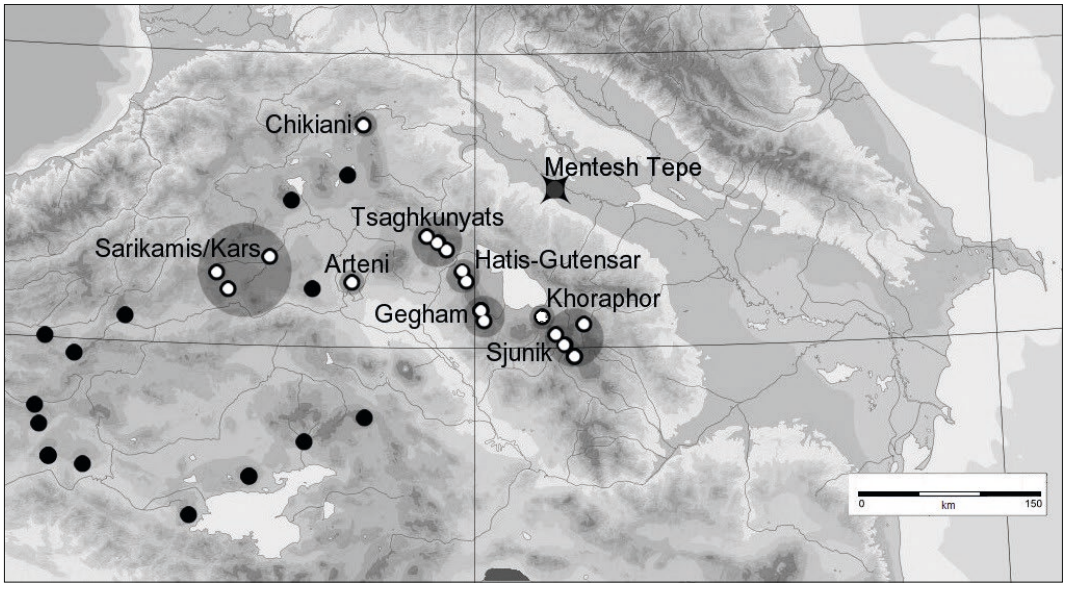

Fig. 10 – Mentesh Tepe, map showing the different sources of obsidian discovered at Mentesh Tepe (Mission Mentesh Tepe; B. Gratuze).

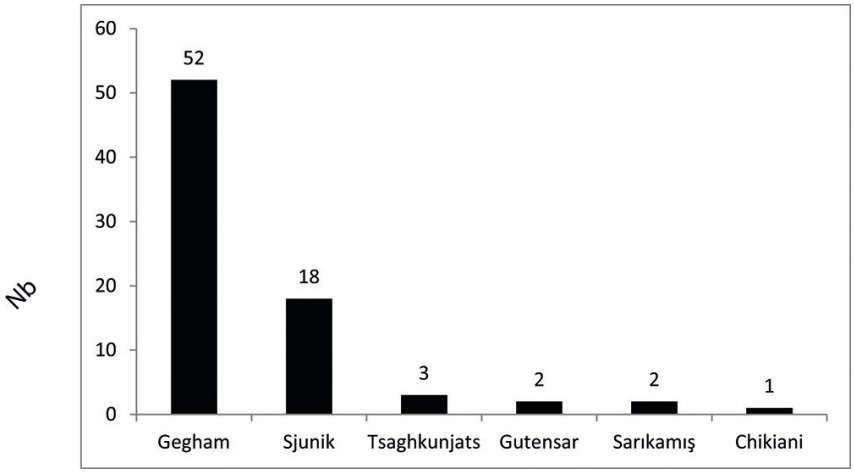

Fig. 11 – Mentesh Tepe, graph showing the repartition of the obsidian sources used as temper in the pottery during the Chalcolithic period (Mission Mentesh Tepe; B. Gratuze).

Though metal was already well in use during the Early Bronze Age, obsidian as a raw material for tools was still worked at that time. The industry, then, is mostly oriented towards the production of flakes by direct percussion (*fig. 8.3*). Various modalities of *débitage* are attested and the nuclei are often discoidal. One sequence of production has been discovered in situ: a long nodule was knapped in thick slices by hard direct percussion. Among the four cores that were analyzed, two are from Chikiani, one from Gegham and one from Hatis. Due to the small amount of samples for this period, this variety shows that, as was the case for the Late Chalcolithic period, multiple sources were also probably exploited during the Early Bronze Age. However, the region of the Paravani lake (Chikiani) may have played the dominant role at that time.

Semi-precious stones

In the levels dated to the Late Chalcolithic period as in the two kurgans of the Early Bronze Age, a number of beads in semi-precious stones have been discovered. A large proportion of them consists of similar small white or black ring beads, while the rest is represented by items of different shapes and dimensions, and of various materials and colors. To characterize their mineralogical composition and the provenance of the raw material, a sample of the most representative in shape and/or material (14 beads, *fig. 12*) were analyzed by S. Ostaptchouk at the Muséum national d'histoire naturelle in Paris using the Fourier Transform Infrared Spectroscopy (FTIR) analytical tool with three different methods: Specular Reflection (SR), Attenuated Total Reflection (ATR), and Potassium Bromide Pellet (KBr). A more detailed article on these analyses has been published (Ostaptchouk 2017). They show that almost the same raw material was used in both periods.

This is the case for green-rock beads composed of silica, carbon and magnesium minerals that leads to serpentine. One is a pendant-like bead (MT10-PO.09) dated to the Late Chalcolithic period, the other a barrel-shaped bead (MT09-PO.16), coming from kurgan ST 4 that had been de-structured, probably due to the heat of the final fire.

Similarly, in both periods were found red translucent beads made from chalcedony, with their red color indicating carnelian. One is a ring-bead from Late Chalcolithic levels (MT10-PO.16), three others, triangular in shape (MT13-PO.32, -PO.34 and -PO.29) were found on one of the women's skeleton in kurgan ST 54 of the Martkopi phase of the Early Bronze Age.

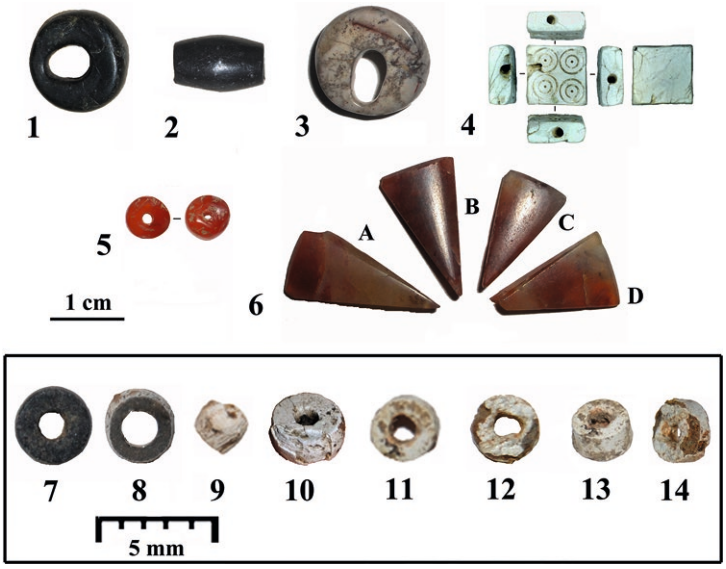

Fig. 12 – Mentesh Tepe, beads and micro-beads from periods III and IV analysed through FTIR; upper part, beads; 1: MT10-PO.09; 2: MT9-PO.16; 3: MT13-PO.01; 4: MT13-PO.23/IO.157; 5: MT10-PO.16; 6: MT13-PO.32, -PO.34, -PO.29; lower part, micro-beads; 7, 8: black beads MT09-PO.40A (7) & B (8); 9-14: white beads MT09-PO.40A (9), C (10) & D (11), MT10-PO.25 (12), MT10-PO.01 (13), MT10-PO.02 (14) (Mission Mentesh Tepe; S. Ostaptchouk).

In both periods, too, are found white and black micro-beads, all ring-shaped except for one, poorly preserved, whose original shape is unknown. The raw material of the black ones (MT09-PO.40A and -PO.40B) is hard, while the white ones (MT09-PO.40A[2], MT09-PO.40C-D, MT10-PO.25, MT10-PO.01, MT10-PO.02) are soft and crumbly, most of them with a crust on the surface. Analyses point to an enriched-talc rock like steatite for one of the black ones, and to serpentine (chlorite-serpentinite) for the other. Both come from kurgan ST 4 at the beginning of the Early Bronze Age. As for the white ones, their analysis show that they were made from talc-paste, but more or less completely dehydroxylated and heated to different degrees of temperature; they are identified as steatite-paste beads. They come from both the Late Chalcolithic levels and from kurgan ST 4 at the beginning of the Early Bronze Age.

One white-rock pendant-like bead has been found in Late Chalcolithic levels (MT13-PO.01). From the analysis, it is made from an undetermined clay-rich rock.

Finally, one of the 10 square beads (MT13-PO.23/IO.157) found on the arm of one of the women's skeleton in kurgan ST 54 (Early Bronze Age) has been identified as a paste bead made of a mixture of talc/steatite and clay.

Similarities in geological formation (serpentinite or steatite rocks) link together the white paste beads and the stone steatite beads. Steatite should be searched for with serpentinite and gabbros in ophiolithic series.

Carnelian is a chalcedony, i.e. an assemblage of very fine quartz crystals of a regular size, all organized in the same way leading to the formation of pseudo fibers and colored by iron oxide impurities. It is close to flint in which the quartz crystals are arranged without orders. Both come from silica in solution. Quartz-bearing sandstone is converted into quartzite through heating and

2. The same number was given to a group of black and white beads found together.

pressure related to tectonic compression within orogenic belts. Quartzite can be issued both from sedimentary and metamorphic formation processes and we cannot, from our small number of samples, better identify its origins.

To sum up, the raw materials used for the beads come from ophiolitic series (serpentinite, gabbros, steatite/talc associated in metamorphic zone) and volcanic context (with feldspar-rich rocks, silica glass or hydrothermal silification). These geological formations are attested in the Lesser Caucasus and Mentesh Tepe is very close to a large belt rich in these resources (ca 30 km to the south-west) (*fig. 13*).

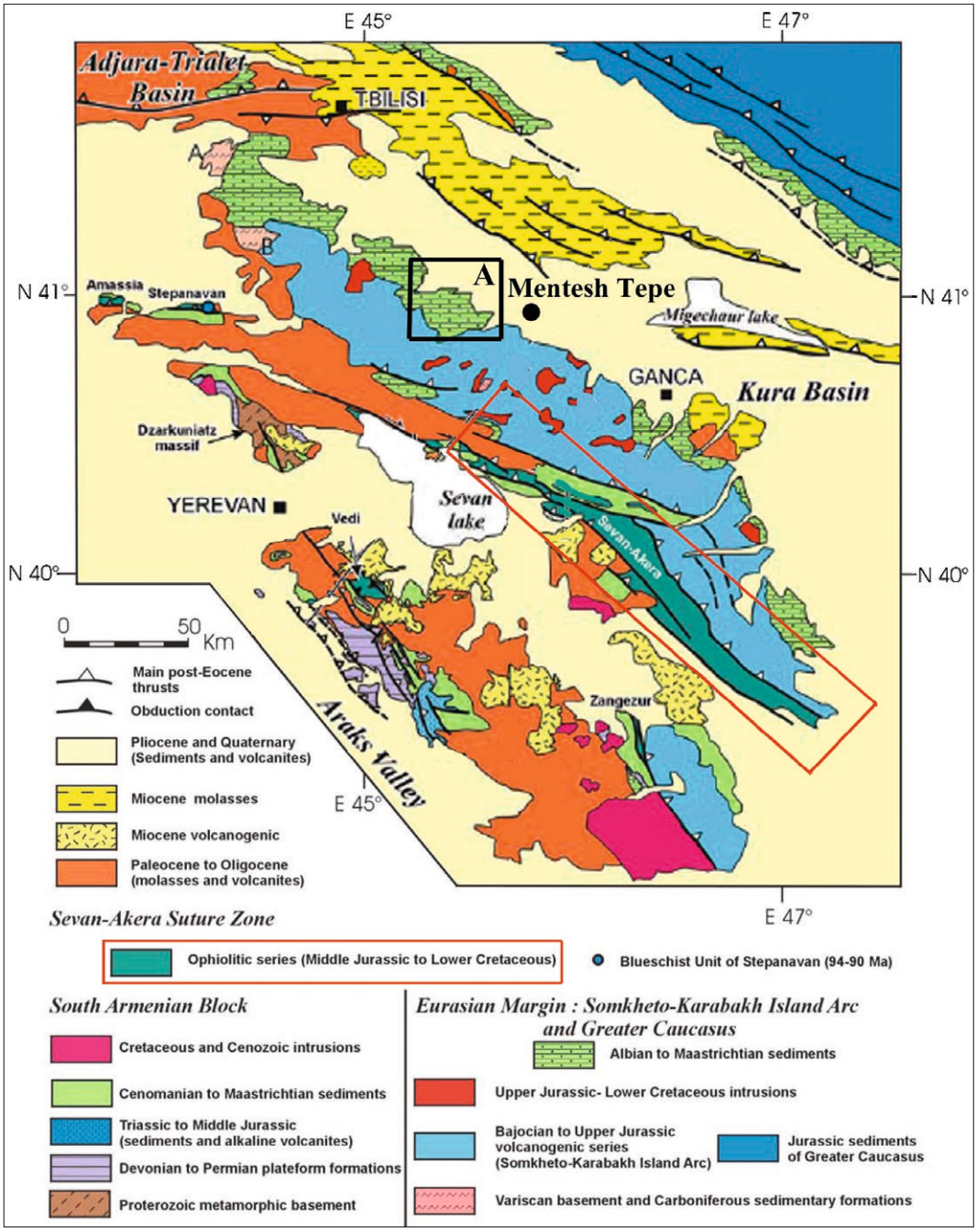

Fig. 13 – Mentesh Tepe, map showing the location of the site in relation to the ophiolitic belt (Mission Mentesh Tepe; S. Ostaptchouk).

Conclusion

The results from analyses of three different kinds of raw material (metal, obsidian and semi-precious stones) used at Mentesh Tepe during the Late Chalcolithic period and the Early Bronze Age show that these raw materials came from an area extending between ca 30 and 300 km away.

The most distant procurement zone is for the obsidian and our results confirm earlier studies showing that the closest sources were not necessarily those that were exploited (Chataigner, Barge 2010). Metal came from copper deposits close to the Sevan Akara ophiolite belt and semi-precious stones could have come from this ophiolitic belt that, actually, extends further, from north-eastern Turkey to Iran, *via* Armenia, Georgia and Azerbaijan, and is close to Mentesh Tepe. Only gold and tin may come from far away, but further analyses are necessary to determine their exact provenance.

None of the rivers close to Mentesh Tepe (Shamkir chaj, Zeyem chaj, Esrik chaj and Tovuz chaj) is directly connected to any of the mentioned volcanos providing obsidian, so that we can exclude an occasional direct fluvial transport of obsidian pebbles. However, these streams pass through the ophiolitic belt and occasional pieces of ores or semi-precious stones/pebbles may have been present downstream.

Among other possibilities of procurement, one is linked with the way of life of the populations. The earliest preliminary results from isotopic analysis on animal teeth from the Late Chalcolithic period tend to show already at that time a possibly mobile way of life with animals living in the pasture lands of the Lesser Caucasus during the summer (Mashkour, study in progress). It is also well known that the Early Bronze Age populations settled higher in altitude than their predecessors. This mobility may have led to the discovery of metal ores and of semi-precious stones in these highlands. It may also explain the preference of the Gegham sources for obsidian since they are at a high altitude and only available in the summer time (Barge, Chataigner 2003). However, the collection of obsidian for tools is already well attested during the Neolithic period when life seems more sedentary, and other explanations have to be sought. These may then be found in the cultural relations and exchanges that have been brought to light between the southern Caucasus and the northern Mesopotamian or eastern Anatolian cultures at the time of the Shomu-Shulaveri culture during the Neolithic and the Late Chalcolithic period.

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