# Chapter 22
# Ancient Metallurgy in the Caucasus From the Sixth to the Third Millennium BCE

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## Introduction

The region known as the Caucasus includes on its northern side several autonomous republics still within the Russian Federation, and on its southern side, three totally independent countries: Georgia, Armenia and Azerbaijan (including the semi-autonomous region of Nakhchivan). Several natural features characterize the Caucasus from north to south: the plains and plateau of Pre-Caucasia (or Ciscaucasia); the chain of the Greater Caucasus; the Colchedia River depression; the mountains of the Lesser Caucasus; the Kura and Araxes River depressions; and the Armenian knot (Frolova 2006, p. 18). The southern part of the Caucasus is also referred to as "Transcaucasia" based on the Russian literature. The Greater Caucasus region is defined by an axis with a general orientation NW–SE, and is 130 km wide on the Elbrus meridian and 170 km wide on that of Dagestan. The highest summits of the Caucasus are located between the Elbrus and the Kazbek mountains. Despite the mountainous terrain, the Caucasus is characterized by several passes that can be crossed seasonally (Freshfield 1896).

According to a recent global imaging systems (GIS) project (Cassard et al. 2009), the Caucasus is characterized by a diverse and complex metallogeny. The outcrops and deposits are numerous (more than 1,800) and present multiple metalliferous mineralizations in the form of mineralogical associations (e.g. fahlores), native metals (Cu, Au and Ag) and hydro-carbonated/oxide ores (e.g. malachite). These deposits were mineralized principally during the Precambrian, Variscian, Alpine and Eocene–Quaternary cycles. It should be underlined that ophiolitic formations were mineralized in the Caucasus (North and South) from the Middle Paleozoic until the Hauterivien. These particular host-rocks are linked to the evolution and the closing of the Thetys Ocean. Copper-bearing ophiolitic formations,

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known in different areas of the Near East (Oman, western Iran, Turkey and Caucasus), are directly linked to nickel and cobalt mineralizations. In spite of a geology generally unfavourable (basic and ultrabasic rocks) to the mineralization of tin, there are some examples of cassiterite and stannite deposits. Several regions contain such tin-bearing deposits, including North Ossetia, Karachay-Cherkessia, Kabardino-Balkaria, Dagestan, Georgia, Armenia and Azerbaijan (Cassard et al. 2009). Unfortunately, we have no information about the concentration or the amount of tin. Furthermore, no recent field research has been done on these deposits. This explains why the existence of tin deposits in the Caucasus is still a matter of debate among archaeometallurgists.

To explain the development of metallurgy in the Caucasus, this chapter will first give a brief introduction to the history of research into early metallurgy of this region. After this, the rest of the chapter is organized chronologically—from the "Early Metallurgical stage" (from sixth to early fourth millennium BCE) to the "rise" of true metallurgy (from early fourth to third millennium BCE)—and then spatially (from north to south). In each stage, we will detail what is known of the metallurgy of each archaeological culture as well as the importance of metals both intra- and inter-regionally.

## History of Research

### *Soviet Scholars*

A. A. Iessen and B. E. Degen-Kovalevskij's 1935 publication was the first systematic research on ancient metallurgy in the Caucasus. In spite of chronological problems, the topic was approached through the combination of archaeological and geological/metallogenical data. Their synthetic work on the ancient extractive and manufacturing metallurgical sites of the northern Caucasus (and to a lesser degree of the southern Caucasus) have not yet been re-examined but nevertheless constitute an important reference for later works (e.g. Kuftin 1944, 1950; Formosov 1965).

Numerous studies appeared during the 1950s and 1960s, mainly concerned with Early Bronze Age metallurgy (ca. third millennium BCE) both in the northern Caucasus (Krupnov 1951, 1960; Iessen 1951) and in Transcaucasia (Dzhaparidze 1955; Abesadze et al. 1958; Khanzadjan 1964, 1967; Iessen 1959, 1965). This period also corresponds to the first use of spectrographic analyses on metal artefacts in the laboratories of Baku and Tbilisi. The results of this research allowed for the characterization of the metallurgical practices of each culture in the Caucasus, and became the basis of theories like that of E. N. Chernykh (1966; see below) and others (e.g. Khanzadjan 1967; Selimkhanov 1960a, b, 1962, 1964, 1966; Selimkhanov and Marechal 1968; Kushnareva and Chubinishvili 1970; Gevorkjan 1974, 1980; Korenevskij 1972, 1974, 1984). These analyses, which were certainly an important scientific contribution at the time, are currently the subject of great debate as to their accuracy. Thus, the theories that are built on their shoulders are worth re-examining.

In the 1960s, Chernykh first put forth his influential theory on the existence of "metallurgical provinces" (Chernykh 1966). This hypothesis was enlarged during the following years (Chernykh 1978a, b, 1988, 1991, 1992, 2005; Chernykh et al. 1991, 2000, 2002) and succeeded in establishing a hierarchical model of metallurgical practice from the Chalcolithic period until the end of the Bronze Age. A "metallurgical province" corresponds to an arborescent system of "provinces", "zones", "focuses/foci" and "nuclei". Each zone contains several "focuses" based essentially on dependant relations: "metallurgical foci" (extractive metallurgy) and "metalworking foci" (manufacturing metallurgy). Such "zones" can correspond to whole regions or just particular metallurgical centres, sometimes even to specific archaeological cultures. However, "foci" often contain several cultures in a defined area. Each focus is characterized by four criteria: (1) typological uniformity of the metal products; (2) similarities of the techniques used, as much in the tools (principally the moulds) as in the types of metalworking (according to metallographic investigations); (3) homogeneity of the alloy compounds (according to spectral analyses); and (4) specific social structure or organization in a metallurgical centre (Chernykh et al. 1991; Chernykh 1992, pp. 7–10).

The technological dynamism and the expansion of a metallurgical province are governed by the "nuclei" which are included in the focus and correspond to metallurgical centres (extractive or manufacture) of production or distribution. The influence of the technological traditions of these metallurgical centres is perceptible over a large area.

For example, according to a widely held theory (e.g. Kushnareva and Chubinishvili 1970, p. 113; Kavtaradze 1999, p. 71), reiterated principally by Chernykh (1966, pp. 48–49, 1992, p. 60), metallurgy appeared first in Transcaucasia owing to favourable metallogenical conditions (hydro-carbonate and oxide copper ores such as malachite, azurite, *etc.*) that were exclusively present in the southern Caucasus. However, this theory is not supported by recent metallogenical data (Cassard et al. 2009; see below). Indeed, numerous copper deposits are also present in the northern Caucasus in their hydro-carbonate and oxide ore state.

Chernykh (1966, 1972, 1978a, b), based on his research in south-eastern Europe, also proposed that only the copper deposits of the Carpatho-Balkan region were characterized by ores without impurities. On the basis of this assumption, he suggested that all objects of "pure copper" found in the Caucasus came from the Carpatho-Balkan region (Chernykh 1991, pp. 585–587, 1992, pp. 39–53). This hypothesis, which is one of the foundations of his metallurgical province theory, has now come into question, given the existence of copper deposits without notable impurities in the Caucasus (Cassard et al. 2009; see below).

Another point of Chernykh's paradigm that needs to be re-evaluated is the "historico-technical" scheme, according to which he considers the type of ore (e.g. nickel cuprous) or the nature of the ore (e.g. hydro-oxidized, sulphate) to be determining factors for ancient metallurgy (Chernykh 1966, pp. 44–49, 1992, p. 11). That is, the earliest metallurgy is supposed to be linked to the exploitation of the altered dissolution zone of a deposit (oxide, carbonated and hydro-carbonated ores). Only in later periods, he argues, were more elaborate processes developed (arbitrarily fixed to the Middle and Late Bronze Age) that allowed early metalworkers to exploit the sulphur ores of the deposit (Chernykh 1966, pp. 45–46 and 49, 1992, p. 5 and 60; Palmieri et al. 1993, pp. 594–598).

This theory of historico-technical determinism was widely adopted by Soviet researchers and still today affects our understanding of ancient metallurgy in the Caucasus (e.g. Pitskhelauri and Chernykh 2003; Korenevskij 2004; Markovin 2004; Rezepkin 2001; Ryndina 2003; Ryndina and Ravich 2000, 2001). In this article, we will underline the limits of Chernykh's paradigm and propose another schema for the development of ancient metallurgy in the Caucasus.

## *Western Scholars*

At the turn of the twentieth century, several discussions on ancient metal productions in the Caucasus were put forth (e.g. Klaproth 1823, 1935; Morgan 1889a, b; Bapst 1885, 1886, 1887, 1898; Baye 1899a, b, c, 1900). These works, however, concern mainly the second and first millennium BCE (from Middle/Late Bronze Age to Iron Age). It was not until the 1950–1960s that studies on earlier metallurgy of the Caucasus were first carried out by Western scholars.

Until recently, the Caucasus was considered a "mysterious periphery" in the archaeological publications on the Near East (Chataigner 1995). Several studies refer to the Caucasus as an hypothetical origin for ores and metals found in different regions throughout the greater Near East (e.g. Field and Prostov 1938; Eaton and McKerrel 1976, p. 176; Penhallurick 1986, p. 19; Vatandoust 1999, p. 124; Yener 2000, p. 3; Berthoud et al. 1982, p. 40; Crawford 1974, pp. 242–244; Kelly-Buccelati 1990, p. 119; Potts 1993, pp. 391–392), Levant (Tadmor et al. 1995, p. 143) and the Aegean (Betancourt 1970, p. 355; Laffineur 1994, p. 633). More specifically, the question about possible tin deposits in the Caucasus fed the debate on the origins of tin for Anatolian and Mesopotamian metallurgy (e.g. Deshayes 1960, p. 14; Muhly 1973, pp. 260–261 and notes 155–157; Moorey 1982, p. 14, 1994, p. 300; Pare 2000, p. 7; Yener 2000, p. 72).

H. Frankfort (1928, pp. 231–233) was one of the first to note parallels in metal artefacts between Mesopotamia and the Caucasus. He argued for a relationship based on a trade in metal between the Caucasus and Anatolia during the Uruk period. He considered the Caucasus to be an important metallurgical centre linking central and eastern Europe with the greater Near East (Frankfort 1932, pp. 39–40). In his brilliant PhD thesis, some 30 years later, J. Deshayes (1960) underlined the typological parallels in the tools and weaponry between south-eastern Europe (Carpatho–Balkan region), the Caucasus, Anatolia and Iran.

Numerous studies carried out in Anatolia and Iran have confirmed prehistoric relationships with the Caucasus and the importance of metals in these exchanges. They propose the importation of ores or of technological know-how from Transcaucasia to Anatolian settlements like Arslantepe (Palmieri 1981, p. 111; Hauptmann and Palmieri 2000, p. 75; Hauptmann et al. 2002, p. 52; Frangipane et al. 2001, pp. 115–116). Relations between the Caucasus and north-western Iran, more specifically the

Urmia region, have also been noted (Burton-Brown 1955, p. 182; Burney and Lang 1971).

Since 1986, P. Kohl from Wellesley College has been studying Transcaucasia in relation to adjacent regions and the importance of metallurgy in these exchanges. His research at Velikent on the Caspian plain (Dagestan) confirms the high technical level of metallurgy reached in the Early Bronze Age and raises again the interesting question of the use of tin in the Caucasus (Kohl 2003; Kohl et al. 2002a, b). More recently, Kohl (2007) has presented an excellent synthesis of cultural relations and the role of metallurgy in the Bronze Age across the Balkans, the Steppes, the Caucasus and the Urals.

Beginning in 1998, A. T. Smith of the University of Chicago has directed a project named "*The Archaeology and Geography of Ancient Transcaucasian States Project (ArAGATS)*" (Smith et al. 2009). It is based on the survey and excavation of settlements in the Tsaghkahovit Valley, and aims to understand the Transcaucasian cultures of the area and the adjacent regions from the Early Bronze Age to the medieval period (ca. 3500 BCE–1200 CE). One of the members associated with the ArAGATS project, D. L. Peterson, recently finished a PhD dissertation on the evolution of metallurgy in the middle Volga and north-eastern Caucasus (ca. 3000–1500 BCE). Peterson (2007) approaches the question from a comparative point of view, noting how the value of metal objects (as imbued through the technical practice of metalworking) interrelates with the 'value' or social standing of individuals and societies.

Since 1999, a scientific team headed by A. Hauptmann of the Deutsches Bergbau-Museum (DBM) at Bochum has developed a project on ancient metallurgy in the Caucasus. Their archaeometallurgical research has focused mainly on Georgia (Gambaschidze et al. 2002) and attempts to demonstrate the exploitation and use of local ores by the Early and Middle Bronze Ages (Hauptmann et al. 2009). Similarly, another German team under E. Pernicka's direction began in 2002 an analytical program (compound and isotopic analyses) on metal artefacts dated to the third millennium BCE, as part of a cooperative program with the archaeological and ethnological institute of Erevan (Meliksetian et al. 2003).

In her PhD dissertation on metallurgy in Transcaucasia from the Late Chalcolithic to the Middle Bronze Age (ca. 3500–1500 BCE.), L. A. Tedesco (2006a) gives a different vision than the traditional scheme established by Chernykh. She argues for the absence of large-scale metal production from the Early Bronze Age to the beginnings of the Middle Bronze Age. On the contrary, she documents the existence of small-scale production on a community level. She also underlines a shared technological style between Transcaucasia and northern Caucasus during the Early Bronze Age and suggests a standardization of the products at this period (Tedesco 2006b).

Research on the relations between the Caucasus and the Near East conducted by B. Lyonnet since 2000 have also underlined the possible importance of metallurgy in the exchanges between these adjacent areas (e.g. Lyonnet 2004, p. 100, 2007b, p. 150; Lyonnet et al. 2009b). The recent chronological scheme proposed by Lyonnet (2007a, b), and her emphasis on the importance of metals in relations between the Caucasus and adjacent areas, led to my own dissertation on the beginning of metallurgy in the Caucasus from the end of Neolithic (sixth millennium BCE) to the

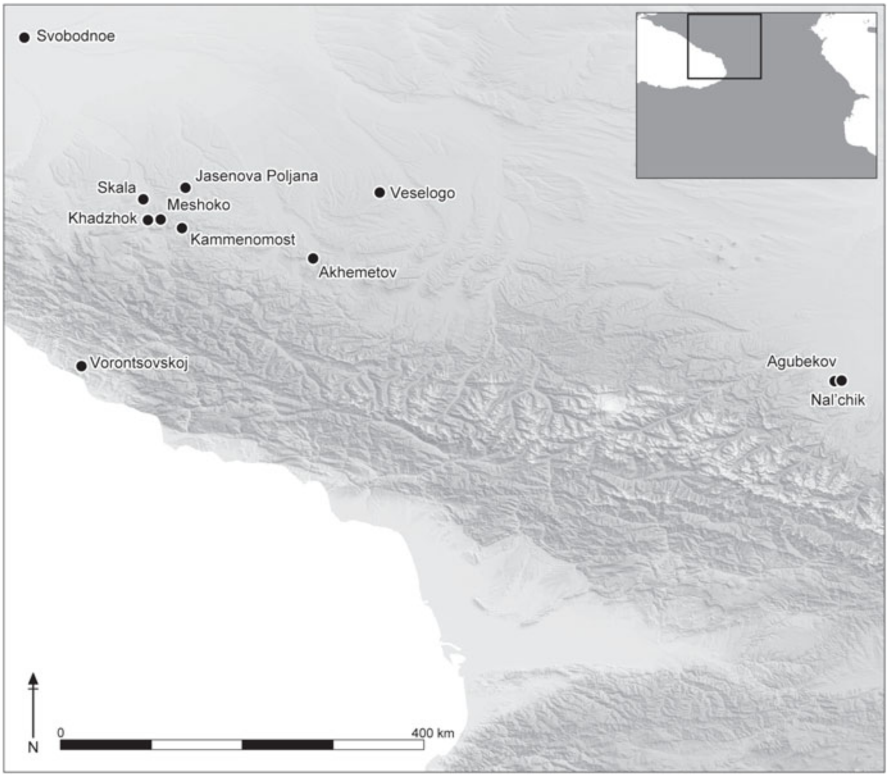


**Fig. 22.1** Settlements attached to the Meshoko culture. (Cassard et al. 2009, GIS project)

Early Bronze Age (third millennium BCE) (Courcier 2010). This work combined archaeometrical analyses of metal objects coming from settlements related to different Chalcolithic cultures of the southern and northern Caucasus with a GIS project conducted by the BRGM (French Geological Institute) and CNRS (French National Scientific Research Center) in which geologic/metallogenic and archaeological data were combined to look for patterns of resource exploitation and trade.

## The Early Metallurgical Stage (From Sixth to Early Fourth Millennium BCE)

### *Meshoko Culture*

In the North-West Caucasus (Fig. 22.1), the Meshoko culture (including sites like Meshoko, Svobodnoe and Zamok) is dated between the middle of the fifth and the beginning of the fourth millennium BCE (Fig. 22.2). The end of the Meshoko culture

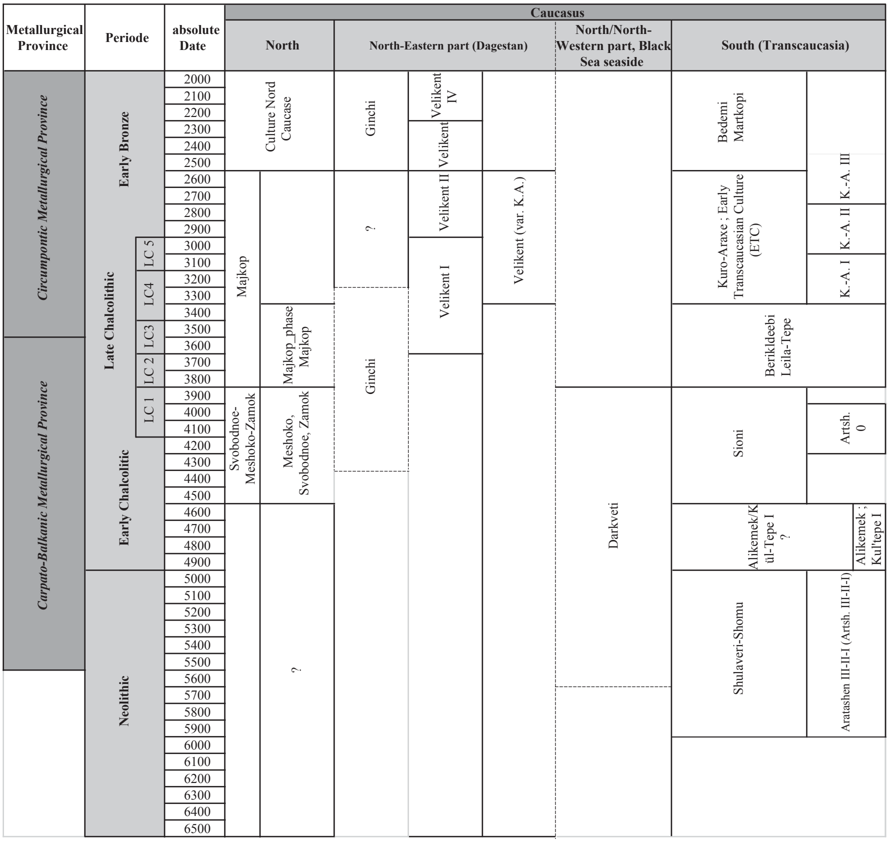


**Fig. 22.2** Chronological scheme illustrating the chronological connections between the cultures of the Caucasus

seems to have overlapped with the Majkop culture, which started during the first half of the fourth millennium BCE. The type-site of the Meshoko culture, Svobodnoe, also contained some sherds considered to be related to the Skelya culture that developed in the steppes north of the Black Sea (Lyonnet 2004, pp. 93–94). A few other objects from this group of cultures suggest relations between the northern Caucasus, the Steppes and the Carpatho-Balkan area during the Karanovo VI–Tripol'e B1 period (ca. second half of the fifth millennium BCE) (ibid.).

The first metal objects discovered in the northern Caucasus come from settlements attached to this culture. They include an undetermined object[1] (Chernykh 1991, pp. 584–585) from the upper level 1 of Svobodnoe (Fig. 22.3), a small ring and a knife blade from Skala (Formozov 1965, pp. 70–71) and 11 fragments of tools and ornaments (awl, bracelet, pendant) from Meshoko (Chernykh 1966, pp. 101–102).

[1] It is not clear, according to the publication, if it is a curved band or a bead.

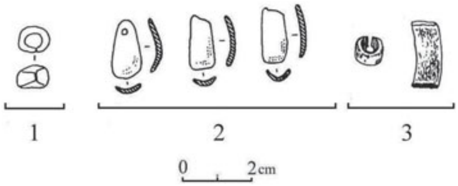


**Fig. 22.3** Ornaments coming from settlements dated to the Late Chalcolithic: *1* Svobodnoe (Chernykh 1991, p. 585), *2* Vesjolaja Rošča II (Idem 1991, p. 585), *3* Kul'tepe I. (Chataigner 1995, p. 131)

At Veselogo, the presence of a crucible (Formozov 1965, p. 116) may suggest the local production of metal objects. According to I. R. Formozov, several traces of extractive and smelting activities have been identified upstream of the many rivers of this region, especially close to the Belorechensk Pass. Nevertheless, the date of these activities is not well established (Formozov 1965, p. 116).

Analysis of the metal artefact from Svobodnoe revealed that it was made of "pure" copper (Chernykh 1991, p. 591, n°40114). Chernykh considered this evidence for the use of copper ores free of impurities, argued to be typical of the copper deposits in the Carpatho-Balkan area (Chernykh 1992, p. 158.; Chernykh et al. 1991, pp. 600–601). Thus, he suggested that this object came from across the Black Sea (Chernykh 1991, pp. 585–587). Although we now know that copper deposits with few impurities also exist in the Caucasus (Cassard et al. 2009), Chernykh's hypothesis implied a west–east circulation that was later reinforced by the discovery of similar prestige objects over a vast area (including bone pearls, tusk pendants, very long flint blades, triangular stone arrowheads, bracelets and adzes in serpentine and zoomorphic sceptres) (Rassamakin 1999, p. 75 et seq.). In this exchange trade, the Skelya culture of the Pontic Steppe (north of the Black Sea) could have played an intermediary role. This culture does seem to have been a link between the entities of the Lower Danube (Suvorovo and Cernavoda I cultures), the Kuban region (including Svobodnoe, Meshoko, Myskhako and Zamok) and the wooded steppes of the Volga River (Khvalynsk). This vast territory coincides with the area of the Carpatho-Balkan metallurgical province (CBMP) as laid out by Chernykh et al. (1991, pp. 593–595, 2002, pp. 83–87). Furthermore, a certain chronological overlap exists between the period of these exchanges (ca. 4550–4100/4000 BCE) and the apogee of this CBMP, dated to ca. 4400–4100 BCE (Chernykh 1978a, pp. 263–265 and 274; 1992, pp. 51–53; see also Pernicka et al. 1997, pp. 51–56 and 131–136; Ryndina 1998, pp. 190–191).

However, the idea of local metallurgical production cannot be excluded from the northern Caucasus. The majority of the metal artefacts found at Meshoko were different from those of Svobodnoe and made of arsenical copper (1–1.2 % As [2]) (Chernykh 1966, pp. 98–99, Table I). Only the blade seems to be of "pure" copper (*ibid.*: 101–102, Table II). Numerous copper deposits in the northern Caucasus contain natural impurities of arsenic (Cassard et al. 2009). The evidence identified by Formozov and the crucible at Veselogo could confirm the hypothesis of extractive metallurgy in this region during the fifth millennium BCE. The transhumant lifestyle thought to

[2] It is assumed (although unclear) that this is wt%.

**Table 22.1** Analysis of the undefined object found at Svobodnoe. (Chernykh 1991, p. 591, percent type not précised)

| n°analyse | Type d'objet | Localisation | Composition percent | | | | | | | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Sn | Pb | Zn | Bi | Ag | As | Fe | Ni | Co | |
| 40114 | Perle | niv. I/Q 631 | | 0.0024 | 0.002 | 0.0009 | 0.0003 | 0.0004 | 0.011 | 0.4 | 0.0047 | 0.0011 | Chernykh 1991, p. 591 |

be typical of this region at this time could have encouraged an early identification of copper deposits by the local population, and the circulation of metallurgical techniques and/or metal artefacts between the cultures living on both sides of the Greater Caucasus.

## *Ginchi Culture*

In the North-East Caucasus, in Dagestan, the first phase of the Ginchi culture is said to be contemporaneous with the end of the Meshoko and the Sioni cultures (Fig. 22.2). The transition between this first phase of Ginchi culture and the second is synchronous with the beginnings of the Majkop culture (see below). At present, no metal objects have been discovered in these settlements.

## *Shomu–Shulaveri Culture*

In the southern Caucasus (Transcaucasia), the Neolithic is characterized by the Shomu–Shulaveri culture, which developed in the middle Kura River Valley during the sixth millennium BCE in five distinctive phases (22.2 and 22.4) (Kushnareva 1997, pp. 25–26). Metal artefacts are rare and occur only in some settlements dated to the end of this period (ca. end of sixth millennium BCE.). They mainly consist of ornaments like beads—e.g. at Gargalar-Tepesi (Arazova et al. 1973, p. 455) and Khramis Didi-Gora (Kiguradze 1986, p. 70 and 93)— and small tools like awls and bradawls—e.g. at Khramis Didi-Gora (Menabde et al. 1984, p. 34). The discovery of unstratified stone-grooved and cupula hammers at Arukhlo (Kushnareva and Chubinishvili 1970, p. 24; Chubinishvili 1971, pp. 31–33), which is close to copper deposits, may suggest extractive metallurgical activities in this region.

Recent survey and cleaning work at Göy Tepe (Lyonnet et al. 2009c) seems to confirm this suggestion, as a vitreous slag with several small copper prills was found by chance in levels dated to the middle of the sixth millennium BCE. This slag "cake", composed of ore gangue and some metal prills, appears to be an intermediate product of the smelting process. Analyses performed on this slag cake have shown that it has an alumino-silicate matrix with zinc impurities[3] (Table 22.2). According

[3] Unpublished data. Analyses carried out in the laboratory of the Deutsches Bergbau-Museum (Bochum), under the direction of A. Hauptmann and M. Prange.

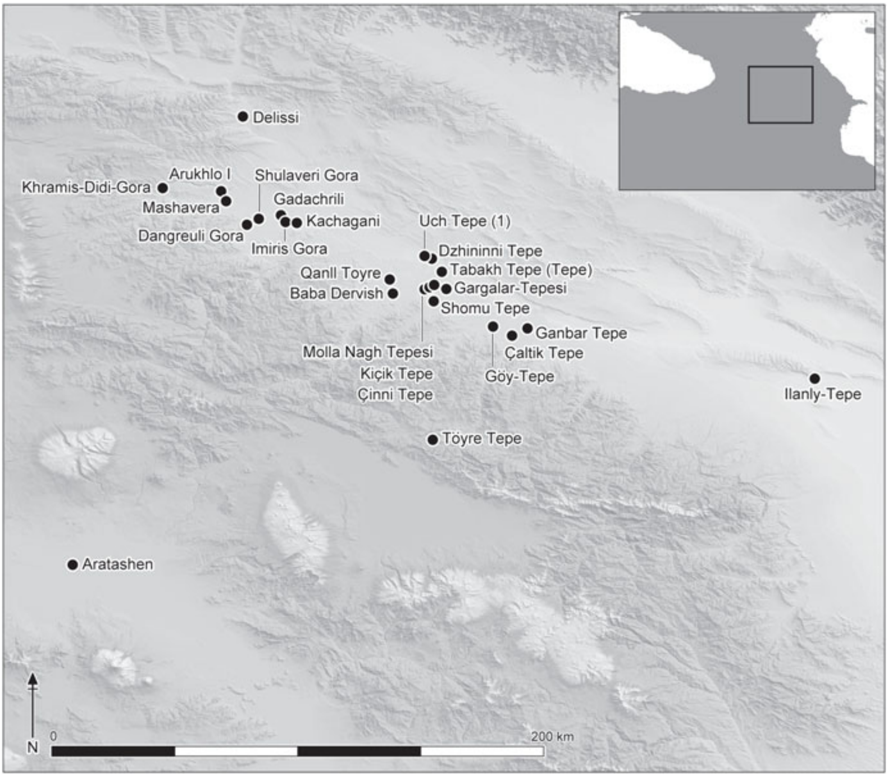


**Fig. 22.4** Settlements attached to the Shomu–Shulaveri culture. (Cassard et al. 2009, GIS project)

to other analyses made on another part of the sample[4], the matrix also contained copper (2.36 wt%) and nickel (0.79 wt%). Nickel and zinc could originate from the copper ore, since these elements are often associated with copper in the deposits of the Caucasus (Cassard et al. 2009).

In contrast, the analysis performed on the artefacts coming from Gargalar-Tepesi (bead) and Khramis Didi-Gora (bradawl and beads) has shown that they were both made from "pure" copper (Narimanov 1990, pp. 8–9; Tavadze et al. 1987, p. 46). If we follow Chernykh's hypothesis, then these objects should be seen as imports from the Balkans. It is, however, more probable that they are local products.

## *Aratashen, Kul'tepe and Alikemek Cultures*

Further south, in the Ararat plain (Armenia) (Fig. 22.4), the Aratashen culture (Fig. 22.2) began in the early sixth millennium BCE (Aratashen levels II and I) and

[4] XRF (ISP 28) analysis carried out in the laboratory of the Institute of Archaeology and Ethnology (Bakou), under the direction of A. Gazanova.

**Table 22.2** Analyses of several objects coming from Kul'tepe I. (Abibullaev 1965b, p. 69; Selimkhanov 1966, p. 230, Table 1; Kushnareva and Chubinishvili 1970, p. 130–131; Kashkaj and Selimkhanov 1971, p. 53, percent type not précised)

| n°analyse | Type d'objet | Localisation | Composition percent | | | | | | | | | | | | | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Sn | Pb | Zn | Bi | Ag | Sb | As | Fe | Ni | Co | P | Mo | |
| | frag. perle | niveau I | majoritaire | | | 0.01 | | 0.004 | | | 0.1 | 0.001 | | | | Selimkhanov 1966, p. 230, Table 1; Kashkaj and Selimkhanov 1971, p. 53; Kushnareva and Chubinishvili 1970, p. 130 |
| | frag. perle | niveau I | majoritaire | | | | | | | | 0.1 | 0.0005 | | | 0.1 | Kushnareva and Chubinishvili 1970, p. 130; Kashkaj and Selimkhanov 1971, p. 53 |
| | frag. perle | niveau I | majoritaire | | | | | | | | > 1 | 0.0005 | | 0.1 | | Abibullaev 1965b, p. 69; Selimkhanov 1966, p. 230, Table 1 |
| | frag. bracelet | niveau I | majoritaire | 0.05 | 0.1 | 0.03 | 0.003 | 0.01 | | | 0.5 | 0.0005 | 0.001 | | 0.002 | Abibullaev 1965b, p. 69; Selimkhanov 1966, p. 230, Table 1 |
| | frag. objet | niveau I | majoritaire | | | 0.05 | | 0.0s14 | | | 0.01 | | | | | Selimkhanov 1966, p. 230, Table 1; Kashkaj and Selimkhanov 1971, p. 53 |
| | frag. objet | niveau I | majoritaire | 0.003 | 0.07 | | | 0.043 | 0.005 | 0.4 | 0.2 | 0.01 | | 0.05 | | Selimkhanov 1966, p. 230, Table 1; Abibullaev 1965b, p. 69; Kashkaj and Selimkhanov 1971, p. 57; Kushnareva and Chubinishvili 1970, p. 130 |

**Table 22.2** (continued)

| n°analyse | Type d'objet | Localisation | Composition percent | | | | | | | | | | | | | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Sn | Pb | Zn | Bi | Ag | Sb | As | Fe | Ni | Co | P | Mo | |
| | alène | niveau I | majoritaire | 0.002 | | | 0.003 | 0.01 | 0.02 | 1.15 | 0.2 | 1.6 | 0.2 | | | Kashkaj and Selimkhanov 1971, p. 72; Abibullaev 1965b, p. 69; Selimkhanov 1966, p. 230, Table |
| | Alène | niveau I | majoritaire | | | | | 0.018 | 0.2 | 1.15 | 0.02 | 1.6 | 0.02 | | | Selimkhanov 1966, p. 224 (nanlyse de l'oxyde) |
| | alène | niveau I | majoritaire | | | | 0.001 | 0.002 | 0.05 | 0.7 | 0.2 | 0.5 | 0.002 | 0.15 | | Selimkhanov 1966, p. 224 (analyse de la patine) |
| | Alène | niveau I | majoritaire | 0.002 | 0.002 | | 0.01 | 0.002 | 0.05 | 0.7 | 0.2 | 0.05 | 0.002 | | | Abibullaev 1965b, p. 69 |
| | pointe de flèche | niveau I | majoritaire | 0.003 | 0.15 | | 0.02 | 0.1 | | 1.14 | 0.001 | 0.005 | | 1.05 | | Kushnareva and Chubinishvili 1970, pp. 130–131 |
| | pointe de flèche | niveau I | majoritaire | | 0.05 | 0.02 | 0.003 | 0.002 | | 0.3 | | 0.002 | | 1 | | Selimkhanov 1966, p. 230, Table 1 |

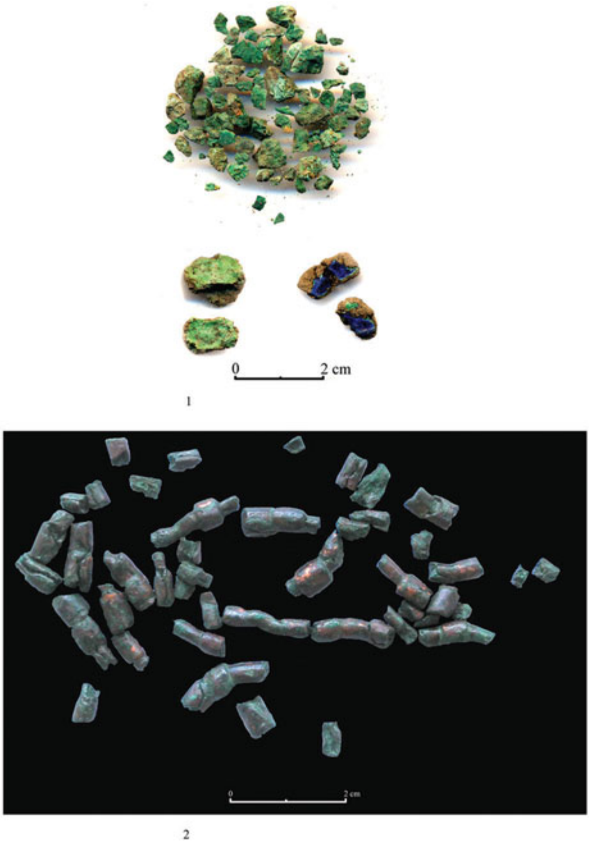


**Fig. 22.5** Fragments of copper ores and beads in cuprous matrix found in the level IId of Aratashen. (Chataigner, personal communication, published in Badaljan et al. 2007, p. 53)

continued into the Chalcolithic period (Aratashen level 0). The material coming from the Neolithic levels presents similarities with those of the Shomu–Shulaveri culture, although local traditions are also noted. Moreover, a few Halaf sherds from northern Mesopotamia have been found, but their stratigraphic context is still unclear. These imported wares are similar to those known at Kul'tepe (Nakhchevan) and at Tilkitepe and Tüllintepe (eastern Turkey). Provenience studies carried out on obsidian also suggest contacts with eastern Anatolia and north-western Iran at that time (Badalyan et al. 2007, pp. 67–73). The Chalcolithic levels contain material considered local, although also presenting similarities with sites in northern Syria and northern Mesopotamia (Palumbi 2007, pp. 73–75).

In the Neolithic level IId of Aratashen, dated to the beginnings of the sixth millennium BCE, several fragments of copper ores (malachite and azurite) and 57 arsenical copper beads (Meliksetian 2009) were discovered (Badalyan et al. 2007, pp. 52–53) (Fig. 22.5). Close to Aratashen, at Khatunark, one fragment of copper ore (malachite) has been discovered in a level dated to the first half of the sixth millennium

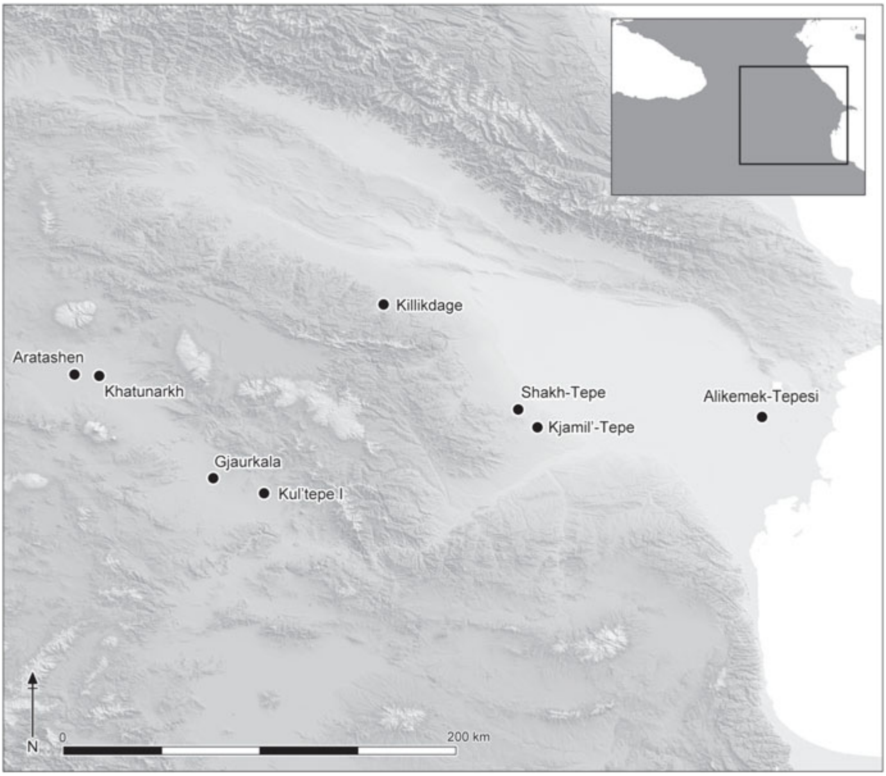


**Fig. 22.6** Neolithic Sites of Aratashen and Khatunakh, settlements attached to the Alikemek/Kül-Tepe I culture (Cassard et al., 2009. GIS project)

BCE[5] (Badalyan and Harutyunyan 2008). This artefact, together with those found at Aratashen, suggest the nascent emergence of metallurgy in the Ararat region already during the Late Neolithic.

Following the Shomu–Shulaveri culture and Aratashen (levels I and II), the Alikemek–Kül'tepe culture of the south-eastern Caucasus covers the transition between the Neolithic and Chalcolithic periods (Kushnareva 1997, p. 25 and 30 *sq.*; Lyonnet 2007a, p. 12, 2008, p. 4) (Fig. 22.2). Situated respectively at the border of the Mugan Steppe and in Nakhichevan (Azerbaijan) (Fig. 22.6), the settlements of Alikemek and Kul'tepe I were excavated in the 1950s–1970s and are not dated with certainty. They probably represent a relatively long period and occupation seems to have started early (probably during the sixth millennium BCE) (Lyonnet 2008, pp. 4–6). The Alikemek–Kul'tepe culture covered the Ararat Plain, Nakhichevan, the Mil'skoj and Mugan Steppes and the region around Lake Urmia in north-western Iran (Kushnareva 1997, p. 33).

[5] I sincerely thank C. Chataigner for her authorization to report on this important discovery.

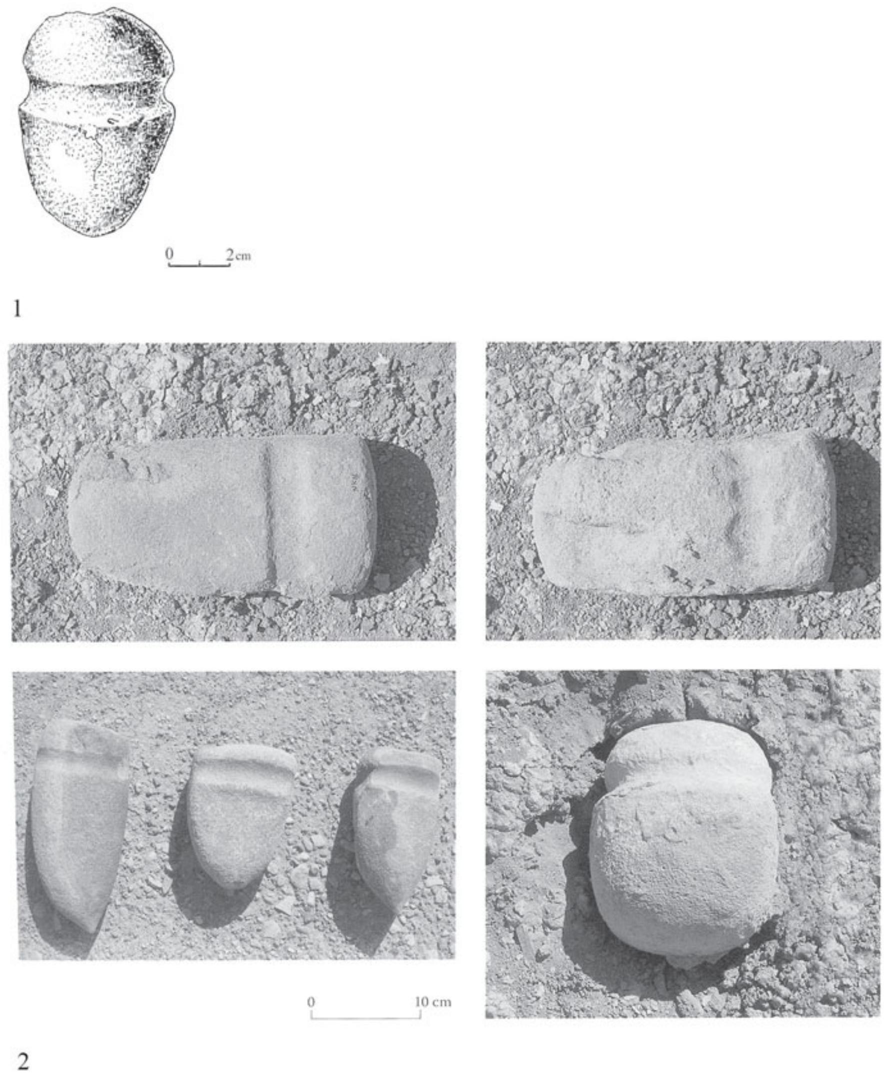


**Fig. 22.7** *1* grooved hammer found at Kul'tepe I (Abibulaev 1963, p. 160), *2* grooved hammer coming from Duzdaği. (Bakhshaliyev et al. 2009, p. 49)

In a tomb of the upper level (Early Chalcolithic) at Alikemek Tepesi, three beads and an awl were discovered (Makhmudov et al. 1974, p. 455). At Kul'Tepe I, seven metal artefacts (Fig. 22.8; Table 22.2) were found in the upper part of level I and in tomb 33 (Abibullaev 1965b, p. 67; Selimkhanov 1966, p. 226). The date of these objects is unclear because level I contains material dating both to the Neolithic (including pottery of the Halaf culture of northern Mesopotamia) and to the beginning of the Chalcolithic (related to the Dalma culture of north-western Iran). A grooved hammer was also found in a tomb of level I at Kul'Tepe I (Fig. 22.7) that is close

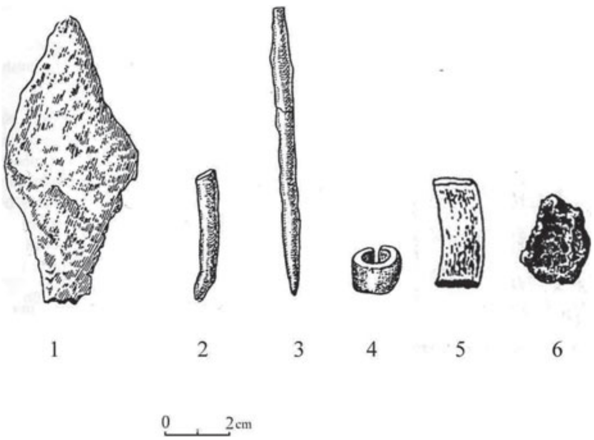


**Fig. 22.8** Metal artefacts found in the level I of Kul'tepe I: *1* arrowhead, *2* fragment of object (awl?), *3* awl, *4* bead, *5* fragment of ring, *6* fragment of undefined object (metallurgical waste?). (Munchaev 1982a, pp. 19–22, Table XLII; Selimkhanov 1966, p. 226, Fig. 2)

to examples known at Gjaurkala (near Shakhtakhy in Azerbaijan) and at Killikdag (near Khanlar in Azerbaijan) (Abibullaev 1963, p. 160). This type of tool is generally associated with extractive metallurgical activities so we could propose that ore mining was being done at Kul'tepe. However, recent research at the salt mines of Duzdaği, close to Kul'Tepe, proves that similar grooved hammers were also used to extract salt (Fig. 22.7) (Bakhashaliyev and Marro 2009).

In addition to their mixed archaeological context, the analyses of the artefacts from Kul'tepe were done decades ago and thus must be considered with caution. However, they appear to be made of both "pure" and arsenical copper. Arsenic is naturally present in numerous copper ore deposits in the Greater and Lesser Caucasus (Cassard et al. 2009). The smelting of these ore types could have led to the presence of arsenic in the resulting objects.

## *Sioni Culture*

During the fifth millennium BCE, the Sioni culture developed in the southern Caucasus, but this phenomenon is still not well characterized and consists of several different settlements over a relatively long period of time (Fig. 22.2). The Sioni culture covered a vast territory including eastern Georgia (Dzhavakhishvilla et al. 1987, p. 8; Kiguradze and Sagona 2003, pp. 40–42), north-western Iran (Lyonnet 2007b, p. 136, footnote 42), Armenia and eastern Turkey (down to Oylum Höyük, at the fringes of northern Mesopotamia) (Palumbi 2007, p. 73; Marro 2007, pp. 79–90). Moreover, some features of the Sioni culture have been discovered in Majkop settlements of the northern Caucasus (Korenevskij 2004, Figs. 4, 5, 12 and 15; Lyonnet 2007b, pp. 135–136), in the upper levels of Meshoko (Formosov 1965, p. 119; Lyonnet 2007b, p. 136) and in some later sites linked to Mesopotamia—e.g. Berikldeebi (Žavaxišvili, Fig. 3; Korenevskij 2004, Fig. 117; Lyonnet 2007b,


**Fig. 22.9** Metal objects coming from Mentesh Tepe: *1* slag, *2* awl, *3* ring, *4* fragment of undefined object, *5* fragment of undefined object (awl?), *6–8* agglomerates of strongly corroded undefined objects, *9* mould, *10* awl. (Lyonnet et al. 2009c)

pp. 135–136), Leilatepe (Akhundov 2007, pp. 108–119) and Boyuk-Kesik (Lyonnet 2007b, p. 136). In some sites, the coexistence of characteristic elements attributed to the Meshoko, Majkop, Ginchi and Sioni cultures presumes a certain chronological overlap between them (Lyonnet 2007b, p. 137) (Fig. 2).

Recent research at Mentesh Tepe[6] (Lyonnet et al. 2009c), a site also associated with the Sioni culture and dated to the second half of the fifth millennium BCE, adds support to the idea of local metallurgy at this time. Indeed, a complete manufacturing process is illustrated at this site (Fig. 22.9), from slags to fragmentary

[6] Unpublished Data. I sincerely thank B. Lyonnet and F. Gulyev for their authorization to present here first these very interesting discoveries.

objects (recycling?), from a mould to the finished object (awl). Several metal objects were discovered at other Sioni culture sites such as Alazani III (Kiguradze 2000, p. 323), Tsiteli Gorebi (Varazashvili 1992, p. 32) and Chalagan Tepe (Narimanov 1985, p. 490). According to analysis, these objects were made of copper with traces of zinc (Tsiteli Gorebi: Varazashvili 1992, p. 69; Chalagan Tepe: Narimanov 1990, p. 5). Upstream of the Alazani River, several copper deposits contain zinc-bearing minerals were found (Cassard et al. 2009). Unfortunately, no research has ever been done on possible extractive activities at these deposits.

Archaeometallurgical studies have been performed at the Deutsches Bergbau Museum (Bochum) on artefacts from Mentesh Tepe[7]. Most of the objects from this site are completely corroded. Only two—an undetermined object (Fig. 22.9, no.°4) and an awl (Fig. 22.9, no.°10)—still contain metal in their centres. Metallographic analysis of the undetermined object reveals a dentritic and eutectoidal structure ($Cu + CuO_2$) (Fig. 22.10), which is characteristic of a cast object. Etching permitted the identification of a few hexagonal grains with annealing twins in the alpha dendrites. They prove that a soft hammering and an annealing step were executed. A rapid energy-dispersive X-ray spectroscopy (EDS) analysis confirms that this object is made of relatively "pure" copper (90.0–96.4 wt% Cu) with minor amounts of arsenic (0.8–3.8 wt% As).

Metallographic analysis done on the awl showed some distorted dendrites (Fig. 22.11), suggesting cold-working. Etching the section confirmed this hypothesis due to the presence of several hexagonal grains with annealing twins and thin strain lines within the grains (Figs. 22.11 and 22.12). In sum, this object was cast, cold-hammered, then annealed and finally cold-worked again. EDS analysis of this awl revealed that it was also made of relatively "pure" copper (91.5–97.9 wt% Cu), with traces of arsenic (0.7–1.4 wt% As) and sulphur (0.5–0.9 wt% S). EDS mapping shows a homogeneous repartition of sulphur, which may correspond with small inclusions seen within the grains. Arsenic is concentrated at the edge of the object, a consequence of the natural segregation of this element. The metal artefacts found at Mentesh Tepe demonstrate the capacity for casting and manufacturing objects in the Sioni culture.

## *Darkveti Culture*

In the north-western Caucasus and along the Black Sea in Georgia (Fig. 22.13), several settlements (Darkveti, Tetramitsa, Samele-Klde and others) were excavated that are linked to a different archaeological group named the "Darkveti culture" (Fig. 22.2). There are no $^{14}C$ dates yet, but it seems that at some settlements occupation began in the Neolithic (perhaps even before) and continued till the end of the Chalcolithic (although not always continuously) (Lyonnet 2004, pp. 89–91, 2007b,

[7] I would like to acknowledge M. Prange, Ü. Yalcin and A. Hauptmann for their support and advice during these analyses.

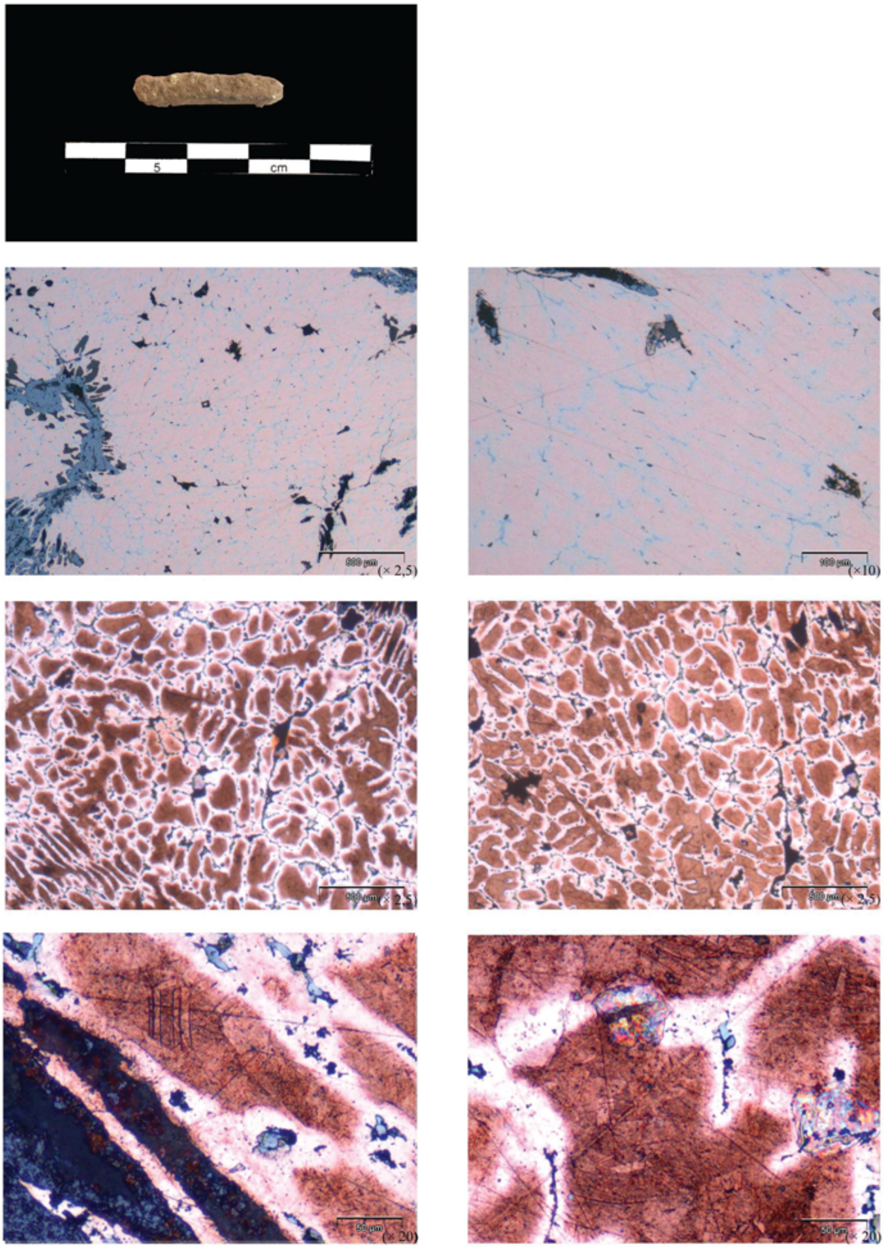


**Fig. 22.10** Metallographies (non-etched and etched) of the fragment of the undefined object seen in Fig. 22.9, no. 4

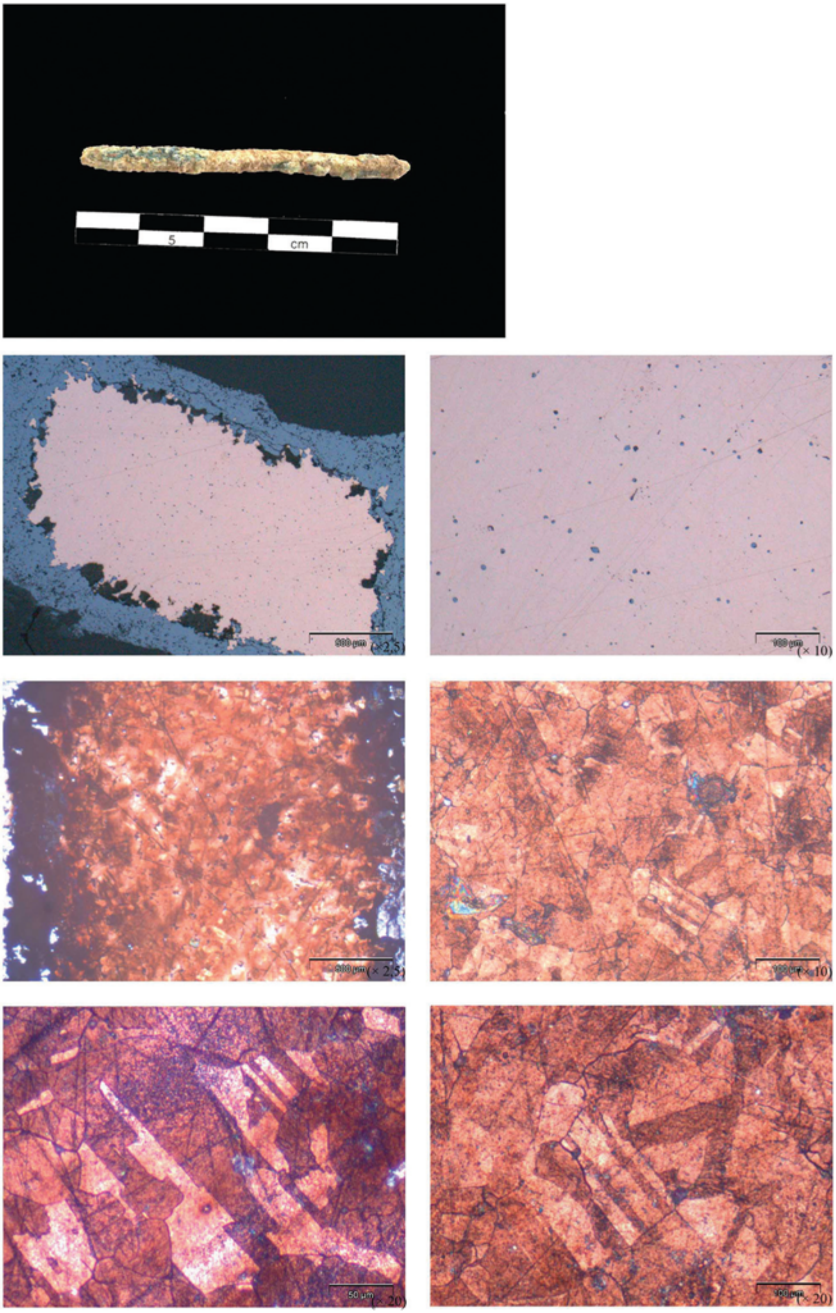


**Fig. 22.11** Metallographies (non-etched and etched) of the awl seen in Fig. 22.9, no. 10

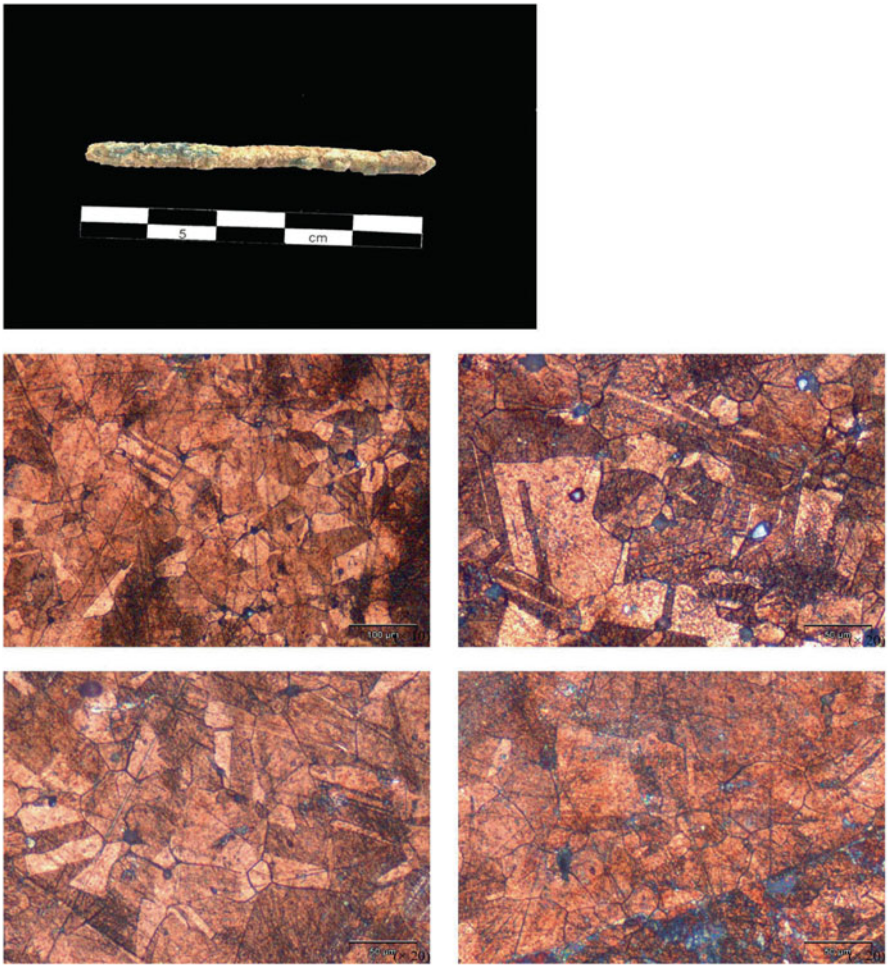


**Fig. 22.12** Metallographies (etched) of the awl found at Mentesh in Fig. 22.9, no. 10

p. 19; Chataigner 1995, pp. 50–51; Kushnareva 1997, p. 19). The Darkveti culture is found principally in caves but open air settlements are also attested (Tetramitsa, Chikhori) with semi-buried oval or circular huts made of light structures (wattle and daub). A few stone bracelets characteristic of the Meshoko culture have been found in some of the Darkveti settlements, especially in caves along the basin of the Kvirila River and at Tetramitsa. These bracelets suggest relations between the two regions, maybe associated with transhumance between the two slopes of the Caucasus (Trifonov 2001; Lyonnet 2004, p. 91).

Early metallurgy is also attested on some settlements of this culture. Evidence mainly consists of artefacts that have been cold-worked and annealed. Some of these objects differ typologically from those discovered in other contemporary cultures. These unique types include rods at Samele-Klde (Formosov 1973, p. 37; Chataigner

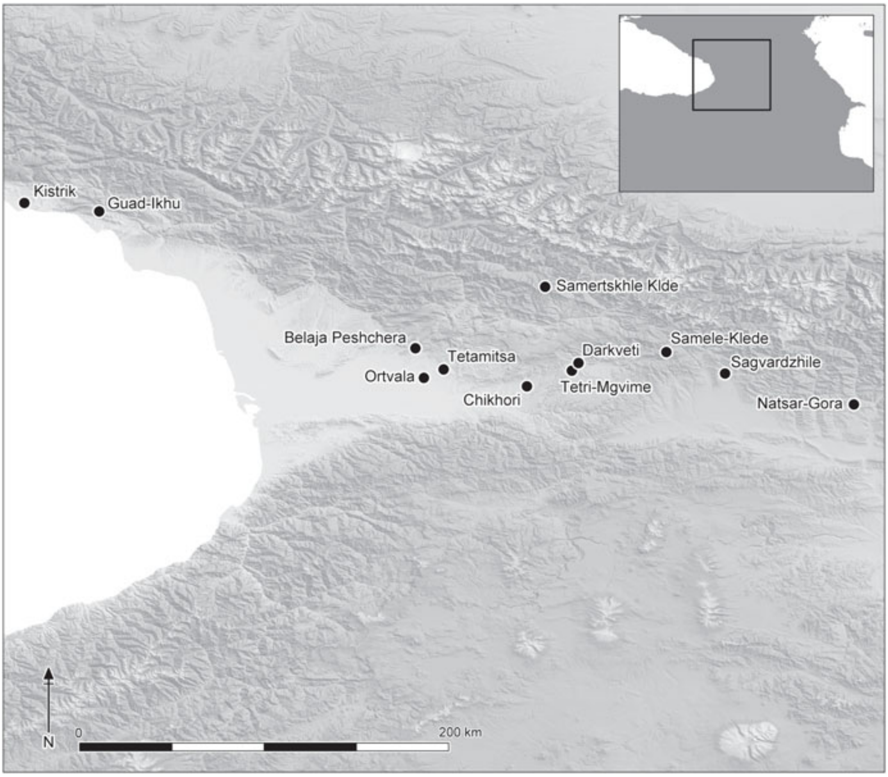


**Fig. 22.13** Settlements attached to the Darkveti culture. (Cassard et al. 2009, GIS project)

**Table 22.3** Analysis of the awl coming from Chikhori. (Tavadze et al. 1987, p. 46, percent type not précised)

| n°analyse | Type d'objet | Localisation | Composition percent | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | | Cu | Ag | As | Ni | |
| | alène | Chikhori | majoritaire | 0.001 | 0.8 | 0.001 | Tvadze et al. 1987, p. 46 |

1995, p. 132) and Chikhori (Nebieridze 1985, p. 9; 1986, p. 10), wire at Natsar Gora (Gobedzhishvili 1951, pp. 242–243; Tekhov and Dzhaparidze 1971, p. 52), a hook at Sagvardzhile (Lordkipanidze 1989, p. 67.), ingots at Guad ikhu (Solov'ev 1967, p. 24.) and hoops at Kistrik (Lukin 1950, p. 282). More common are metal artefacts such as awls at Sagvardzhile (Lordkipanidze 1989, p. 67) and Chikhori (Nebieridze 1985, p. 9, 1986, p. 10), knife blades at Tetri-Mgvime (Kalandadze and Kalandadze 1982; Abesadze and Bakhtadze 1987, p. 51), arrowheads at Belaja-Peschera (Pkhakadze 1988, p. 209), pendants at Chikhori (Nebieridze 1985, p. 9, 1986, p. 10) and undetermined objects at Ortvala (Nioradze 1986, p. 11). The analyses done on these metal objects suggest that the majority were made of "pure" copper (Table 22.3), although we must be careful using older analyses which may not have detected important elements such as arsenic and sulphur. Only three objects (a knife blade, arrowhead and awl coming from Chikhori) contain traces of arsenic (0.7–0.8 %[8] As, Tab. 22.4) (Tavadze et al. 1987, P. 46; Abesadze and Bakhtadze 1987, p. 51). The ingots and the hoops may have been made of lead, according to the analysis (Bzhanija 1961, p. 109; Nebieridze 1985, p. 9, 1986, p. 10), but this has not been confirmed.

### *Understanding the Early Metallurgical stage (ca. Sixth to Early Fourth Millennia BCE)*

To sum up, the beginnings of metallurgy in the Caucasus seem to be characterized by:

- Small objects
- Simple manufacturing techniques
- Non-alloyed copper or copper with minor amounts of arsenic (probably due to the types of ores being used)
- Possibly also lead metallurgy (based on the unconfirmed analyses from the Darkveti culture, above)

The lack of research on the exploitation of local deposits does not allow many conclusions about extractive metallurgy in the Caucasus during this period. Nevertheless, recent research on metal-related data suggests the possibility of local metallurgical activities. In fact, several local metallurgical traditions seem to develop in the different regions of the Caucasus, all of which are probably in close contact with transhumant or fully nomadic cultural groups (e.g. the Sioni). These connections could have encouraged the development of metallurgy through the wider circulation of techniques, metal-bearing ores and artefacts. The cultures of the Caucasus had probably also established long-distance relations with other regions such as the Carpatho-Balkan area, the Steppes, eastern Anatolia, northern Mesopotamia and northern Iran. Though we often cannot demonstrate these relations clearly, such cultural connections probably played a great role in the development of local metallurgies in the Caucasus, and may have even stimulated its growth from the very start.

## The Rise of Metallurgy (Early Fourth to Third Millennium BCE)

### *Majkop and Novosvobodnaja Components*

The Majkop (or "Maikop") culture, which spread over a vast territory (Figs. 22.14 and 22.15) from the Black Sea to the Terek River, from the spur of the Greater Caucasus to the Steppe, began in the second quarter of the fourth millennium BCE (Trifonov 1996;

[8] It is assumed although unclear that this is wt%.

**Table 22.4** Analyses of metal artefacts found at Majkop. (Selimkhanov 1962, p. 74; Chernykh 1966, pp. 98–101; Korenevskij 1988, p. 94; percent type not précised)

| n° analyse | Type d'objet | Localisation | Composition percent | | | | | | | | | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Sn | Pb | Zn | Bi | Ag | Sb | As | Fe | Ni | Co | Au | |
| 34/7 | lame plate d'outil | kourgane | majoritaire | 0.002 | | 0.015 | | 0.035 | | 0.5 | 0.01 | 1.05 | | | Selimkhanov 1962, p. 74, Table I |
| 34/9 | Hache | kourgane | 97.3 | 0.004 | 0.005 | | | 0.049 | | 2.03 | 0.015 | 0.007 | | 0.003 | Selimkhanov 1962, p. 74, Table I |
| 34/10 | hache-houe | kourgane | 92.8 | 0.001 | 0.01 | | 0.01 | 0.5 | 0.007 | 4.55 | 0.05 | 1.6 | | 0.005 | Selimkhanov 1962, p. 74, Table I |
| 34/11 | Houe | kourgane | 94.9 | 0.0005 | 0.04 | | 0.01 | 0.052 | 0.015 | 3.57 | 0.06 | 0.85 | | | Selimkhanov 1962, p. 74, Table I |
| 34/12 | hache plate | kourgane | 85.7 | 0.0005 | 0.01 | 0.015 | | 0.031 | 0.002 | 9.08 | 0.2 | 4.4 | 0.002 | | Selimkhanov 1962, p. 74, Table I |
| 34/13 | hache plate | kourgane | 91.5 | 0.001 | 0.003 | 0.015 | 0.03 | 0.039 | 0.005 | 7.8 | 0.1 | 0.01 | 0.001 | | Selimkhanov 1962, p. 74, Table I |
| 34/14 | Ciseau | kourgane | 97 | 0.001 | 0.02 | 0.005 | 0.002 | 0.05 | 0.006 | 2.37 | 0.05 | 0.001 | | | Selimkhanov 1962, p. 74, Table I |
| 34/15 | ciseau | kourgane | 93.3 | 0.001 | 0.02 | 0.004 | 0.002 | 0.035 | 0.008 | 6.08 | 0.1 | 0.001 | | | Selimkhanov 1962, p. 74, Table I |
| 34/16 | alène | kourgane | 93.2 | 0.001 | 0.01 | | | 0.012 | | 6.06 | 0.2 | 0.01 | | | Selimkhanov 1962, p. 74, Table I |
| 29608 | vase | kourgane | majoritaire | | 0.01 | | | 0.04 | 0.01 | 2.5 | 0.001 | 0.02 | | < 0.001 | Korenevskij 1988, p. 94 |
| 29609 | seau | kourgane | majoritaire | | 0.02 | | | 0.1 | 0.02 | 1.3 | 0.001 | 0.02 | | < 0.001 | Korenevskij 1988, p. 94 |
| 29610 | cruche | kourgane | majoritaire | | 0.02 | | | 0.04 | 0.01 | 5 | 0.002 | 0.02 | | < 0.001 | Korenevskij 1988, p. 94 |
| 29611 | Paroi de vase | kourgane | majoritaire | | 0.01 | | | 0.03 | 0.009 | 2.5 | 0.008 | 0.015 | | < 0.001 | Korenevskij 1988, p. 94 |
| 29612 | vase à corolle | kourgane | majoritaire | | 0.006 | | | 0.004 | | 3 | 0.015 | 0.003 | | < 0.001 | Korenevskij 1988, p. 94 |

**Table 22.4** (continued)

| n° analyse | Type d'objet | Localisation | Composition percent | | | | | | | | | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Sn | Pb | Zn | Bi | Ag | Sb | As | Fe | Ni | Co | Au | |
| 29613 | vase à corolle | kourgane | majoritaire | | | | | 0.03 | 0.01 | 2.5 | 0.002 | 0.02 | | < 0.001 | Korenevskij 1988, p. 94 |
| 29614 | vase à corolle | kourgane | majoritaire | | 0.004 | | | 0.03 | | 5 | 0.001 | 0.015 | | < 0.001 | Korenevskij 1988, p. 94 |
| 29615 | Coupe | kourgane | majoritaire | 0.002 | 0.004 | 0.01 | | 0.1 | 0.004 | 2.5 | 0.002 | 0.06 | | < 0.001 | Korenevskij 1988, p. 94 |
| 29616 | coupe à bord | kourgane | 10 | Traces | Traces | Traces | Traces | 90 | | | | | | | Korenevskij 1988, p. 94 |
| 29617 | tige à baldaquin | kourgane | 10 | Traces | Traces | | Traces | 90 | | | Traces | Traces | | Traces | Korenevskij 1988, p. 94 |
| 29618 | vase à nervures | kourgane | 11 | Traces | Traces | | Traces | 91 | | | Traces | Traces | | Traces | Korenevskij 1988, p. 94 |
| | lame de couteau | kourgane | majoritaire | 0.002 | | 0.015 | | 0.035 | | 0.5 | 0.01 | 1.05 | | | Chernykh 1966, pp. 98–99 |
| | Hache-herminette | kourgane | 94.1 | 0.001 | 0.01 | | 0.01 | 0.5 | 0.007 | 4.55 | 0.05 | 1.6 | | ≈ 0.005 | Chernykh 1966, pp. 98–99 |
| | herminette | kourgane | 95.7 | 0.0005 | 0.04 | | 0.01 | 0.052 | 0.015 | 3.57 | 0.06 | 0.85 | | | Chernykh 1966, pp. 98–99 |
| | herminette | kourgane | 89.9 | 0.0005 | 0.01 | 0.015 | | 0.031 | 0.002 | 9.08 | 0.2 | 4.4 | 0.002 | | Chernykh 1966, pp. 98–99 |
| | hache | kourgane | 97 | 0.004 | 0.005 | | | 0.049 | | 2.03 | 0.15 | 0.007 | | 0.003 | Chernykh 1966, pp. 101–102 |
| | hache | kourgane | 91.5 | 0.001 | 0.003 | 0.015 | 0.03 | 0.039 | 0.005 | 7.8 | 0.1 | 0.001 | | | Chernykh 1966, pp. 101–103 |
| | gouge, burin | kourgane | 97 | 0.001 | 0.02 | 0.005 | 0.002 | 0.05 | 0.006 | 2.37 | 0.05 | 0.001 | | | Chernykh 1966, pp. 101–103 |
| | gouge, burin | kourgane | 93.3 | 0.001 | 0.02 | 0.004 | 0.002 | 0.035 | 0.008 | 6.08 | 0.1 | 0.001 | | | Chernykh 1966, pp. 101–103 |
| | alène. | kourgane | 93.2 | 0.001 | 0.01 | | | 0.012 | | 6.06 | 0.2 | 0.01 | | | Chernykh 1966, pp. 101–103 |

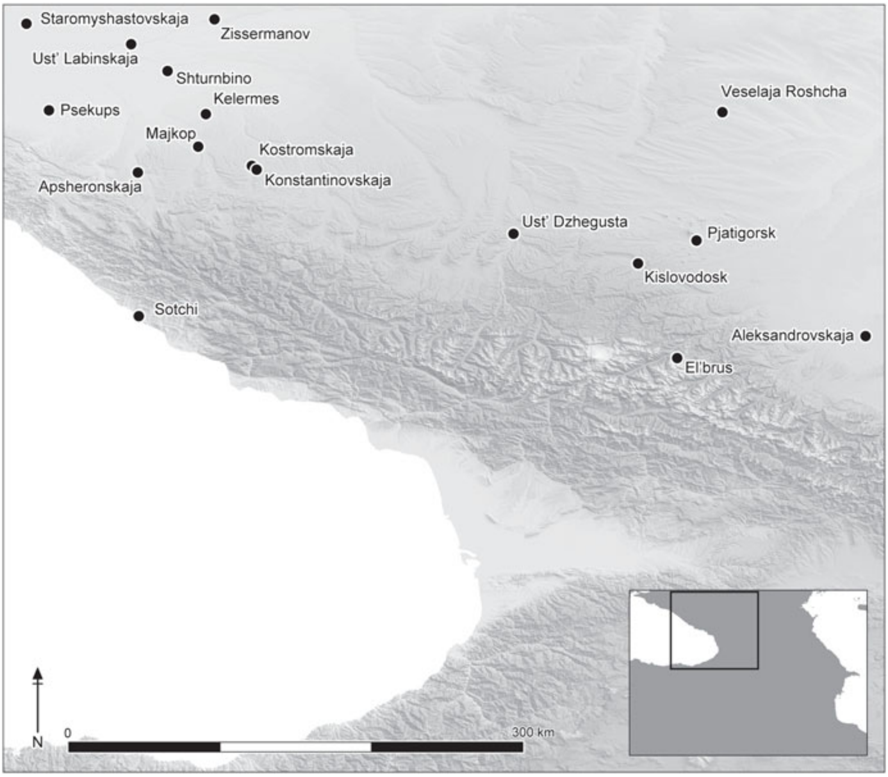


**Fig. 22.14** Settlements attached to the Majkop culture—Majkop component. (Cassard et al. 2009, GIS project)

Lyonnet 2000, 2004) . Recent research by B. Lyonnet (2007a, b) has helped to distinguish two "components" of the Majkop culture: Majkop and Novosvobodnaja (Fig. 22.2). The end of the Meshoko and Sioni cultures in the late fifth/early fourth millennium BCE coincides with the beginnings of the "Majkop component" and a chronological overlap seems to have existed between these three cultural groups (Meshoko, Majkop and Sioni) (Fig. 22.2). The "Majkop component" was grafted onto the Meshoko cultural background but blended with foreign influences (Lyonnet 2007b, p. 134). Indeed, the Majkop component presents close similarities with material found in northern Mesopotamian settlements that are dated to the Late Chalcolithic (LC2-LC4) (ca. 3800–3500 cal. BCE). This period also corresponds to the final phase of the Early Uruk Period in Mesopotamia and the beginning of the Middle Uruk Period (Lyonnet 2007b, p. 148). Parallels have also been established between the Majkop ceramic material and that known from the contemporary Leilatepe–Berikleedebi culture of the southern Caucasus (Fig. 22.16).

As for the "Novosvobodnaja component" (Fig. 22.15), dated to ca. 3300–2600 BCE, part of its ceramic material presents affiliations with the preceding Majkop component. The rest of the pottery shows a number of similarities with the ceramic material of the Kura–Araxes culture of the southern Caucasus (Lyonnet 2007b,

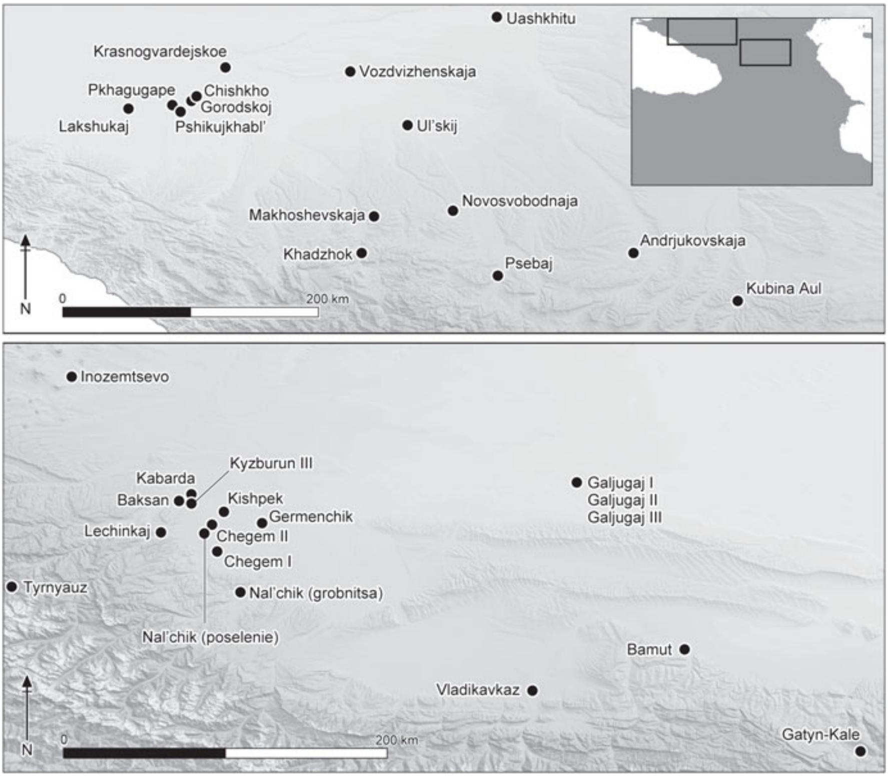


**Fig. 22.15** Settlements attached to the Majkop culture—Novosvobodnaja component. (Cassard et al. 2009, GIS project)

p. 148; see below). By this time, the northern Mesopotamian features had begun to disappear.

It is thought that in the early fourth millennium BCE, the CBMP lost its importance in favour of the circumpontic metallurgical province (CMP), which covered, at its maximum geographical extent, a zone including the Caucasus, the Steppe area, the northern Balkans, the Carpathians, the Aegean, Anatolia and Mesopotamia (Chernykh et al. 2002, p. 83). As with the preceding province, the CMP corresponds to an arborescent scheme ("province", "zone", "focus", "nucleus") in which the different regions within it are seen as dependent upon one another. According to E. N. Chernykh (1978b, pp. 55–56), the beginning of the CMP coincides with the beginning of the Kura–Araxes culture—thought at that time to be more or less contemporary with the beginning of the Majkop culture, around the second half of the fourth millennium BCE (ca. 3500/3300 BCE) (Chernykh et al. 2002, p. 83). Chernykh based his argument upon the chronological framework that was then used by Soviet archaeologists. This framework has now been revised and confirmed by recent C14 dates. The beginning of the Majkop component (and thus the origins of his Circumpontic Metallurgic Province) should be dated back to the first half of the

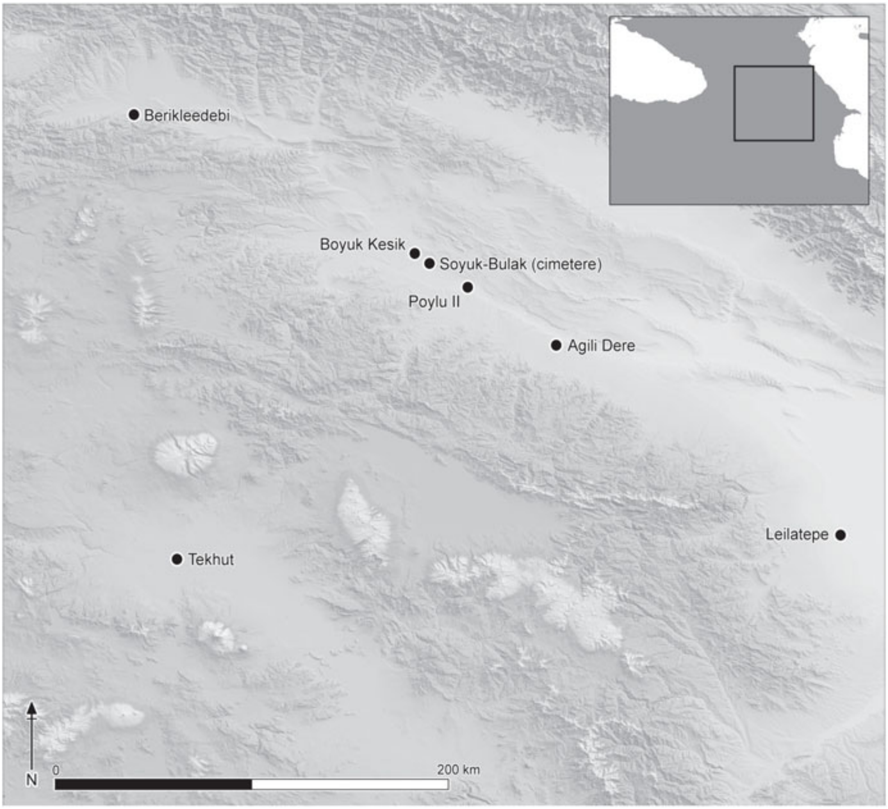


**Fig. 22.16** Settlements attached to the Majkop culture – undefined component (Cassard et al., 2009. GIS project)

fourth millennium BCE (LC2) (Rassamakin 1999), earlier than the beginning of the Kura–Araxes culture.

Chernykh considered the metallurgy of the Majkop culture to be entirely dependent upon the southern Caucasus—principally the Kura–Araxes culture—due to a belief in migration theories, the hierarchical concept of the metallurgical province, the hypothesized lack of cupriferous hydrocarbonate (malachite, azurite, *etc.*) and cupronickelous ores in the northern Caucasus, as well as the apparent absence of furnaces in this region. Under this scheme, the Majkop culture is believed to have been a mere intermediary between the regions rich in ores (Anatolia, Iran, Transcaucasia) and those deprived of raw material for metallurgy (e.g. the Steppes) (Chernykh 1992, pp. 59–67). This theory was widely accepted by Soviet researchers (e.g. Abesadze et al. 1958; Korenevskij 1972, 1974).

Recent research in this region (Cassard et al. 2009; Courcier 2006, 2007, 2008; Courcier et al. 2009a, b), including the new chronological scheme proposed by B. Lyonnet (2004, 2007a, b, 2009), has led us to reconsider Chernykh's theory

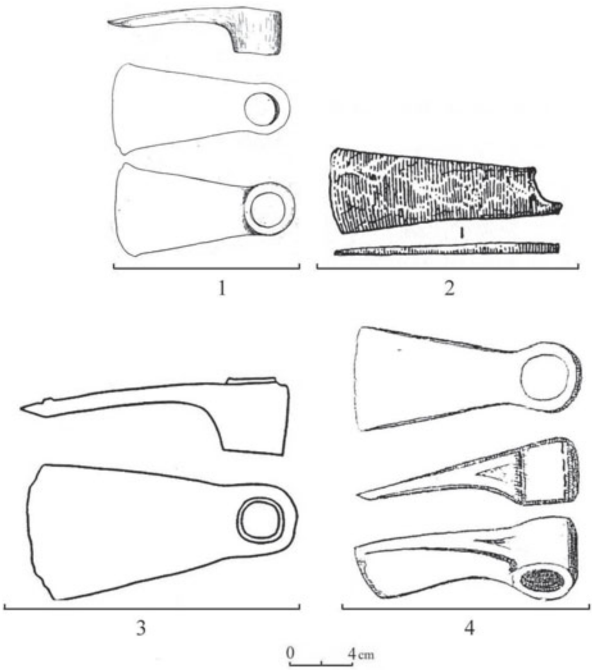


**Fig. 22.17** Adzes coming from Majkop component settlements: *1* Galjugaj I (Korenevskij 1995, p. 170), *2* Konstantinovskaja (Markovin 1994a, p. 270), *3* Psekups (Lovpache 1985), *4* Maïkop (Chernykh 1966, p. 98)

on the northern Caucasus's dependence on the southern Caucasus. It is clear that metallurgy expanded significantly in both regions during the first half of the fourth millennium BCE. Two major categories of metallurgy can be distinguished: copper objects and precious metals (gold and silver). The former is characterized by a spread of technologies and a rise in the quantity and diversity of the objects made. The latter is notable for some of the most elegant and complex workings of gold and silver alloys anywhere in the Old World at this time. Due to the importance of this new research in overturning long-held theories about the technological dominance of the southern Caucasus over the northern Caucasus, the Majkop material is laid out in detail below.

## Metallurgy of Copper Objects (Majkop and Novosvobodnaja)

### *Tools*

Throughout the Majkop and Novosvobodnaja phases, there was continuity in certain types of metal objects—notably awls and bracelet even from the previous period (Meshoko culture). Some new tool types appeared in the Majkop phase and most continued into the Novosvobodnaja phase. These consist of hollow chisels, flat axes (Fig. 22.18), adzes (Fig. 22.17), axe-adzes and plain chisels (both types only known in the Majkop kurgan). These tools seem linked to woodworking rather than to

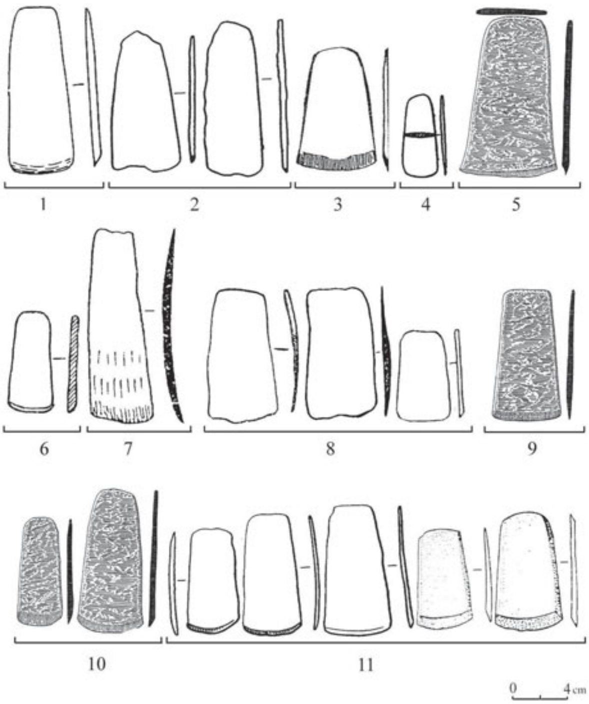


**Fig. 22.18** Flat axes found in settlements attached to Majkop component and Novosvobodnaja component. **Majkop component:** *1* Apsheronskaja (Chernykh 1992, p. 75), *2* Majkop (*Idem* 1966, p. 98), *3* Psekups (Lovpache 1985), *4* Sturbino (Chernykh 1966, p. 98 and 100–101). **Novosvobodnaja component:** *5* Bamut (Ibidem; Munchae 1994, p. 206), *6* Chegem II (Betrozov and NaGoev 1984, p. 42), *7* Chirkejskogo (Makhmundov et al. 1968), *8* Kishpek (Miziev 1984, p. 92), *9* Kuban area (Chernykh 1966, p. 98 and 100–101), *10* Makhoshevskaja (Munchaev 1994, p. 206), *11* Novosvobodnaja (ibidem)

agricultural production or military activities as proposed by Korenevskij (2004, pp. 45–46). Similar adzes are known at Ordzhoshani (Georgia), which is linked to the Kura–Araxes culture (Dzhibladze 2005, pp. 100–101) and at Susa in southwestern Iran[9] (Deshayes 1960, p. 233; Tallon 1987, p. 174). Axe-adzes were present in the Carpatho-Balkan area since the first half of the fifth millennium BCE (Gernez 2007, p. 248) and moulds of this tool type have been discovered at Tepe Ghabristan (Period II) and Tepe Sialk (Period III, 4–5) in Iran, both dating to the fourth millennium BCE (Amiet 1986, p. 42; Gernez 2007, p. 248). Since the axe-adzes have only been discovered in the Majkop kurgan, their presence could confirm existing contacts between the northern Caucasus and the Carpatho-Balkan area, while also showing new relations with Iran. Interestingly, Deshayes (1960, p. 41 and 107) also suggested an Iranian influence for the flat axes and the hollow chisels. However, Mesopotamian contacts have also been attested during the Majkop phase (Lyonnet 2007b) and we cannot rule out the idea that Mesopotamia may have influenced a local production of metal artefacts in the northern Caucasus.

During the Majkop phase, the pickaxe (Fig. 22.19) appears for the first time at sites such as Ust'-Labinskaja and El'brus (Ryndina 2003, pp. 16–17). Similar stone and bone pickaxes were known in the previous Meshoko culture (e.g. at Jasenova Poljana, Veselogo and Svobodnoe) (Munchaev 1975, p. 191; Nekhaev 1992, p. 88), which, as

[9] Undated artefact.

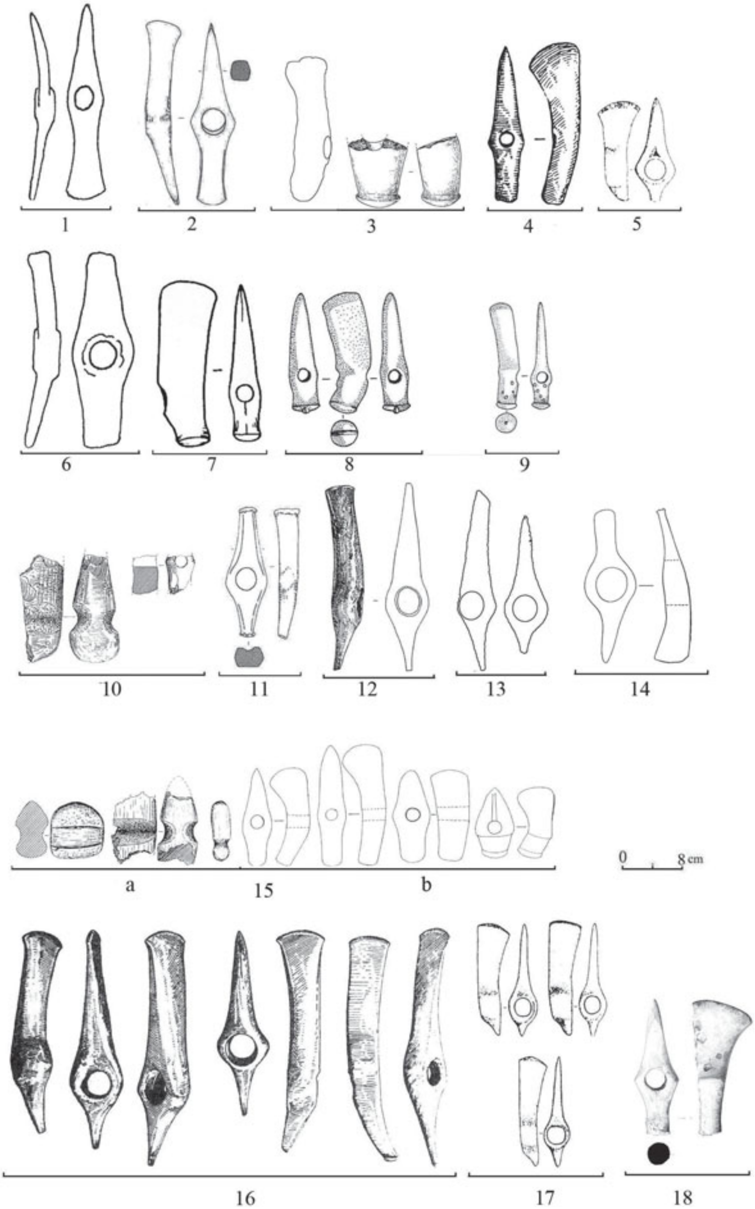


**Fig. 22.19** Pickaxes discovered in settlements attached to the Majkop and Kura–Araxes cultures and in Iran. **Majkop component**: *1* Elbrus area (metal; Ryndina 2003, p. 17), *2* Ust'-Labinskaja (ibid.). **Novosvobodnaja component**: *3* Gatyn-Kale (stone; Markovin 1963, p. 92), *4* Mikhajlovskaja (stone; idem 1994a, p. 270), *5* Lenchinkaj (metal; Batchaev 1984, p. 131), *6* Vladikavkaz (metal; Ryndina 2003, ibid.), *7* Vodzdvizhenskaja (metal; Chernykh 1992, p. 75), *8* Novosvobodnaja (stone), *9* Klady (metal; Masson 1997, p. 69). **Kura–Araxes**: *10* Kabaz-Kutan (stone; Gadzhiev et al. 2000, p. 55), *11* Rugudzha (metal; Chernykh 1991, p. 585), *12* Alaverdi (metal; Martirosjan and Miatsakanjan 1973, p. 125), *13* Dmanisi (ibid.), *14* Leninakan (Martirosjan 1964, p. 32), *15a* Velikent tell II, *15b* Velikent tell III grave 11 (stone; Gadzhiev et al. 2000, p. 64 and 93). Other: *16* Dzhrashen (metal; Chernykh 1992, p. 64–65), *17* Sé Girdan (metal; Muscarella 2003, p. 126), *18* Suse (metal; Tallon 1987, p. 75)

shown earlier, was in contact with the Carpatho-Balkan area. The two metal pickaxes discovered in the northern Caucasus are indeed typologically close to models known in the Carpatho-Balkan area (Jászladány Devnja and Siria types) (Ryndina 2003, p. 15; Gernez 2007, pp. 249–251). Because of its composition in "pure copper", the undated pickaxe from Ust'-Labinskaja was considered by Chernykh (1991, pp. 585–590; 1992, p. 48) to be an import from the Carpatho-Balkan area. Since there is no real proof for that, and since pure copper objects are also known in the Caucasus, the label of "import" requires further evidence.

During the Novosvobodnaja phase, the pickaxes are still present alongside a new variant, the axe-hammer. It differs from the pickaxe by its convex and circular shoulder. These two types are known in several settlements (Fig. 22.16; Klady, Vozdvizhenskaja, Lenchinskaj and Vladikavkaz) and are close to stone models in the same or contemporary settlements (Fig. 22.19; Gatyn-Kale, Novosvobodnaja and Mikhajlovskaja). The diffusion of this tool (and its variant) in the northern Caucasus during the Novosvobodnaja component is concomitant with the appearance of pickaxes (in metal or stone) in many Kura–Araxes settlements. It should be underlined that Lyonnet (2007b) has already noted strong parallels between Novosvobodnaja and Kura–Araxes ceramics. Parallels made with pickaxes from Se-Girdan (Muscarella 2003, p. 124) and Susa[10] (Tallon 1987, pp. 97–99) also suggest continued contact with Iran.

New tools appeared during the Novosvobodnaja phase such as needles, hooks, forks and rolled rods[11]. Contrary to the tools of the Majkop phase, the tools of the later Novosvobodnaja phase have no real parallels with other contemporaneous cultures in the Caucasus or beyond, except with the Kura–Araxes (e.g. a fork found at Dag-Ogni in Dagestan; Gadzhiev 1991, p. 192). It seems likely that the metal artefacts of the Novosvobodnaja phase are mainly local productions.

The socketed axe appeared during the Majkop phase at a number of sites (Fig. 22.20). During the Novosvobodnaja phase, numerous socketed axes are characterized by different shapes of the blade. The exact function of the socketed axes is not clear—they could be either tools or weapons—but they are important for the first use of the socket. Socketing was probably mastered first in the Carpatho-Balkan area during the fifth millennium BCE (Gumelnitsa/Karanovo VI cultures) and suggests the use of bivalve moulds (Gernez 2007, p. 173 and 546). This technique could have come from the Carpatho-Balkan area, although it is surprising that no evidence of bivalve mould use is known from the previous culture (Meshoko), which was in contact with the Carpatho-Balkan area during the fifth millennium BC.

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[10] Undated axe-hammer.

[11] Possibly parts of bits for horses according to Munchaev 1975: 209, although this has been contested.

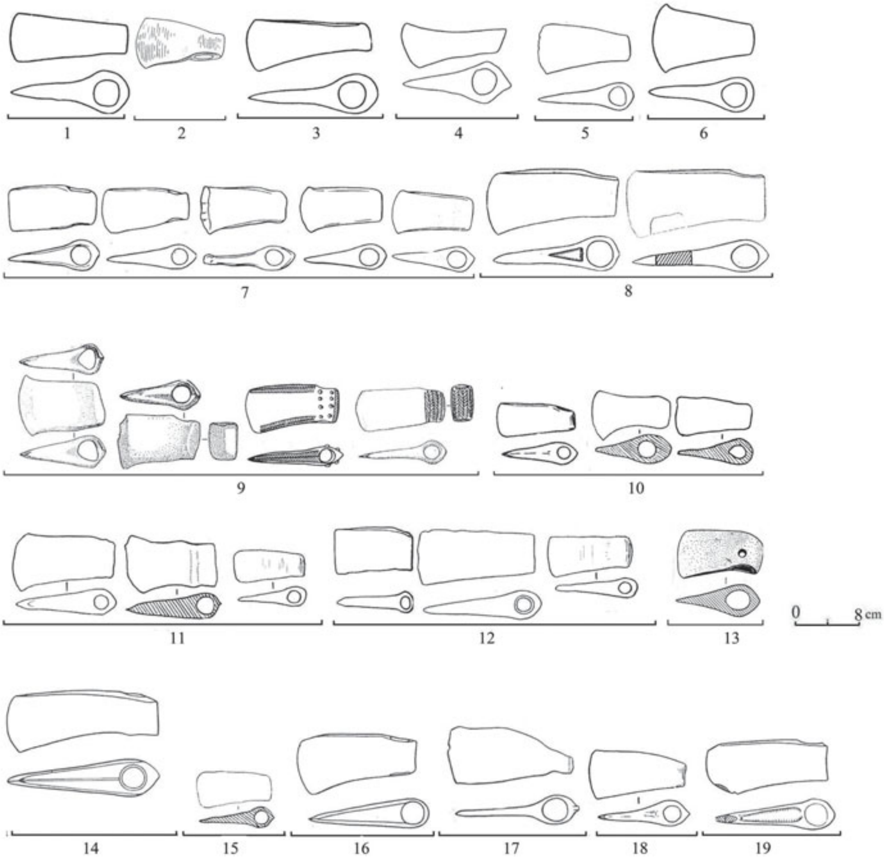


**Fig. 22.20** Socketed axes coming from the Majkop culture. **Majkop component**: *1* Majkop (Chernykh 1992, p. 75), *2* Kostromskaja (Munchaev 1975, p. 259), *3* Ust'-Dzhegusta (Korenevskij 1974, p. 17), *4* Pjatigorsk (Korenevskij 1972, p. 336), *5* Apsheronskaja (Idem 1974, p. 20), *6* Balaklava (Idem, p. 17). **Novosvobodnaja component**: *7* Novosvobodnaja (Chernykh 1966, p. 98; Korenevskij 1974, p. 20; Munchaev 1975, p. 250; Chernykh 1992, p. 75), *8* Andrjukovskaja (Korenevskij 1974, p. 24), *9* Klady (Masson 1997, p. 270), *10* Chegem II (Betrozov 1984, p. 42; Chernykh 1992, p. 75), *11* Kishpek (Chechenov 1980, p. 21; Miziev 1984, p. 92), *12* Nal'chik (Chernykh 1966, p. 100; Korenevskij 1974, p. 20), *13* Bamut (Munchaev 1975, p. 259), *14* Dolinka (Korenevskij 1974, p. 22), *15* Kyzburun III (Miziev 1984, p. 101), *16* Lakshukaj (Korenevskij 1974, p. 24), *17* Psebaj (Ibidem). **Undefined component:** *18* Khashi (Chernykh 1992, p. 75), *19* Anatas'evskaja (Korenevskij 1974, p. 24)

## *Weapons*

During the Majkop phase, new types of weapons appear: daggers with flat blades (Fig. 22.21) and tripartite spearheads (e.g. at Psekups). The dagger coming from the Majkop kurgan shows that the technique of riveting was known even in the early phase; during the next period (Novosvobodnaja) a similar technique was widely used.

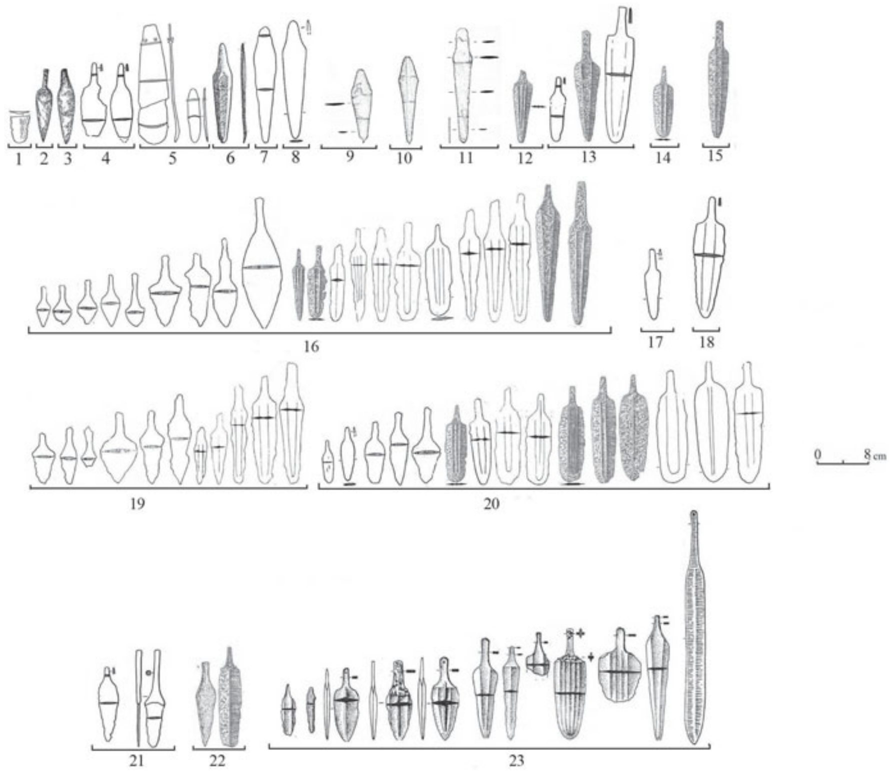


**Fig. 22.21** Daggers found in settlements linked to the Majkop culture. **Majkop component:** *1* Galjugaj I (Korenevskij 1995, p. 170), *2* Kislovodsk (Markovin 1994a, p. 270), *3* Konstantinovskaja (ibid.), *4* Kostromskaja (Chernykh 1966, pp. 101–102), *5* Majkop (Chernykh 1966, p. 100, 1992, p. 75), *6* Psekups (Lovpache 1985, p. 32), *7* Zissermanov (Chernykh 1966, pp. 100–101), *8* Aleksandrovskaja (Chernykh 1992, p. 75), *9* Zunda-Tolga (Shishlina 2008, p. 30), *10* Chograj (ibidem), *11* Mandjikiny. **Novosvobodnaja component**: *12* Baksan (Munchaev 1994, p. 204), *13* Bamut (Chernykh 1992, ibidem), *14* Kyzburun III (Miziev 1984, p. 101), *15* Krasnogvardejskaja (Munchaev 1994: *idem*), *16* Chegem I (Betrozov and NaGoev 1984, p. 45 et 70), *17* Kubina Aul (Chernykh 1992, p. 75), *18* Timachevsk (Chernykh 1966, p. 98 et 100–101), *19* Chegem II (Chernykh 1966, p. 102; Betrozov and NaGoev 1984, p. 45 and 70; Munchaev 1994, p. 204), *20* Kishpek (Betrozov and NaGoev 1984, pp. 37–39 and 70; Munchaev 1994, p. 204), *21* Novosvobodnaja (Chernykh 1992, p. 75), *22* Nal'chik (Markovin 1994a, p. 264), *23* Klady (Masson 1997, p. 270)

Similar but narrower daggers are known in the Leilatepe–Berikldeebi culture (Boyuk-Kesik and Soyuq-Bulaq), which is contemporaneous with the Majkop component (Museibli 2007, p. 85, Fig. XL; Akhundov 2007, p. 106; Lyonnet 2007b, p. 150; Courcier et al. 2008a, p. 21). During the Novosvobodnaja phase, daggers with flat blades continue to exist while new types with ribbed blades appear (Fig. 22.21). This new type of dagger is characteristic of this period and seems to be a local production. Similar models are known later in the Near East during the Early Bronze Age III period (ca. 2600 BCE) at Tell Melebiya (phase 2), Tell Brak, Uruk and Mari (Gernez 2007, pp. 489–490).

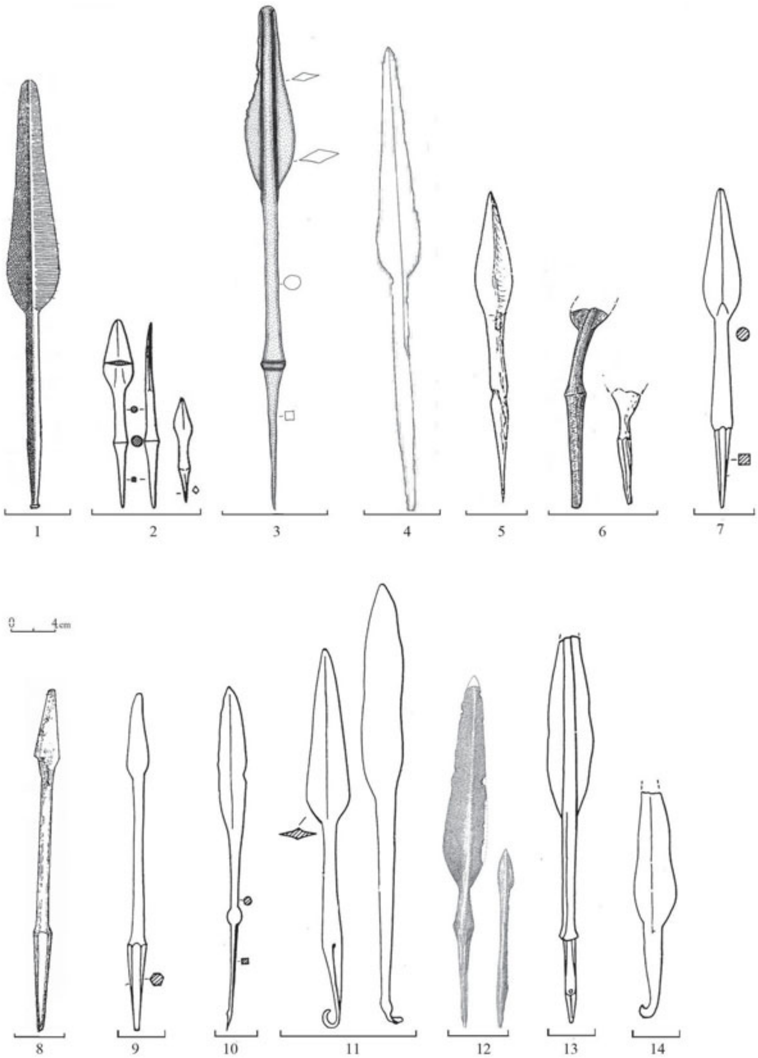


**Fig. 22.22** Tripartite spearhead discovered in settlements of the Majkop culture (Novosvobodnaja component) and the Kura–Araxes culture. **Novosvobodnaja component**: *1* Psekups (Lovpache 1985, p. 33), *2* Novosvobodnaja (Chernykh 1966, p. 98; Idem, 1992, p. 75), *3* Klady (Rezpkin 2000, p. 12), *4* Psebaj (Museum of Saint-Petersburg). **Kura–Araxes**: *5* Chirkejskogo (Gadzhiev 1991, p. 140), *6* Sigitma (Gadzhiev 1991: *idem*; Markovin 1994b, p. 292), *7* Akhaltsikh (Kushnareva and Chubinishvili 1970, p. 124), *8* Tskhinvali (Tekhov and Dzhaparidze 1971, p. 66), *9* Osprisi (Kushnareva 1997, p. 199), *10* Sevan (*ibidem*), *11* Tbilisi (*ibidem*), *12* Telman-Kend (*ibidem*), *13* Tsartis-Gora (*ibidem*), *14* Zemo-Avchalskaja (*ibidem*)

The Novosvobodnaja phase is also characterized by the apparition and wide diffusion of the tripartite spearheads (Fig. 22.22). Spearheads similar to these are also known in Kura–Araxes settlements. A large diffusion of this weapon type seems to

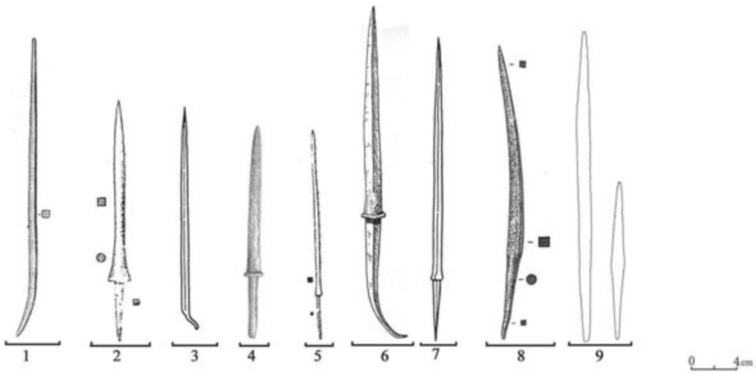


**Fig. 22.23** Spearheads, whose head was prolonged with a sharp wedge-shaped blade and finished with a pike, in the Majkop culture (Novosvobodnaja component) and the Kura–Araxes culture. **Novosvobodnaja component**: *1* Bamut (Mnchaev 1975, p. 306). **Kura–Araxes**: *2* Akhalchihskogo grave (Amiranis-Gora) (Kushnareva et al. 1963, p. 15), *3* Khachbulag (Schachner 2002, p. 124), *4* Kul'tepe II (Kushnareva and Chubinishvili 1970, p. 124), *5* Kvatskhelebi (*ibidem*), *6* Tsartis Gora (*ibidem*), *7* Verkhnegunibskoe (Gadzhiev 1991, p. 192)

have occurred throughout the northern and southern Caucasus at the end of the fourth millennium BCE, spreading into eastern Anatolia, northern Syria and as far as Turkmenistan by the first half of the third millennium BCE (Gernez 2007, pp. 296–298; Courcier 2007, p. 215). A second type of spearhead appeared during the Novosvobodnaja phase—i.e. a pike with a square section (Fig. 22.23; Munchaev 1975, p. 306; Korenevskij 1986, p 7). This type is also close to examples known in the Kura–Araxes culture (Kushnareva and Chubinishvili 1963, 1970, p. 124 and 170; Schachner 2002, p. 124). This again underlines the strong parallels between these two cultures. Similar pikes are also known during the Early Bronze Age II/III (ca. 2800–2600 BCE) at Tell Kara Hassan (Woolley 1914, pl. 19), Jerablus-Tahtani and Carchemish (Woolley and Barney 1952, pl. 60–61; Gernez 2007, pp. 285–286).

## *Copper Vessels and Other Objects*

The Majkop phase is also characterized by the appearance of copper vessels. Discoveries made in the Majkop kurgan and at Kislovodosk illustrate these metal types (Munchaev 1975, p. 213; 1994a, p. 199 and 209). They show that the techniques of cold-hammering, annealing and embossing were already fully mastered. During the next period (Novosvobodnaja), the copper vessels become more widespread (Munchaev 1994, p. 208; Shishlina 2008, p. 41).

Some particular metal objects confirm the diversity of metal production during the Majkop phase, including a square-section rod at Kelermes (Munchaev 1975, p. 225), a helix-shaped object at Majkop (Munchaev 1975, p. 213) and hoops at Majkop (Munchaev 1994, p. 199). This diversity is still attested during the Novosvobodnaja phase with the presence of discs at Klady and Chegem I (Bochkarev et al. 1980, p. 97;

**Fig. 22.24** Silver and gold artefacts coming from the Majkop kurgan. (Korenevskij 2004, Plate VI)

Betrozov and NaGoev 1984, p. 11), a wheel with four spokes at Klady (Bochkarev et al. 1980, p. 97), metal sheet at Chegem I (Korenevskij 1984, p. 189) and metal plates at Chegem I (Betrozov and NaGoev 1984, p. 16).

Copper ornaments, already known in the Meshoko culture, are present in settlements linked to the Novosvobodnaja phase and represented by beads, pendants, earrings, rings, wristbands and cones at Chegem I, Chegem II and Kyzburun III (Betrozov and NaGoev 1984, p. 18, 30, 32, 36; Chechenov 1984, p. 209; Miziev 1984, p. 100).

## Metallurgy of Precious Metals (Gold and Silver)

Precious metals had appeared in the northern Caucasus already by the Majkop phase in the first half of the fourth millennium BCE. Such finds are mainly illustrated by the treasures of the Majkop and Staromyshastovskaja kurgans (Figs. 22.24, 22.25 and 22.26). The number of precious metal artefacts found in the Majkop kurgan is extraordinary: 68 gold strips with stamped gold lions and bull figurines; 2 gold vases; 14 silver vases (2 of which were ornamented); many gold rivets and nails; a stone macehead with its upper part in gold; 10 gold rosettes; many silver and gold beads (often decorated in relief); numerous gold rings; and 6 long rods of silver on

**Fig. 22.25** Gold and silver necklaces found at Majkop, arsenical copper and gold animal figurines coming from Staromyshastovskaja. (Korenevskij 2004, Plate VII)

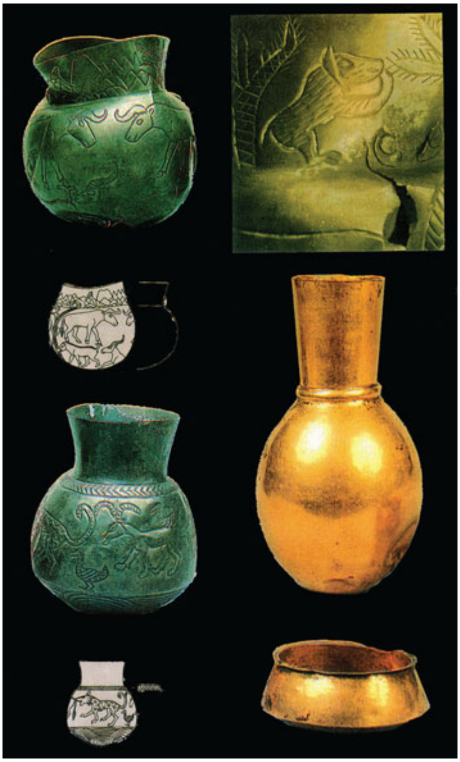

**Fig. 22.26** Gold and arsenical copper wares coming from Galugaj I, Alikovovskoe and Majkop. (Korenevskij 2004, Plate III)

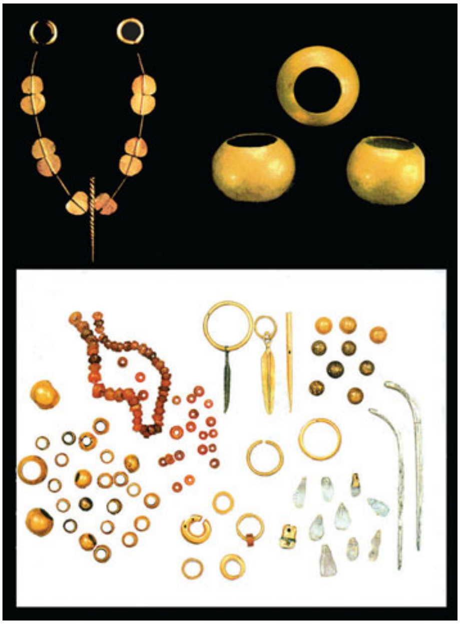

**Fig. 22.27** Jewellery ornaments found at Novosvobodnaja. (Korenevskij 2004, Plate VIII)

which gold and silver bull figurines were attached (Munchaev 1975, p. 213 et seq.). Similarly, the Staromyshastovskaja Treasure included: 1 silver vase; 2 silver figurines of a bull and an antelope; 1 gold lion head figurine; 3 gold rosettes; 40 small rings; and over 2,500 gold and silver beads (Rostovtsev 1918, p. 8–25; Munchaev 1975, p. 213 *sqq*.; 1994a: 199). In both collections, all of this precious metal ornamentation was accompanied by numerous semi-precious stones including turquoise, carnelian and even lapis-lazuli.

In other kurgans linked to the Majkop phase, other precious metal artefacts were also discovered, like the silver vessel from Staryj Urukh (Munchaev 1975, p. 228) and the silver rings found in two kurgans in the north of the Stravropol hills (Kuma-Manych depression; Shishlina 2008, p. 28). These discoveries present some parallels with the 23 gold beads, 33 electrum beads, 2 electrum rings and numerous semi-precious stone beads coming from the kurgans of Soyuq-Bulaq in Azerbaijan, which are considered to be related to the Leilatepe–Berikldeebi culture and therefore contemporaneous with the Majkop phase (Lyonnet et al. 2008; Courcier et al. 2008a). Other parallels can be drawn with the material of kurgans III and IV at Se-Girdan in north-western Iran (Muscarella 1969, p. 20; 1971, pp. 11–12; see also 2003), at Tepe Gawra in north-eastern Iraq dating to levels XI, XA, X and IX, ca. 4000–3600 BCE (Rothman 2002, p. 105, 111–127, 282–285 and 366–381) and at Hacinebi in eastern Turkey, from an infant's tomb dated to the Late Chalcolithic A, ca. 4100–3800 BCE (Stein et al. 1997, p. 142; 1999a: 167). These parallels between the northern Caucasus (Majkop component), Transcaucasia (Leilatepe–Berikldeebi culture) and northern Mesopotamia present evidence for the pre-Uruk expansion which affected both slopes of the Caucasus at the same time (LC 2–4) (Lyonnet 2007b, p. 150; 2009, pp. 5–6).

During the next phase (Novosvobodnaja), starting around 3500/3400 BCE, the use of precious metals continued (Fig. 22.27). In many kurgans (e.g. Novosvobodnaja, Klady, Kubina Aul, Kishpek, Chegem I, Nal'chik and Bamut), prestigious objects in gold and silver were discovered including beads, rings, needles, awls, sheet fragments and wristbands associated with carnelian, rock crystal and lapis-lazuli beads (Chechenov 1973, pp. 119–120; Munchaev 1975, pp. 242–244, 273, 305). Some parallels seem also to exist with Tell Brak, level TW 16 (LC2) (Emberling and McDonald 2003) and Arslantepe (level VIB "Royal Tomb", ca. 3000–2900 BCE; Frangipane et al. 2001; Hauptmann et al. 2002; Norcera et al. 2004). Besides these examples, relations with the surrounding areas seem them to have been much reduced during the Novosvobodnaja phase.

## Questions on the Composition of Metals (Majkop and Novosvobodnaja Phases)

The chemical composition of Majkop and Novosvobodnaja phase artefacts (Tables 22.4 and 22.5) constitutes the basis of Chernykh's theories about Majkop metallurgy (Chernykh 1966: 44–50; 1992: pp. 157–160). His analysis of 85 objects related to the Majkop culture[12] (4 coming from Meshoko, 15 from the Kuban area, 24 from kurgans related to Phase I and 42 to Phase II), led him to identify two groups of metal objects characterized either by a low percentage of nickel ($< 0.1\,\%$ Ni) or by a high percentage of nickel (0.1 to 4.4 % Ni) (Chernykh 1966, p. 38). In these two groups, the percentage of arsenic is very similar: 0.5–9.08 % and 0.70–10 % As, respectively (Chernykh 1966, p. 43). Chernykh also considered that these two groups corresponded respectively with the two phases of the Majkop culture, and underlined the importance of high nickel concentrations for assigning artefacts to the later phase (*ibid.*).

On the basis of Selimkhanov's work (Selimkhanov 1960a, b, 1962, 1964), Chernykh (1966, pp. 44–46) further detailed the areas and settlements with metal objects containing nickel (i.e. Transcaucasia, Iran, Anatolia and Mesopotamia) and the copper deposits characterized by nickel ores in Transcaucasia and eastern Anatolia. In his discussion, he mentions that the copper deposits situated in the northern Caucasus contain many impurities but no nickel and are almost entirely sulphidic ores (Chernykh 1966, p. 49). As a proponent of the linear "historical–technical" scheme[13], he thus concluded that Majkop metallurgy was wholly dependent upon the metal products manufactured by the Kura–Araxes population in the South who could take advantage of more favourable metallogenical conditions (Chernykh 1966, pp. 49–50).

In order to characterize Majkop metallurgy, these results need to be reconsidered.

As we have seen, the analyses made in the 1960s do not allow us to characterize with certainty the metal composition of the objects related to the Majkop component. However, two alloys seem to have been used: Cu–As and Cu–As–Ni. The origin of the nickel depends on the ores but also on the possible recycling of objects. The

[12] As Chernykh (1966: 38) defined it, with Phase I corresponding more or less to the Majkop phase mentioned in this article and his Phase II to the Novosvobodnaja phase.

[13] According to which native copper was used first, then carbonaceous and oxides ores, and finally sulphidic copper ores.

**Table 22.5** Analyses of metal artefacts found at Novosvobodnaja. (Selimkhanov 1962, p. 75; Chernykh 1966, p. 98–103; percent type not précised)

| n° analyse | Type d'objet | Localisation | Composition percent | | | | | | | | | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Sn | Pb | Zn | Bi | Ag | Sb | As | Fe | Ni | Co | Au | |
| | fourche | kourgane 6 | 95.2 | 0.008 | 0.18 | | 0.003 | 0.015 | 0.003 | 4.08 | 0.02 | 0.001 | | 0.0005 | Selimkhanov 1962, p. 75, Table I |
| | hache | kourgane 2 | 94.7 | 0.0005 | 0.01 | | | 0.004 | 0.005 | 4.73 | 0.01 | 0.001 | | | Selimkhanov 1962, p. 75, Table I |
| | hache | kourgane 2 | 97.45 | 0.001 | 0.07 | | 0.007 | 0.042 | 0.005 | 1.95 | 0.005 | 0.002 | | 0.002 | Selimkhanov 1962, p. 75, Table I |
| | hache | kourgane 1 | 90.8 | 0.001 | 0.04 | | 0.001 | 0.022 | 0.015 | 6.68 | 0.02 | 1.9 | 0.002 | 0.001 | Selimkhanov 1962, p. 75, Table I |
| | pointe de lance tripartite | kourgane 4 | 96.6 | 0.0005 | 0.002 | | | 0.013 | | 2.7 | 0.15 | 0.001 | | 0.0005 | Selimkhanov 1962, p. 75, Table I |
| | ciseau muni d'une gouge | kourgane 5 | 96.3 | | 0.1 | | 0.002 | 0.005 | 0.005 | 3.16 | 0.02 | 0.007 | | | Selimkhanov 1962, p. 75, Table I |
| | poignard | kourgane 7 | 92.9 | | 0.08 | | 0.005 | 0.025 | 0.005 | 6.49 | 0.05 | 0.001 | | 0.001 | Selimkhanov 1962, p. 75, Table I |
| | fragment d'objet | kourgane 7 | majoritaire | 0.001 | 0.1 | | 0.003 | 0.023 | 0.015 | 0.7 | | 0.003 | | 0.002 | Selimkhanov 1962, p. 75, Table I |
| | herminette | kourgane 8 | 89.4 | 0.001 | 0.001 | | | 0.003 | 0.007 | 10 | 0.01 | 0.001 | | | Selimkhanov 1962, p. 75, Table I |
| | dague | kourgane 8 | 91.3 | | 0.07 | 0.004 | 0.002 | 0.017 | | 8.07 | 0.01 | 0.001 | | 0.002 | Selimkhanov 1962, p. 75, Table I |
| 10 | burin | kourgane 2, tombe 2 | majoritaire | | 0.01 | | 0.001 | 0.05 | 0.003 | 1.7 | 0.001 | 0.45 | | | Chernykh 1966, pp. 98-99 |
| 959 | couteau arc manche | kourgane 2, tombe 2 | majoritaire | | 0.003 | | 0.001 | 0.5 | 0.005 | 1.2 | 0.009 | 0.35 | | | Chernykh 1966 pp. 98-99 |
| 963 | puisoir | kourgane 1, tombe 1 | majoritaire | un peu | 0.016 | | 0.006 | 0.025 | | 0.8 | 0.001 | 0.004 | | | Chernykh 1966, pp. 101–102 |
| 946 | hache | kourgane 1, tombe 1 | majoritaire | | 0.001 | | 0.001 | 0.003 | | 2 | un peu | 0.003 | | | Chernykh 1966, pp. 101–102 |

**Table 22.5** (continued)

| n° analyse | Type d'objet | Localisation | Composition percent | | | | | | | | | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Sn | Pb | Zn | Bi | Ag | Sb | As | Fe | Ni | Co | Au | |
| 948 | hache | kourgane 1, tombe 1 | 94.7 | 0.0005 | 0.01 | | | 0.004 | 0.005 | 4.73 | 0.01 | 0.001 | | | Chernykh 1966, pp. 101–102 |
| 947 | hache | kourgane 1, tombe 1 | majoritaire | | 0.005 | | 0.002 | 0.01 | | 0.65 | | 0.007 | | | Chernykh 1966, pp. 101–102 |
| 957 | hache | kourgane 1, tombe 1 | majoritaire | | 0.006 | | 0.001 | 0.02 | | 1.3 | un peu | 0.003 | | | Chernykh 1966, pp. 101–102 |
| 960 | hache plate | kourgane 2, tombe 2 | majoritaire | | | | | 0.006 | | 4.5 | 0.001 | 0.003 | | | Chernykh 1966, pp. 101–102 |
| 955 | hache plate | kourgane 2, tombe 2 | majoritaire | | | | | 0.0007 | | 3.4 | un peu | 0.001 | | | Chernykh 1966, pp. 101–102 |
| 954 | hache plate | kourgane 1, tombe 1 | majoritaire | | | | < 0.001 | 0.0005 | | 2 | | 0.001 | | | Chernykh 1966, pp. 101–102 |
| 956 | hache plate | kourgane 1, tombe 1 | 89.4 | 0.001 | 0.001 | | | 0.003 | 0.007 | 10 | 0.001 | 0.001 | | | Chernykh 1966, pp. 101–102 |
| 962 | fourche | kourgane 1, tombe 1 | majoritaire | 0.001 | 0.012 | | 0.003 | 0.019 | | 1.8 | un peu | 0.004 | | | Chernykh 1966, pp. 101–102 |
| 953 | pointe de lance | kourgane 1 | 96.6 | 0.0005 | 0.002 | | | 0.013 | | 2.7 | 0.15 | 0.001 | | 0.0005 | Chernykh 1966, pp. 101–102 |
| 1060 | couteau | kourgane 1 | majoritaire | | | | 0.001 | 0.006 | | 4 | 0.001 | 0.003 | | | Chernykh 1966, pp. 101–102 |
| 951 | ciseau | kourgane 1 | majoritaire | | 0.02 | | 0.004 | 0.016 | | 0.8 | | 0.003 | | | Chernykh 1966, pp. 101–102 |
| 950 | ciseau | kourgane 1 | 96.3 | | 0.1 | | 0.002 | 0.005 | 0.005 | 3.16 | 0.02 | 0.007 | | | Chernykh 1966, pp. 101–102 |
| 952 | ciseau | kourgane 1 | majoritaire | | 0.001 | | 0.002 | 0.01 | | 2 | | 0.003 | | | Chernykh 1966, pp. 101–102 |
| | poignard | kourgane 1 | 92.2 | | 0.08 | | 0.005 | 0.025 | 0.005 | 6.49 | 0.05 | 0.001 | | 0.001 | Chernykh 1966, pp. 101–103 |
| | chaudron | kourgane 1 | majoritaire | 0.001 | 0.1 | | 0.003 | 0.023 | 0.015 | 0.7 | 0.03 | 0.003 | | 0.002 | Chernykh 1966, pp. 101–103 |
| | poignard | kourgane 1 | 91.3 | | 0.07 | | 0.002 | 0.017 | | 8.07 | 0.01 | 0.001 | | 0.002 | Chernykh 1966, pp. 101–103 |

question of whether the ores used to make these alloys came from the south or the north must await further studies.

## Questions on Metalworking (Majkop and Novosvobodnaja Phases)

Metallographic studies by N. V. Ryndina and I. G. Ravich of dagger blades from kurgans of the Novosvobodnaja phase have demonstrated the presence of two styles of metalworking (Ryndina and Ravich 1995). The first style involves casting the object and then carrying out an alternating series of cold-working and annealing steps in order to obtain a more homogenous microstructure. The second style consists of casting and cold-working the object, then annealing it once before cold-working it again. The blades made via the first method present fewer impurities, while blades made via the second method contain higher amounts of nickel. Both metalworking styles are probably local to the Caucasus (Ryndina and Ravich 2000). However, according to the authors of these studies, the existence of two metalworking styles may suggest the specialisation of a particular group of metalworkers. Therefore, these metallurgical "traditions" illustrate the manner in which metal production was locally organized and specialized at different sites (Ryndina and Ravich 1995, p. 12).

These conclusions are akin to Tedesco's research on metallurgy in Armenia during the Early Bronze Age. She identified close parallels between the microstructures of the Novosvobodnaja daggers and the metallography she performed on two blades found at Yerevan (Armenia) dated to the beginnings of the third millennium BCE (ca. 2800–2700 BCE). In spite of typological differences between her daggers and those studied by Ryndina and Ravich, the manufacturing sequences show close similarities, such as ghost dendritic structures with heavily strained and compressed grains along the cutting edges. However, the Yerevan daggers did not present the same degrees of segregation as in the Novosvobodnaja daggers (Tedesco 2006a, p. 207, pp. 235–236). Her studies led Tedesco to propose the absence of large-scale production in the Majkop phase. On the contrary, she argued for the existence of household-level production but following a standardized technical tradition, which could explain the widespread uniformity of metallurgy in Transcaucasia and the northern Caucasus (Tedesco 2006a, p. 205, pp. 315–322). Her hypothesis is in accordance with our own research, which demonstrates strong similarities between the Novosvobodnaja and the Kura–Araxes metallurgical styles (see Courcier 2010).

## Questions on Extractive Metallurgy (Majkop and Novosvobodnaja Phases)

Among the 204 ore deposits known in the northern Caucasus, 57 contain copper, and 17 deposits, irrespective of the copper deposits, contain arsenic as the main element. Some of these deposits present natural associations of copper and arsenic. In addition, nickel is present in numerous ore deposits in the northern Caucasus (Cassard et al. 2009). An important metalliferous potential thus exists in this area.

These deposits would have been more than adequate for supplying the ores used in the production of metal objects of the Majkop component (Cu–As and Cu–As–Ni alloys). Furthermore, many gold and silver deposits are known from the northern Caucasus. Silver ores correspond to native formations or are linked with Pb–Zn ores. Gold is present in native form, often associated with copper or silver (Cassard et al. 2009).

No research concerning ancient extractive metallurgy has been done in the northern Caucasus for the Majkop component. Chernykh theory about the reliance of the Majkop culture upon Kura–Araxes metalworkers of the South has remained unchallenged until now, thus discouraging scholars from even exploring the possibility of local ore extraction in the northern Caucasus. However, thanks to local geological research carried out between 1920 and 1933 by A.A Iessen and B. E. Degen-Kovalevskij, we know of several settlements in the northern Caucasus which could be directly or indirectly connected with extractive metallurgy (Iessen and Degen-Kovalevskij 1935, pp. 36–41). Although the deposits remain undated, their descriptions constitute invaluable information. When combined with our recent survey data of the ore deposits of the region, it is clear that the deposits with noticeably ancient exploitation all contain either argentiferous ores associated with lead or cupriferous ores associated with some arsenic and even nickel. It is also important to note that recent research by C. Hamon (2007, pp. 192–196) on stone tools from Majkop sites has provided further evidence of extractive metalworking in this region.

## The Origin of Majkop Metallurgy

There are a variety of theories on the origins of metallurgy in the Majkop culture. First, many authors have suggested that the metal objects discovered in the Majkop culture were imported from Mesopotamia based on typological and iconographic similarities (e.g. Rostovtsev 1918, pp. 24–25; Childe 1936; Betancourt 1970; Sulimirski 1970, pp. 123–125; Andreeva 1977, 1979; Nekhaev 1986). Chernykh, as we have already seen, has suggested that Majkop metallurgy was derived from highland cultures of the Middle East (Iran, Anatolia) via Transcaucasia (Kura–Araxes) (Chernykh 1966, pp. 45–50; Chernykh 1992, pp. 65–73 and 155–160). Such theories of "migration waves" from the Middle East also helped to explain Mesopotamian influence on the Majkop culture (Munchaev 1975, pp. 322–329; 1994a, pp. 169–170; Korenevskij 2004; Akhundov 2007).

Far rarer are arguments in favour of a local basis for Majkop metallurgy (e.g. Iessen 1950, p. 191; Munchaev 1975, pp. 322–335, 1994a, pp. 199–209, 2005, pp. 13–15). Such indigenous origins theories are based on the existence of deposits in the northern Caucasus with different metalliferous minerals that parallel the composition of metal objects of the Majkop culture. Other scholars underline the unique character of certain types of metal production which are only known in the northern Caucasus (e.g. Formozov 1965, p. 117; Korenevkij 1974, 1988a, pp. 93–95) as well as local styles of metalworking (e.g. Ryndina and Ravich 1995).

Our own research supports the idea of a local metal industry in the Majkop culture. The metallurgical processes, most likely originating in the Carpatho-Balkan area and already known during the preceding Meshoko culture, were probably further developed by the Majkop population. It seems that this western influence continued into the beginning of the Majkop phase, as suggested by the introduction of the socket and the metal pickaxe. We cannot exclude, however, that metallurgical technologies in the Majkop culture were also influenced by exchanges with the southern Caucasus, especially with the Sioni culture. As we saw above, the Majkop culture had relations with several areas (Transcaucasia, north-western Iran and eastern Anatolia) where metallurgy had already started, and its metallurgy shows close similarities with that of the Leilatepe–Berikldeebi culture (below).

Nevertheless, several types of objects (flat axes, tripartite spearhead, adzes, copper vessels, gold and silver vessels and gold and silver zoomorphic figurines) seem to be typical only of the Majkop culture, both during the Majkop phase and during the Novosvobodnaja phase. During this later phase, we see an intensification of local metal production and, except for the ornaments and some types of weapons (like tripartite spearheads), the parallels with the neighboring regions seem to disappear. Interestingly, contact is still apparent with the Kura–Araxes culture of Transcaucasia (below).

## *Metallurgy of the Leilatepe–Berikldeebi Culture*

During the Late Chalcolithic 2–4, the "Pre-Uruk" expansion can be traced in Transcaucasia within several settlements (Fig. 22.16). We group these sites together under the name of the Leilatepe–Berikldeebi culture, which is contemporaneous with the early phase of the Majkop culture. Compared to the previous cultures known in this area (Shomu–Shulaveri and Aratashen), metallurgy shows a more similar development to that observed for the Majkop phase.

At Tekhut in Armenia, three metal objects (a small knife, an awl and an arrowhead) were discovered that were shown to have been made of arsenical copper (Selimkhanov and TorosJan 1969). Metallographic studies on these pieces suggest cold-hammering, although their results are difficult to utilize (Tedesco 2006a, p. 104). In level V1 of Berikldeebi in Georgia, the discovery of a copper wristband and of a copper flat axe (Žavaxišvili 1998) confirms the appearance of metallurgy during this period. This is even more noticeable at Leilatepe in Azerbaijan, where several metal artefacts have been discovered: awls, wire, fragment of a curved plate and extremity of a knife/dagger (Akhundov 2007, pp. 103–108). Moreover, in Building 4 at Leilatepe, prills and rest of melting mixed with ashes and slags suggest the manufacturing of metals. According to T. Akhundov (2007, p. 107), one of the 11 ovens discovered on site was probably associated with metallurgy given its proximity to where the metal artefacts were discovered. We cannot discuss here in detail the results of the analysis done on the metal artefacts, but we can nevertheless underline this paradox that copper prills come mainly from the slags (Aliev and Narimanov 2001, p. 135; Akhundov 2007, p. 106). The authors do not explain this fact which, for us, suggests an uncontrolled smelting process.

Recently, six awls, a plate, two daggers with rivets, metal slag and a stone axe mould were discovered (Table 22.6) at Boyuk-Kesik in Azerbaijan (Museibli 2007,

**Table 22.6** Analyses of several artefacts coming from Boyuk-Kesik. (Museibli 2007, p. 86, percent type not précised)

| n° analyse | Type d'objet | Localisation | Composition percent (massique) | | | | | | | | | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Sn | Pb | Zn | Bi | Ag | Sb | As | Fe | Ni | Co | Au | |
| 25 | lame poignard (analyse 1) | Boyuk Kesik | 96.8 | 0.041 | 0.014 | 0.018 | 0.0006 | 0.00016 | 0.0027 | 0.0008 | 0.034 | 0.054 | 0.054 | 0.0005 | Museibli 2007, p. 86 |
| 26 | lame poignard (analyse 2) | Boyuk Kesik | 97.86 | 0.012 | 0.006 | 0.0107 | 0.0008 | 0.00001 | 0.0006 | 0.0008 | 0.024 | 0.0005 | 0.0001 | 0.0005 | Museibli 2007, p. 86 |
| 27 | lame poignard (analyse 3) | Boyuk Kesik | 96.9 | 0.008 | 0.005 | 0.0012 | 0.0007 | 0.00003 | 0.0006 | 0.0012 | 0.012 | 0.0024 | 0.0005 | 0.0005 | Museibli 2007, p. 86 |
| 28 | lame poignard (analyse 4) | Boyuk Kesik | 96.42 | 0.012 | 0.0056 | 0.0018 | 0.0006 | 0.00002 | 0.0008 | 0.0019 | 0.016 | 0.0016 | 0.0009 | 0.0005 | Museibli 2007, p. 86 |
| 29 | lame poignard (analyse 4) | Boyuk Kesik | 97.14 | 0.014 | 0.0048 | 0.0007 | 0.0012 | 0.00004 | 0.0005 | 0.0021 | 0.009 | 0.0015 | 0.0006 | 0.0005 | Museibli 2007, p. 86 |
| 30 | lame poignard (analyse 5) | Boyuk Kesik | 96.15 | 0.016 | 0.0034 | 0.0012 | 0.0005 | 0.00003 | 0.0009 | 0.0012 | 0.008 | 0.0012 | 0.0012 | 0.0005 | Museibli 2007, p. 86 |
| 31 | lame poignard (analyse 6) | Boyuk Kesik | 97.5 | 0.0024 | 0.003 | 0.0008 | 0.0007 | 0.00006 | 0.0007 | 0.002 | 0.012 | 0.0016 | 0.0005 | 0.0005 | Museibli 2007, p. 86 |
| 32 | lame poignard (analyse 7) | Boyuk Kesik | 95.8 | 0.0018 | 0.0051 | 0.001 | 0.0004 | 0.00007 | 0.0012 | 0.0016 | 0.014 | 0.0017 | 0.0001 | 0.0005 | Museibli 2007, p. 86 |
| 33 | lame poignard (analyse 8) | Boyuk Kesik | 97.54 | 0.012 | 0.006 | 0.008 | 0.0008 | 0.00002 | 0.0016 | 0.0008 | 0.016 | 0.0012 | 0.0002 | 0.0005 | Museibli 2007, p. 86 |
| 34 | fragment de poignard | Boyuk Kesik | 96.44 | 0.064 | 0.086 | 0.0005 | 0.0005 | 0.00002 | 0.0008 | 0.0006 | 0.062 | 0.014 | 0.0003 | 0.0005 | Museibli 2007, p. 86 |
| 35 | fragment de poignard | Boyuk Kesik | 96.9 | 0.0028 | 0.021 | 0.0007 | 0.0006 | 0.00001 | 0.0006 | 0.0005 | 0.057 | 0.009 | 0.0002 | 0.0005 | Museibli 2007, p. 86 |
| 36 | objet en forme de balle | Boyuk Kesik | 93.6 | 0.046 | 0.096 | 0.024 | 0.0004 | 0.00003 | 0.0007 | 0.0008 | 0.012 | 0.0012 | 0.0001 | 0.0005 | Museibli 2007, p. 86 |
| 37 | fragment de couteau | Boyuk Kesik | 96.14 | 0.016 | 0.063 | 0.096 | 0.0006 | 0.00001 | 0.0012 | 0.0004 | 0.021 | 0.014 | 0.0002 | 0.0005 | Museibli 2007, p. 86 |
| 38 | Fragment d'alène | Boyuk Kesik | 97.5 | 0.024 | 0.0012 | 0.008 | 0.0007 | 0.00001 | 0.0008 | 0.0005 | 0.01 | 0.0006 | 0.0002 | 0.0005 | Museibli 2007, p. 86 |
| 39 | fragment de couteau | Boyuk Kesik | 96.8 | 0.013 | 0.006 | 0.0008 | 0.0008 | 0.00001 | 0.0021 | 0.0008 | 0.01 | 0.0008 | 0.0001 | 0.0005 | Museibli 2007, p. 86 |


**Fig. 22.28** Dagger coming from kurgan 1 of Soyuq-Bulaq. (Lyonnet et al. 2008, p. 31)

pp. 85–87). The daggers are typologically close to those found at Majkop, which is more or less contemporaneous. Nearby, in kurgan 6 of Soyuq-Bulaq, another similar dagger (although without rivets) has also been found (Akhundov 2007, p. 106), and various other metal objects (bead, awl and fragment of blade) come from the same cemetery of kurgans. The excavations carried out on other kurgans of this cemetery by a French–Azerbaijani team, co-directed by B. Lyonnet and T. Akhundov, has confirmed the diversity of the Leilatepe–Berikldeebi metallurgy: 33 beads in silver–gold alloy (probably electrum), 23 gold beads, a copper knife/dagger, two copper rings and a copper awl have been unearthed (Lyonnet et al. 2008, pp. 30–34; Courcier et al. 2009a). A stone sceptre with an equid head and numerous semi-precious stone beads (e.g. cornaline, steatite, lapis-lazuli) were also found there. Recent analyses and metallographic studies (Figs. 22.28, 22.29, 22.30, 22.31 and 22.32; Tables. 22.7, 22.8, 22.9, 22.10, 22.11 and 22.12) performed on this material have demonstrated a high manufacturing level for the silver–gold beads (Figs. 22.33, 22.34, 22.35, 22.36, 22.37, 22.38, 22.39 and 22.40) (Courcier et al. 2009a). Preliminary proveniencing on these beads has suggested that the ores used could come from four close districts: Madneuli, Sakdrisi–Bolnissi (Georgia), Dagkesaman (Azerbaijan) or Alaverdi (Armenia). Only future research, in particular on the gold beads, could allow for a more precise origin to be proposed.

The metal objects from Soyuq-Bulaq present similarities with the Majkop component (Majkop and Staromyshastovskaja Kurgans) as well as with Se-Girdan, Tepe Gawra and Hacinebi as mentioned above. All of these examples demonstrate the rather widespread use of precious metals in combination with copper-base alloys at the very earliest stages of silver and gold use in the ancient Near East.


**Fig. 22.29** Silver beads found in kurgan 1 of Soyuq-Bulaq. (Lyonnet et al. 2008, p. 34)


**Fig. 22.30** Gold beads found in kurgan 1 of Soyuq-Bulaq. (Lyonnet et al. 2008, p. 34)

**Fig. 22.31** Silver rings found in kurgan 4 of Soyuq-Bulaq. (Lyonnet et al. 2008, p. 38)


## *Metallurgy of the Kura–Araxes Culture*

The Kura–Araxes culture (also called the Early Transcaucasian or Karaz culture) (Fig. 22.41) appeared in the second half of the fourth millennium BCE (ca. 3400/3300 BCE, at the end of LC4) and lasted until the end of the third millennium BCE. Its very long duration led to several divisions which are still a matter of debate (e.g.


**Fig. 22.32** Awl found in kurgan 4 of Soyuk-Bulaq. (Lyonnet et al. 2008, p. 38)

**Table 22.7** Results of analyses (EDS analyses) of the silver beads whose compound is characterized by silver-with little traces of copper. (Courcier et al. 2009a, p. 23)

| Lab. | Artef. | Composition (weight percent) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | O | Mg | Si | S | Cl | Ca | Cu | Ag | Br | Au | Sn | Pb | Zn | Sb | Fe |
| Bm | Bead 1 | 13.7 | 0.28 | 3.28 | 0.67 | 6.57 | 13.52 | | 40.22 | 21.58 | | | | | | |
| Bm | Bead 1 | 7.47 | 0.25 | 2.47 | 0.17 | 6.81 | 8.29 | | 49.25 | 25.29 | | | | | | |
| Bm | Bead 1 | 11.08 | 0.33 | 1.32 | 0.39 | 5.71 | 18.25 | | 39.38 | 23.53 | | | | | | |
| Bm | Bead 1 | 7.39 | | 2.44 | | 7.04 | 8.3 | 0.41 | 49.09 | 25.34 | | | | | | |
| Bm | Bead 3 | 17.3 | | 1.02 | 0.76 | 4.23 | 33.23 | 2 | 29.81 | 11.65 | | | | | | |
| Bm | Bead 3 | 15.88 | | 2.21 | 0.82 | 5.33 | 26.41 | | 34.15 | 15.21 | | | | | | |
| Bu | Bead 3 | | | | | | | 1.57 | 35.14 | | 0.034 | 0.02 | 0.2 | 0.2 | 0.02 | 0.05 |

**Table 22.8** Results of analyses (EDS analyses) of the silver beads whose compound is characterized by an alloy of silver-gold-copper. (Courcier et al. 2009a, p. 24)

| Lab. | Artef. | Composition (weight percent) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | O | Si | S | Cl | Ca | Cu | Ag | Br | Au |
| Bm | bead 2 | 8.75 | 1.93 | | 7.59 | 5.86 | | 46.01 | 24.01 | 5.86 |
| Bm | bead 2 | 5.63 | 1.99 | | 7.81 | 1.99 | | 51.41 | 25.79 | 5.38 |
| Bm | bead 2 | 5.52 | 0.66 | | 7.7 | 1.78 | | 46.38 | 16.59 | 21.36 |
| Bm | bead 2 | 2.17 | 2.55 | | 2.05 | 0.27 | 5.5 | 19.17 | 8.26 | 60.04 |
| Bm | bead 2 | 0.72 | 0.34 | | 6.75 | | 0.6 | 56.03 | 30.52 | |
| Bm | bead 2 | 0.18 | 0.31 | | 6.54 | | 0.04 | 57.23 | 30.76 | |
| Bm | bead 2 | 3.08 | 1.35 | | 8.26 | | 2.77 | 50.24 | 15.96 | 18.34 |
| Bm | bead 2 | 18.91 | 1.78 | | 1.27 | 33.77 | 5.31 | 9.56 | 0.74 | 28.66 |
| Bm | bead 2 | 8.27 | 1.48 | | 6.88 | 10.11 | 0.87 | 43.27 | 22.4 | 6.71 |
| Bm | bead 2 | 10.91 | 1.89 | | 8.6 | | 2.74 | 46.4 | 14.75 | 14.71 |
| Bu | bead 2 | | | | | | 5.32 | 50.02 | | 41.03 |
| Bm | bead 6 | 15.54 | 1.67 | 0.89 | 5.86 | 24.07 | | 34.51 | 15.08 | 2.37 |
| Bm | bead 6 | 5.55 | 1.36 | 0.5 | 10.11 | 1.08 | | 57.44 | 23.5 | 0.47 |
| Bm | bead 6 | 20.19 | 0.74 | 0.98 | 2.98 | 31.49 | 1.58 | 22.61 | 4.13 | 15.31 |
| Bm | bead 6 | 21.69 | 1.71 | | 2.19 | 36.25 | 3.96 | 17.66 | | 15.51 |
| Bm | bead 6 | 2.73 | 1.87 | 0.35 | 8.65 | 0.16 | | 58.06 | 28.17 | |
| Bm | bead 6 | 18.69 | 1.85 | | 2.26 | 31.27 | 3.77 | 21.53 | 5.36 | 15.26 |
| Bm | bead 6 | 16.33 | 1.41 | | 3.35 | 30.48 | 2.7 | 29.51 | 8.95 | 10.88 |
| Bm | bead 6 | 2.56 | 1.5 | 0.12 | 9.42 | 0.24 | | 59.21 | 26.95 | |
| Bu | bead 6 | | | | | | 1.58 | 34.72 | | 6.95 |

**Table 22.9** Results of analyses (EDS analyses) of the silver beads whose compound is characterized by an alloy of silver–gold. (Courcier et al. 2009a, p. 24)

| Lab. | Artef. | Composition (weight %) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | O | Mg | Si | Cl | Ca | Cu | Ag | Br | Au | Sn | Pb | Zn | Sb | Fe |
| Bm | bead 4 | 4.23 | | 1.6 | 7.26 | 4.45 | | 48.24 | 20.21 | 14 | | | | | |
| Bm | bead 4 | 3.22 | | 0.75 | 6.17 | 2.02 | | 48 | 11.16 | 27.89 | | | | | |
| Bm | bead 4 | 4.63 | | 1.33 | 7.72 | 4.55 | | 52.67 | 16.99 | 11.68 | | | | | |
| Bm | bead 4 | 8.27 | 0.3 | 2.51 | 6.5 | 6.38 | | 42.94 | 15.62 | 17.29 | | | | | |
| Bm | bead 4 | 4.2 | | 0.75 | 6.91 | 4.08 | | 45.37 | 15.45 | 9.51 | | | | | |
| Bm | bead 5 | 19.18 | 7.23 | 13.61 | 5.8 | 2.73 | | 32.78 | 18.12 | | | | | | |
| Bm | bead 5 | 20.83 | 8.32 | 16.18 | 5.59 | 1.78 | | 30.94 | 16.35 | | | | | | |
| Bm | bead 5 | 21.93 | | | | 36.33 | | 21 | | 21.04 | | | | | |
| Bu | bead 5 | | | | | | 0.72 | 30.45 | | 8.12 | 0.02 | 0.05 | 0.2 | 0.2 | 0.15 |

**Table 22.10** Results of analyses (EDS analyses) of the silver rings. (Courcier et al. 2009a, p. 27)

| lab. | Artef. | Composition (weight percent) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | O | Al | Si | Cl | Ca | Cu | As | Ag | Br | Au | Sn | Pb | Zn | Sb | Ni | Co | Fe |
| Bm | Ring 1 | 1.85 | 1.13 | 2.61 | 0.99 | 2.04 | 2.66 | | 83.19 | | 5.54 | | | | | | | |
| Bm | Ring 1 | | 0.9 | 3.52 | 0.57 | | 2.69 | | 87.85 | | 4.49 | | | | | | | |
| Bm | Ring 1 | 10.14 | | 2.84 | 3.87 | 13.71 | 2.06 | 0.13 | 51.86 | 10.62 | 4.77 | | | | | | | |
| Bm | Ring 1 | 0.87 | | 3.38 | 0.7 | 0.18 | 2.53 | | 87.96 | 0.23 | 4.15 | | | | | | | |
| Bu | Ring 1 | | | | | | 1.9 | 0.03 | 51.57 | | 9.5 | 0.02 | 0.03 | 0.05 | 0.2 | 0.01 | 0.02 | 0.12 |
| Bm | Ring 2 | 10.08 | | 1.12 | 7.17 | 8.66 | | | 42.79 | 26.42 | 3.77 | | | | | | | |
| Bm | Ring 2 | 2.79 | | 0.6 | 9.14 | 1.53 | 0.58 | | 56.23 | 28.6 | 0.54 | | | | | | | |
| Bm | Ring 2 | 19.08 | | 2.11 | 3.32 | 20.87 | 5.15 | | 17.35 | 9.36 | 21.74 | | | | | | | |
| Bu | Ring 2 | | | | | | 1.5 | 0.03 | 51.85 | 9.7 | | 0.02 | 0.05 | 0.02 | 0.05 | 0.005 | 0.02 | 0.12 |

**Table 22.11** Results of analyses (EDS analyses) of the awl. (Courcier et al. 2009a, p. 28)

| Sector | Artefact type | Composition (weight percent) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | O | Al | Si | S | Cl | Ca | Cu | As | Br | Ni | Sn | Pb | Zn | Sb | Au | Bi | Co | Fe |
| K. 1 | awl | 3.95 | | 0.44 | | 0.24 | | 92.34 | 1.2 | 0.32 | 1.51 | | | | | | | | |
| K. 1 | awl | 4.07 | 0.52 | 0.53 | 0.14 | 0.75 | | 91.87 | 0.72 | | 1.39 | | | | | | | | |
| K. 1 | awl | 3.18 | 0.61 | 0.34 | | | | 95.87 | | | | | | | | | | | |
| K. 1 | awl | 4.2 | 0.54 | 0.44 | | 2 | | 90.01 | 2.83 | | | | | | | | | | |
| K. 1 | awl | 6.19 | 0.48 | 0.49 | 0.11 | 0.27 | | 79.29 | 6.79 | | 6.38 | | | | | | | | |
| K. 1 | awl | 4.14 | 0.35 | 0.26 | | 2.89 | 0.26 | 88.94 | 2.36 | | 0.79 | | | | | | | | |
| K. 1 | awl | | | | | | | 90.05 | 1.2 | | 1.18 | 0.03 | 0.1 | 0.2 | 0.2 | 0.055 | 0.03 | 0.2 | 0.12 |

**Table 22.12** Results of analyses (EDS analyses) of the dagger. (Courcier et al. 2009a, p. 29)

| Sector | Artefact type | Composition (weight percent) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | O | Al | Si | Cl | Ca | Cu | As | Sn | Pb | Zn | Sb | Ag | Au | Bi | Ni | Co | Fe |
| K. 1 | Dagger | 10.42 | 0.77 | 0.23 | 15.76 | 0.3 | 71.24 | 1.29 | | | | | | | | | | |
| K. 1 | Dagger | 15.78 | 0.53 | 0.13 | 22.67 | 0.22 | 62.67 | | | | | | | | | | | |
| K. 1 | Dagger | 10.89 | 0.42 | 0.05 | 18.31 | 0.14 | 68.66 | 1.51 | | | | | | | | | | |
| K. 1 | Dagger | 11.67 | 0.61 | 17.52 | | 0.19 | 68.59 | 1.42 | | | | | | | | | | |
| K. 1 | Dagger | 13.18 | 0.65 | 17.96 | | 0.34 | 65.76 | 2.1 | | | | | | | | | | |
| K. 1 | Dagger | | | | | | 70.21 | 1.17 | 0.37 | 0.05 | 0.21 | 0.25 | 0.005 | 0.05 | 0.03 | 0.01 | 0.3 | 0.2 |

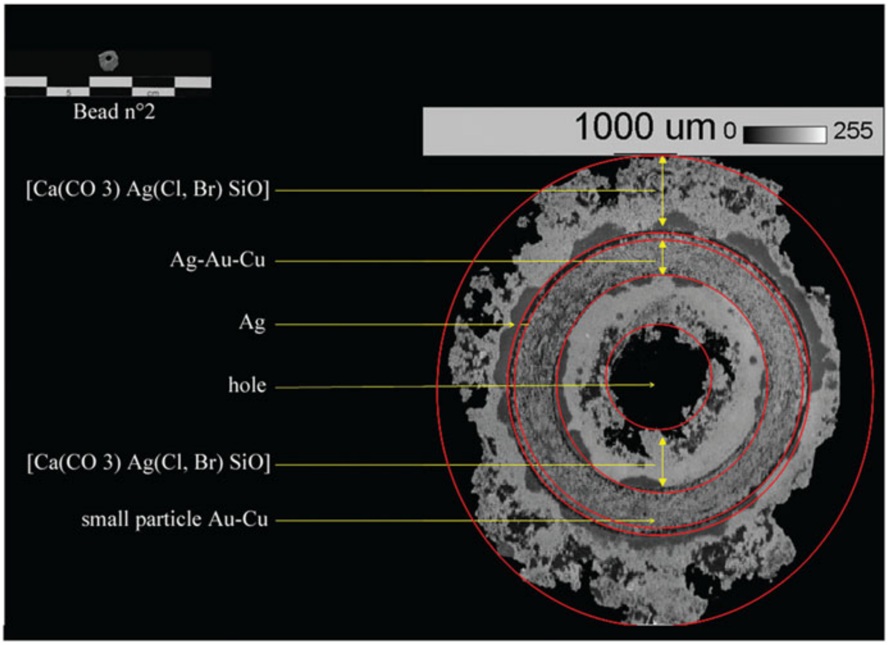


**Fig. 22.33** Section of bead no.°2 with SEM observations. (Courcier et al. 2009a, p. 24)

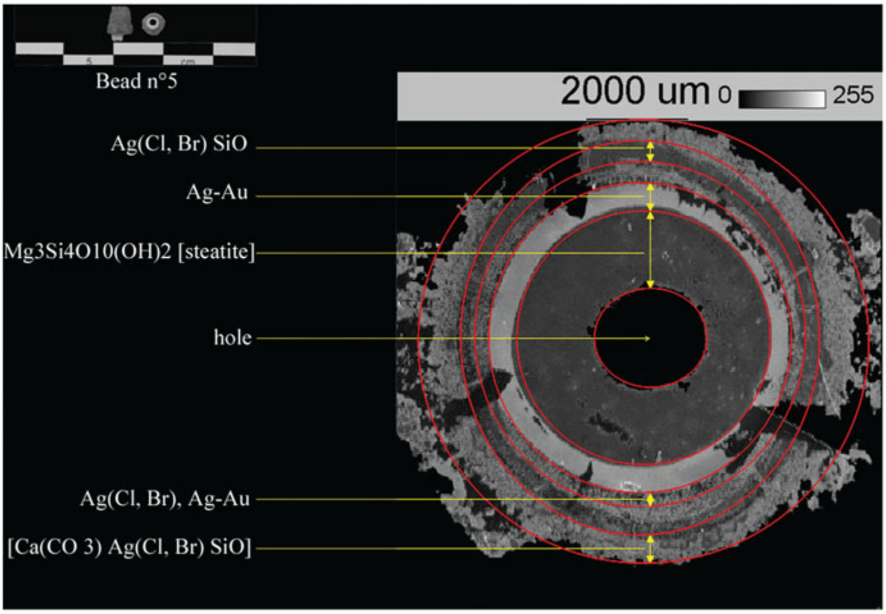


**Fig. 22.34** Section of the bead no.°5 with SEM observations. (Courcier et al. 2009a, p. 24)

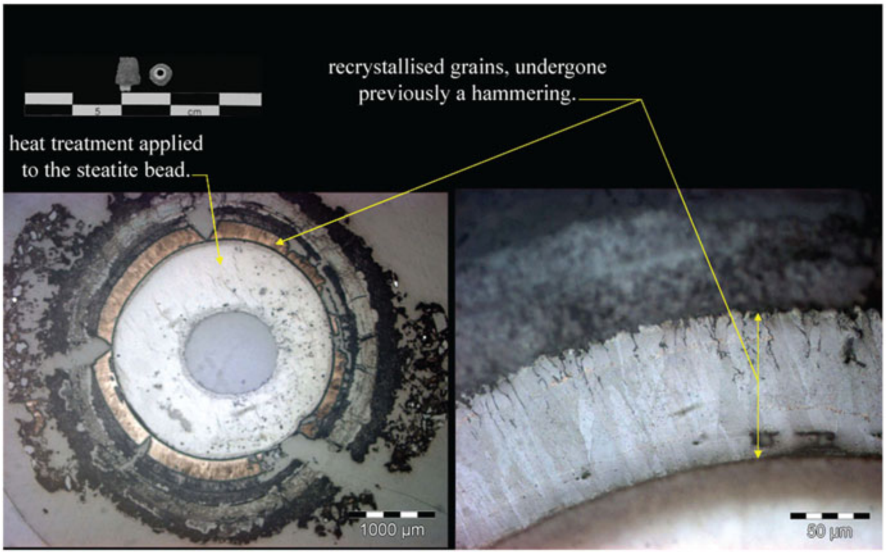


**Fig. 22.35** Microstructure of bead no.°2, etched sample, magnifications 50 × and 100 × . (Courcier et al. 2009a, p. 25)

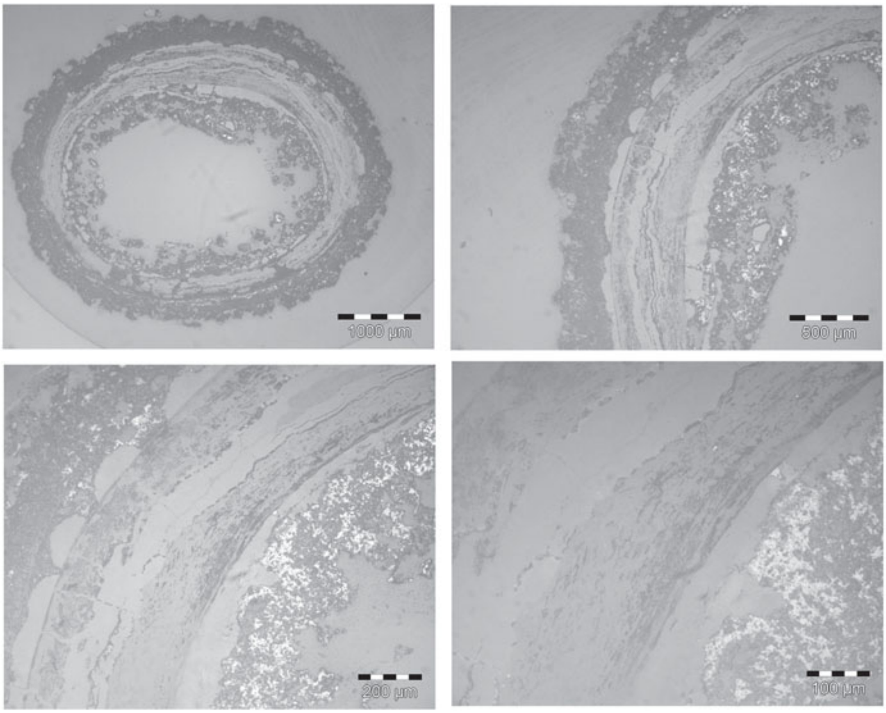


**Fig. 22.36** Microstructure of bead no.°3, etched sample, magnifications 25 × , 50 × , 100 × and 200 × . (Courcier et al. 2009a, p. 26)

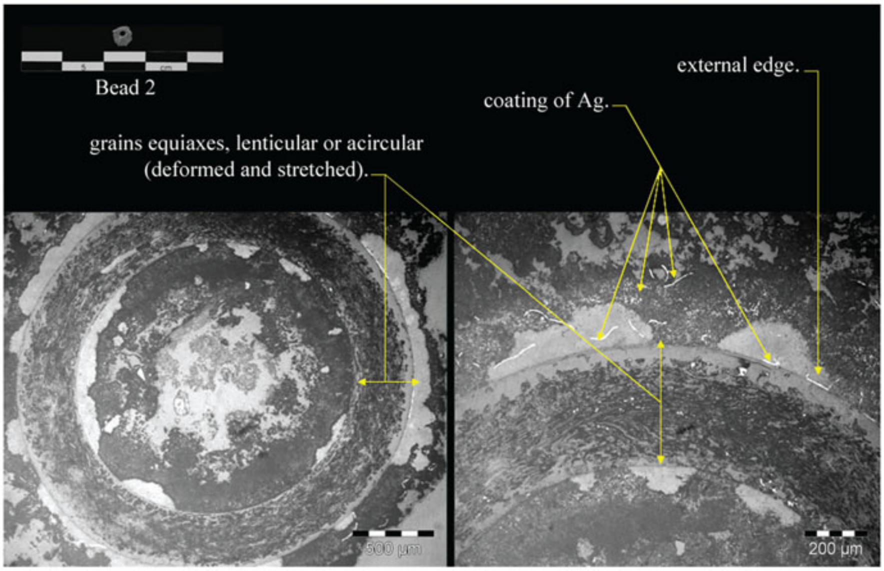


**Fig. 22.37** Microstructure of bead no.°5, etched sample, magnifications 50 × and 100 × . (Courcier et al. 2009a, p. 26)

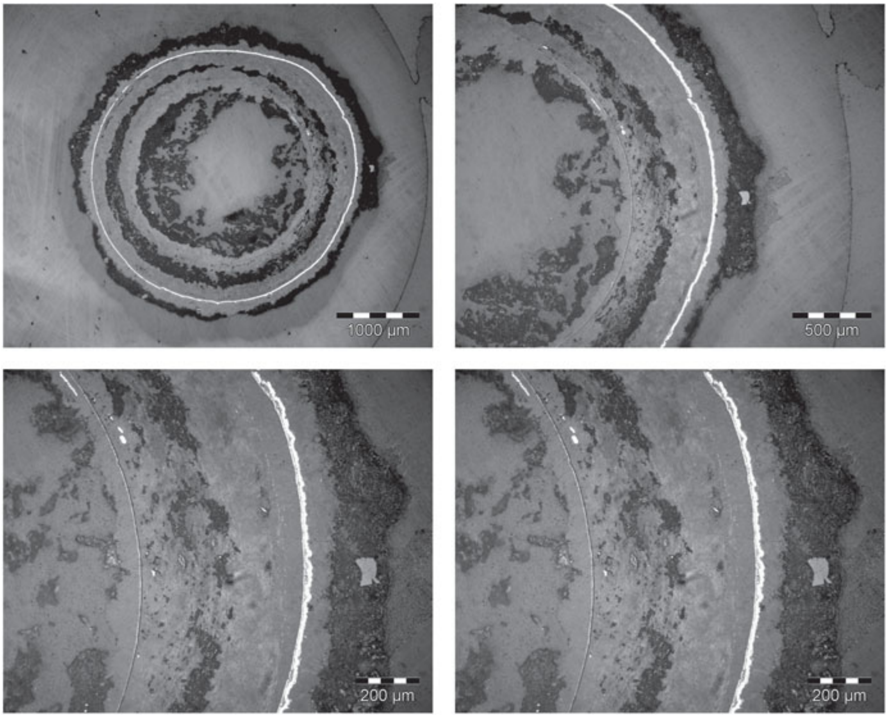


**Fig. 22.38** Microstructure of bead no.°6, etched sample, magnifications 25 × , 50 × , 100 × and 200 × . (Courcier et al. 2009a, p. 27)

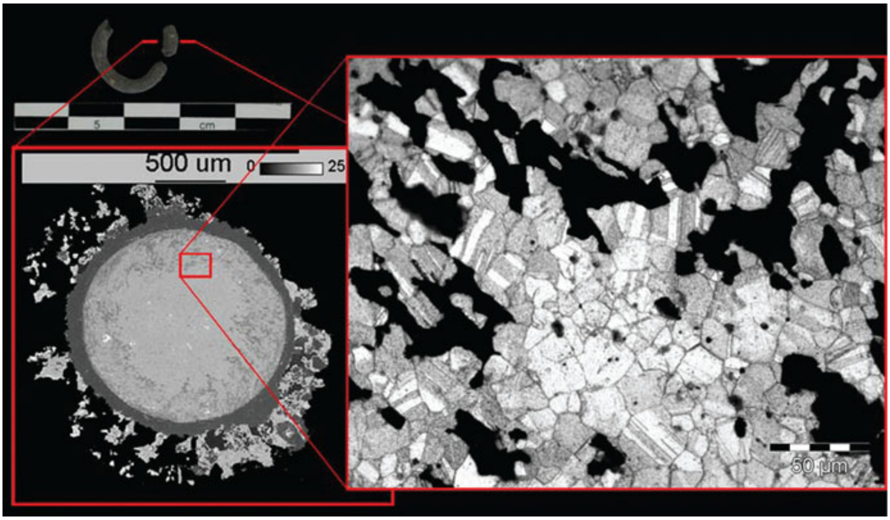


**Fig. 22.39** Metallographic studies of ring no.°1, etched sample, magnifications 500 × . (Courcier et al. 2009a, p. 28)

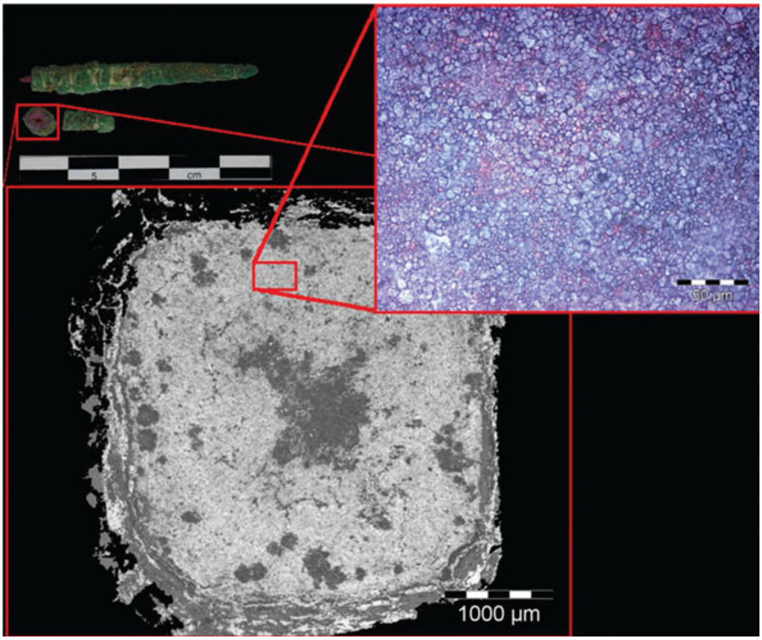


**Fig. 22.40** Metallographic studies of the awl, etched sample, magnifications 500 × . (Courcier et al. 2009a, p. 29)

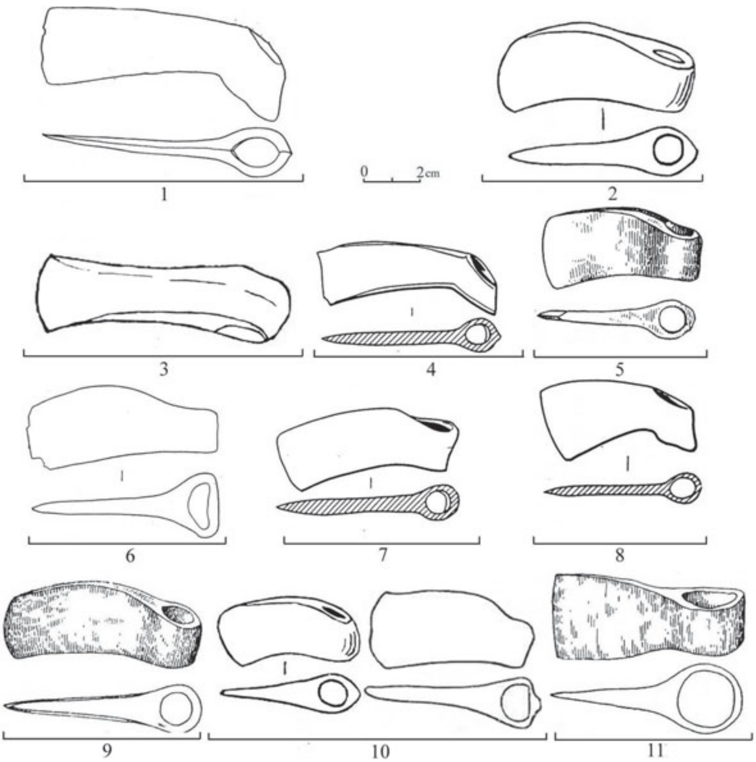


**Fig. 22.41** Socketed axes coming from Kura–Araxes settlements. *1* Ararat region (Khanzadjan 1964), *2* Brdadzor (*Ibidem*), *3* Dzhrashen (Chernykh 1992, pp. 64–65), *4* Egmiadzin (Kushnareva 1997, p. 201), *5* Kulbakeli (*Ibidem*), *6* Leninakan (*Ibidem*), *7* Marneuli (*Ibidem*), *8* Medzhvriskhev (*Ibidem*), *9* Sadakhlo (*Ibidem*), *10* Jalbuzi (Korenevskij 1974; Kushnareva 1997, p. 201), *11* Zemo-Avchalskaja (*Ibidem*)

Kushnareva 1997; Kavtaradze 1999; Marro 2000; Sagona 2000). The earliest sites of this culture are found between the Kura and Araxe Rivers in Transcaucasia, but are unknown in the western part of Georgia (Fig. 22.41). P. L. Kohl (2007, p. 88) also includes south-eastern Dagestan in the early Kura–Araxes culture, although he specifies that Velikent is not a "Kura–Araxe variant" (Munchaev 1975, pp. 172–191) but rather a distinct culture of its own (Kohl 2007, p. 103).

Around 3000 BCE, the Kura–Araxes culture began to spread into eastern and central Anatolia and eventually into the northern Levant (Sagona 2000, p. 340; Frangipane and Palumbi 2007, p. 253). This phenomenon is documented through the diffusion of red-black-brown burnished ceramics characteristic of this culture (Frangipane 2000; Rothman 2003). Close relations between the Upper Euphrates, north-eastern Anatolia and Transcaucasia had begun in the preceding LC4 period and continued into the LC5/early Kura–Araxes period (Frangipane and Palumbi 2007, pp. 253–254). The Kura–Araxes phenomenon is, however, strongly regionalized, leading to distinct cultures such as Novosvobodnaja in the North-West Caucasus, Velikent in the North-East Caucasus and Kura–Araxes in the southern Caucasus and eastern Anatolia (Lyonnet 2007a, *idem*). An additional regional variant is known from north-western Iran (Summers 2004), north-central Iran (Thornton 2009, p. 18, 67) and in the central Zagros (Weiss and Young 1975; see Rothman 2005). The internal divisions of the Kura–Araxes chronology as well as its finale are still the subject of much debate (e.g. Muscarella 2003, p. 90; Sagona 2004, pp. 477–479; Magomedov 2006, pp. 153–155; Kohl 2007, pp. 86–88; Makharadze 2008, pp. 66–67).

One aspect of the Kura-AraxesKura–Araxes culture that remains undisputed is the strong evidence for local metallurgical production and metalworking. At Amiranis Gora in Armenia, in a level probably dated to the early phase[14], a furnace, charcoal and a tuyère were found (Chubinishvili 1963, pp. 94–103). Another "metallurgical workshop" was discovered at Baba-Dervish II in Azerbaijan, comprised of three furnaces (two of which were equipped with a ventilation system), tuyères, clay moulds and slags (Makhmundov et al. 1968, pp. 18–20). At Mokhra-Blur on the Ararat plain, some vestiges of casting/melting processes suggest local metalworking (Khanzadjan 1975, p. 477). In Mound II of Velikent in Dagestan, dated to ca. 3000 BCE (Kohl et al. 2002a, p. 115), fragmentary blades, a chisel or gouge, metal prills, hammer-stones and half of a two-part clay mould for casting a shaft-hole axe indicate local metallurgy also in the north-eastern Caucasus (see Peterson 2007, p. 193 and 198). At nearby Kabaz-Kutan, a crucible and a mould were found in a level probably contemporaneous with Velikent (Gadzhiev et al. 2000, pp. 49–51), which confirms the presence of metalworking in Dagestan at this time (Peterson 2007, pp. 178–179).

The discovery of furnaces, crucibles, ingots or slags from other Kura–Araxes settlements in Georgia, Azerbaijan and Armenia—all probably dated to ca. 3000 BCE[15]—as well as in later third millennium BCE sites such as Shortepe, Shengavit, Igdir and Pichori, firmly establish the importance of metallurgy in the Kura–Araxes culture (Makhmundov et al. 1968; Narimanov 1987). The practice of transhumance and other pastoralist activities in the Kura–Araxes culture (e.g. Kushnareva 1997, pp. 192–195; Piro 2008, p. 462) certainly played a role in the spreading of metallurgy across the wide realm of Kura–Araxes influence (e.g. Palmieri et al. 1999 for Arslantepe; Frame 2010 for Godin Tepe).

In contrast to the Majkop culture, most of the metal artefacts found at Kura–Araxes sites come from domestic contexts. Amiranis-Gora, Kvatskhelebi and Dzagina in Georgia; Khachbulag in Azerbaijan; and Elar in Armenia are the only sites where metal artefacts have been unearthed in funerary contexts (Kushnareva and Chubinishvili 1963; Glonti et al. 2008).

## Copper Metallurgy

Most ornaments of the Kura–Araxes culture are copper-based. A few wristbands, spiralled rods and earrings were discovered at Dzagina, Amiranis-Gora and Akhaltsikh in Georgia (Kushnareva and Chubinishvili 1963, p. 16). Tombs 2 and 5 at

[14] The $^{14}$C date proposed for this settlement varies by author. The sample (TB-4; 4835 ± 180 BP) provided a date of the metallurgical level, which Kavtaradze (1999: 73–74) calibrates to 3790–3373 cal. BCE (1σ). For Chernykh (CHERNYKH et al. 2000: 74–75) the same sample is a little earlier: 3900–3350 (1σ) and 4050–3100 (2σ) cal. BCE.

[15] According to $^{14}$C dates, *cf.* Kushnavera, 1994: 52 and Chernykh et al. 2000: 74–75.

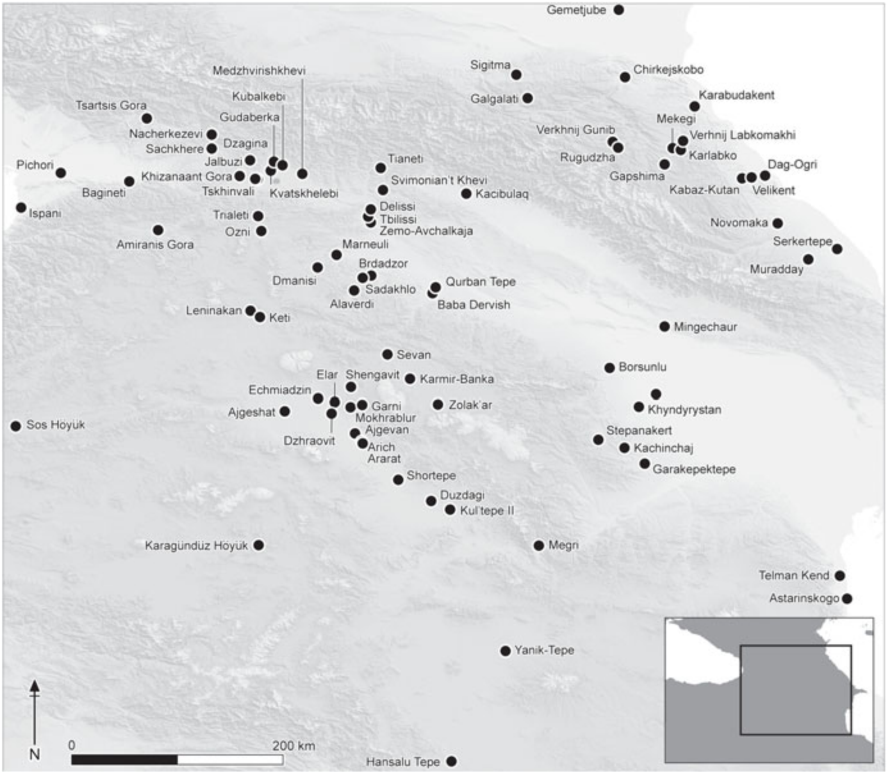


**Fig. 22.42** Settlements attached to the Kura–Araxes culture. (Cassard et al. 2009. GIS project)

Kvatskhelebi contained the well-known diadem and others ornaments like wristbands, a double spiral-headed pin and various copper beads (Glonti et al. 2008). Some earrings and rings are also known at Serkertepe, which is dated probably to the end of the fourth millennium BCE.

Copper-base awls are found in most Kura–Araxes settlements, and their shape (i.e. generally quadrangular, straight or slightly curved) resembles those rare specimens known from earlier periods. In this later period, the first true needles were being made of metal (thin pins with a rounded, loop-like head). Needles from even later sites, like Serkertepe (Munchaev 1997, p. 152), have more elaborate shapes, such as the twisted bilateral wire involutions known at Kul'tepe II.

Several tool types are close to those known from the Novosvobodnaja phase of the Majkop culture, like flat axes (e.g. Makhmundov et al. 1968, p. 21; Kushnareva et al. 1971, p. 117) and some socketed axes (Fig. 22.42). The majority of the Kura–Araxes shaft-hole axes is characterized by a short shaft-hole and a rectangular or trapezoidal inclined blade (e.g. Khanzadjan 1964; Chernykh 1992, p. 65). According to the recent typology elaborated by Gernez (2007, pp. 159–160), these axes are principally localised in the southern part of the Caucasus and in north-eastern Anatolia (e.g.

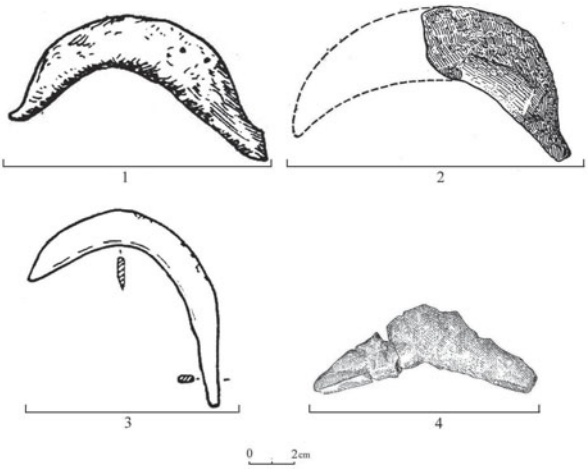


**Fig. 22.43** Sickles found in Kura–Araxes settlements. *1* Amiranis-Gora grave (Kushnareva and Chubinishvili 1963), *2* Garni (Khanzadjan 1964), *3* Khizanaant-Gora (Kushnareva 1997, p. 197), *4* Kul'tepe II (Kushnareva and Chubinishvili 1970, p. 114)

at Norsuntepe level VIII). This geographical distribution demonstrates clearly the cultural connection between these two regions during the Kura–Araxes culture.

Pickaxes (Fig. 22.12) also illustrate existing connections between the northern Caucasus (Novosvobodnaja), Transcaucasia (Kura–Araxes) and the Near East (in particular Iran). Indeed, the Kura–Araxes metal and stone examples from Leninakan, Dmanisi, Alaverdi, Dzhrashen, Rugudzha and Velikent Mound II (Martirosjan 1964, p. 32; Martirosjan and Miatsakanjan 1973, p. 125; Chernykh 1992, pp. 64–65; Gadzhiev 1991, p. 55, 64 and 93, respectively) are close to pickaxes known in Novosvobodnaja sites (see above) and at Se-Girdan (Muscarella 2003, p. 126) and Suse (Tallon 1987, p. 75) in western Iran. On the contrary, metal sickles (Fig. 22.43) known from some settlements and tombs at Garni, Amiranis-Gora, Khizanaant-Gora and Kul'tepe II (Kushnareva and Chubinishvili 1963, 1970, p. 116) seem to be unique to the Kura–Araxes culture (Tedesco 2006a, p. 116).

The Kura–Araxes daggers present some similarities with those known in the Novosvobodnaja phase of the Majkop culture. This is especially true of the ribbed daggers found at Amiranis-Gora and Ajgevan (Kushnareva and Chubinishvili 1963, pp. 14–15; Kushnareva 1994b, pp. 93–94). These weapons are rather typical of Novosvobodnaja, since over 100 examples are known there (see above; Fig. 22.21). On the other hand, the flat blade with oblique shoulders from Elar, Kul'tepe II, Stepanakert and Yerevan (Kushnareva et al. 1971, pp. 116–119; Kushnareva 1994b, p. 110; Tedesco 2006a, p. 235) presents some parallels with north-eastern Anatolia (Arslantepe "Royal Tomb", Ikiztepe and Düdartepe) and with Tepe Sialk in north-central Iran (level IV) according to recent typological research (Gernez 2007, pp. 449–450). The daggers with biconvex blades from Ajgechat (Kushnareva 1994b, p. 94) are also known in later settlements of the Novosvobodnaja phase like Klady (Rezepkin 2000, pl. 54.9) and in Velikent Mound III, tomb 11 (Kohl et al. 2002a, pp. 123–124), as well as in the cultures following the Kura–Araxes culture like Martkopki and Bedeni (Gernez 2007, p. 451).

The tripartite spearheads (Fig. 22.22) found in a tomb from Amiranis-Gora as well as at various Kura–Araxes sites (Kushnareva et al. 1971, pp. 116–119) are similar to spearheads from the Novosvobodnaja phase (see above) and from the Near East. This weapon type illustrates clearly the expansion of the Kura–Araxes culture throughout the eastern part of Anatolia, North Mesopotamia and perhaps as far as Turkmenistan (see above).

The picks (Fig. 22.16) discovered at Kura–Araxes settlements such as Amiranis-Gora, Khachbulag, Kul'tepe II, Kvatskhelebi and Tsatsis-Gora (Kushnareva and Chubinishvili 1963, 1970, p. 124 and 170; Schachner 2002, p. 124) also confirm relationships between Transcaucasia and the northern Caucasus, where similar picks are known during the Novosvobodnaja phase (see above). Furthermore, these picks can also be compared to weapons from Tell Kara Hassan (Woolley 1914, pl. 19), Jerablus-Tahtani and Carchemish (Woolley and Barney 1952, pl. 60–61; Gernez 2007, pp. 285–286) dating to Early Bronze Age II/III transition (ca. 2800–2600 BCE).

## Precious Metals of the Kura–Araxes Culture

Few objects in precious metals are known from the Kura–Araxes sites. A gold and silver earring comes from a tomb in Kachbulag (Narimanov 2004, p. 471), while three silver rings have been found in the cemetery of Amiranis-Gora (Chubinishvili 1963, p. 99). Tombs 2 and 5 of Kvatskhelebi[16] contained some silver spiralled rods (Glonti et al. 2008), while a gold bead has been discovered in a house at the settlement of Mingechaur (Chubinishvili 1971, pp. 105–106; Narimanov 2004, p. 470). More recently at Velikent, silver rings and a gold leaf were found in tomb 11 on Mound III, while a gold ringlet was discovered in tomb 1 on Mound IV, both dated to the first half of the third millennium BCE (Kohl et al. 2002a, p. 124).

These ornaments (in particular those which come from Kvatskhelebi) offer parallels with the jewellery found in the "Royal Tomb" at Arslantepe (end of level VIA/beginning of VIB2, dated to ca. 3000 BCE[17]; Norcera et al. 2004). Beyond the typological parallels, this tomb illustrates trade associated with pastoralist activities between Transcaucasia and the Malatya region at this time (Frangipane and Palumbi 2007, pp. 245–248). These exchanges probably included not only metal objects but also the ores, particularly in the period between 3350 and 3000 cal. BCE corresponding to level IVA (Palmieri et al. 1998, p. 42, Hauptmann and Palmieri 2000, p. 80).

[16] Tombs 1, 3, 4 and 5 are dated to the last quarter of the fourth millennium BCE; tomb 2 is not precisely dated but the excavators compared its material with those of the "Royal Tomb" at Arslantepe dated to 3000 BCE (Glonti et al. 2008: 154).

[17] 14C date: 3081–2897 (1 $\sigma$), 3308–2879 (2 $\sigma$); Palumbi 2004: 115.

## The Composition and Manufacture of Kura–Araxes Artefacts

Most metal artefacts from the Kura–Araxes culture that have been analyzed derive from the latest phase of this culture and are made of arsenical copper (Schachner 2002, p. 120 and 124–125, Tables 1 and 2; Akhundov 2004, p. 427). Some objects coming from the sites of Ozni, Kul Tepe II and Karaköpek have low percentages of arsenic (Selimkhanov 1966, pp. 230–231; Kushnareva and Chubinishvili 1970, p. 132), while others have higher contents (Kushnareva and Chubinishvili 1970, pp. 130–135, Table II, Table III, Table IV, Kavtaradze 1999, pp. 89–97, Table 1). In general, most arsenic-bearing copper artefacts contain between 2 and 4 wt% As (Courcier 2007). A small minority of artefacts from Kvatskhelebi and Kul'tepe II have contents higher than 6 wt% As, some even as high as 22.7 % As[18] (Selimkhanov 1966, p. 130; Kushnareva and Chubinishvili 1970, pp. 130–135, Table II). Such a large percentage of arsenic improves the cast-ability of the copper while giving it a silvery aspect, but it also makes the object more brittle. For this reason, the use of high-arsenic copper alloys seems to have been reserved for jewellery (Kushnareva 1997, p. 203).

In addition to the presence of arsenic, objects from the Kura–Araxes culture often have minor amounts of zinc, ranging from 1 to 5 wt% Zn (Kushnareva and Chubinishvili 1970, p. 132, Table II; Chernykh 1992, p. 66). Lead content rarely exceeds 0.1 wt%, although for some artefacts it can be as high as 14.7 wt% Pb (Kushnareva and Chubinishvili 1970, p. 132, Table II). The earliest phase of the Kura–Araxes culture is characterized by very little antimony (0.005–1.15 wt% Sb) and most of the artefacts are low in nickel ($\leq$ 0.03 wt% Ni)—only slightly higher levels of nickel (0.04–1 wt% Ni) are found in a few rare objects (Chernykh 1992, p. 66; Gevorkjan 1980, pp. 49–52). Low nickel content has been determined for most artefacts from Georgia and Armenia, suggesting local ore deposits with similarly low nickel content (Kushnareva 1997, pp. 200–202). Recent archaeometallurgical studies carried out by L. A. Tedesco (2006a) have allowed a better characterization of the manufacturing techniques in Transcaucasia during the Early Bronze Age. The artefacts in arsenical-copper present several cycles (two or four) of cold-working/annealing steps, and for some daggers, strong work-hardening. She also identified a standardization of Kura–Araxes metalworking which seems similar to that argued previously for the Novosvobodnaja component (Ryndina and Ravich 1995, pp. 12–14). Tedesco (2006a, p 320) proposes metal production on a small-scale in individual households in Transcaucasia (and perhaps also in the northern Caucasus), while acknowledging a widespread uniformity in the way various classes of artefacts were made throughout the Early and early Middle Bronze Ages.

In another recent study, D. L. Peterson (2007, p. 237 and 280) analyzed 11 objects (rings and bracelets) coming from the tomb 1 on Mound III at Velikent. Previously, three metal groups had been identified at this site based on earlier spectral analyses (Gadzhiev and Korenevskij 1984, p. 19): unalloyed copper, arsenical copper and tin

[18] We ignore the analytical method used; this percentage could correspond to surface segregation.

bronze. However, Peterson (2007, p. 194) noted three exceptional types: one bracelet with 90 wt% Ag and two other bracelets cast in a copper–silver alloy with 70 wt% Cu and 30 wt% Ag. For the arsenical copper objects, the amount of arsenic ranged from 0.1 to 20.0 wt%, with the majority lying between 0.1 and 5 wt% (Gadzhiev and Korenevskij 1984, p. 19). The arsenical copper artefacts were further separated into two groups: arsenical bronze (1.5–20 wt% As)[19] and arsenical copper (0.1–0.9 wt% As), corresponding to intentional alloys and unalloyed metal (Gadzhiev and Korenevskij 1984). The intentionally alloyed pieces seem to be mostly ornaments and were excluded from tools and weapons (*ibid.*: 20).

From the same tomb 1 on Mound III at Velikent, 8 % of the total number of metal artefacts proved to be tin–bronze alloys. These tin bronzes are the earliest recorded for the Caucasus (Kohl et al. 2002a, pp. 126–127). According to lead isotopic analyses, these artefacts may have come from the same source as the early tin bronzes from Oman (Weeks in Kohl et al. 2002b, pp. 180–183). However, Peterson (2007, pp. 199–200) has underlined that this conclusion is based on a small number of analyses and that more analyses are needed in order to point out with more certainty the probable source. He adds that the extension of the Kura–Araxes culture may have provided numerous opportunities to acquire tin from a variety of sources. Peterson concludes by noting that metalworking at Velikent was "implicated in a social process of hierarchization involving both the production and use of metal objects, in which shifts in production and consumption were linked to changes in joint constructions of value and related technological and social practices" (Peterson 2007, p. 312).

## Extractive Metallurgy in the Kura–Araxes Culture

In contrast to the impression given by Chernykh (1966, pp. 45–49, 1992, pp. 59–67), there is little evidence of exploitation of metalliferous deposits during the Kura–Araxes culture. Currently, research into early mining practices of the Kura–Araxes culture is barely more important than for the Majkop culture. The early research carried out by Iessen and Degen-Kovalevskij identified several sites where ancient extractive metallurgy was practiced in Transcaucasia (Iessen and Degen-Kovalevskij 1935, pp. 42–61). Unfortunately, in most cases, such mines were not dated; at best, a few mines were datable to the second or first millennium BCE. Others studies, mainly done in Georgia (Ratcha and Svanetia districts), have not securely proven extractive metallurgy during the Kura–Araxes culture, since most sites were dated to the second millennium BCE (e.g. Mudzhiri 1975, 1977, 1979, 1988a, b; Mudzhiri and Kvirikadze 1978, 1979). Nevertheless, some authors have argued that the deposits investigated (all situated in Transcaucasia) were probably exploited earlier and have conjectured exploitation during the Kura–Araxes period (e.g. Gevorkjan 1980,

[19] Most scholars would define arsenical bronze as containing above 4–5 wt% As, although this is still much debated (e.g. Northover 1988; Lechtman 1996).

pp. 21–33; Chernykh 1992, p. 60; Palmieri et al. 1993, pp. 594–595; Kushnareva 1997, p. 197).

The composition of the Kura–Araxes artefacts has also led scholars to the suggestion that polymetallic ores and arsenic-rich ores (e.g. orpiment and realgar—arsenious sulphides) had been used. Paradoxically, G. L. Kavtaradze rejects the idea that sulphur-based ores were used, pointing to the absence of sulphur[20] in most objects to support his view. He argues that towards the later phase of the Kura–Araxes culture (ca. the middle of the third millennium BCE), the extraction of copper–sulphur such as chalcopyrite became necessary due to the extinction of sources of copper oxides and hydrocarbonates (Kavtaradze 1999, p. 81). Thereafter, he argues, the principle of co-smelting was utilized consistently in Transcaucasia.

It should be noted that besides the recurring problem of trusting these early analyses, the issue of metal recycling has never been raised. It is highly probable that the practice of re-melting was carried out both by the Kura–Araxes and the Majkop cultures. It is well known that each stage of the recycling process involves a change in the composition of particular impurities (As, Ni, Sb, Pb, Zn, Bi, etc.). The presence of these elements is therefore not exclusively related to the type of ores used but also to the various phases of the metallurgical transformation. In addition, melting (or re-melting) of copper-base metal under even slightly oxidizing conditions can lead to the loss of sulphur (and other important elements, such as arsenic). Thus, the conclusions of Kavtaradze about the "shift" to copper sulphides in the third millennium BCE must be re-examined.

The recent research carried out by the Deutsches Bergbau-Museum on the Bolnisi–Madneuli copper–gold district in Georgia has shown that the Sakdrissi gold deposit was already exploited during the second half of the third millennium BCE, and it is proposed that extraction there began even before 3000 BCE (Stöllner et al. 2008; Hauptmann et al. in press). In our opinion, the Sakdrissi deposit was not the only one exploited by the Kura–Araxes population. Recent archaeometallurgical research in the Kedabeck district in Azerbaijan has identified a probable Kura–Araxes exploitation at Perizamenly, where Kura–Araxes ceramic sherds were discovered (Lyonnet et al. 2009b). We also identified many other sites with evidence for ancient extractive activities, but we found no way to date them.

## *Understanding the Rise of Metallurgy (ca. From Fourth to Third Millennium BCE)*

From the beginnings of the fourth millennium BCE, metallurgy in the Caucasus underwent an important transformation characterized by technological developments in extractive metallurgy as well as in manufacturing techniques. This modification is not as clear for extractive metallurgy as for manufacturing techniques because of

[20] The lack of sulphur is most likely due to the analytical methods used, which were often unable to detect sulphur.

the lack of research in this field. However, based upon the admittedly limited data at hand, it would seem that local deposits were exploited often containing complex ores (e.g. copper sulphides interlaced with arsenic- and nickel-bearing minerals). An important rise in copper metallurgy is also noticeable, including the generalized production and use of copper alloys (e.g. Cu–As, Cu–As–Ni); diversification of tool and weapon types; and the rise in the sheer number of metal objects known from this period. The high technical level of metalworkers in this period is testified by the masterful production of objects in precious metals (silver, gold and electrum), although mostly this is true for the Majkop, Novosvobodnaja and the Leilatepe–Berikleedebi cultures. Although relations between the Caucasus and the Near East never ceased from the Neolithic until the Middle Bronze Age, they appear to have been especially important during the fourth millennium BCE. The role of metals and metallurgy was undoubtedly significant in these exchanges.

## Conclusion

Between 5000 and 2000 BCE, metallurgy in the Caucasus underwent a tremendous development. The first appearance of metal in the northern Caucasus dates to the Meshoko culture, around the second half of the fifth millennium BCE, although it may have emerged earlier, given metal's early appearance in Transcaucasia by the end of the sixth millennium BCE in the Shomu–Shulaveri, Aratashen and Kul'tepe–Alikemek cultures. However, the lack of known Neolithic sites in the northern Caucasus limits our ability to say more about this hypothesis.

Both the Carpatho-Balkans region, characterized at this time by an apogee of metallurgy, and the Sioni culture may have stimulated the development of metallurgy in the northern Caucasus, as Chernykh has suggested. However, local deposits of copper ores could also have been exploited by the Meshoko and Sioni cultures from earlier periods. The way of life of these populations, probably nomadic and practising transhumance, could have allowed the diffusion of metallurgical activities, of technical principles, of raw material (ores, ingots), as well as of metal object between the northern and southern Caucasus. It has to be underlined that southern Transcaucasian cultures (Shomu–Shulaveri and others) were also closely connected with Anatolia, northern Iran and northern Mesopotamia, which had been using native metals since at least the seventh millennium BCE.

The beginnings of metallurgy in the Caucasus are characterized by smelting, melting, casting, cold-hammering, annealing and probably recycling of mainly "pure" copper and copper with minor (probably natural) impurities. The finished products were mainly implements (awls, bradawls, pins, knives, hooks, rods, wires, hoops, ingots), ornaments (rings, beads, pendants) and small weapons (daggers, arrowheads). Paradoxically, relatively little metallurgical waste (slags, fragments of crucibles or moulds) has been reported and no furnaces have been discovered. From the beginning of the fourth millennium BCE, metallurgy is connected to the rise of the Majkop and Leilatepe–Berikldeebi cultures, followed later by the Novosvobodnaja, Kura–Araxes and Velikent cultures. This cultural sequence is characterized by an intensification of extractive metallurgy (still poorly documented), a diversification of the types of metals being used (i.e. precious metals and copper alloys), the development of new technologies (e.g. smelting of complex ores, alloying, cladding, casting in bivalve moulds, copperware), the invention of new types of metal objects (e.g. forks, adzes, flat axes, gouges, pickaxes, socketed axes, spearheads, sickles, harness pieces, long daggers, swords) and the increase of the number of metal objects produced. Surprisingly, the only furnaces known come from Kura–Araxes settlements.

The increase in metallurgical activity by ca. 3000 BCE is concomitant with an intensification of relations north to south between the Caucasus and the Near East. The diffusion of some specific objects (like the tripartite spearheads) from the Caucasus (Novosvobodnaja and the Kura–Araxes c) to Anatolia, northern Mesopotamia and as far away as Turkmenistan, confirms the importance of metallurgy in the Caucasus during this period. Nevertheless, several features concerning metallurgy in the Caucasus remain unclear—in particular, the rise of extractive metallurgy and the processes used in manufacturing metals. We hope that future excavations, the use of modern analyses and new methods (e.g. the use of GIS), as well as an increased attention on the Caucasus will help to better understand these crucial points.

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