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The Copper Age. The Gold and Copper Metallurgy

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Abstract: In the first part of the paper we discuss the terminology in use for this period. Subsequently, we address the sources of raw materials, traces of exploitation and the metallurgical and open-hearth activities. We further rediscuss the metallographic analyses performed on some artefacts in the collection of the The National History Museum of Transylvania, Transylvania being a province with an important batch of copper artefacts. These have evidenced the high level of knowledge of the craftsmen involved in copper working.

In terms of gold mining and working, we referred to the jewellery workshop at Cheile Turzii-*Peştera Ungurească*, unique in Europe to date. It is a workshop with several stages of restoration (with oven and hearths), where, beside ornaments, some of the tools used in their making were also discovered. By contrast with other areas, the gold artefacts of Cheile Turzii-*Peştera Ungurească*, even though not amounting to a very heavy weight, record the art of goldsmiths, being paralleled, in terms of how these were worked and decorated, with a number of artefacts in the Moigrad hoard.

Keywords: Copper Age; terminology; raw material sources (copper, gold); workshops; installations; chemical analyses; technologies; tools; copper and gold artefacts.

The term of Cooper Age (Kupferzeit) is differently understood by archaeological schools. Where local development is stressed, the Eneolithic term is used, however, where innovations and new technologies are brought to the forefront, the term of Copper Age is utilized.

The latter is justified for areas with existing raw material sources, yet also where workshop traces were identified. In areas with extant metal sources (either copper or gold), workshop operations extended over several historical periods[1]. The determining factors of such operations are multiple.

Copper objects from Romania are discussed in several large syntheses produced by Alexandru Vulpe and Ion Mareş[2]. The latter, tackled not only typologies, but also the much more varied technological aspects, the chemical and technological analyses, his works representing significant contributions in this field.

Sources

For Transylvania, Banat, Oltenia, Maramureş, Dobruja yet also the Carpathian or sub-Carpathian areas from the rest of Romania, one may speak of a Cooper Age marked by metallurgical and open-hearth activities, identifiable based on workshop traces, tools, installations/ovens, molten metal remains, minerals, slag and so on, yet especially by the existing copper sources (mines, pits/stone hearths).

Copper sources are of different genetic origins, hence different mixtures of major or minor elements (Fig. 1).

Mining traces

It is difficult to establish mining traces with certainty, even though mining tools were discovered in secure contexts. Overall, during the Copper Age (in copper, gold etc.), stone and copper tools are the same: in stone – crushers, hammers, pierced hammers; in antler – hoes or horns; in copper – pickaxes, hammers, chisels; other: for instance, a miner's bag, for the carriage of ores[3], is rendered on a menhir.

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1 For copper, certain elements may be traced within workshops: metal, ovens/furnaces, slag, blowing tubes, grains, yet especially moulds, evidence of metalworking.

2 Vulpe 1975; Mareș 2002; 2012; and references in both authors.

3 Wollmann 1996, pl. XXVII/3, VII1–2, 297, 462, pl. XXVII/2 Dacian? could be also older; are also recorded in copper or

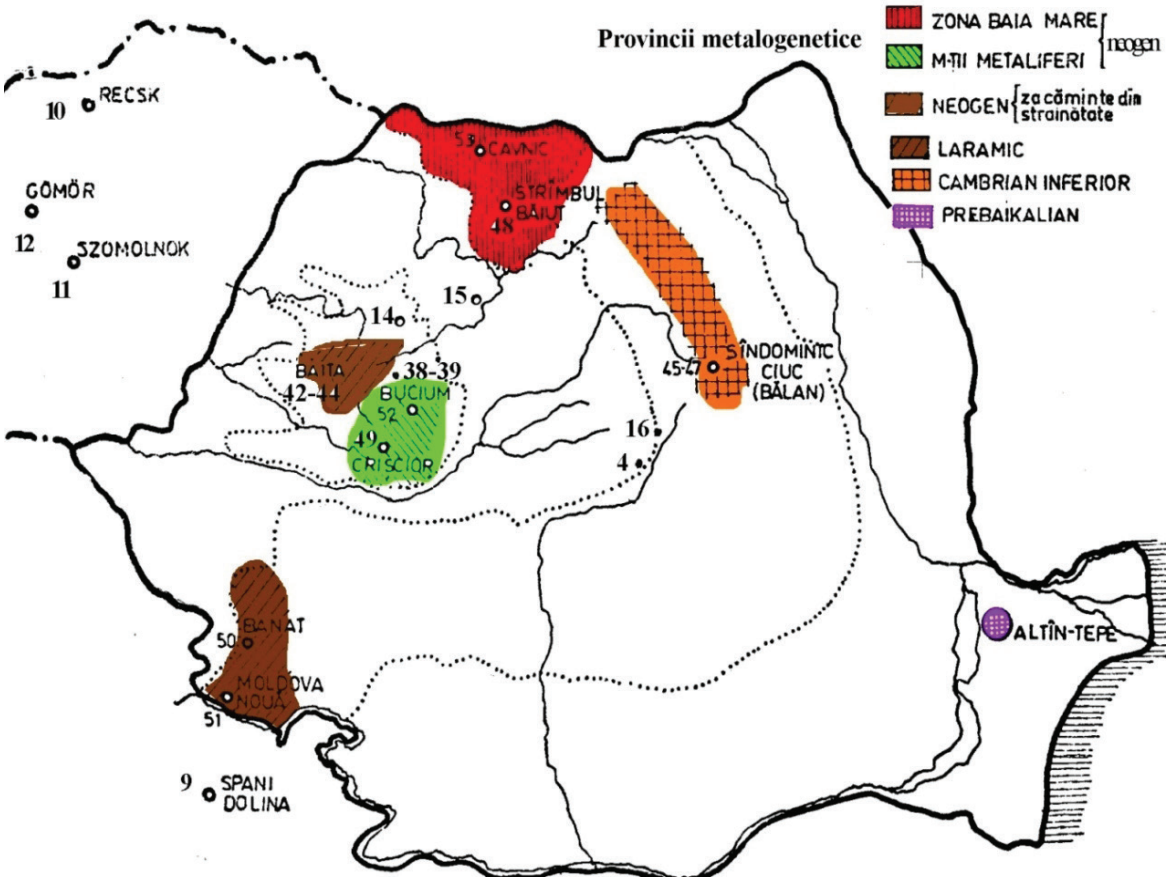

Fig. 1. Metallogenetic provinces for deposits.

At Cornereva – *Piatra Ilişovii* we discovered traces of a mine, today filled, and mining traces, although dated to Coţofeni II[4].

Metalworking activities

We use the term of metalworking activities in reference to workshop traces (consisting of several object types) from deposit areas, yet also outside these (as artisans were travelling, moving in Romania on routes towards mineral deposit areas: Ciceu, Gherla, Cluj-Napoca) or in mine areas (Baia de Criş, Baia – Hamangia: "baie" = mine, exploitation, ore washing).

Since the Copper Age, digging was carried out by hammerstones[5] or socketed hammers (15 × 24 × 9.5, weighing 5.240 kg)[6], ore crushing hammers (22 × 13.5 × 7.5, of 3.970 kg)[7], red deer antlers[8], occasionally copper pickaxes, with bent cutting edges owing to their use in metalliferous mines or salt mines[9].

The **open-hearth activities** associated to metalworking are marked by kilns, holes for charcoal

gold areas (Baia de Arieș) and Baia Hamangia; or in barrow graves: ****Enciclopedia Arheologiei*, s.v. menhir and *Polus 2008*: Rotea 2008, cat. 18, cover 1, fig. 4, p. 24; similar items with the miner's bag emerge in Spain.

4 The literature mentions it as a cave, aven. Fr. Resch, member of the research team, with his 19 years of imprisonment experience deemed it a mine, while skarn traces of minerals existed between the rocks as well. In fact, we identified there traces of a copper workshop too, alongside its implements, copper grains in cracks on a cliff from one side of the workshop: LK 155, Lazarovici C.-M., Lazarovici Gh. 2007; Kalmar 1993; Gogâltan 1999, 118, apud Zimerman; Lazarovici Gh. 2014, 262, fig. 24–28.

5 Rudna Glava, Jovanović 1982, cover 1.

6 Rudna Glava, ocna 4a, Jovanović 1982, 28, fig. 2.

7 Rudna Glava, platform zapadna, Jovanović 1982, 35, fig. 3.

8 Rudna Glava, Jovanović 1982, 31, 33.

9 Vulpe 1975, cat. 43, 54, 57, 182, 195, 216, 236B.

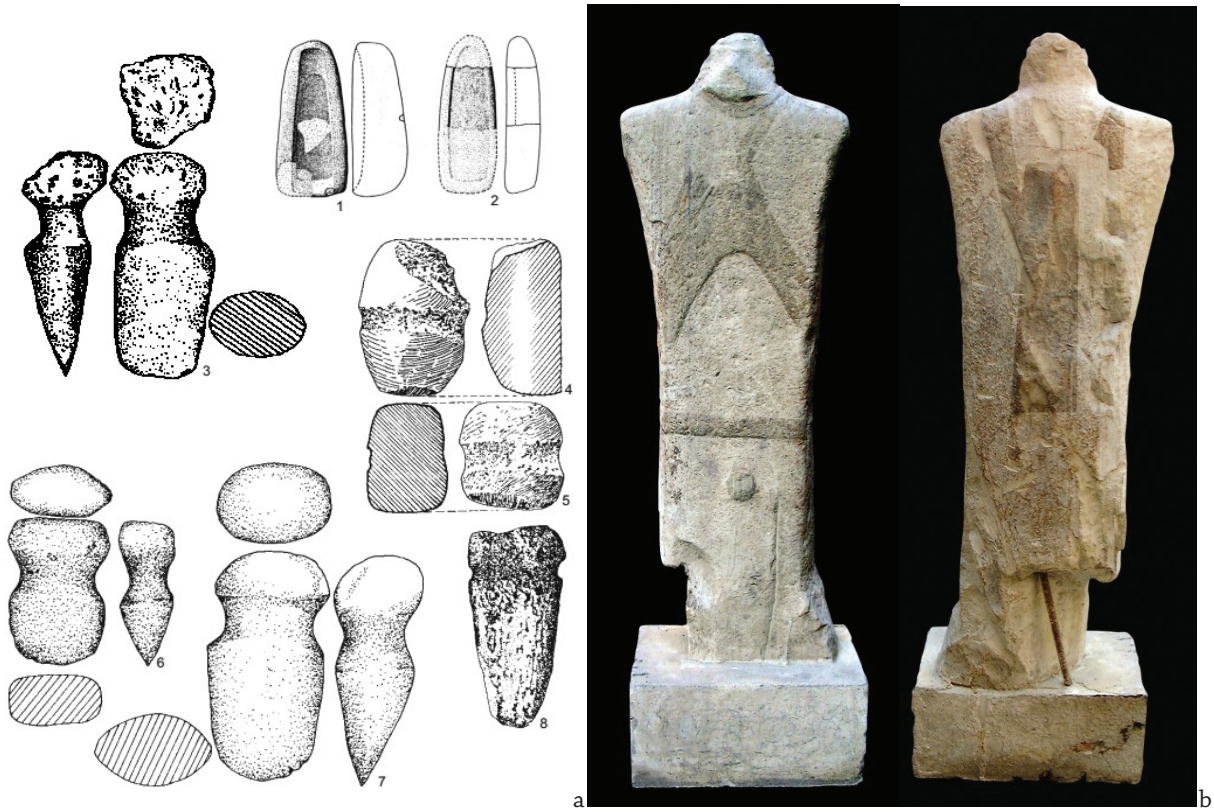

Fig. 2.a. Mining tools: 1–2, moulds, apud Mareş 1992; b. Menhir Ciceu, miner's bag (photo Lazarovici Gh.).

preparation or other, slag, crushed ores, native copper traces; yet also to ore mining and transport[10]. Mountain archaeology is limited in Romania, with a lack of specialisation among the archaeologists, while cooperation with geologists is absent.

In some of the provinces from Romania, rich in mineral and deposit areas, the large quantity of metal objects is key (Transylvania, copper, over 60 kg; Banat, copper, ca. 20 kg, Oltenia, Moldova). Similarly important are some large deposits (here, only for Romania), like at Vâlcele I (Banjabic[11]) or the huge workshop – deposit of Uioara[12]. With respect to gold working, the Moigrad hoard[13] and the Cheile Turzii-*Peştera Ungurească* workshop[14] evidence the high technological level achieved during the Copper Age.

For the copper and gold working peak period in the Bodrogkeresztúr – Toarte Pastilate/ Knobbed Handles culture (hereafter BK-TP), evidence is given by a workshop for gold processing provided with installations (kiln with blowhole, hearths: see below for gold Figs. 6b; 9a, b-c; 10c**)** and technological operations: for gold (see below Peştera Ungurească) and copper (Peştera Binder[15]).

In the case of installations/kilns we mention only a part of workshops from Romania and Serbia, as argued elsewhere[16] too:

- Slag, slag holes, workshop? (Baia de Aramă, Cuptoare-*Piatra Iloşovii)*[17]
- Metal remains in pots/jars or crucibles, workshop (Foeni, Tăulaş-Turdaş II)[18]

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[10] Jovanović 1971, 106–107; Pernicka 1987, 613–619; Avilova 2008, 74 ff; Szentmiklosi, Drașovean 2004; Šljivar *et al.* 2011; Hansen 2013, 140.

[11] Roska 1942, 36, 302–4; Hansen 2009, 11.7–10; Szeverényi 2013, (sub vocem/s. v.).

[12] Petrescu-Dîmboviţa 1977, s.v. Uioara and bibl.

[13] *S.V. Moigrad***:** Fettich1953, pl. XLII.2, 10.2; Makkay 1989; 1991; 1996; Vlassa 1970; Vlassa *et al.* 2021; László 2000, 92.

[14] Lazarovici Gh., Lazarovici C.-M. 2008; 2018; etc.; Lazarovici Gh. *et al.* 2022 and bibliography.

[15] Lazarovici C. -M., Lazarovici Gh. 2016a.

[16] *Anatolia and the Middle East***:** Hauptmann, Weisgerber 1996, 97; Timna: Segal *et al.* 1998, tab. 1; Radivojević, Kuzmanović-Cvetković 2014, 11, fig. 2–3a, 15, fig. 7; Hauptmann, Weisgerber 1996, 97; Borić 2009, 191, no. 1.

[17] Mareș 2002, 80; Pătroi 2009, 66.

[18] Drașovean 2015, fig. 2.

• micro furnace; baseless pots, slag, workshop (Belovode[19])

• pots with minerals, minerals, workshop? (Turdaş, inf. S. Luca)

• Manganese holes, workshop (Serbia)[20]

Slag traces are often mentioned, usually without details or analyses, in areas with sources or metalworking activities from Banat (Cornereva – *Piatra Ilişovii*)[21].

Slag is reported until the end of the Copper Age in the Coţofeni culture[22], when copper axes still existed[23].

Among the implements we mention:

• Stone axes for digging or crushing, antler tools: from Romania and other metalworking areas[24];

• Moulds, traces of mould remains like burrs (in those bivalve). Their number is very high (over 80 entries in our database); the earliest are from Belovode[25], followed by those in the Sălcuţa[26], Gumelniţa[27] or Petreşti cultures, Bodrogkeresztúr and other from Transylvania[28] and Banat[29].

• Some continue in the Early Bronze Age, however singularly, therefore they are difficult to frame culturally and chronologically. In the series of moulds are worth mentioning those bivalve, according to the burr remaining on some of the exemplars[30]. Evidently, there is much more information from other studies and cases when casting remains subsequent to wax moulding were found (à *cire perdue* = lost-wax process)[31];

• Blowpipes (*Tondüsen*) are used to increase heat temperature and some may also originate from pottery or gold firing kilns. These are found at: Vărăşti, Văleni, Truşeşti, Ţaga – L15[32] and in other sites from south-eastern Europe[33];

• Still in connection with metalworking activities we mention the crucibles or pots with metal traces (see above) emerging in broad areas of the Vinča (Belovode, Selevac, Ocolište[34]), Tiszapolgár[35], Cucuteni[36], Coţofeni[37], Schneckenberg and other cultures[38];

• Ore melting kilns or for re-melting objects are rather rare, and even though blowpipes were discovered, these may be assumed. At Belovode, above a hearth there was a biconical pot – while blowholes lay at hearth level[39]. At Iclod and Tureni-*Terasă* we excavated two kilns with massive stone walls and floor of river boulders[40]. At Iclod we found a silvered copper button (similar to one from the Cheile Turzii-*Peştera Ungurească*[41] workshop), while at Tureni, nearby, we identified string decorated fragments;

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19 Šljivar *et al.* 2006; Šljivar, Jacanović 1996; Šljivar, Jacanović 1996a; Radivojević, Kuzmanović-Cvetković 2014.

20 Šljivar *et al.* 2011, 30; Blagojević 2014, 189, fig. 11.

21 Lazarovici C.-M., Lazarovici Gh. 2007; Kalmar 1993.

22 Popa 2009, 294, 508, 509–510, 558, 560–562.

23 Coldău: Vulpe 1975, pl. 34, 295.

24 Jovanović 1982, 23–44 52–58, pl. XXII-XXVI la Stanojević.

25 Hansen *et al.* 2016, fig. 4, after Mehmed Karucak.

26 Vulpe 1975, 59, Nr. 273, Taf. 33., 273–288, exemplars of Ostrovu Corbului.

27 Hansen *et al.* 2019, fig. 3–6, 4.33.

28 Vulpe 1975, 73, cat. 375; Diaconescu, Tincu 2016, 108, fig. 3.

29 Roska 1942, 32; Patay 1975, 67, 13; Sălceanu 2008, 68; Szentmiklosi, Drașovean 2004, 56, fig. 38.

30 Mareș 2002, 66, 71; Topan *et al.* 1996.

31 Ryndina, apud Mareș 2012, 68–71, 75 and appendix 2.

32 Truşești, Văleni, Ţaga – L15: Comșa 1974, 14. pl. II; ****Cucuteni 1997*, cat. 116; Lazarovici C.-M., Lazarovici Gh. 2007, 321, 322, fig. VIIa.17b; Brudiu 2001; Lazarovici Gh. 2014, 258, fig. 17.

33 Müller *et al.* 2013, 228, fig. 5B, inv. 10502, 41352; Sveti Kirilovo; Lazarovici C.-M., Lazarovici Gh. 2007, 322, fig. VIIa.17a1; ***Macht, Herrschaft 1988, 218, Abb. 148, Kat. 46, 58.2, 61.

34 ***Neolithic Greece, 1973, fig. 127; Kalmar *et al.* 1987, 75, pl. 2.6, 4.11; ***Macht, Herrschaft 1988, 148 Abb. 87, 217, Kat. 40–41; ***Polus 2008, cat. 11; Diaconescu 2009, 13; Blagojević 2014, Pl. I.1.

35 Bognár-Kutzián 1976, 74; Diaconescu 2009, 13; Müller *et al.* 2013, 228, fig. 5B, inv. 10502, 42122, C14 calibrated data, 4800 – 4200 BC.

36 Monah *et al.* 2003, 85, fig. 28–30; ****Cucuteni 1997*, cat. 114, 135.

37 Diaconescu, Tincu 2016, 108 fig. 3.

38 Prox 1941, 185, pl. XXV.2; Eibl *et al.* 2014, 94, fig. 3.1–2; Hansen *et al.* 2019; Kalmar 1993; Lazarovici C.-M., Lazarovici Gh. 2007; Blagojević 2014, Pl. I.1.

39 Jacanović, Šljivar 1998, 189–190; Šljivar *et al.* 2006, 253, pl. II/3–5; Radivojević, Kuzmanović-Cvetković 2014, 12; Diaconescu 2009, 14.

40 Lazarovici Gh. 2012, fig. 16c; Lazarovici Gh. 2014, 258, fig. 18.

41 Lazarovici Gh. *et al.* 2022.

• Some massive copper pieces are marked with circles and semicercuros, sometimes round presses, believed artisan marks[42];

• Are deemed workshops or possible metalworking related and jewellery making workshops areas where minerals, implements, slag, copper grains, crucibles, copper melt are found. Thus, at Belovode significant is the presence of molten minerals in pots (amphorae), native copper, malachite, cinnabar, azurite[43] and cuprite[44].

In certain metal source rich areas there are traces of metalworking activities, namely workshops whose operations extended over several historical periods. In this respect are worth mention the synthesis works of Al. Vulpe and Ion Mareș (see there also rich reference information)[45].

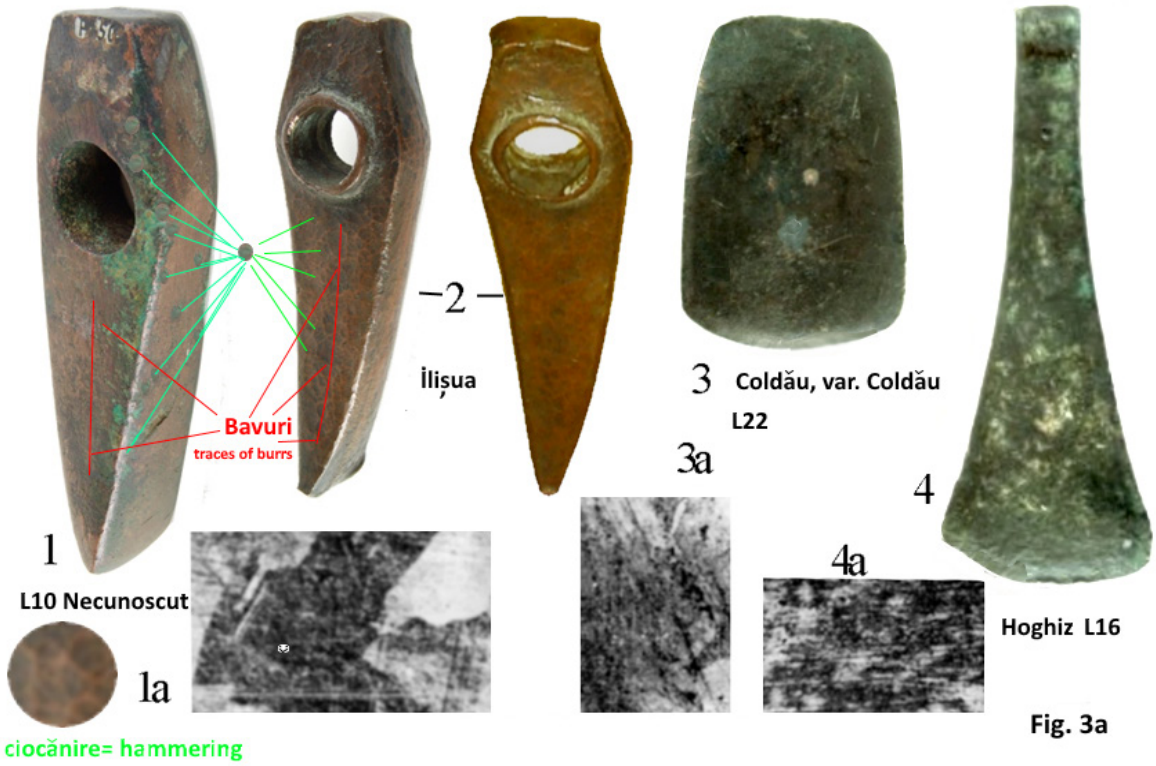

Fig. 3. Copper artefacts in the collection of the National History Museum of Transylvania (MNIT) analysed by Gh. Topan and his team: 1–1a, L10 = axe-hammer, unknown findspot, Transylvania; 2, axe-hammer, Ilișua; 3–3a, flat axe, Coldău, Coldău type; 4–4a, chisel with semi-round edge, Hoghiz; 1a, 3a,4a: metallographic analyzes on *macles* (Fr.)/structures of copper crystals.

Metallographic analyses

The metallographic analyses and certain experiments performed in Romania yielded new data and information, important for the technologies used in copper working[46]. Though few, carried out by specialists in metallurgy and non-ferrous metals like Gheorghe Topan[47] and at the counsel of other specialists, these brought new data on casting technologies and procedures, metal working, finishing, structures, remains, casting flaws, sharpening, tempering, annealing, casting traces, the nature and behaviour of metals and many other. Upon the study of the metal structure (crystal shapes), their behaviour and other traces, the team led by Gh. Topan reached a series of conclusions useful to us with respect to the high technological level achieved or experienced.

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42 Vulpe 1975, cat. 35, 39, 44, 47, 48b, 58, 59A, 60, 62, 65, 68, 109A 110, 158, 160, 174, 176, 180, 196, 200, 201, 211, 227.
43 Jacanović, Šljivar 1998, 189–190; Šljivar *et al.* 2011, 30–31, pl. II.1–2.
44 Mareș 2012, No. 1455.
45 Vulpe 1970; 1975; 1976 and bibl.; Mareș 2002; 2012 and bibliography.
46 Mareș 2012, Appendix 3 in cooperation with Ilie Cojocaru; Topan *et al.* 1996; Lazarovici Gh. 2014, 252f, 254–255.
47 Topan *et al.* 1996.

General information

Gheorghe Topan chose for analysis a few objects in the MNIT collection published in the 1996 study[48]. The author and his team reached the following conclusions: the elongated crystals are indicative of hammering, forging operations: the medium and large twinning crystals evidence native copper or exposure to high temperatures for extended periods; there is copper with a 0.005% high purity; copper with up to 1% impurities comes from ores; in copper with impurities, there were occasionally discovered up to 14 elements, Au As Sb Hg Ni Sc Fe Zn Co Tn Sn, which provide hardness and durability; in finishing are noticed burr cutting, whetstone friction (sharpening), hammering (sharpening, hardening); the lack of the cuprous oxide was noted in artefacts P852, P853, P850 L13 axe, P843, when evenly distributed referencing native copper; the lack of the cuprous oxide increases in temperature rise and air excess from fire; the cuprous oxide increases upon repeated heating; the lack of the cuprous oxide is marked by red dots at 450°C; in artefacts L15, L16 fire wood or charcoal were used; the copper sulphide depends on the sulphur containing charcoal; the green patina (= basic copper carbonate) depends on the environment where the artefacts were stored, if dark green, it has a high percentage of arsenic; the lack of patina may be due to fat treatment.

Mixture with other elements: it was noted that the axe-adze L10 (Fig. 4.4 structure), of unknown origin, Transylvania, contains arsenic in a small to medium percentage; the hardness at 28–20 HB[49] is soft, while from 35–40 HB, in other items, it is higher; the artefact has later additions elements like Sb and As.

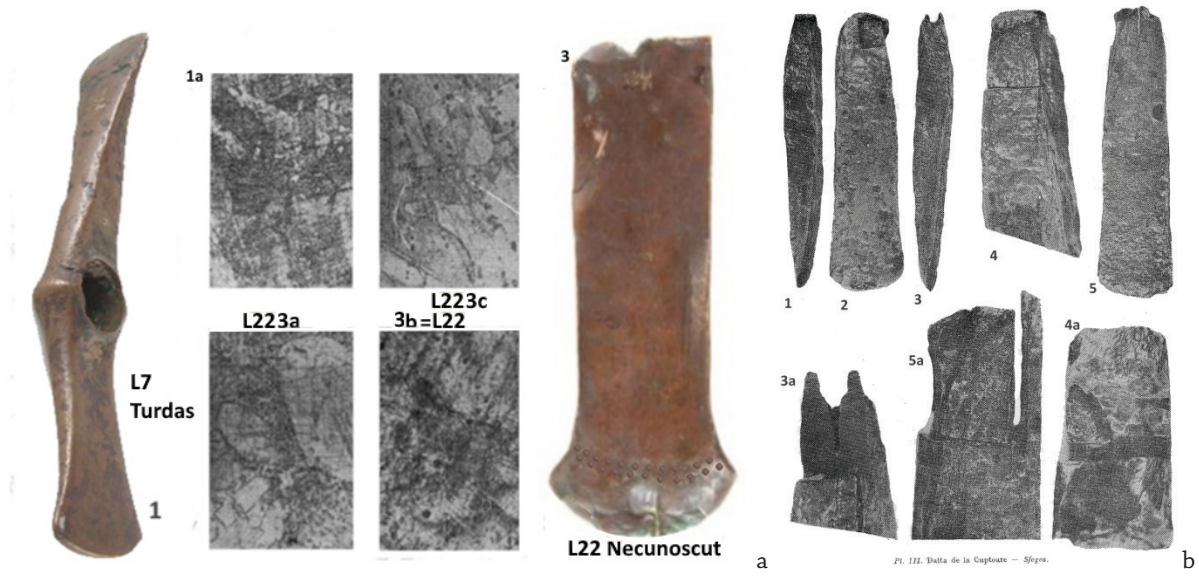

Fig. 4. Copper artefacts from various locations: 4a: 1–1a Turdaș = L7, pick-axe; 3–3a-c L22 = chiesel, unknown findspot; 4b. the chisel of Cuptoare-Sfogea. Macles-crystals: 1a (L7), 3a–3c (L22); copper sulfide: 3c (L22).

Cuptoare -Sfogea, chisel, Sălcuța IIc – III culture (**Fig. 4b).** The base of the artefact was made of native copper, by hammering; its handle/head is of impure, viscous, fragile, flaking material; it exhibits corrosion traces due to the medium's unevenness; on the wide surface it displays dotlike corrosion caused by moisture, soil acids; the corrosion environment is composed of clay, kaolin, charcoal and ash; molten copper was added in order to complete the form, emerging in layers (through the dripping technique), with rare traces of flowing noticeable on the original copper (native copper, worked by hammering), to which added new layers; there are casting dislevelments, causing non-metal inclusions; the microstructure of elongated crystals is the result of forging; it is incompact, hence there is no metallurgical health; some yellow stains are the result of alloying with zinc; in the head area it has a flaw ("mushroom"-shaped) for which reason, by striking, used as chisel the head broke; it thus may be concluded that in its final appearance it was used as a chisel. On the flat surfaces, which sat on the

[48] Topan *et al.* 1996, 643.

[49] HB = measure unit for standard hardness.

anvil, it may be noted that the narrow parts are slightly concave subsequent to striking; the circular arc shaped blade was suppressed by hammering, exhibits no decay traces; the item was chemically treated in the lab and wire brush was used; slag in indents during further additions.

Hoghiz, L16 chisel, flat axe – chisel (Fig. 3–4). It is of native copper mixed (eutectic) with copper – arsenic (arsenic black grains as at L22, Fig. 4a/3b); cast in clay mould (surface of the artifect in Fig. 3.4); rare elements: arsenic 6270 ppm, silver 378 ppm, poor traces of antimony, zinc, nickel and gold; the head exhibits blunting traces (Fig. 3.4); polyhedral crystals; deformation by cold working, hardness 68.8 HB; lacking cuprous oxide; the lack of whithdraws (to reduce its dimensions in a technological process), sulphides, sand inclusions, charcoal are indicative of good casting technologies.

L10, Transylvania, axe-hammer (Fig. 3.1). Weight of 165 gr.; cast in bivalve mould, cut burrs; owing to the presence of polyhedral crystals (as in Fig. 3.1a), it may be concluded that it was exposed for a long time at temperatures over 600°C; hardness 43.7 HB (Brinel measured 1s at 1000kf); hammered with round object, not too wide, 0.5 kg hammer intended for cold working; annealed after hammering, which increased hardness, soft average of 35–40 HB; mixture with arsenic (2820 ppm) small to medium: 28–20 HB soft average, 35–40 HB harder, Sb (1220 ppm), Sn 11100 ppm; Ag, 913 ppm, Ni 370 ppm, Zn 1310 ppm; hot welding 750–900°C; verdigris between blade and body, red patina by hot fat greasing.

Unknown origin, L13, axe-hammer. Of polyhedral crystals; weight of 534 gr., average hardness after treatment, 58.6 HB; longitudinal finishing by whetstone; base of native copper, copper oxide/sulphide in metal mass; parallels at Lacu L7; possible total or partial melting; high tin content, added by hot welding overlapping the native copper; 40–60 HB hardness, forged and annealed.

Coldău L15 chisel, flat axe, Coldău variant. It is part of cluster 1.1.2[50], has a high percentage of As 16800 ppm (= 1.68%); in the basic mass there are round inclusions of copper sulphide; worked by hammering (lacking the cuprous oxide), without melting, 68.8 HB hardness, weight of 305 gr., sized 105 × 68 × 3 mm; on edges, traces of projections that may originate from the native material; casting with quick cooling is not excluded, yet it is difficult to assume based on the flat shape; a horizontal or oblique casting is not excluded either, followed by hammering; on the edges, cutting traces with hard object.

Unknown origin, L22, chisel. Compact material, made of native copper by hammering, on body traces of different hard objects; cold working deformation; on edges, traces of hammering and cutting; torsions and overlapping from hammered soldering to the blade and head; round cutting blade sharppened by hammering (Fig. 4a, mark H), at the blade start small circle traces: craftsman's mark or cold welding through dots; surface with reddish appearance resulted from grease hot treatment, at low temperatures (200–300°C), which led to a reduction of hardness (although it is higher than 121 HB) by cold working (it is also called cold ecruisation).The presence of certain elements in ppm: Zn 20700, Sn 28200; As 1540; Ni 1210; Ag 925; Au 10.9 is the result of the native copper source.

Lacu, L7, pickaxe, type Jászladány, Petreşti variant (Fig. 4.1). The item is part of cluster (1.1.1.2) of native copper from Transylvania, while its source is the Bălan mine area (code UC 47)[51]; twinning polyhedral crystals (*macles* = crystal structure of Cu), subsequent to long time exposure to high temperatures, greased against oxidation; it was originally thicker and hammered for thinning, thus receiving the desired shape; sized: 170 × ¼ mm; near the hole there is an impression – likely an artisan's mark. On the surface it exhibits many flaws in the form of holes caused by manganese or pebble inclusions, likely from the mould (à cire *perdue*); in the handle hole it has two fissures caused by the overstress of a very rigid handle (antler?).

In conclusion, the technologies noted subsequent to the analysis of above mentioned items are as follows:

- Casting in hot mould[52];
- Casting in mould à cire *perdue,* L7;
- Casting by dripping to complete the form (kilns);
- Casting in monovalve mould, L16;

[50] Beşliu *et al.* 1992; Lazarovici Gh. *et al.* 1992; 1995.
[51] Beşliu *et al.* 1992, fig. 1–4.
[52] Topan *et al.* 1996, in sample L7.

• Casting in bivalve mould, L10 (burrs show differences from mould attachments), removal (of burrs[53]);

• Mould or procedure intrusions, L7;

• Mechanical working after casting[54] (tempering/annealing, hardening by hammering the cutting edges);

• Grease anointing to treat surfaces at high temperatures (L7, L10, L22);

• Use of various materials in melting (manganese, charcoal etc.);

• Casting flaws (kilns), use, L7.

All this shows us a high technological level, specific to the Copper Age, at the time of the Tiszapolgár-Bodrogkeresztúr, Petrești cultures.

The metallographic analyses, although affecting certain parts of the artefacts, evidenced and proved a series of technologies indicative of existing artisans who held a vast knowledge of mediums, minerals and technological procedures (hot and cold soldering, cold working, annealing, finishing).

Gold working

Gold working in Transylvania has been extensively discussed since one century and a half. Debates addressed hoards, gold sources, object typologies and types, analyses; Mircea Rusu reported over 3100 golden items etc.[55]

Numerous works were written on gold and gold mining in prehistory by specialists from several fields, including ethnographers, geogra-phers, geologists, historians, archaeologists and physicists. Moreover, there is a vast literature[56] on analyses of gold objects or gold sources. In Transylvania and Banat are reported over 43 gold placer mining/panning locations[57].

Fig. 5. Entrance in the Peștera Unguréască/Peștera Caprelor cave.

Our contribution concerning gold working is recent and occasioned by the find of a gold jewellery workshop at Cheile Turzii – *Peștera Ungurescă/ Peștera Caprelor* (Fig. 5).

An extensive archaeological monograph on Nicolae Vlassa's and our research together with the teams involved in the excavations is forthcoming at Timișoara, for the UISPP Congress of this year[58].

For this reason we synthesise here the main results we achieved, especially with regards to gold working.

Once we started to work together with Paolo Biagi, the materials from our all excavations at Chei were water-sieved by a 0.5 mm grid.

Thus, numerous micro-objects were collected, including gold jewellery (88 pieces), plus other in copper, bone, stone, marble, flint tools, obsidian, quartzite, micro-bones, seeds and charcoal remains.

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53 Mareș 2002, 63, 67, 68–71, 73, 76, 146; Topan *et al.* 1996.

54 Topan *et al.* 1996.

55 Rusu 1972, p. 30 ff, of which 428 mentioned rings, 34, fig. II/2; 1975.

56 To mention only a few: Cheșu 1983; Constantinescu 2001; Constantinescu *et al.* 2010; Tămaș 2010; Pop *et al.* 2011; Cristea 2012; Ciugudean 2012.

57 Rusu 1972, 30; Rusu 1975; Rusu 1977, 209, apud Roska 1940, 106.

58 Based on the research at Cheile Turzii other works were drafted as well: Colesniuc 2008; Colesniuc 2014.

The workshop of Cheile Turzii

The Peștera Unguresc cave is 69.5 m long, has an ascending slope of +7 m and a ca. 18 to 20 m span entrance (with a vault below the Vulturi Cliff), with favourable air currents during the hot season (May-September, Fig. 5b).

In 1974, we excavated a 10 × 10 m trench by the cave's mouth, near the westward wall. In the last internal grids (c. D1-D5), layers were not touched by previous excavations (Orosz, Berciu and Aldea, Milea, Vlassa). There, stratigraphy seemed intact at –0.70 m deep. We discontinued the investigation, as this was a complex stratigraphy that required special research teams.

In 2012, we noted that amateurs of archaeological artefacts dug around in the excavation profile and destroying features during the process (kiln, Fig. 5c). We resumed excavations between 2003–2013, when we focused on the kiln research. In 2003–2004 we worked in cooperation with Paolo Biagi[59]. This was a successful cooperation, resulting in complex anthracological analyses[60] and other[61].

During 2005–2013 we worked in cooperation with the Brukenthal National Museum, which provided us funding and not only, so most artefacts yielded by the excavations were delivered to the Sibiu-based museum. The first gold objects and pottery are stored at Cluj-Napoca, in the National History Museum of Transylvania.

In the jewellery workshop area and where we identified habitation traces of the artisans (our former 1994 trench in areas undisturbed by previous excavations, Fig. 7a, yellow highlighting), we identified hearths with border set up in locations without dripping traces from the vault in order to maintain ember in the thick ash layer for relighting necessary fire and the performance of the technological processes[62] (or areas for craftsmen to rest).

a

b

c

Fig. 6. Peștera Unguresc/ Peștera Caprelor cave: a. survey; b. location of the jewellery workshop; c. amateur disturbances 1994–2003.

The workshop was disturbed in its southern side by Berciu and Aldea excavations (Fig. 7a-b)[63] and possibly other (Orosz in 1898, in other caves as well)[64].

[59] Yearly reports 2003–2004.
[60] Nisbet 2009.
[61] Biagi, Voytek 2006; Girod 2009.
[62] Lazarovici Gh. *et al.* 2022, 72, fig. IB.19.
[63] Materials are at the Museum of Alba Iulia: many references in D. Berciu and other.
[64] Lazarovici Gh. *et al.* 2022, 7 ff.

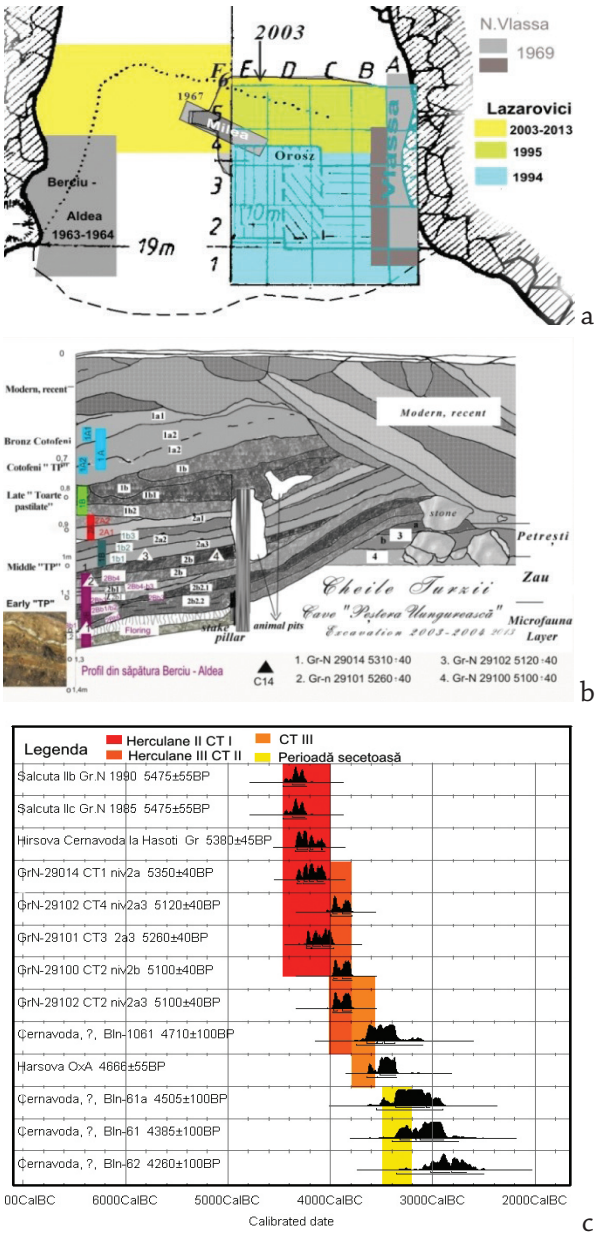


Fig. 7. Peștera Ungurească/ Peștera Caprelor cave: a. excavations by the cave mouth; b. stratigraphy on the west side of the workshop; c. C14 dates and BK-TP development.

A first stratigraphic profile was made during the first research in the kiln area and on ca. 1.8 m from the west side of the workshop (Fig. 7b).

The ^{14}C analyses were performed by the care of Paolo Biagi (Fig. 7b–7c)[65]. On the first inhabitancy levels was discovered BK-TP pottery (short for Bodrogkeresztúr – Toarte Pastilate/ Knobbed Handles) and Sălcuța IIIc-IV shards painted with wide red-dark red stripes on Sălcuța fabric (gray grooved fabric).

By corroborating ^{14}C data with the climate evolution of the time[66], we note that over the course of the workshop's operation (between 4200–3800 BC according to C14 data, although a shorter timeline, we believe), with the 24–30 abandonment and resumption horizons, they correlate with Sălcuța IIc and Cernavodă dates (there are a few string decorated shards in upper levels). The table from fig. 7c presents both the hot and cold periods as well. There, we also used Petre Roman's term of ***Herculane-Cheile Turzii*** with three development phases confirmed by C14 dates (Fig. 7c; 10d).

Workshop layout

The layout of the workshop (Fig. 8a) was reconstructed with the location of the wooden structure postholes (Fig. 8b). Postholes seem many, however they date to two-three phases of operation over the course of a 200–250 years' span (C14 dates seem longer, yet one must also take into consideration the errors, expressed by ± in ^{14}C dates).

On the southern side were noted two posthole alignments, while on the eastern side, some overlap. It is uncertain which posts survived during certain periods when workshop activities were resumed, some being removed and replaced (wider holes were made).

The workshop was shaped as a canopy and it had no side walls except for the western side (a short fence was found by the kiln's mouth) and possibly to the north, as the land was levelled upon the workshop's construction.

During the first phases an external hearth was operational, where later a kiln with three restoration phases (the last, still a hearth on top of the kiln debris) was built. The kiln was roofed, to its exterior existing two postholes[67].

The workshop produced many objects that formed a series of structures of adornments, jewellery, marks of wealth and power. They embellished the elites of the time(see Moigrad, as well as the annexes of the workshops from the Peștera Ungurească and Peștera Binder), yet possibly also for the common people, but for them they were only jewels made of different stones and clay.

65 Biagi *et al.* 2005.
66 See comments in Lazarovici Gh. *et al.* 2022, 79, fig. IB.29.
67 Lazarovici Gh. *et al.* 2022, 146, fig. IIC.5.

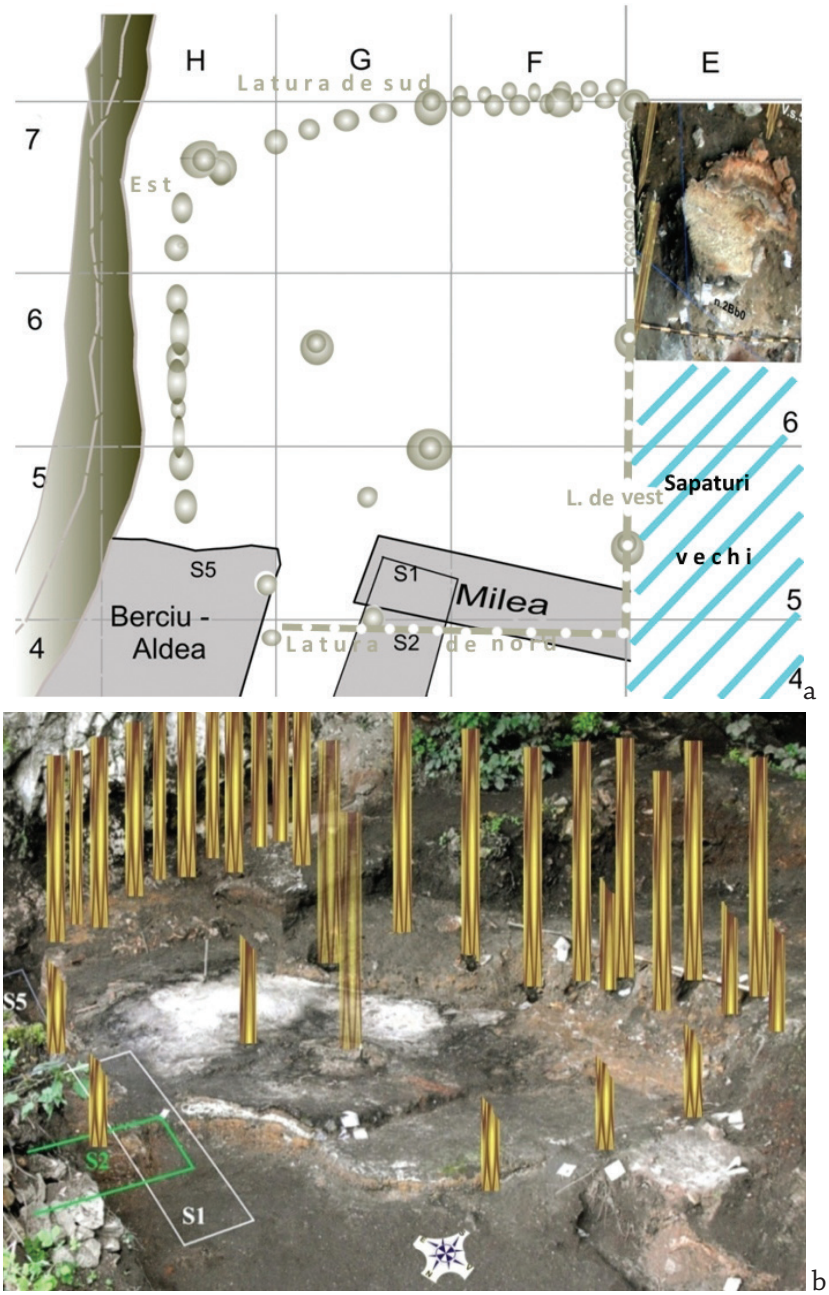


Fig. 8. Peștera Unguresc㠖/ Peștera Caprelor cave: a. workshop layout; b. posthole structures.

Upon the completion of the excavations, we noted the existence of other more ancient levels than the former level 2Bb0 (Fig. 9a), which we did not further investigate: we left the 2Bb0 floor untouched, for a possible reconstruction of the workshop *in situ*.

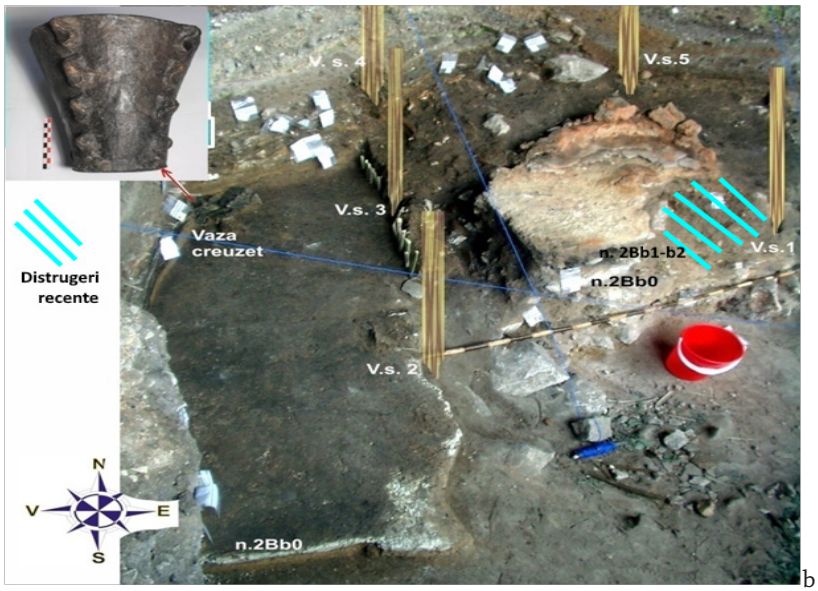
After three restoration phases, in levels ***2Bb2, 2Bb1-b2*** a special kiln with three reconstruction phases (Fig. 9b) was built. In the first, the kiln had a central post for the dome (Fig. 9c), shaped as a ladyfinger.

Then, the kiln was rebuilt, two reconstruction phases of the hearth being noted. In both, the kiln was provided with a hole for the bellows, in order to control firing (Fig. 9d)[68].

In the last reconstruction phase, central to the kiln was built a small rectangular base (12 × 12 cm) with a semicircular frame (Fig. 10a-b) running to the mouth, aimed to channel towards the mouth the molten remains from the crucible, which would have been overturned during handling.

[68] In Bulgaria: Rusev, Boyadziev 2010, Chapter 5.2, fig. 82.

a



b


c


d

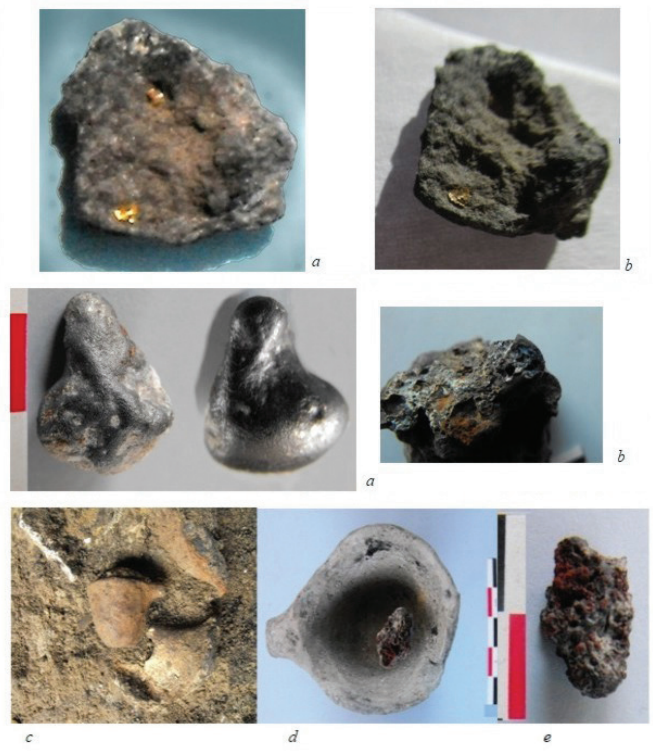
Fig. 9. Peștera Unguresc ă/ Peștera Caprelor cave: a. Workshop, hearth level 2Bb0; b. kiln, level 2Bb1–2Bb2.

The direction of the air flow was oriented towards this base, where the pots or crucibles for melting minerals or discarded objects and working waste stood (Fig. 10a).

The kiln vault was a hemispherical dome, slightly elongated towards the mouth (Fig. 10c). On the floor nearby, there was a vase with thick walls and knobbed handles (Fig. 10b, right up corner), suitable for melting. In the hole there was a femur of an animal, broken (Fig. 9d, probably blowpipe?).

On kiln hearths no golden grains were discovered, however on other hearths from within the workshop were discovered small molten gold grains (Fig. 11 or small sheet fragments). We identified a number of smaller posts that could be related to certain operation phases, however we could not establish a stratigraphic relationship, many postholes being almost empty (a range rod entered easily almost 1 m in the hole, Fig. 10d).

Fig. 10. Peștera Unguresc㠍/ Peștera Caprelor cave, kiln with rebuilding phases: a-b. recent phase; c. reconstruction; d. Băile Hercullane II/III –Cheile Turzii –Sălcuța.



After a period when the workshop was abandoned, the kiln dome collapsed inwards, being levelled and used as external hearth for a while. Within the workshop, in all levels there were several hearths from the same operational phase, which we believe were used to solder beads, fine bone pipes, omnivorous animal teeth with burning traces in the tip area being discovered. Still on some of the hearths were found remains of golden grains, very likely form scrap or hot soldering (parts destroyed by inadvertence or resulting from welding).

The presence of such a kiln and its implements are indicative of the artisans' knowledge of open hearth technologies and gold working techniques.

Fig. 11. Peștera Unguresc㠍/ Peștera Caprelor cave, melting traces: crucible, slag, golden grains from within the workshop (apud Lazarovici Gh. *et al.* 2022, fig. IIC. 39–40).

Slag fragments, although small and few, evidenced they melted certain copper minerals as well (some copper loop rings were discovered) or gold.

Fig. 12. Peștera Unguresc㠍/ Peștera Caprelor cave, western area of the workshop: kiln and bellows (reconstruction) ▲, anvils, hammers.

Fig. 13. The Peștera Ungurească/ Peștera Caprelor cave. Stones used for hammering and hot soldering sheets and other items (apud Lazarovici Gh. *et al.* 2022, fig. IIC.26).

In the workshop vicinity, south the kiln, by the edge of the canopy domestic waste was discarded (large animal ribs, ca. 118 fragments[69]).

The faunal material originating from the culture layer belonging to the Toarte Pastilate/Knobbed Handles horizon, also termed the Herculane II – Cheile Turzii horizon, amounts to 546 bone remains, of which 79.73% belong to domestic species (they exchanged jewellery for cattle for food), the remainder of 20.7% being wild animals, representing a higher percentage during the BK-TP[70]. Over the course of the 1994–1995 excavations were discovered 2000 bone fragments, yet at that time, culture layers were not broken down: the wild represented 15.3%, while those domestic 84.7%[71]. Domestic animals for meat were in a 35–36% percentage; among the wild animals, well represented were the red deer and the roebuck; dog bones were also discovered.

Implements used in the workshop

There is little information on the jeweller's tool used during the Copper Age, obviously, the artisans carried these wherever they travelled, while only those destroyed or lost remained, otherwise rather few. Two large stones with depressions, in the shape of grinders, were discovered in the abandoned workshop, one very large on the eastern edge (Fig. 12.b) and another on the southern edge (Fig. 12.a-a1).

[69] We noted that certain wild animals returned to the cave after each abandonment of the workshop and disturbed the bones: Lazarovici Gh. *et al.* 2022, fig. IIB.28–29, 34–37 etc.

[70] Bindea 2005; Bindea 2008.

[71] Bindea, Sângerean 1996.

On one of the hammered sheets (Fig. 12c), soldered incompletely by hammering, are still visible the leather pores, as sheets were hammered through skins[72], a technology known in fact.

In the workshop survived a series of rough or smoothened stones, collected from riverbeds, used as hammerstones to cold solder golden sheets and obtain desired shapes (stripes, wires, etc.).

There is no scrap from large finished items, as these were exchanged, yet there is a series of copper loop rings (Fig. 14a), similar to those in the Copper Age date cemetery of Varna II-III[73].

Copper items were discovered on hearth 5[74], contemporary with those of Varna II-III. There are shell loop rings (Fig. 14b), finely cut (likely with copper knives, flint or obsidian implements)[75]; it is not excluded that also gold rings existed, however our research of cemeteries is limited.

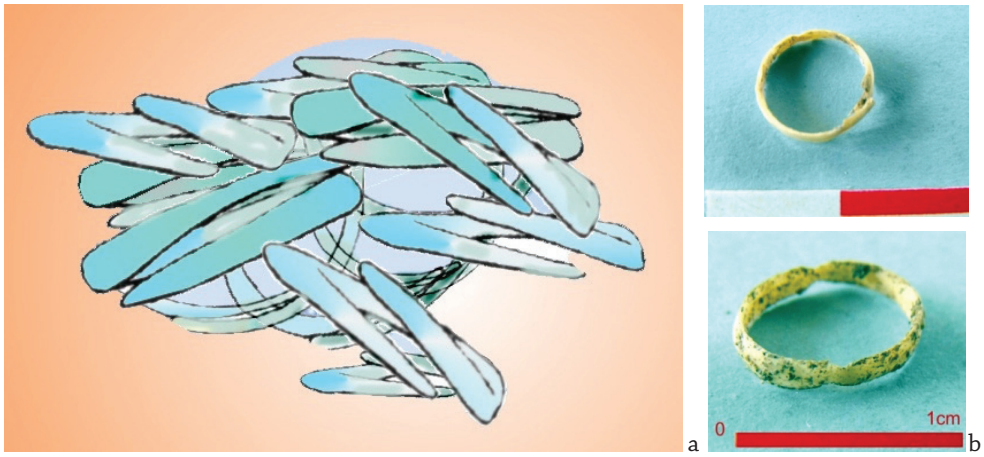


Fig. 14. Loop rings: a. Varna, in copper, type Varna; b. in shell, the Peștera Ungurească cave.

Except the large hammerstones used to hammer sheets certain artifacts exhibit traces of small hammers[76] utilized for adjustment, like for instance the bead soldering area (Fig. 15a).

Copper knives and daggers. Among these we mention: a broken dagger tip, cold hammered and treated with fat, with a high content of arsenic (according to the patina); a wooden handle knife with two rivets and a two-bladed knife.

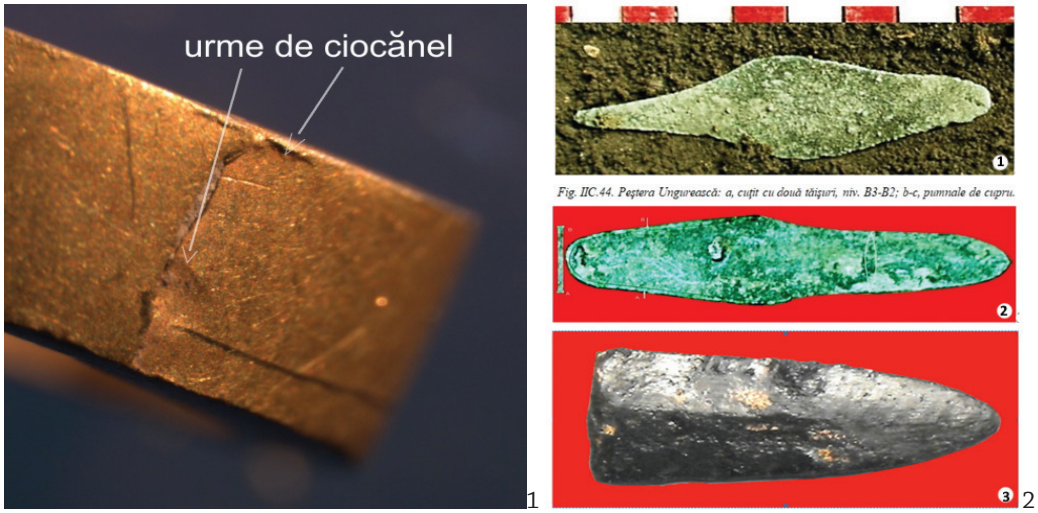


Fig. 15. Peștera Ungurească/Caprelor cave, jeweller's tools: 1, bead with traces of a small hammer; 2.1 knife; 2.2–2.3 daggers; 2.3 dagger with Asw content according to color.

[72] https://ro.wikipedia.org/wiki/Foite_de_aur

[73] Dimitrov 2002, II.1, p. 145, types A1b A2b, Abb. 167 in levels Varna II-III, contemporary to Cheile Turzii.

[74] Lazarovici Gh. *et al.* 2022, fig. IIC.85: a, loop rings from hearth 5.

[75] Lazarovici Gh. *et al.* 2022, workshop in: grid G6, level 2Bb3; grid H6, level 2B1 or 2Bb4.

[76] Small gold hammers are in the Moigrad treasury, but those used in the Peștera Ungurească had to be made of hard materials (copper or stone): ***Aurul și argintul* 2014, 187–189 și bibl.

The two-bladed knife might have been provided with a wooden or bone handle, while its blades might have been exchanged according to the need (Fig. 15.2a). Awls and needles, common to these horizons, yet also to the Developed Neolithic (the Vinča culture) were used for piercing certain pot fragments or sheet, to twist the band or semicircular section wire (type *saltaleone,* later cut for beads, Fig. 17b-c, f), yet also for soldering; the large copper body does not melt when beads were soldered, a short-term process in high fire (Fig. 19).

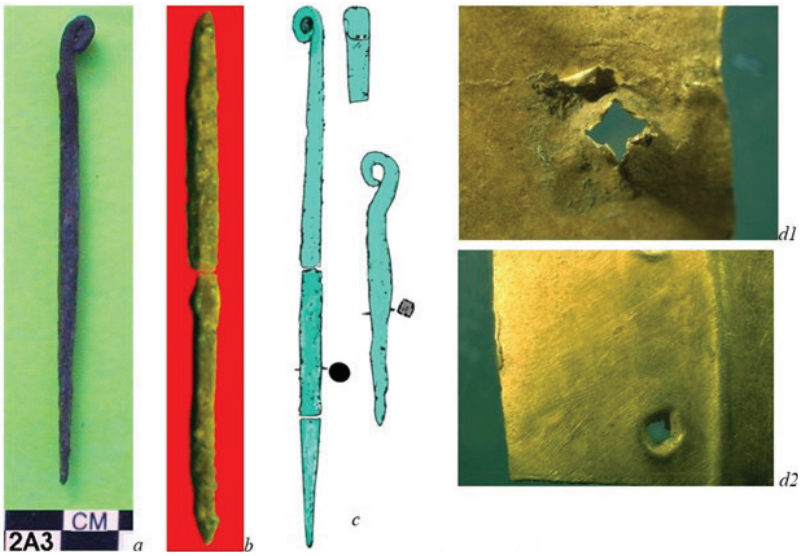


Fig. 16. Peștera Ungurească/ Peștera Caprelor cave, awls and needles used for piercing, twisting wire for beads, yet also soldering (apud Lazarovici Gh. *et al.* 2022, fig. IIC.43).

Among the beads lost in the ash, charcoal, sands and guano from the cave, carried by the wind, some survived as discarded items or were lost during the cutting and bending operations. According to their shape, we know they were bent in the form of spirals as in *saltaleone* (Fig. 17b-c, f). Others were half-cut (Fig. 17.b-c), while another, bent, soldered, was no longer finished (Fig. 17.a).

In another exemplar, Fig. 17, is visible an internal, slightly triangular edge, according to the section of the awl onto which it was bent. There is also a specimen that shows it was made of a rectangular section wire/bar (Fig. 17d); it is the same with the hammer traces used for cold soldering (Fig. 15.1).

The small internal groove was invisible, the image here being enhanced tens of times. These evidence the craftsmanship of the gold working artisans of the Chei workshop. The macroscopic study of these items provided us with the opportunity to observe certain details, undetectable to the naked eye. Nonetheless, there are other items as well that evidence how careful the work of these artisans was.

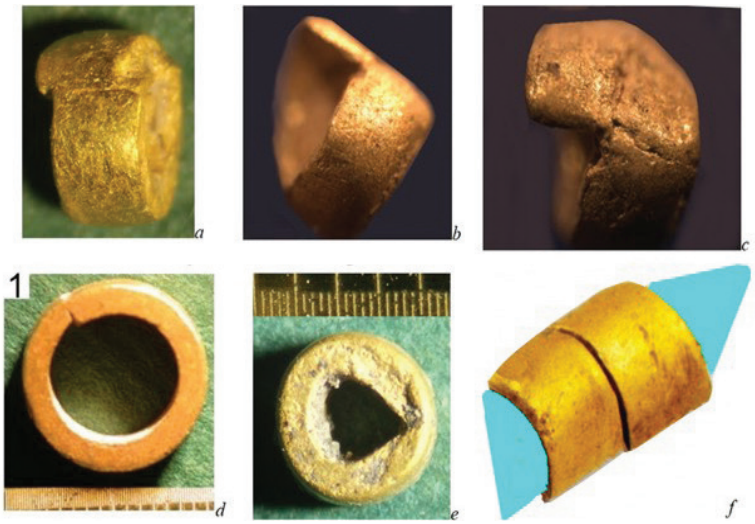


Fig. 17. Peștera Ungurească/ Peștera Caprelor cave. Beads in various working phases, lost in the workshop (apud Lazarovici Gh. *et al.* 2022, fig. IIC.37).

Hot and cold soldering

The gold, a soft metal, may be soldered, especially in the case of sheets, by hammering. Sheets were placed side by side with overlapping parts between two animal skins: for the front, the fine skin side was chosen, for the back side, that with pores. Sheets were obtained by repeated hammering and continued control. Where gaps formed, new sheet was added.

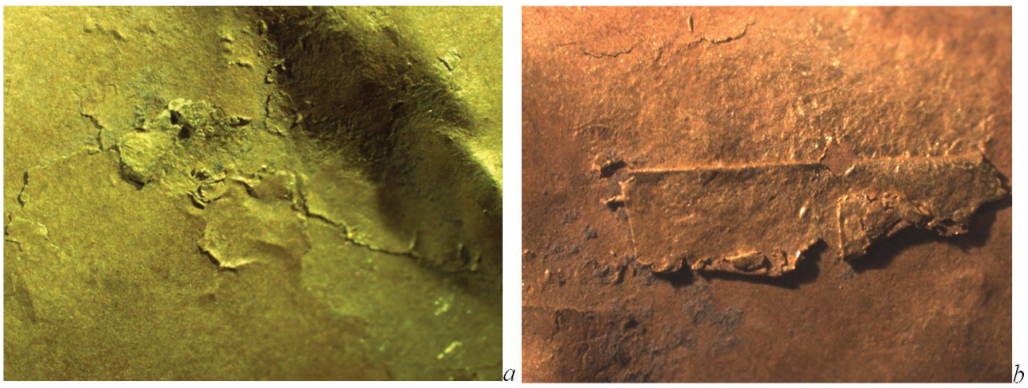


Fig. 18. Peștera Ungurească/ Peștera Caprelor Cave. Cold soldering by hammering (apud Lazarovici Gh. *et al.* 2022, Fig. IIC.27).

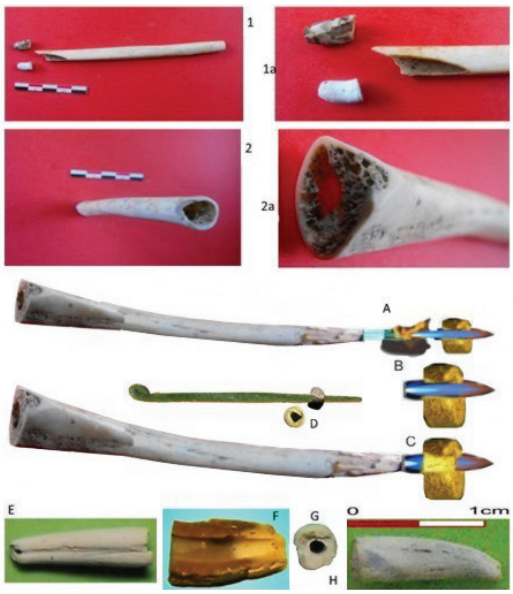


Fig. 19. Peștera Ungurească/Caprelor cave.

Tools and hot soldering technologies in beads; E-H, animal fangs used as tips for the blowpipe, with burning traces. If sharper bends were made, especially on the back side, where the hammering occurred, certain solders crack by the edges, the added parts being thus more obvious.

In macro-photos, the added parts, especially those of different thicknesses, are noticeable (Fig. 18). The part that represented the front side was finished with a wooden spatula or wolf fangs (jeweller information).

Hot soldering may be performed with the aid of a blowpipe: today, goldsmiths that work in fairs use a copper pipe with a very narrow, heated tip (where the temperature rises). The pipe may be replaced with burning charcoal, which blown by a reed pipe, a wolf fang tip or other, rises the melting and soldering temperature (Fig. 19).

Modelling and decoration

There is a series of objects, mostly fragmentary, on which decorative patterns were attempted. For some artifacts there are analogies, but others are unique. The remaining parts were discarded,

intended for remelting, yet were still preserved (either intact or fragmentary) so that the artisans could understand which operations were flawed. Obviously, there existed a wooden carved model so that the metal sheet was pressed on it. The workmanship is very fine, attempts were ambitious. With the aid of certain knives (Fig. 15.1) with a narrow end, wooden models could have been carved, which certainly, did not survive.

On the plaquette from Fig. 20a, the bends from the part above the double lines seem to render a spherical body (chin, neck etc.), however because of the curved bends the item broke, while the artisans gave up its further decoration. The right half was simpler, yet as mentioned, further work on the item was abandoned. The item from Fig. 20b seems to render a hand (the right), yet in the palm modelling, the model wrinkled and it was later abandoned. The two pieces were possibly designed to adorn a festive attire.

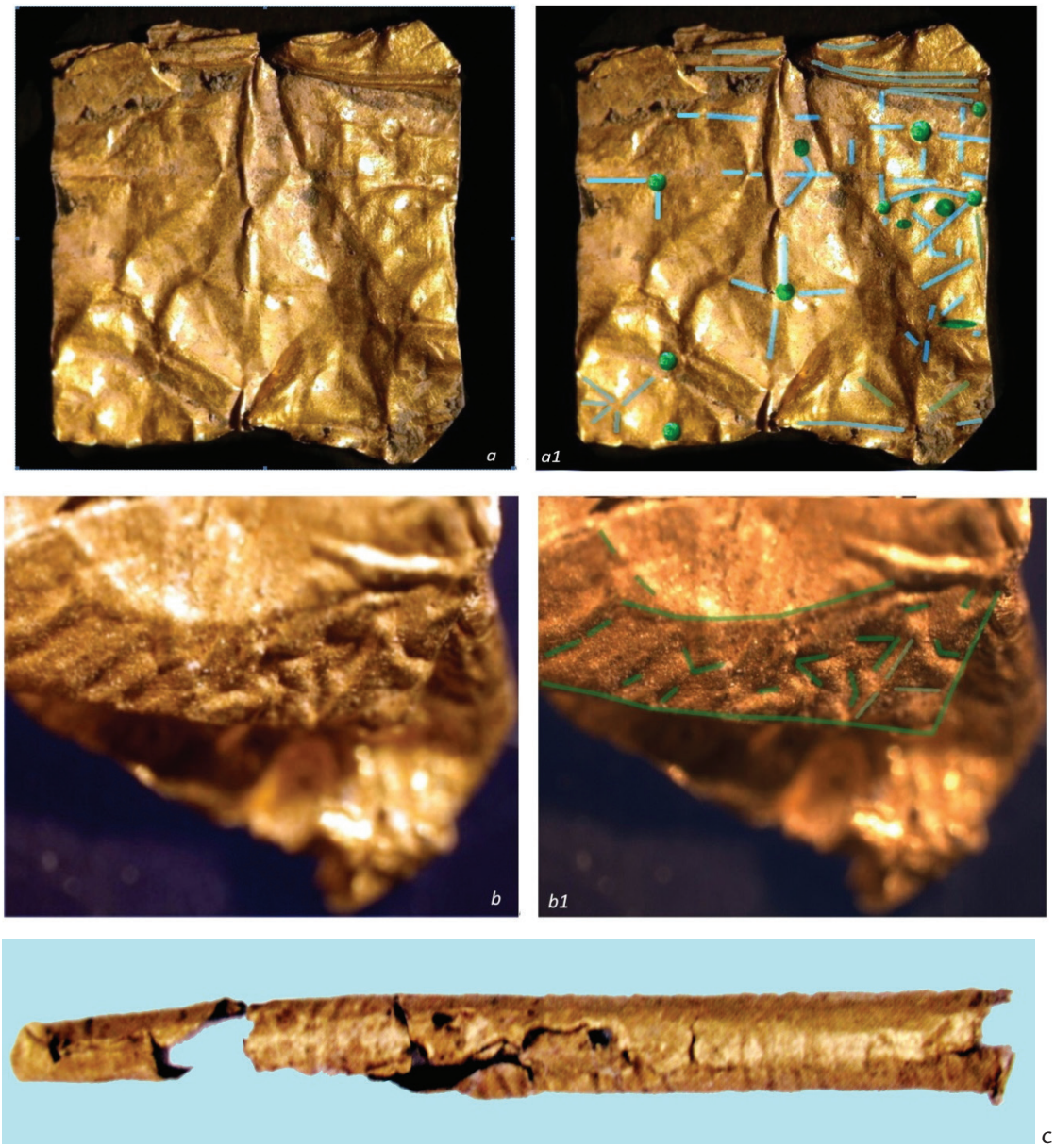


Fig. 20. Plaquettes of sheet with decorative patterns (discarded): a-b. The Peștera Ungurească/ Peștera Caprelor cave; c. Cămin-Podul Crasnei.

The third piece seems to be a medallion applied on a leather piece of clothing (Fig. 21a-b). The bent part seems to represent a horse head. We attempted to reconstruct the right half in mirror and obtained an interesting image (Fig. 21a). Though speculative, the image offers a possible interpreting of the item as pendant. Many of these items have short bends on the edges, thus making possible their

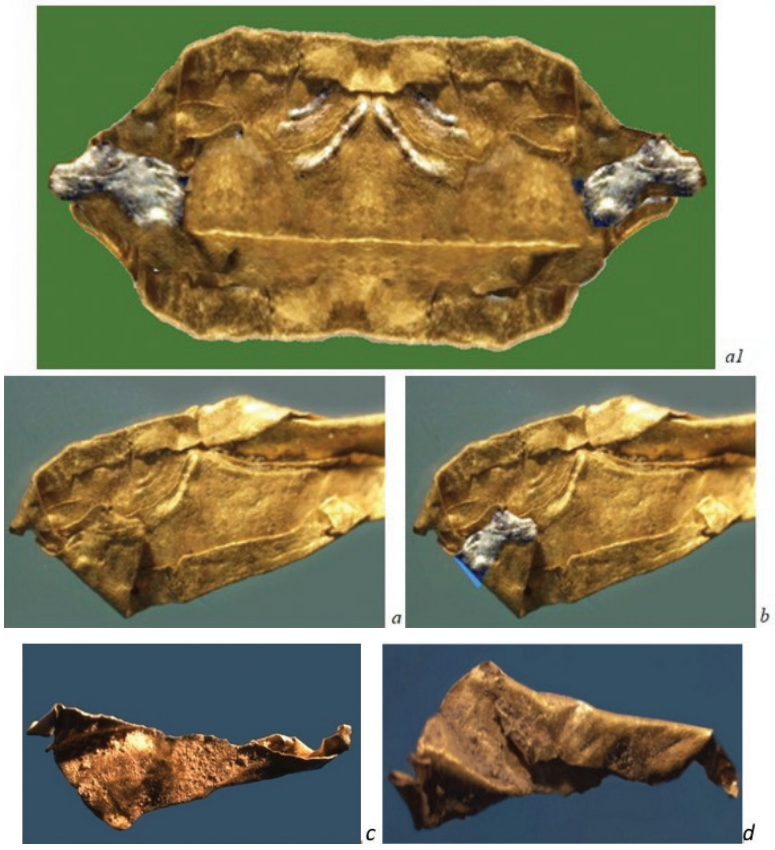


Fig. 21. Peștera Ungurească/ Peștera Caprelor cave. Gold sheet with patterns: a-b. pendant; c-d. sheet cuts.

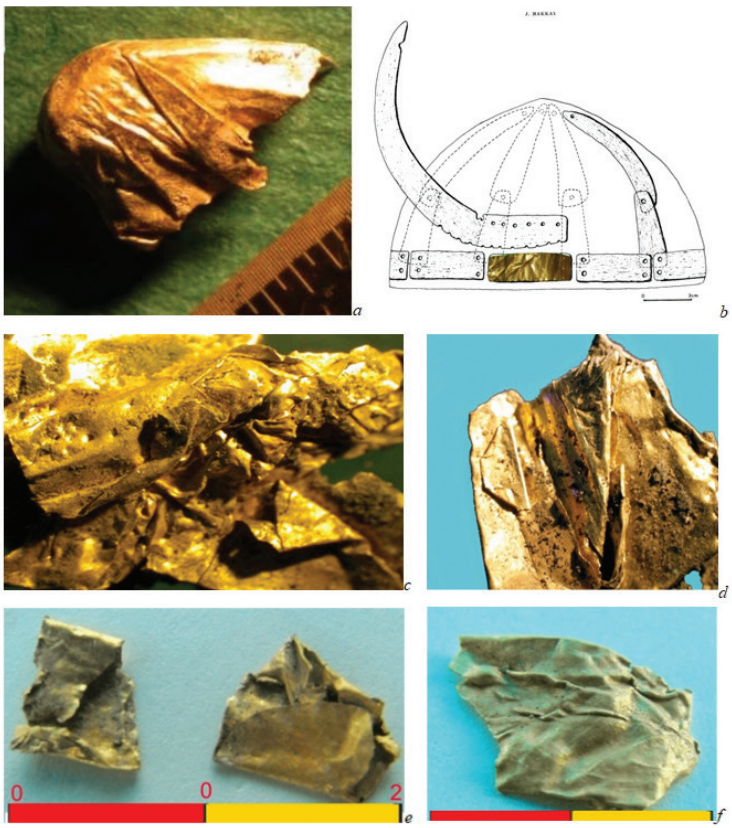


Fig. 22: a–b. Pieces commonly attached to leather; c-f. sheet and discarded remains, crumpled (apud Lazarovici Gh. *et al.* 2022, fig. IIC.32).

attachment to animal skins (especially cattle), and then sewn or attached to apparel. Others were assembled on wooden models, like the hairpin of Cămin – *Podul Crasnei* (Fig. 20c)[77].

On other sheet fragments, are noticeable best the pores of the skin onto which the sheets were hammered for thinning and then modelling (Fig. 21.c). Certain discarded items were crumpled (Fig. 22), with the further intent of remelting and reuse of the material.

On each of these items are noticeable certain modelling attempts, decorations, bends, these being preserved for remelting and reuse. The kiln was set up precisely with such remelting processes in mind (where you could control the temperature by blowing with hand bellow).

On a fragment of discarded sheet are visible a head, a hand and possibly a scarf near the left ear. In fact, there are numerous human head depictions at Moigrad (Fig. 27.a/1–4, 27c).

The most interesting and symbolic modelling is that of a bird in relief, which we believe to depict an eagle (Fig. 24, the Eagle Goddess in our opinion). Unfortunately, there are many breaks on the edges that rendered it useless, while the thin sheet could not be soldered. The head is in the shape of a bird beak. The anonymous artist made a second image on the item's body, whose head started from the beak, arms like two wings and very long feet, in one claws being visible. The image suggests the idea of flight. The left side of the head was voluntarily flattened, which is very well noticeable on the back side of the piece (Fig. 23.a left).

[77] Virag 2007; Virag *et al.* 2006; Lazarovici C.-M, Lazarovici Gh. 2007, 270, fig. VIb2.d-e.

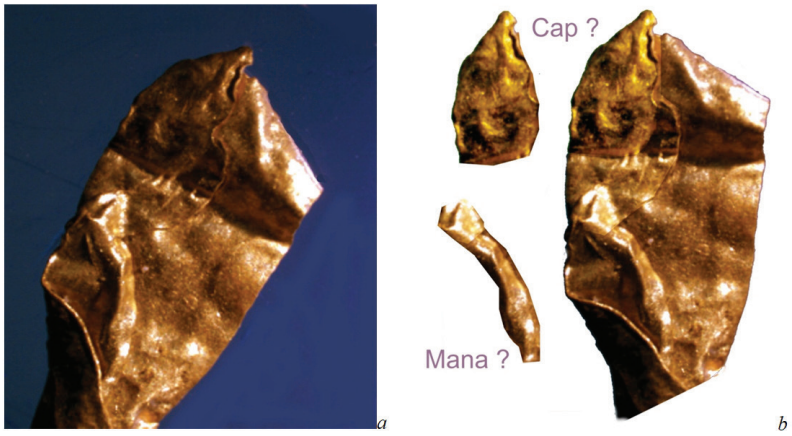


Fig. 23. The Peștera Ungurească/Caprelor cave. Sheet with head and hand depiction.

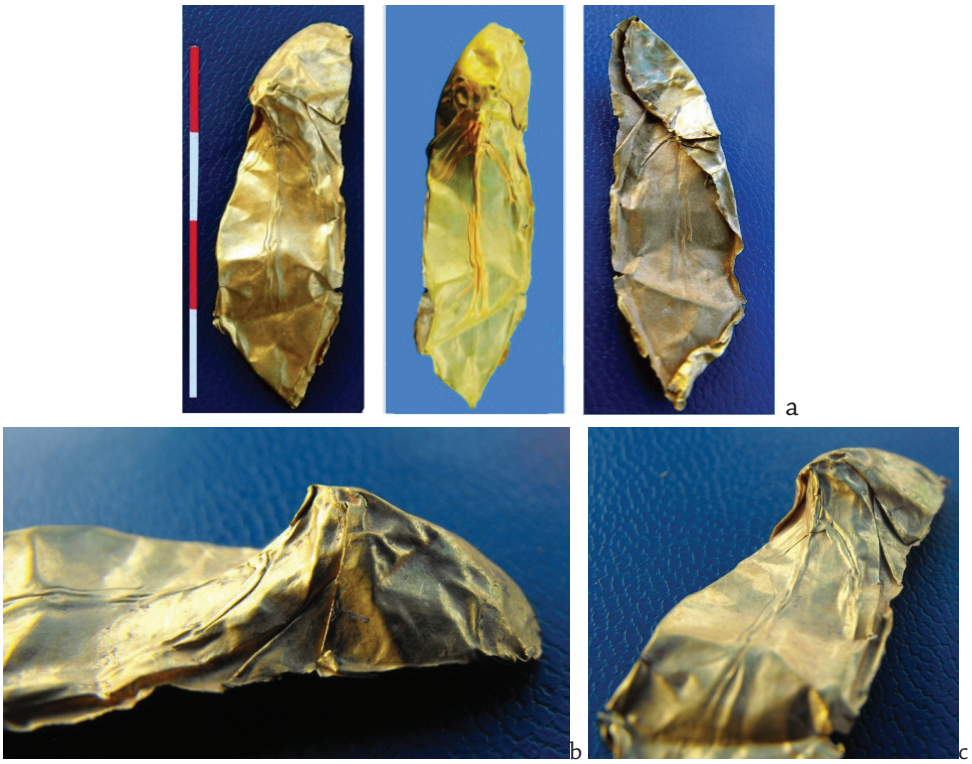


Fig. 24. Peștera Ungurească/ Peștera Caprelor cave. Eagle Goddess, level 2Bb2, hearth 8.

Moigrad

Not only the BK-TP culture date Cheile Turzii workshop illustrates the richness of gold working, but also other hoards or stray finds.

The richest hoard is that of Moigrad, which likely belonged to an artisan or his master. There is much literature on this hoard[78]. The most complex analysis was made by János Makkay, in 1989.

The large idol deemed by J. Makkay the largest artefact from south-eastern Europe[79], is reminiscent of the shape of ***en violon* idols**, other times

Fig. 25. The Moigrad hoard, large pendant. The edges were bent to attach the model on something more rigid (wood, possibly hardened resins or thick leather).

[78] Patay 1944–1945; Patay 1958; Patay 1975; Vlassa, hoard sheets 13.FEBR. 1970, 31, 4 PE 24.1 discovered in 1912; Lazarovici Gh. *et al.* 2022; Makkay 1989 and previous literature; Dumitrescu Vl. 1974, 269, fig. 294; Dumitrescu H. 1961; *Neolithische Kunst in Rumänien 2008*, cat. 89; Anthony, Pernicka 2010, 165; ***Aurul și argintul 2014*, 187 and references; Lazarovici Gh. *et al.* 2015.

[79] Makkay 1989, 59–60 ff..

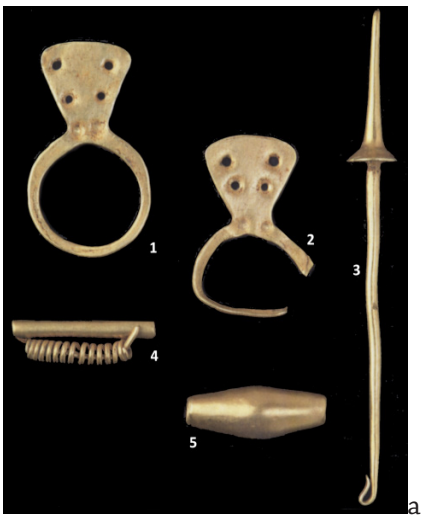
of a ***Beotian shield*** (Fig. 25), defined as pendants, a very widely spread topic in the Copper Age not only via golden exemplars[80], but also pottery[81]. Among such artefacts, defined as pendants, yet smaller, we mention another item still of Moigrad (Fig. 26a).

We believe that the large pendant, according to its sizes, attached to a thick leather breastpiece of a female festive, princely attire, alike many other items that have breasts depicted on objects.

Fig. 26. Golden artefacts: a-e. Moigrad: a. pendant – loop ring; b-e. female pendants; f. buttons, Ostrovu Corbului, BK-TP, apud P. Roman.

Still of thick sheet are other four pendants, all with female symbols and small holes for attachment to festive garments. All these pieces belong to the Bodrogkeresztúr culture. From the same period dates also the Oradea hoard (Fig. 27.a, apud A kárpát-Medence 2015, 87)[82], which includes two idols similar to the small Moigrad idol, yet also other golden artefacts from Jászládany[83].

80 Dumitrescu H. 1961 and references; Traian *** *Istoria Românilor 2001*, 160, fig. 21.
81 Monah 1978–1979; Monah 1997, 207.
82 ***A kárpát-Medence 2015, 87.
83 ***A kárpát-Medence 2015, 89.



a

b

c

Fig. 27. Golden artefacts: a. Oradea hoard; b-c. Moigrad hoard.

János Makkay published other items worked on thin sheet as well: some are female figures (Fig. 27.b1,3, our colour editing), bearded male figurines (Fig. 27.c3), possibly animal heads (Fig. 27. b1, b6) and other.

The resemblance of the sheet workmanship of Cheile Turzii with that of Moigrad suggests the idea that the artisans of the two workshops mastered these goldsmithing crafts and might have apprenticed together. On the other hand, their themes are also common, like the bird–eagle? (Moigrad, Fig. 28)[84].

Artisans were not many, the great resemblance of the artefacts showing they knew each other, nonetheless the Peștera Ungurească workshop also shows that the artisans also maintained secrecy over their craftsmanship[85]: for instance, those who worked in the Peștera Binder cave produced the same type of beads in various stones[86], alike the artisans from the Peștera Ungurească workshop, however the golden artefacts were worked only at Peștera Ungurească.

[84] Makkay 1989.
[85] Eliade 1981, 406, n. 15 and references.
[86] Lazarovici C.-M., Lazarovici Gh. 2016; Lazarovici C.-M. *et al.* 2016; Lazarovici C.-M. *et al.* 2018.

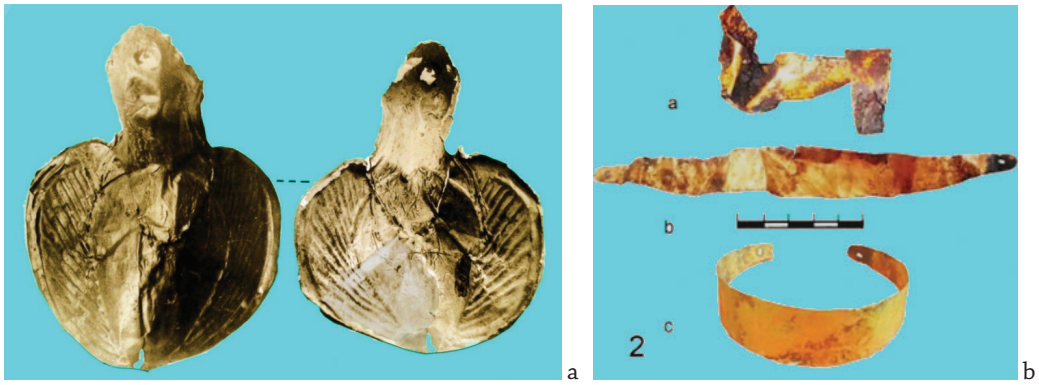


Fig. 28. Various gold objects: a. Moigrad, bird/eagle? (edited after Makkay); b. Golden sheet (*apud* Dergacev[187]).

Fig. 29. Gold nuggets from the Arieş and Pian river valleys, apud the Gold Museum of Brad.

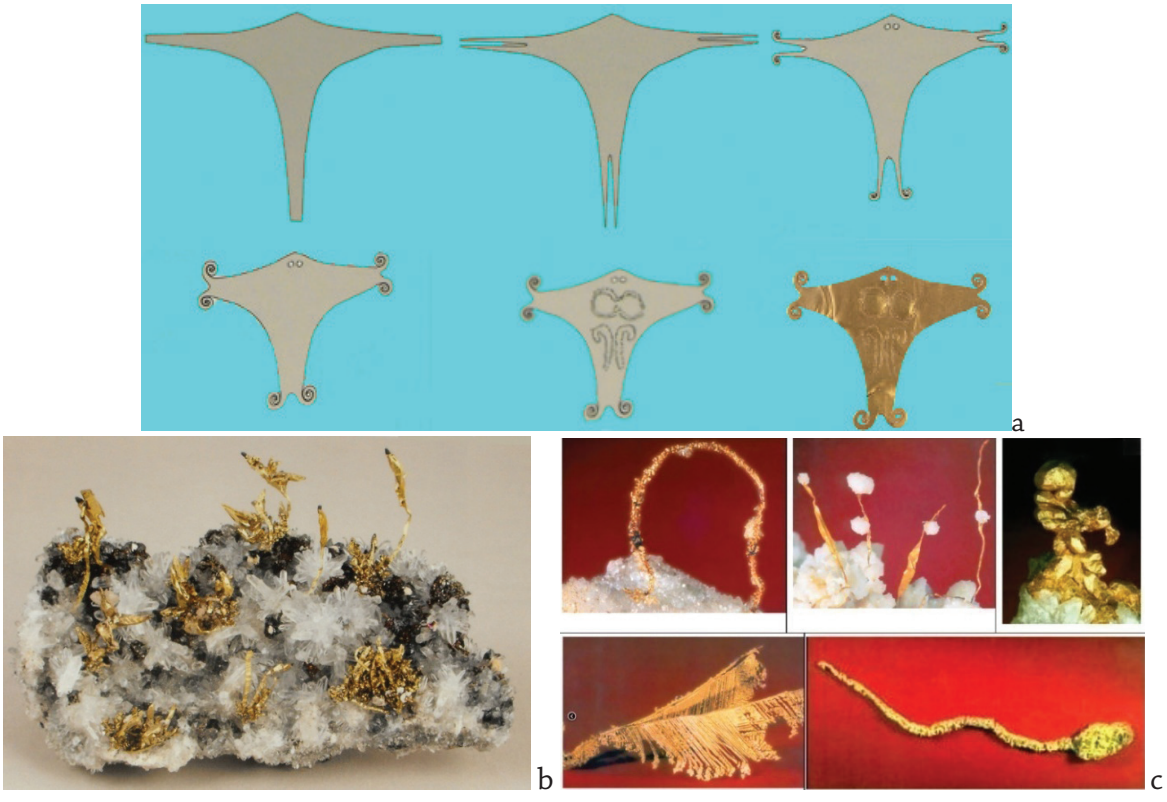


Fig. 30. Gold artefacts and nuggets: a. the working stages of the Moigrad pendant (apud Cârligeanu 2014); b-c. native gold on minerals (b. apud ***Aurul şi Argintul 2014, 29; Lazarovici Gh. *et al.* 2015, Table 22).

87 Dergacev 2016, fig. 2/2.

Most of the items are worked in river gold. In fact, the Peștera Unguerească cave lies at only a few kilometres from the Arieș river valley, rich in golden nuggets (Fig. 29)[88].

Native gold emerges as incredible art of nature (Fig. 30b-c), with forms difficult to reproduce by human hand.

Lastly, we wish to discuss the tests performed by Bogdan Constantinescu on the golden items from Cheile Turzii, now in the collections of the Cluj and Sibiu museums, as well as on other items of Copper Age date[89].

Based on Fuzzy set cluster analyses (nuanced sets[90]) we noted that item *capra Ibex* of Varna belongs to a separate cluster, although five analyses were performed on the same object (it might have been worked by hammering after the different collection of gold nuggets). In the second cluster are included almost all items from Cheile Turzii, except for two sheets with the Sibiu-based museum, which contained high iron levels (possibly not well cleaned, clay-influenced results?), yet also high lead values which associate them with those of Gumelnița, although in-between the latter two there are certain differences. It is possible that the remelting of various cut fragments gave certain differentiations in the two sheets from Sibiu. The Gumelnița pendant enters a cluster with many of the Cheile Turzii items.

Two terminological debates are always topical in the archaeological literature: the Eneolithic or the Copper Age. Certainly, where no copper and gold mineral resources exist, or distances hinder access to these, it is difficult to speak of one or another of the terms. On the other hand, a series of disciplines and research methods, tests (micro-SR-XRF, Micro-PIXE and XRF, X-Ray Spectroscopy and so on), determinations and many other... which modern science offers archaeology are insufficiently known. We have often acknowledged that mountain archaeology in Romania with interdisciplinary research teams (geologists, geographers, ethnographers, metallurgists, physicists etc.) is limited, hence any answers are questionable. If for copper metallurgy there are certain metallurgical tests, for gold there are only physicochemical analyses, with modern research methods based on X-ray and optical and electronic microscopy, yet even these were classified as methodologies that leave unanswered many questions.

A 34 x 4	Ag	Au	Cu	Fe
Ibex aur,	150000	825000	2250	3000
Ibex aur,	148800	836000	550	3400
Ibex aur,	147000	844000	510	3800
Ibex aur,	145000	824000	2800	3800
Ibex aur,	144000	847000	550	3700
mărgea Sibiu T5732 CT mas 2	97000	890000	1000	1300
mărgea Sibiu FN 1G6c CT	98000	889000	3000	9000
mărgea Sibiu T5725 CT	89000	896000	1000	1200
Foița mare CJ MNIT P.174776 CT	81000	909000	1000	6000
pandantiv tip Gumelnita (apud H. Dumitrescu	78000	919000	970	2350
mărgea CT MNIT 174781	81000	910000	1000	9000
mărgea CT MNIT 174782	82000	902000	1000	12000
Foița Sibiu T5722 CT mas. 1	77000	913000	1000	5000
Foițacolt fr. MNIT P.174786 CT	77000	913000	1000	6000
mărgea CT	77000	913000	1000	6000
Foița FN Sibiu G6b CT mas. 1	77000	914000	2000	6000
mărgea CT MNIT 174778	79000	905000	1000	12000
Foița Sibiu FN 5 G6a CT	77000	914000	2000	8000
Foița FN Sibiu G6b CT mas. 2	75000	913000	3000	8000
Foițacolt fr. MNIT P.174786 CT	72700	914000	5000	5000
margea CT NMIT 174777	71000	919000	1000	7000
Foița Sibiu T5730 CT mas. 1	71000	912000	3000	9000
FoițaMNIT P.174785 CT 1	67000	921000	1000	5000
fragment folieMNIT P.174785 CT 2	67000	921000	4000	5000
mărgea Sibiu T5733 CT mas 1	67000	921000	1000	8000
Foița Sibiu T5730 CT mas. 2	70100	911000	7000	9000
mărgea CT MNIT 174780	68000	921000	500	11000
mărgea CT MNIT 174784	66000	920000	1000	8000
mărgea Sibiu T5733 CT mas 1	64000	925000	2000	8000
pandantiv tip Gumelnita (apud H. Dumitrescu	63000	932000	4240	6600
mărgea CT MNIT 174778	63000	924000	5000	7000
Foița Sibiu T5727 CT	62000	926000	1000	9000
pandantiv tip Gumelnita (apud H. Dumitrescu	59000	937000	1660	2130
Foița Sibiu CT T5728	56000	934000	2000	6000

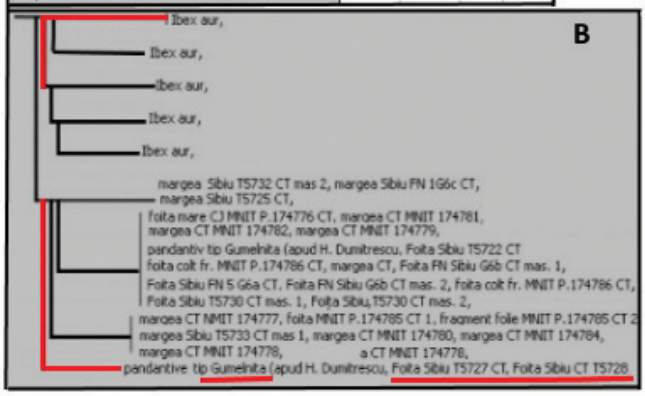


Fig. 31. Classification of analyses performed by Bogdan Constantinescu.

Many scholars agree that there are only certain geographical centres where developments and

88 ***Aurul și Argintul 2014.*

89 Lazarovici Gh. *et al.* 2015.

90 Classification made by programme Zeus: theory Dan Dumitrescu: Dumitrescu D. 1990; Dumitrescu D., Lazarovici Gh. 1990.

innovations occur, objectively determined by local resources and subjectively, by migration and diffusion phenomena (individuals, populaces, technologies). We are aware of the limits of our approach, of the lack of means and projects, yet especially of an understanding of these needs. The rich copper and gold natural resources allow us to use the term of Copper Age for certain areas in Romania, nonetheless, this is not the only criterion: for instance, among the largest artefacts from south-eastern Europe counts the brass axe of type Mezőkeresztes (43 cm long)[91], similarly the large idol of Moigrad (31.4 × 24.1 cm, 764.4 gr., MNIR 54570 Bucharest)[92], both belonging to the Bodrogkeresztúr culture. To these we add the most important gold processing workshop, namely that of Cheile Turzii – the Peștera *Ungurească/Caprelor* cave.

The rich gold sources of Transylvania rank 5 in the world, according to certain 2006 statistics, by which in prehistory, the mining percentage was of 10%, the Dacian period included (Fig. 32)[93].

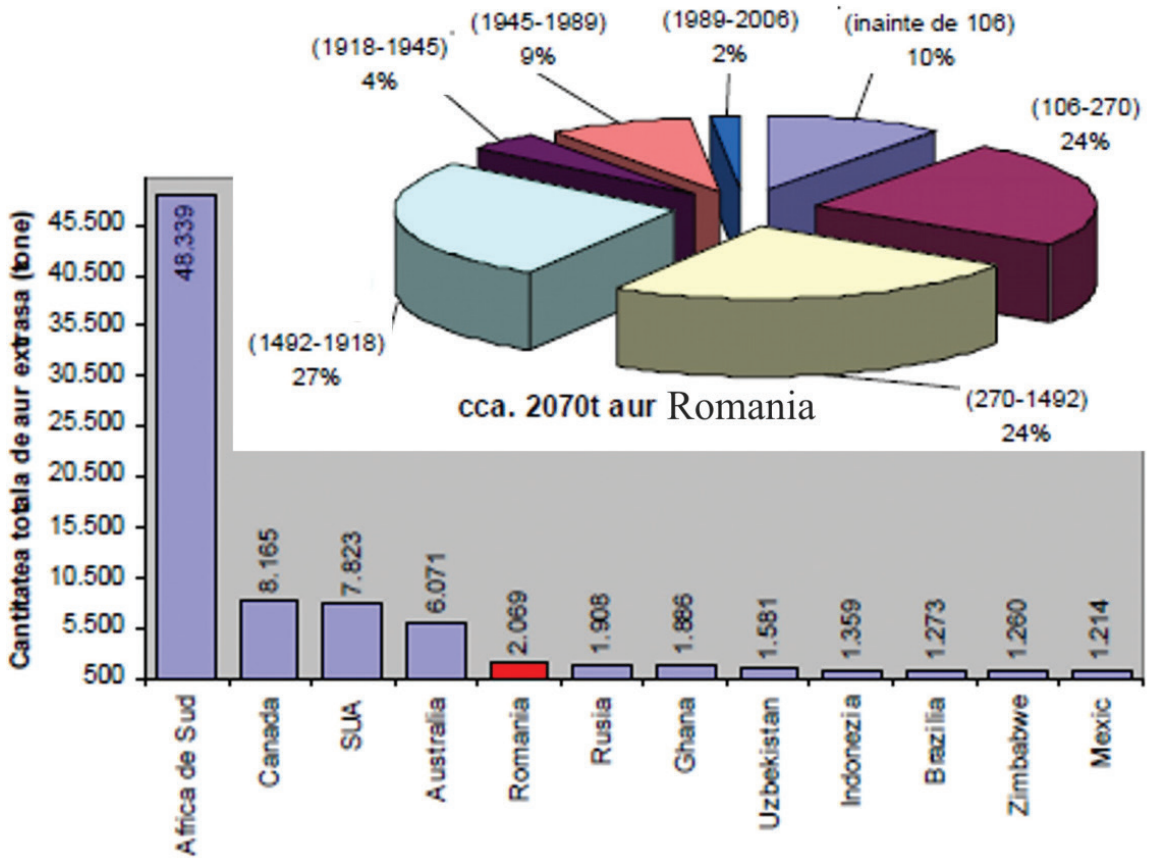


Fig. 32. Gold mining in Romania comparative to other areas in the world and over the course of time in our country, after Tămaș Bădescu 2010.

Annexes

Many of the images below regarding the Peștera Ungurească cave have been recently published together with the find conditions, which we synthesise here. Jewellery was designed for the elites, priestesses, gods.

[91] Vulpe 1975, 29, cat. 72A; Mareș 2012, D5, chapter 5, type A.B.1.12; 10, 1; no. 1762, map 6.

[92] Roska 1938, 12, cat. 7 3.2 la 750 gr.; Patay 1944–1945; Patay 1958; Patay 1975; Dumitrescu H. 1961; Dumitrescu H. 1974, fig. 293; Makkay 1989, 54 ff pl. 9.1; *Neolithische Kunst in Rumänien 2008*, cat. 88; Luca 1999, 58 (mentions Vl. Milojčić, M. Rusu, N. Iercoșan); Hansen 2013, 145, fig. 12; Oanță-Marghitu R., Oanță-Marghitu S. 2014, 187–189 and references, etc.

[93] Tămaș-Bădescu 2010.

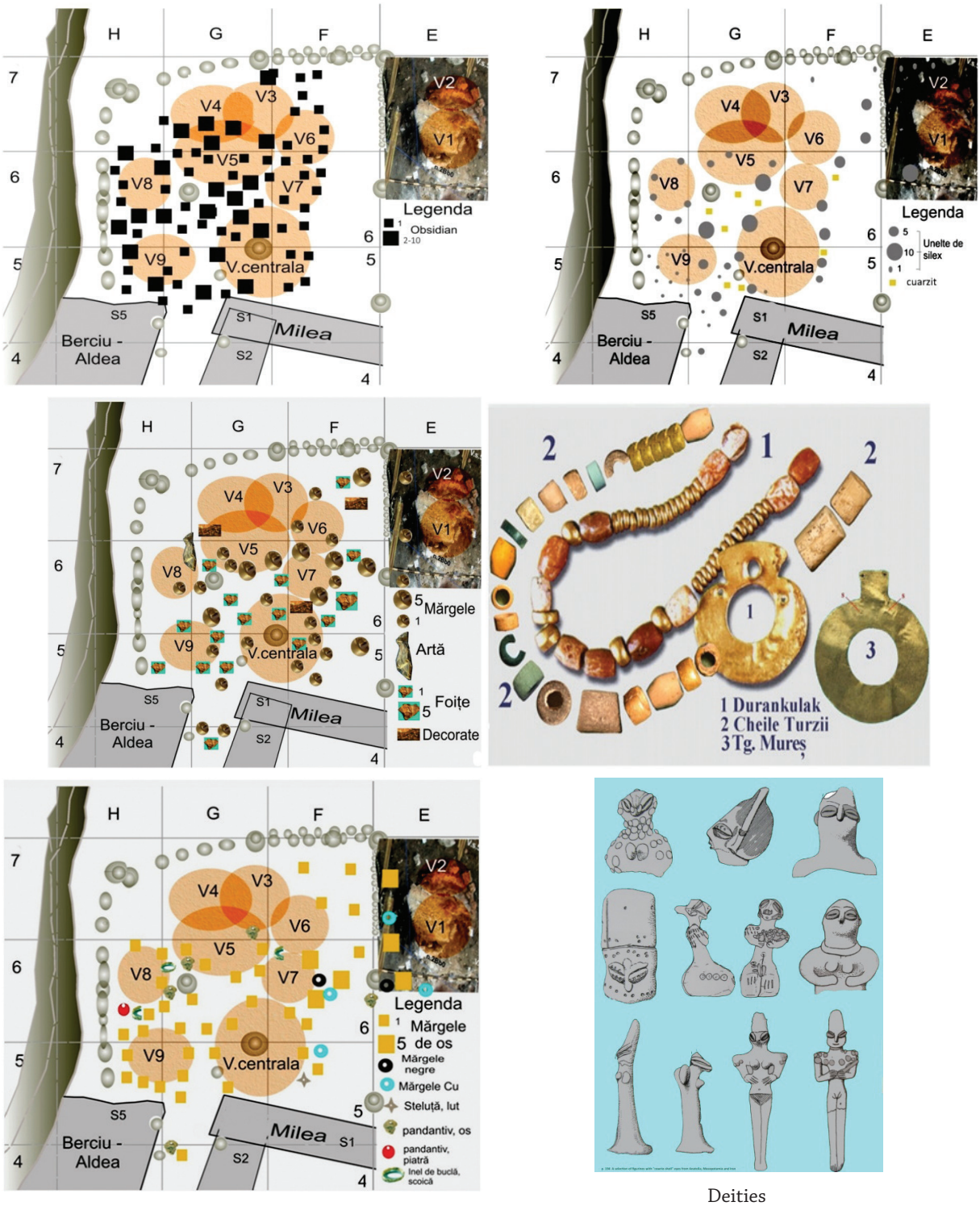


Fig. 33. Distribution of various artefacts in the Peștera Ungurească-Caprelor cave and goddesses with shell necklaces, apud The Goddess of Sha'ar Hagolan IMG_4095 (apud Lazarovici Gh. *et al.* 2022).

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Abbreviations

AB	Analele Banatului, I-IV 1928–1931; S.N. I 1981-, The Museum of Banat/The National Museum of Banat, Timişoara.
ACTA	Yearbook of the Székely Museum in Csík and the Székely National Museum, Miercurea Ciuc – Sepsiszentgyörgy.
ActaArchHung	Acta Archaeologica Academiae Scentiarum Hungaricae, Budapest.
AÉ	Archaeologiai Értesitö, Budapest.
Acta Historica	Acta Universitatis Szegediensis (Szeged).
ArchHung	Archaeologia Hungarica.
ArhMed	Arheologia Medievală.
AM	Mitteilungen des Kaiserlich Deutschen Archaeologischen Instituts, Athenische Abteilung (Athenische Mitteilungen), Athen, (1876-).
AMM	Acta MoldaviaeMeridionalis (Vaslui).
AMN	Acta Musei Napocensis, The National History Museum of Transylvania, Cluj – Napoca.
AMP	Acta Musei Porolisensis, County History and Art Museum of Zalău.
ArhMold	Arheologia Moldovei, Iași.
BCH	Bulletin de Correspondence Hellénique, Paris, 1 (1877-).
BerRGK	Berichte der Römisch-Germanischen Kommission.Roman-Germanic Commission. Frankfurt am Main.
EphNap	Ephemeris Napocensis, Cluj-Napoca.
CCA	Cronica Cercetărilor Arheologice din România, Ministry of Culture.
CCCA I	M. J. Vermaseren, Corpus cultus Cybelae Attidisque (CCCA), I. Asia Minor, Leiden, New York, København, Köln, 1987.
CIG	Corpus Inscriptionum Graecarum, I-IV, (ed. A. Boeckh), Berlin, 1828–1877.
CIL	Corpus Inscriptionum Latinarum, consilio et auctoritate Academiae litterarum regiae Borussicae editum. (1863-).
Dacia	Dacia. Recherches et découverts archéologiques en Roumanie, S.V. I-XII; N.S. Revue d´archéologie et d´histoire ancienne, I. 1957 şi urm., Vasile Pârvan Institute of Archaeology, Bucharest.
DAGR	Dictionnaire des Antiquités grecques et romaines, I-X, sous la direction de Ch. Daremberg et E. Saglio, Paris, 1877–1929.
DolgSzeged	Dolgozatok a Szegedi Josef Tudomanyegyetem Archaeologiai Interzetbol (I, 1925…XIX, 1943).
IGB V	Inscriptiones Graecae in Bulgaria repertae, (ed. Georgi Mihailov), vol. V: Supplementum, addenda et corrigenda. Sofia, 1997.
IGDOP	Inscriptions grecques dialectales d'Olbia du Pont, (ed. L. Dubois), Genève, 1996.
IGRR IV	Inscriptiones Graecae ad Res Romanas Pertinentes, IV (ed. G. Lafaye), Paris, 1927.
ISM I, II	Inscriptiones Scythiae Minoris – Inscripţiile din Scythia Minor, I: Histria şi împrejurimile (ed. D. M. Pippidi), Bucharest, 1983; II: Tomis şi teritoriul său, (ed. Iorgu Stoian), Bucharest, 1987.
LIMC	Lexicon Iconographicum Mythologiae Classicae, I–VIII + index vol., (eds. J. Ch. Balty, E. Berger, J. Boardman, Ph. Bruneau, F. Canciani, L. Kahil, V. Lambrinoudakis, E. Simon), Zürich, München, Düsseldorf, 1981–1999.
LSJ	Liddell H. G., Scott R., Jones H. S., A Greek-English Lexicon, with a revised supplement. Oxford, 1996.
MAA	Monumenta Avarorum Archaeologica.
OM	*Orbis Mediaevalis*.
PBF	Prähistorische Bronzefunde, München.

RA	Revue Archéologique, Paris (1844-).
RAC	Rivista di archeologia cristiana, Rome (1924-).
RevBistr	Revista Bistritei, Bistrița-Năsăud Museum Complex, Bistrița.
RH	Revue historique, Paris, (1876-).
RIG	Recueil d'inscriptions grecques, par Ch. Michel, Bruxelles, 1900.
Sargetia	Sargetia. Acta Musei Devensis, Deva.
SCIV(A)	Studii şi Cercetări de Istorie Veche, tom 1–25, Bucharest, 1950–1974; începând din 1974 (tom 25): Studii şi Cercetări de Istorie Veche şi Arheologie, Bucharest.
SCN	Studii *şi* Cercetări de Numismatică, Bucharest.
SEG	Supplementum epigraphicum graecum, Lugdunum Batavorum, Leiden, 1923–1971; Alphen aan den Rijn 1979–1980; Amsterdam, 1979–2005; Boston, 2006-.
StCl	Studii Clasice, Bucharest.
Syll^3	Sylloge inscriptionum Graecarum, (3rd edition), (ed. W. Dittenberger), 1915–1924.
Terra Sebus	Terra Sebus, Sebeș.
ThesCRA	Thesaurus Cultus et Rituum Antiquorum, I–V + index vol., (eds. J. Ch. Balty, J. Boardman, Ph. Bruneau, R. G. A. Buxton, G. Camporeale, F. Canciani, F. Graf, T. Hölscher, V. Lambrinoudakis, E. Simon), Basel, Los Angeles, (2004–2006).
UPA	Uiversitätsforchungen zur Prähistorischen Archäologie, Institut für Ur-und Frühgeschichte der Universität Kiel.
ZSA	Ziridava. Studia Archaeologica, Arad Museum, Cluj-Napoca.