Horia Ciugudean.* ANCIENT GOLD MINING IN TRANSYLVANIA: THE ROȘIA MONTANĂ - BUCIUM AREA**

Keywords: gold mining, Transylvania, mining archaeology, Roșia Montana, Alburnus Maior, Bucium

Abstract: In this study, the author reviews the older and newest discoveries regarding the ancient gold mining in the "Golden Quadrangle" of the Apuseni Mountains, Transylvania. The finest and most extensive Roman mining works are those which are still to be seen at Roșia Montana and Bucium, where mediaeval and modern mining activities made very little impact on them. As the existence of pre-Roman hard rock gold mining is still debated by the scholars, some new finds are discussed here, including the Roșia Montana ^{14}C data and the new results in the study of the metal provenance applied to the Transylvanian gold. Although it is still difficult to estimate the location of the first prehistoric mining areas, some of the ancient opencast mines at Roșia Montană (Găuri and Cetate) and Bucium (Ieruga, Gaura Perii) may be considered very good candidates in this respect. According to the author's view, a connection could be proposed between the alignment of Early Bronze tumulus-burials graves and the ancient routes of communication in the Roșia Montană – Bucium – Zlatna area. There was a "Golden Corridor" along the Ampoi valley, which connected Transylvanian metal ores with different cultural regions (Lower Danube, the Adriatic shore and northern Greece).

Rezumat: Studiul trece în revistă descoperirile vechi sau recente privind mineritul aurifer din zona "Patrulaterului Aurifer" din Munții Apuseni. Cele mai ample și complexe lucrări miniere din perioada romană sunt cele de la Roșia Montană și Bucium, care au fost puțin afectate de activitățile miniere din perioada medievală și modernă. În condițiile în care existența mineritului subteran pre-roman este încă un subiect larg dezbătut de specialiști, sunt aduse în discuție unele date 14C de la Roșia Montană și rezultatele studiilor recente de proveniență a metalului aplicate în cazul aurului din Transilvania. Deși este încă dificil de precizat amplasamentul zonelor miniere preistorice, pot fi luate în considerare câteva dintre vechile exploatări la suprafață de la Roșia Montană (Găuri și Cetate) și Bucium (Ieruga, Gaura Perii). În opinia autorului, se poate stabili o conexiune între aliniamentele de tumuli aparținând Bronzului timpuriu și vechile rute de comunicație din zona Roșia Montană - Bucium – Zlatna. Se propune funcționarea unui „Coridor aurifer" de-a lungul văii Ampoiului, care lega zăcămintele metalifere ale Transilvaniei de alte zone culturale (Dunărea de Jos, coasta Adriaticii sau nordul Greciei).

Fig. 1. Distribution of Early Bronze Age gold hair rings (Leukas type): 1. Ampoița; 2. Jurilovca; 3. Tărnava; 4. Velika Gruda; 5. Leukas.

Due to its plentiful natural resources, such as rich deposits of copper, gold and silver, the region of Transylvania represents the most likely area of Central and South-East Europe, where some of the major achievements in the development of ancient mining took place. The "Golden Quadrangle" in the Apuseni Mountains (Pl. I/1) has been one of the main producer of gold in Europe.[1]

The prehistoric exploitation of gold in the Apuseni Mountains was already proposed at the end of the 19th century, when G. Téglás published some grooved stone hammers from Căraci.[2] There are many references to the huge number of mounds related to the recovery of gold from placers in the Arieș valley (Fig. 2), at Lupșa, Baia de Arieș, Sălciua, Lunca Arieșului etc., some of them dated with Roman finds.[3] There are no field surveys or archaeological excavations in such areas, so it is hard to estimate the beginning of the placer mining. However, the recent discovery of a Copper Age workshop in the Peștera Ungurului cave at Cheile Turzii, was connected by the excavators with the recovery of gold from the Arieș river.[4] More than 70 gold items were recovered, most of them small beads (<4 mm), together with golden sheets (Pl. III/1-2), either finished or in working process.[5] Some preliminary analysis showed a much lower content of silver in the composition of Cheile Turzii objects, in comparison with the gold from the

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1 Huber, Huber 1983; Lehrberger 1995; Ududbaşa *et alii* 2001.
2 Téglás 1888, p. 464, no. 5; Wollmann, Ciugudean 2005, p. 96; Boroffka 2006, p. 74, fig. 2/3; 3/1.
3 Wollmann 1996, 146-148 (with older literature).
4 Lazarovici *et alii* 2012.
5 Lazarovici *et alii* 2012, fig. 9-12.

Fig. 2. Mounds related to ancient placer mining at Muncelu (Baia de Arieş) in the Arieş valley.

Roșia Montana mines, while copper is present in a significant percentage, a situation similar to other gold objects related to the Gumelnița and Petrești cultures.[6] This observation strongly supports the theory that Copper Age gold was mainly collected from alluvial deposits.[7]

Together with copper, gold was another new material which appeared in the 5th millennium BC both in the Carpathian Basin and the Balkan region[8]. Gold objects have been found at contemporary sites across this part of Europe in settlements[9] as well as mortuary contexts[10]. Work on the sourcing of gold and on gold processing technologies on sites has considerably advanced in the last decades.[11] D. Popescu and M. Rusu supposed an alluvial origin for the Bronze and Early Iron Age gold objects in Transylvania.[12] J. Makkay proposed the same origin for the Copper Age gold objects of the Carpathian Basin.[13] A. Harding recently supported the idea that most of the Bronze Age gold in Europe was extracted through placer mining, but he also accepted the possibility that ore extraction may have taken place at certain major sources, notably the Wicklow Mountains of Ireland and the Metallic Mountains of Transylvania.[14] Underground mining for copper was already well known in the European Bronze Age,[15] so that it is more than likely that also gold was mined in this way. The "Golden Quadrangle" in South-West Transylvania remains as a very good candidate in this respect.[16]

By the second quarter of the 3rd millennium BC, Transylvania seems to play an important role in the long distance gold trade, the golden hair-rings found in the Early Bronze Age tumulus of Ampoița being similar to the ones found in the Early Helladic II cemetery of Leukas, in the Ionian Sea and in the Velika Gruda mound, on the Adriatic shore (Fig. 1).[17] The Early Bronze Age Pit-Grave culture of the Tisza Plain was also connected to the Transylvanian gold, as the rich gold items associated with typical Livezile pottery of the Sárrétudvari-Őrkohalom tumulus pointed out.[18] However, it is difficult to estimate when the ore extraction became an alternative for placer mining, and where the location of the first Bronze Age gold mines was. It is well-known that the earliest prospectors concentrated their mining activities on well-selected geological targets of gold enriched quartz veins, deep trenches being excavated along them. Recent progress in mining archaeology has produced evidences for the hard rock mining of gold in the late 4th – early 3rd millennia BC in South-East Georgia.[19] In Ancient Egypt gold mining started in Predynastic time (around 3000 BC) with open pits and moderate underground activities.[20] The new excavations at Ada Tepe (Krumovgrad) in Bulgaria have produced evidences for the Late Bronze Age hard rock gold mining.[21]

There are many references about the ancient mining activities in the Roșia Montană region in the geological and mineralogical literature of the 19th and 20th century.[22] They refer both to the opencast and underground mines, a special attention being paid to the famous "Cetate", a volcanic dacite massif located South from the village (Pl. II/1), where spectacular Roman and probably pre-Roman opencast mining was visible until 1970.[23] The map drawn by F. Posepny in the 19th century has not many details of this area due to its scale, but a more accurate map (1:500) was made in 1970 (Pl. II/2), before the complete destruction of this monument by

6 Lazarovici *et alii* 2012, table 14.
7 Eluère, Raub 1991, p. 20.
8 Makkay 1991; Makkay 1996; Jovanović 1996.
9 Comşa 1991; Hansen *et alii* 2010, p. 53, fig. 23.
10 Ivanov 1988; Éluère 1989.
11 Hartmann 1970; Eluère 1989; Eluère and Raub 1991, Cauuet 1999.
12 Popescu 1956 ; Rusu 1972.
13 Makkay 1996, pp. 39-40.
14 Harding 2000, pp. 199-200.
15 Weisgerber, Pernicka 1995.
16 Bacskay 1985; Boroffka 2006, p. 73, footnote 4.
17 Ciugudean 1991, p. 94; Primas 1996, pp. 75-91.
18 Dani, Nepper 2006.
19 Stöllner *et alii* 2010.
20 Klemm *et alii* 2001, p. 648.
21 Popov *et alii* 2011.
22 Pošepny 1868b; Téglás 1889; Wollmann 1996, pp. 143-146 (with older literature).
23 Starting with 1970, the "Cetate" mountain lost its protected status as a national heritage site and it was transformed in a huge opencast mine.

the new opencast mine.[24] To my knowledge, this map has not been used so far by the archaeologists who worked in Roşia Montană. In 2000-2001 a French-Romanian team directed by B. Cauuet made a systematic study in the area of the "Cetate" massif,[25] but it seems they did not have any knowledge about the 1970 map.[26] Not only the larger pits named "Curte" (I-IV) are well marked on this map, but a lot of narrow trenches and pits as well, which clearly followed the gold-bearing quartz veins (Pl. II/2). The surveys and small-scale excavation made by B. Cauuet's team in the North-West area called "Zeus" of the former "Cetate" massif, yielded ancient mining workings such as great vertical exploitations, cut from the very surface, drifts and exploration galleries. According to the ^{14}C results and different artefacts, most of them were dated back to the 2nd century AD, although an even earlier mining activity (1st century AD = Dacian time) has been also proposed in the area.[27]

Fig. 3. Roşia Montană: general view of the "Găuri" mining site.

There is a very strong possibility that the beginning of hard rock mining in the "Cetate" massif could date back even to the Bronze Age, but there are few ancient opencast mines still preserved in this mining sector. One of them is the so-called "Găuri" site, which lies on the South-West slope of the former "Cetate" massif (Pl. I/2; fig. 3). It is an ancient vertical site, mostly opened by fire-setting. This technique left characteristic traces as smooth, rounded walls and vaults cut in oval section (Fig. 5). The site has been investigated

Fig. 4. Roşia Montană: ancient opencast mine following a rich quartz vein at the "Găuri" site.

by B. Cauuet and her team,[28] but the filling of the two main working levels did not provided any archaeological artifact or ancient wood residues, susceptible to offer dating elements. Most of the area had been cleared up in late mediaeval period and mining activity continued here with gunpowder during the Modern times, according to radiocarbon data.[29] So, the beginning of the great depilage in the "Găuri" site remains unknown, as long as the modern reopening of this mining sector destroyed the vestiges of the earliest work. However, similar deep trenches excavated along gold enriched quartz veins (Fig. 4), are known at the Early Bronze Age gold mines

[24] I would like to express my deep gratitude to A. Sâtimbreanu, former chief mining engineer in Roşia Montană, who kindly offered me a copy of this map.
[25] Cauuet *et alii* 2003, pp. 489-500.
[26] Cauuet *et alii* 2003, p. 470.
[27] Cauuet *et alii* 2003, p. 497 and fig. 15.
[28] Cauuet *et alii* 2003, pp. 497-501.
[29] Cauuet *et alii* 2003, p. 501.

in Georgia[30] or in Predynastic time of Eastern Egypt.[31] Early Bronze Age barrows have been recently excavated at Roşia Montană.[32]

Other two mining sites, "Țarina" and "Cârnic", produced evidences which support hard rock mining in the La Tène period.[33] The most reliable data came from the Cârnic 1 area, where a piece of wood was radiocarbon dated to 2160±50 BP (Fig. 8). The excavators proposed several phases of underground mining activities in this area, starting with the Dacian period (Pl. IV/1) and going on into the Roman one (Pl. 4/2). The recent discovery of the Dacian gold bracelets has considerably changed the views not only on the precious metal handling in pre-Roman Dacia,[34] but on the origins of the metal as well.[35]

Roman mining in the Roşia Montană area was nothing more than a reorganization and enlargement by improved technology of earlier mining activity, evidence for such a development being common from other sites (Rio Tinto, Cyprus, Feinan, Timna). At Limousin, Central France, the Celts obtained most of their gold from primary deposits starting from the 6th/5th century BC.[36]

Dacia had a reputation for fabulous wealth, "a California of the Antiquity", as V. Parvan called it.[37] The abundance of gold in this area was certainly one of the major reasons for the two large military expeditions by the Romans at the beginning of the 2nd century AD. The booty must have consisted of hoarded gold, like Caesar's in Gaul. Whether or no we reject as absurd the figure, 5.000.000 lbs gold and 10.000.000 lbs silver, given by Johannnes Lydus, the price of gold in the Empire sank during the next few years: in AD 97 a pound of gold cost 3,962 dr., in 127 at most 3,800.[38] The total gold production of the Roşia Montană area was estimated of about 1500-2000 tons from ancient times to the present.[39]

After the province of Dacia was integrated into the Roman empire, huge mining activities were organized in the area of "*Aurariae Dacicae*". The gold mines, once a monopoly of the Dacian kings, became a monopoly of the Roman emperors, who administered them, under lease, through a vast bureaucracy of over-seers, registrars, bookkeepers etc. The most important gold mines were no doubt at *Alburnus Maior* (today Roşia Montană),[40] but extensive mining workings are also known at Bucium,[41] Almaşu Mare and Brad areas.[42] As early as the time of Trajan, several tribes of skilled miners from Dalmatia, the *Pirustae*, *Baridustae*, *Sardeates, Ansi* and *Maniates* were brought in to work the mines.[43] The finest and most extensive Roman mining works are those which are still to be seen at Roşia Montana and Bucium, where mediaeval and modern mining made very little impact on them. Just in the south-western part of the Cârnic massif more than 4 km of linear Roman mining works were discovered, having a 98 m vertical development and covering an area of 13,600 m^2.[44]

The techniques which were employed to extract gold at Roşia Montană are far more impressive than hydraulic mining of the type well known from Roman mines at the Iberian Peninsula.[45] The underground Roman works are usually of very good quality and they systematically present trapezoidal sections (Fig. 6). The different ancient mining fields include galleries, downward sloping adits, narrow vertical works, inclined or staged stopes (Fig. 7), and chambers with pillars. At Alburnus Maior gold was exploited to a huge extent and the Romans did not spare any effort to set up a sophisticated drainage system within the mines. This is shown by several bucket wheels found at depths of up to 60 m.[46]

Administrative responsibility for all the gold mines in Dacia lay on the imperial official, the *procurator aurariarum,* who has his headquarters at *Ampelum* (today Zlatna).[47] The town was guarded by troops belonging to a *Numerus Maurorum Hispanorum*.[48] Most interesting details of Roman mining, and the organization under the supervision of the *procurator aurarium* were revealed by the famous wax-tablets with Latin inscriptions, found in the 18th and 19th centuries inside the ancient mines.[49] They range in date from 131 to 167 and were hidden during the panic of Marcus Aurelius' Marcomanic wars. Their subjects are various: contracts of purchase and sale, mine-rental, receipts for loan

30 Stöllner *et alii* 2010.
31 Klemm *et alii* 2001, fig. 6.
32 Rişcuță 2005.
33 Cauuet *et alii* 2003, p. 486, 497, 503, fig. 15 and 21.
34 Spânu 2011.
35 Constantinescu *et alii* 2009; Pop *et alii* 2011.
36 Cauuet 1999.
37 Pârvan 1926, pp. 595, 597.
38 Carcopino 1924.
39 Cook, Ciobanu 2004.
40 For the most complete history of research in the area see Wollmann 1996.
41 Ciugudean 2010.
42 Wollmann 1996, pp. 127-153; Wollmann, Ciugudean 2005, pp. 102-104.
43 Wollmann 1996, pp. 165-171; Piso 2004; Timofan, Barbu 2007.
44 Cauuet 2005; Baron *et alii* 2011, p. 1093.
45 Domergue 1990; Romero 2002.
46 Posepný 1868a; Wollmann 1996, pp. 114-119; Wollmann, Ciugudean 2005, pp. 102-103; Cauuet 2008.
47 Wollmann 1996, pp. ; 179-187; Ardevan 1998, pp. 51-55.
48 Petolescu 2002, pp. 137-138.
49 IDR I, pp. 192-256; Hofmann 2002, pp. 65-90; Wollmann 2002, pp. 91-124.

Fig. 5. Roşia Montană: work opened by fire-setting at the "Găuri" site.

Fig. 6. Roşia Montană: an ancient drift of typical trapezoidal section in the Cârnic massif.

Fig. 7. Roşia Montană: the Stairs Drift network (2nd -3rd century AD) in the Cârnic massif.

repaid, the details of the dissolution of a burial society. Though the wax-tablets stop in 167, the inscriptions continue, and show that the mines were still worked though with reduced production. The last evidence of Roman exploitation of the mines dates from 215 AD, which corresponds quite well with the 14C data recently published from the "Cârnic" and "Cetate" massifs.[50]

When gold was produced and exported on such a large scale, a fully functional and simple system of communications was essential. Whenever metal production exceeded the local or regional scale, mining communities were perforce linked into interregional networks of communication and exchange. No data has been found in ancient sources concerning the Roman road that linked Apulum (today Alba Iulia) and Alburnus Maior. Most researchers have nonetheless pleaded for the existence of a Roman road along the Ampoi valley between Apulum and Ampelum.[51] There are numerous hypotheses concerning the Zlatna – Bucium – Roșia Montană network of Roman roads.[52] The road between Zlatna and Bucium is 16 km long and heads North. Before reaching the ancient mining site of Vâlcoi-Corabia at the "Poduri" area, the road crosses a Roman cemetery (Fig. 9/7). Then it goes up the Corna Valley and reaches Roșia Montană. A Bucium – Abrud *deverticulum* has existed too and it is still called by the villagers "Calea Bătrânilor"– Old men road (Fig. 9/6). It was both a connection towards the Arieș valley and the Brad mining area, a *castellum* being located at Abrud – "Cetățeaua",[53] right at the confluence of Abrudel and Ciuruleasa valleys.

It should be noted here that the road between Zlatna and Bucium was probably much older, several Early Bronze Age barrows being identified along the Morile valley, a tributary stream of the Ampoi river.[54] According to recent studies in Southern Scandinavia, a connection could be detected between the alignment of Early Bronze megalithic graves and contemporary routes of communication.[55] The tumulus-burials formed part of the local topography to be negotiated by traffic and thereby contributed further to channeling the traffic into certain corridors. An important "Golden Corridor" existed along the Ampoi valley in the Early Bronze Age, as part of the larger trade network which connected Transylvanian metal ores with the elite "clients" of neighboring regions.[56] Ancient miners not only collected the gold in the riverbed of Ampoi and tributary streams, but they worked the veins and veinlets of gold bearing quartz and, mainly, auriferous quartz hydrothermal lodes outcropping in the southern part of the Vulcoi-Corabia Mountain near Bucium.

[50] Cauuet *et alii* 2003, fig. 15.
[51] Macrea 1969, p. 154; Fodorean 2006, pp. 252-253.
[52] Wollmann 1996, pp. 70-71, pl. LXVI.
[53] Moga, Mesaroș 1980.
[54] Ciugudean 1996, pp. 75-76.
[55] Johannsen, Laursen 2010.
[56] Primas 1996, pp. 141-162.

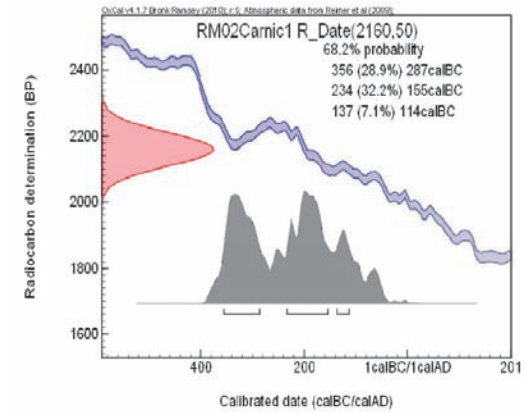

Fig. 8. Probability distribution of the Iron Age date (RM02 Cârnic 1-Cam 1 G3 US4, *apud* Cauuet *et alii* 2003) from Roşia Montană – Cârnic massif.

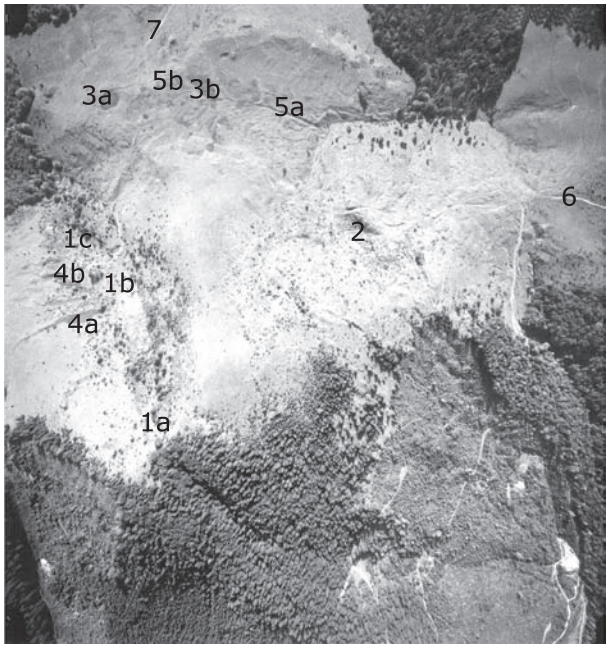

Fig. 9. Aerial view (1970) of the Vâlcoi-Corabia mountain near Bucium with ancient mining sites (1a-c. Ieruga opencast mine; 2. Gaura Perii opencast mine; 3a-b artificial ponds at Poduri site; 4a-b. artificial ponds and chanells; 5a-b chanells; 6. Roman road towards Abrud; 7. Roman road towards Zlatna – Ampelum).

The Bucium gold deposits are located within the northernmost volcanic belt of the "Golden Quadrangle". This complex is similar in size and geology to the nearby Roşia Montană complex. It contains similar types of epithermal style gold-silver and porphyry style gold-copper mineralization associated with dacitic and andesitic intrusions respectively. The Bucium complex, which measures approximately 6 x 3 km in plan, is elongated NW-SE and comprises several distinct sub-volcanic intrusions aligned along three separate NW-

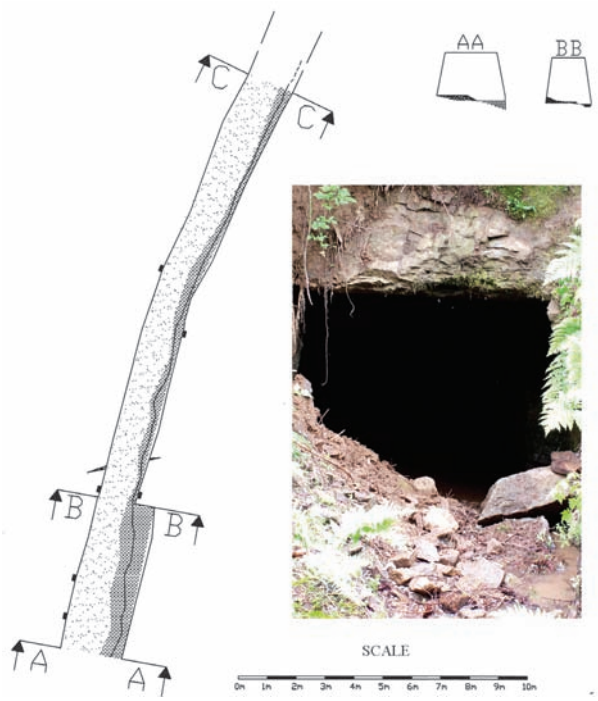

Fig. 10. Bucium: photo, overall plan and section cuts in the Roman gallery at "Baia Domnilor" (former "Petru şi Pavel") mine.

trending zones sub-parallel to the major Neogene tectonic trend of the Golden Quadrilateral.[57] It should be noted that the metalogenetic fields Conțu, Arama and Vâlcoi - Corabia are related to a majore fracture system developing NNV-SSE on approximately 8 km. length. Some authors consider that in antiquity this fractural vein system represented, at least at a certain moment, the most important mining field of the Apuseni Mountains. The Vulcoi-Corabia metallogenetic field represents the south-eastern end of the major vein system, developing between Conțu and Vâlcoi - Corabia massifs (Pl. VII/1). This metallogenetic field consists of a major NNW-SSE vein, called Corabia (Ieruga), with some vein splays and diagonal NE-SW connection veins and several subsidiary sub-parallels veins, developing especially toward West.[58]

Geological and archaeological research recognized the existence of outcropping gold veins and ancient opencast mines north to the Zlatna town already in the 19th century.[59] Several Late Bronze Age golden earrings have been found on the Vâlcoi-Corabia mountain.[60] Dacian silver coins (Fig. 11) were also found

[57] Leary *et alii* 2004.
[58] Ghițulescu, Socolescu 1941.
[59] Ackner 1856, p. 13; Téglás 1890.
[60] The ornaments were found in the 19th century (Roska 1942, p. 308) and they are exhibited in the Naturhistorische Museum in Wien.

Fig. 11. Iron Age silver coin found at Vâlcoi-Corabia mountain near Bucium (drawing *apud* Téglás 1890).

in the same area, aparently in the ancient mines.[61] Roman lamps and other tools were discovered in the mine called "Petru și Pavel" (Peter and Paul).[62] Part of the main gallery has the characteristic trapezoidal section (Fig. 10), well-known from the other Roman mines at Roșia Montana. Probably the most remarkable feature is the conservation of the original Roman entrance, although the mine has been worked till modern times.

By the end of the 19th and beginning of the 20th century, B. Lukacs and G. Téglás excavated several Roman burial mounds on the saddle between Corabia and Boteș massifs.[63] G. Téglás published the first archeological map of the area and an impressive drawing of the Corabia massif with the Ieruga opencast mine (Pl. V/1). Other Roman cremation graves were excavated in 1938,[64] but less attention was paid to the study of the ancient mining workings.[65] According to the funerary customs, the Roman miners originated from Illyricum, a situation similar to the one already known at Alburnus Maior.[66]

The most important ancient opencast mines in the Bucium area are located on the peak (1349 m high) and southern slopes of the Vâlcoi-Corabia massif (Pl. VII/1-2). The ancient miners attacked a quartz vein opencast, and to the deeper levels they drove a huge adit, more than 600 m long and 40 m deep, which is called "Ieruga" (Pl. VII/1; Fig. 9, 1a-c). It should be noted that this huge excavation has been already drawn in the second half of the 19th century (Pl. V/1). Its general view was much better up to the middle of the 20th century (Pl. V/2), today most of the area being covered by forest. Ore treatment areas were located all along the eastern edge of the "Ieruga" opencast mine, easy to be identified in the 1970 aerial photos (Fig. 9/4a-4b). They comprise trenches cut into the slope, ending in long ponds. A second impressive ancient opencast mine is called "Gaura Perii" (Pl. VI/1-2; Fig. 9.2) and it develops on the south-western slope of the Corabia massif.

An aerial photo made in 1970 shows many larger or smaller trenches and pit-like excavations, distributed on a relatively large area (Fig. 9). As the veins crop out, mining has always started at Vâlcoi-Corabia as opencast. The ore extraction may have been performed by fire-setting but clear evidences of this type of operation is still missing in the Bucium area. As usual, the waste had been dumped up near the excavations. Piled up in hillocks at the sides of the opencast mines, these dumps had gradually subsided inside the mining works after the end of mining activity. The subsidence of these dumps has contributed to the partial filling of the interior of these opencast mines, completely hiding the entries of possible underground works.

The gold-bearing quartz veins were crushed in situ by stone hammers and then transformed to a fine powder fraction with grinding stones and mortars. Most of the material extracted from the Vâlcoi-Corabia mines was pilled along the "Podurile" ridge. It appears that the ancient miners of Bucium preferred to do the enrichment of the ore close to the mines. It shows a wish to control the gold production as close as possible to the place where the ore was extracted. A complex water drainage and storage system is still visible at the "Poduri" site (Pl. VII/2; Fig. 9: 3a-b, 5b). The miners used a large quantity of water, stored nearby in several ponds. For each operation, they mixed the gold sands with water and let the mixture flow down the trench. At the end the muddy mixture collected in the terminal basin could have been recovered and recycled many times to extract the majority of the gold. A gold-bearing concentrate is retained in the trench by the traps. The presence of a straight, relatively steep water channel in the western side of the "Poduri" site (Fig. 9: 5a) suggests that "in ground sluicing" (hatching) was probably used as a "secondary" recovery method of the gold from the lower grade material.

Primitive grinders, mortars and crushing tables were found all-over the "Poduri" area (Pl. VIII/1-4, X-XI). These stone tools are made out of local rocks, such as andesite, and they might date in pre-Roman time. Similar tools are known at the prehistoric gold mines from Sakdrisi,[67] Ada-Tepe,[68] Gros-Galet-nord in France,[69] as well as in Spain.[70] However, it should be noted that mainly Roman ceramics (2nd – 3rd century AD) were found at the bottom of several canals (Pl. 9/1-4). The presence of Late Bronze Age and Dacian finds in

61 Téglás 1890.
62 Téglás 1889, p. 260.
63 Téglás 1890.
64 Floca 1941.
65 Wollmann 1996, pp. 140-142.
66 Bărbulescu 2003, pp. 410-413.
67 Stöllner *et alii* 2010, fig. 16-17.
68 Popov *et alii* 2011, fig. 9, 16-17.
69 Cauuet 1999, fig. 7/a, 43.
70 Romero 2002, pp. 348-350.

the area of the Vâlcoi-Corabia massif could be an indirect proof that gold mining started at this site already in pre-Roman times, but this hypothesis has to be verified by further systematic excavations.

A different approach towards the early mining of Transylvanian gold and in particular of the Roşia Montană – Bucium deposits is represented by the geochemical analyses. In his investigation on prehistoric gold in Europe, A. Hartmann has characterised several major gold sources, including the Transylvanian Apuseni Mountains, with high silver contents.[71] Hartmann suggested that the gold of his group A3 that is, on average, characterized by 25% Ag, 0.3% Cu and occasionally small contents of tin, may have its origin in Transylvania. It is mainly to be found in artifacts of the Early and Middle Bronze Age and Hartmann also suggested that this type of gold may be the earliest that derived from hard rock mining.[72] Recent studies clearly demonstrated that higher copper amount of 0.05 wt% was recorded only in two Roşia Montană samples and in the Bucium-Vâlcoi samples (up to 0.04 wt% Cu).[73] These variations in the Transylvanian gold's copper content may be related to the influence of the porphyry copper mineralization located nearby or to the different sampling levels within the same ore deposit. The recently studied gold samples from Roşia Montană outline a specific pattern with relatively high Ag and significant Te content (up to 0.34 wt% is one of the highest found in Transylvanian gold),[74] compared with previously published data on primary gold from Southern Apuseni Mountains[75] and various other deposits outside Romania. This pattern can be considered as typical geochemical signature for Transylvanian gold, according to the authors of recent analysis. It is somewhat surprising that A. Hartmann found only one gold object from the Danubian region in his investigations of prehistoric gold artifacts that contained any measurable tellurium.[76] Of course, this raises the question if Roşia Montană was indeed an important source for prehistoric gold in south-east Europe as is frequently held. However, it should be noted that both tellurium and copper were missing from some of the samples analysed by Hauptmann and Pernicka.[77] and Te was not identified by EMPA in the 19 samples from Roşia Montană published by C. Tămaş.[78] So far, tin was mainly detected in the samples from the placer deposits of the Arieş and Pianu valleys.[79] It was also detected in two recently analysed Late Bronze Age gold objects from Romania, one ring from the Tăuteu gold hoard and the decorated disk from Călăraşi, considered to be made of alluvial gold.[80]

However, both the limited database of ore sample compositions and the lack of archaeological and geological contexts for the samples render the conclusions of these recent studies questionable.[81] Further and more complex investigations of the archaeological objects and of the ore samples are still needed.

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[71] Hartmann 1970.
[72] Hartmann 1970, p. 20.
[73] Pop *et alii* 2011, p. 917.
[74] Pop *et alii* 2011, pp. 916-917.
[75] Hauptmann *et alii* 1995.
[76] Hartmann 1970 (his detection limit for Te seems to have been in the order of 0.01 %).
[77] Hauptmann *et alii* 1995, p. 373, table 1 (sample no Ro 1 and Ro 37).
[78] Tămaş 2007, pp. 151-176.
[79] Vasilescu *et alii* 2011, p. 369, 371, table 1; Bugoi *et alii* 2008.
[80] Constantinescu *et alii* 2009, fig. 6-7.
[81] Baron *et alii* 2011, p. 1091.

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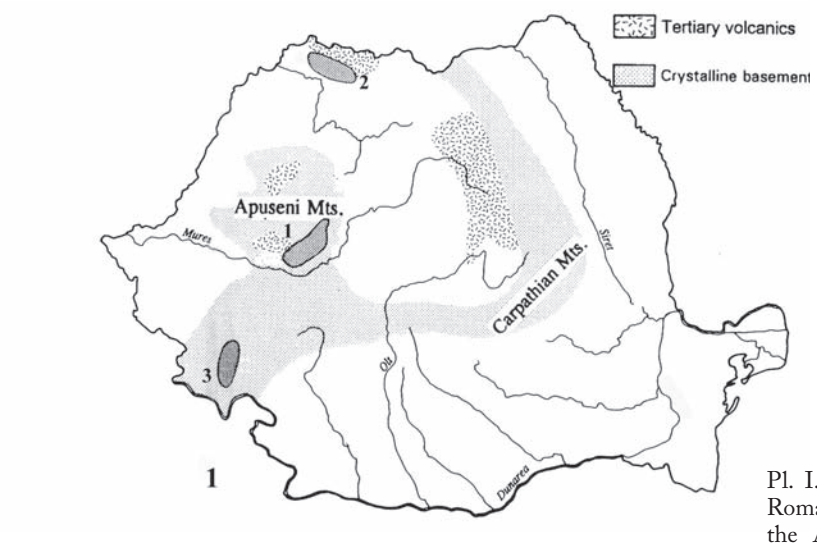
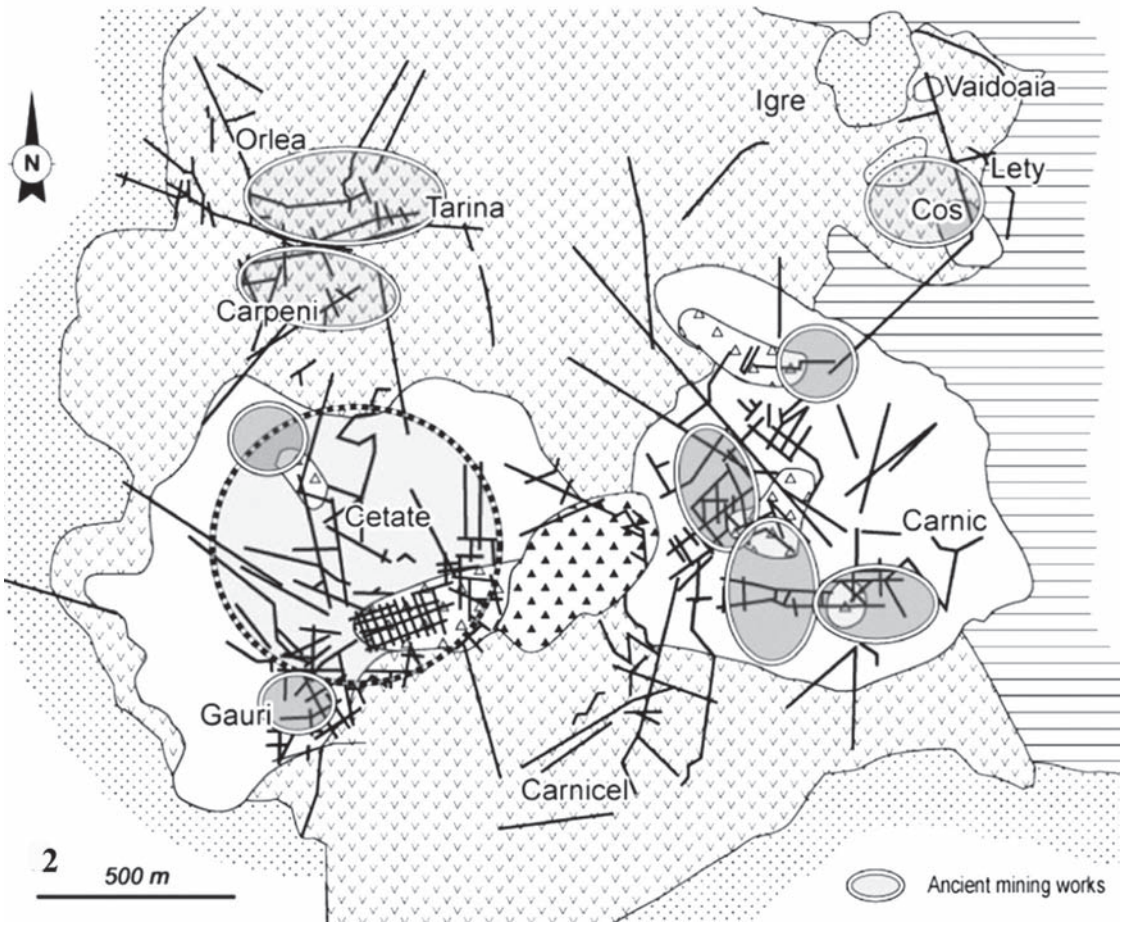
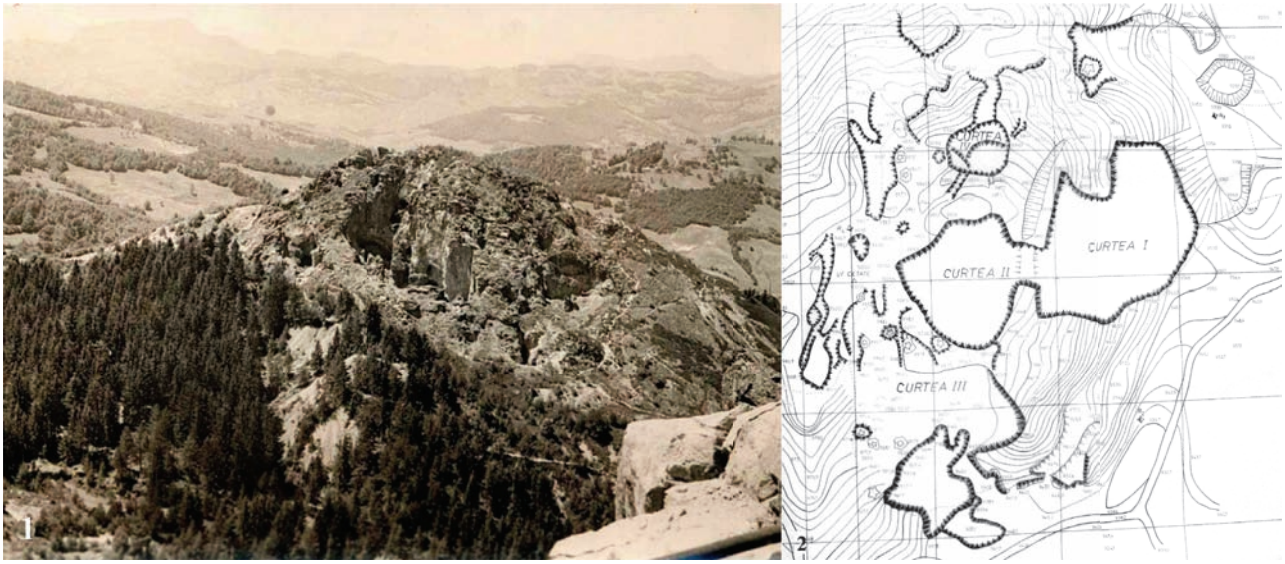
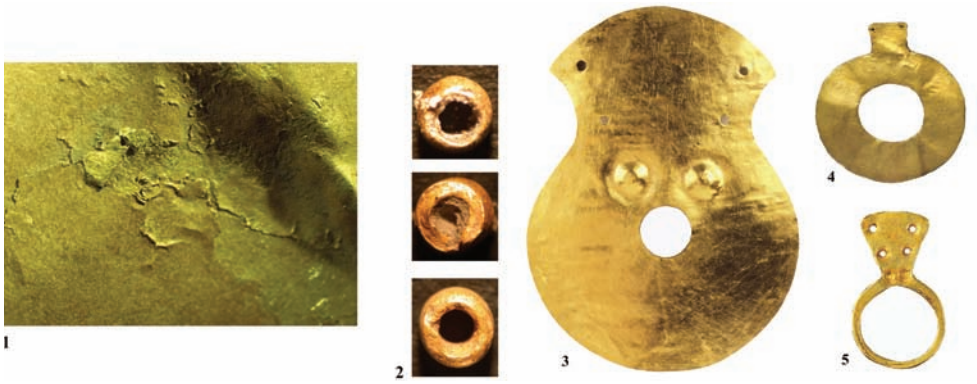


Pl. I. **1**. Major gold mining districts of Romania: 1 - "Golden Quadrangle" in the Apuseni Mountains, 2. Baia Mare and Baia Sprie in the Maramureș region, 3 – South Carpathian metamorphic zone (*apud* Lehrberger 1995); **2**. Geological map of Roșia Montană, with the main mining areas (*apud* Baron *et alii* 2011).

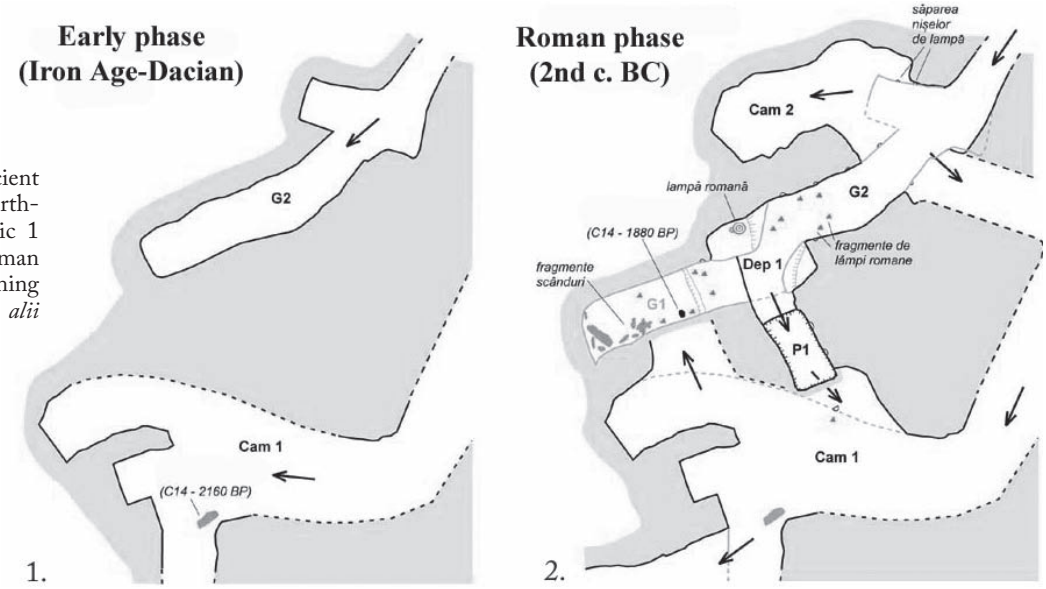




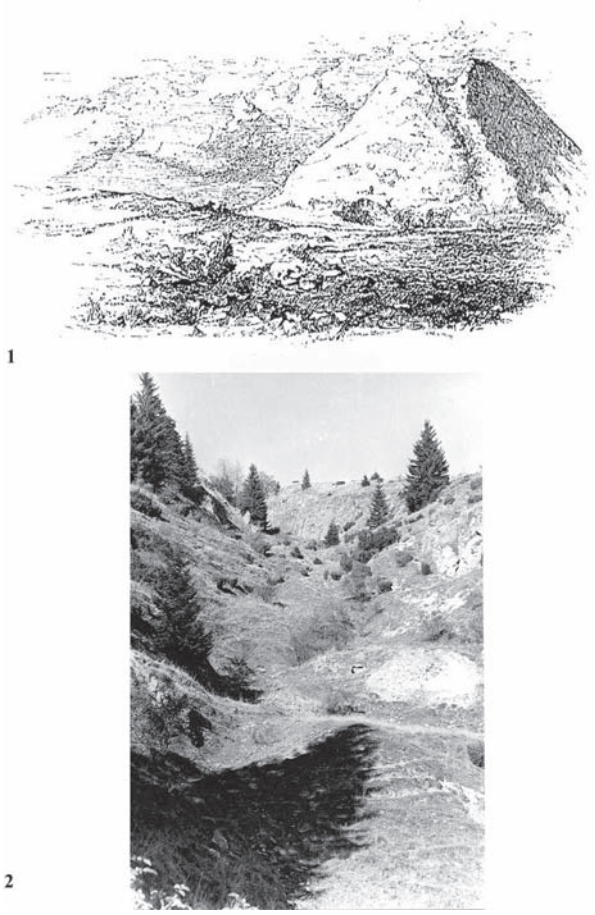
Pl. II. Roșia Montană: old picture (1) and map (2) of the "Cetate" massif.



Pl. III. Copper Age gold artifacts found in Transylvania: 1. Closer view of a gold sheet found in Cheile Turzii; 2. Gold beads discovered at Cheile Turzii - Peștera Ungurului; 3. Gold pendant found at Moigrad; 4. Gold pendant found at Târgu Mureș; 5. Gold pendant found at Oradea (1-2, *apud* Lazarovici *et alii* 2012).

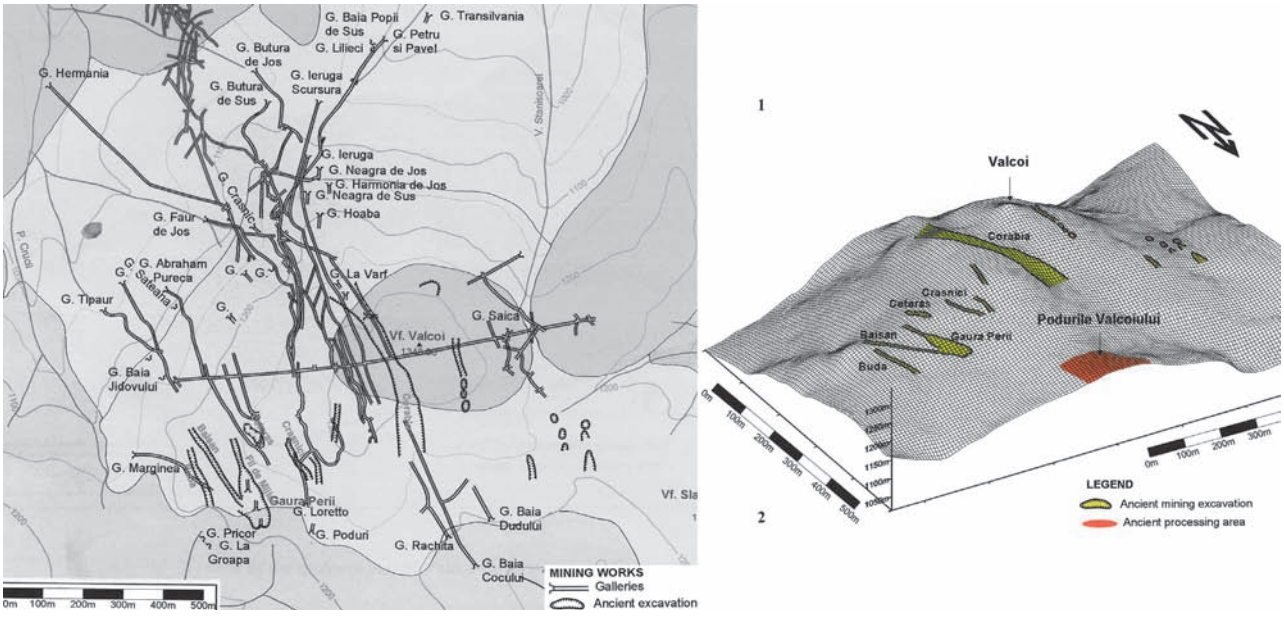


Pl. IV. Plan of an ancient network from the North-West area of the Cârnic 1 massif with the pre-Roman (1) and Roman (2) mining works (*apud* Cauuet *et alii* 2003).

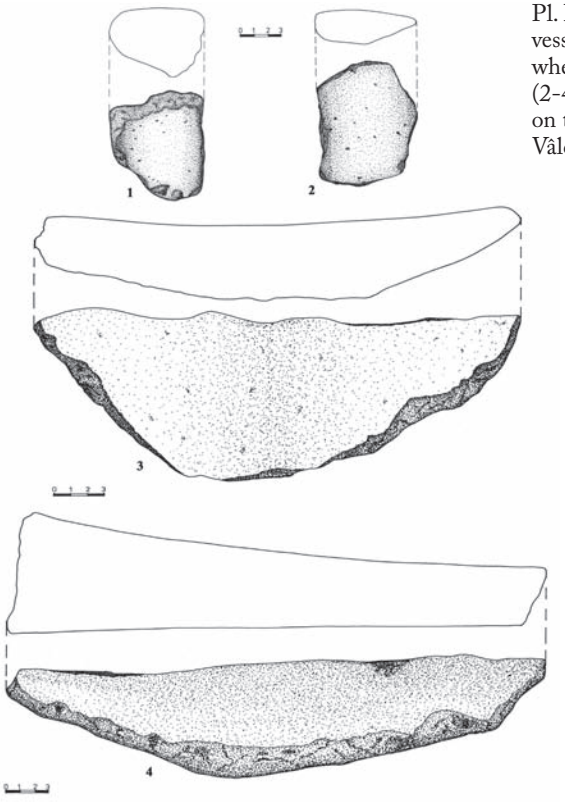


Pl. V. Bucium: 19th century drawing (1) and old photo (2) of the "Ieruga" opencast mine in Vâlcoi-Corabia massif.

Pl. VI. Bucium: old (1) and recent (2) photos of the "Gaura Perii" opencast mine in Vâlcoi-Corabia massif.

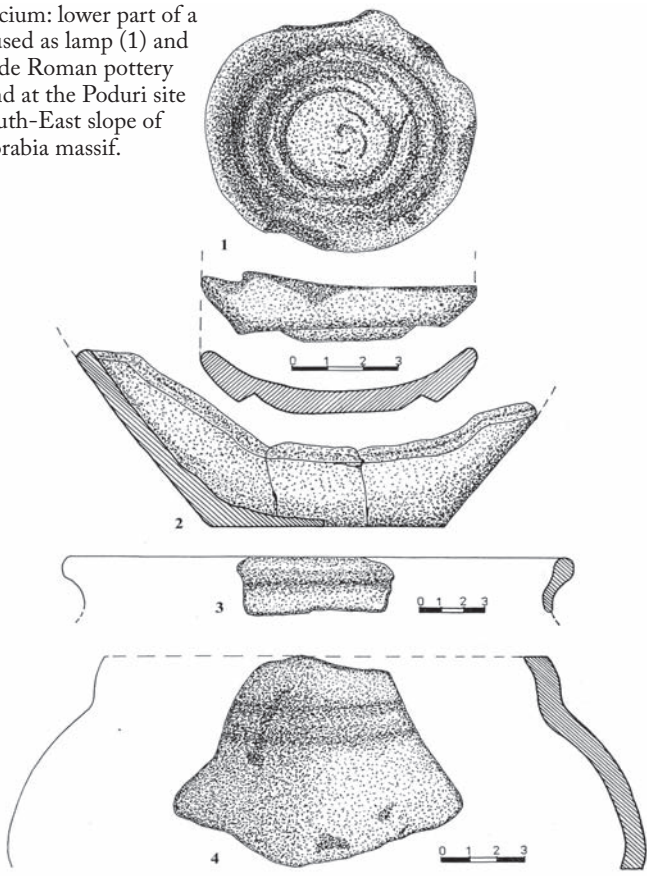


Pl. VII. Bucium: map (1) and 3D model (2) of modern and ancient mining works in the Vâlcoi-Corabia massif.

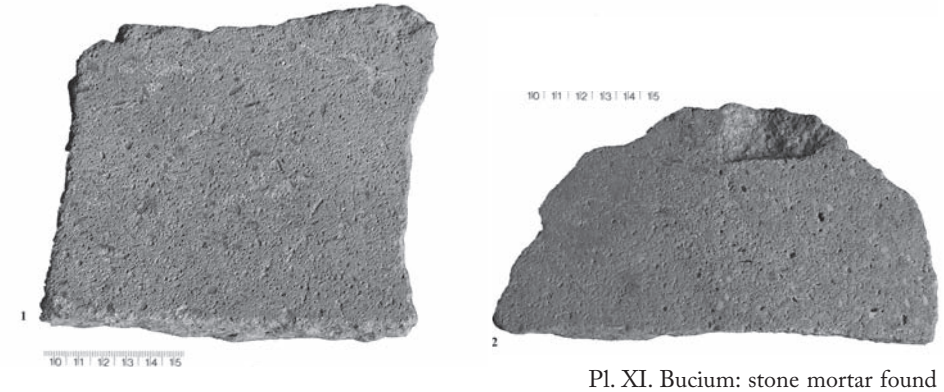


Pl. VIII. Bucium: grinding stones (1-4) found on the South-East slope of the Vâlcoi-Corabia massif.

Pl. IX. Bucium: lower part of a vessel re-used as lamp (1) and wheel-made Roman pottery (2-4) found at the Poduri site on the South-East slope of Vâlcoi-Corabia massif.



Pl. X. Bucium: grinding stones (1-2) found on the South-East slope of the Vâlcoi-Corabia massif.



Pl. XI. Bucium: stone mortar found on the South-East slope of the Vâlcoi-Corabia massif.