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Recent perspectives on a neglected category of heritage. Roman mining in the "Golden Quadrilateral"

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Abstract: *Recent perspectives on a neglected category of heritage. Roman mining in the "Golden Quadrilateral***.** Research on mining archaeology in Romania focused – mostly – on the historical interpretation of earlier mentions and very little on proper documentation (archaeological and topographic) of this peculiar type of vestiges. Only in the late 1990' the first scientific approach to mining archaeology was undertaken in the framework of a Romanian-French cooperation, initially in the area of the Pianu Valley (Alba County) and later in the Roșia Montană – Bucium area, in the context of the "*Alburnus Maior*" National Research Program. In this context, the area of the "Golden Quadrilateral", especially Roșia Montană, benefitted from a series of systematic mining archaeological research, both on the surface and underground. Despite the important results yielded by the research lasting more than a decade at Roșia Montană, by a national research program (halted later on), the field of ancient mining heritage in the "Golden Quadrilateral" is deeply neglected, with deep inconsistencies between what is happening in Romania and the international developments in this field. The paper lists the issues approached during the last 15 years concerning mining archaeology and related heritage in Romania, bringing to the public's attention a new approach concerning the latter's documentation according to specific international practice.

Keywords: mining heritage, Roman mining, "Golden Quadrilateral", multidisciplinary approach for documentation, GIS correlated database

Introduction

It is well known than much of the human activities have effect on the environment, leaving their mark on the natural surroundings. Thus, exploiting useful deposits, in all their forms, left significant traces, sometimes visible, other times "hidden" to the direct visual perspective.

This is also the case of the ancient mining vestiges in the "Golden Quadrilateral" in the Apuseni Mountains (Fig. 1). Interest for the vestiges resulting from old exploitations and metal-processing in this area dates as early as the 16th c., and is well-exemplified by the writings of the foreign travellers that also mention certain ancient heritage monuments[1]. Technical information, maps and numerous details start to be mentioned especially during the second half of the 18th c., once extension of mining activity in this area became a priority for the Habsburg Empire and the *Mountain Treasury* was formed; therefore, today we have an important archive, not enough researched yet, but through the effort of several scientists the archive in Cluj was put in order and published (Slotta *et al.*, 2002). From the middle of the 19th c., especially in the context of the discovery of the wax tablets at *Alburnus Maior* and their publication by Th. Momsen[2], the interest shown by historians and archaeologists (largely "amateurs" at that time) for ancient mining vestiges in the "Golden Quadrilateral" augmented constantly, with the first field surveys undertaken for determining their precise location[3]. Thus, at the beginning of the 20th c. a new distinct research

direction was formed, mountain archaeology, a precursor of what is now comprised by the concept of "mining archaeology"; focus continued to be on cataloguing the different mining object discovered by chance and the publication of the epigraphic inscriptions from the Classical period coming from this area. All along the 20th c., information on the ancient mining heritage also came from chance discoveries made in the context of extension of historical exploitations such as those in the area of Roșia Montană, Zlatna, Bucium or Brad[4]. Starting only with 2001, when an ample mining project started at Roșia Montană, did the first proper mining archaeology research begin in Romania (B. Cauuet, 2003, p. 471–473). In a paradoxal way, this research did not stimulate this research field in Romania, and most of the mining vestiges in the "Golden Quadrilateral" are still practically unknown. Their proper documentation, by corroborating bibliographical sources with field surveys, detailed mapping and correlating with geological data (objectives of my PhD stage) constitute a first step for the preservation and putting to good value of extremely important heritage elements.

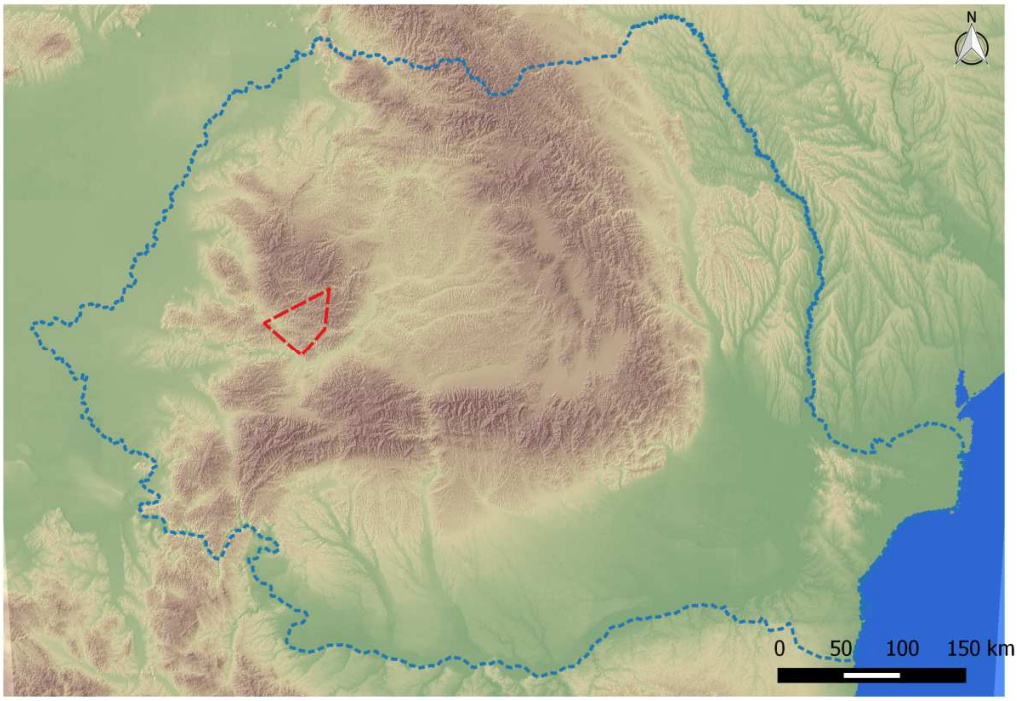

Fig. 1 – Location of "Golden Quadrilateral"

Defining mining heritage

The study of mining heritage is an important component for understanding historically and culturally an area where mining activities took place. The areas with historical mining vestiges represented – and still do – a peculiar category of heritage from the perspective of studying economic and social development, as well as putting to good value these elements through cultural tourism.

Human activity in spaces that can be mined generated a large series of testimonies with high cultural value. Starting from this point, a recent study mentioned that "due to the impregnation and marking or the territories with their own identity, the latter leave their own inheritance, which we call mining heritage" (D.J. Carvajal, 2010, p. 49). Basically, a distinct definition of *historical mining heritage elements* is difficult to formulate, given its belonging to the general category of *industrial heritage*[5]. In order to clarify this term, in 2003, on the occasion of the Congress of the International Committee for the Preservation of the Industrial Heritage[6], a thematic document was drawn, that contains the definition of terms, values, legal

protection and obligations regarding the latter (*TICCIH, 2003). From this perspective, *industrial heritage* is made up of the testimonies of the industrial culture with historical, social, technological and scientific significance (buildings, machines and installations, mills, factories, **mines**, transport structures and infrastructures, cult places). Also, *industrial archaeology* is identified as a distinct discipline, whose object of study are the testimonies concerning or created by industrial processes (*TICCIH, 2003, art. 1).

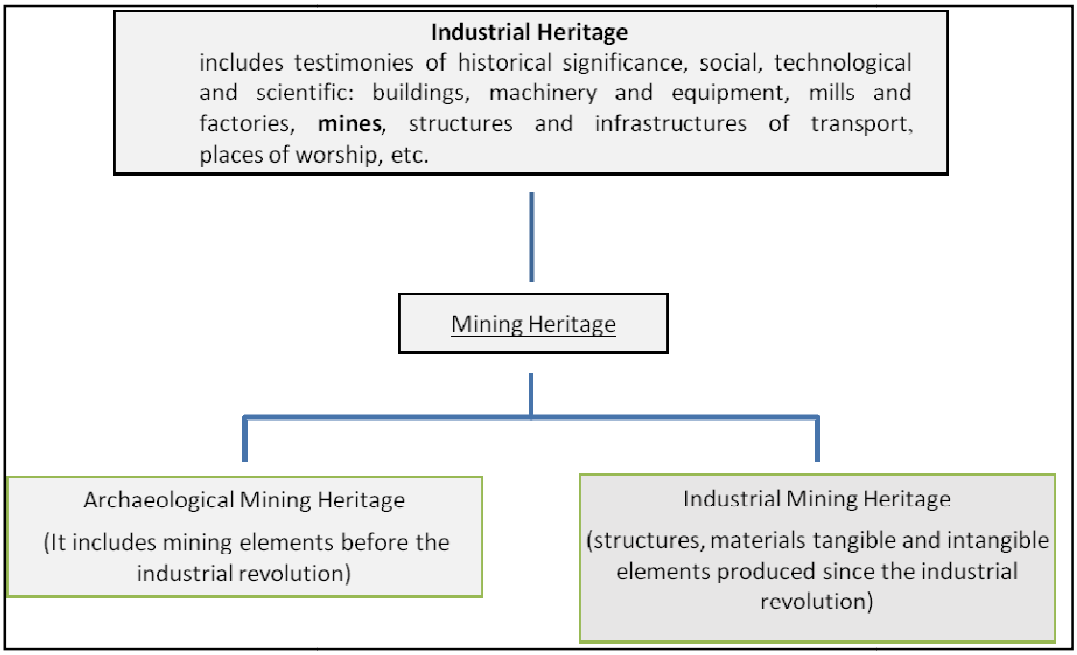

Fig. 2 – Mining Heritage as a subclass within the Industrial Heritage
(after Alberruche del Campo *et al.* 2012, p. 8)

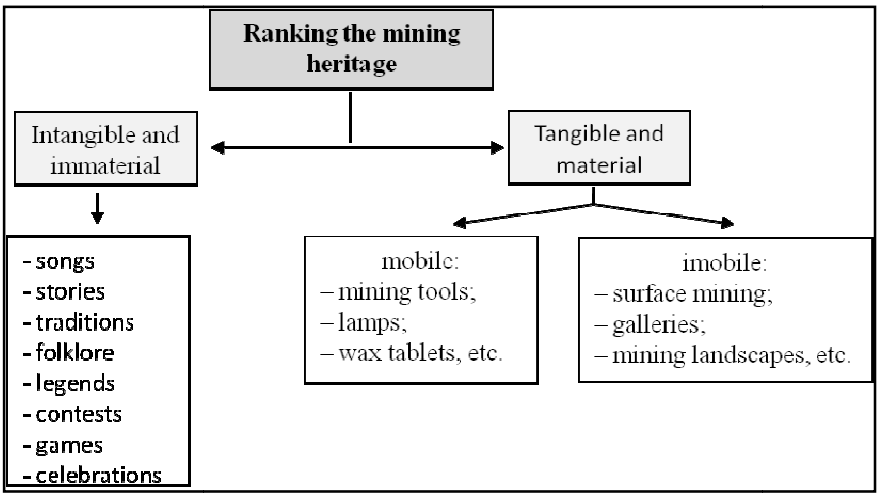

Fig. 3 – Representing the defining elements of the mining heritage

In this context it is necessary to make the distinction between *historical/archaeological mining heritage* and *industrial mining heritage* (Fig. 2). The latter, according to the most recent

analysis in this field (Alberruche del Campo *et al.*, 2012, p. 8), contains the vestiges of mining works starting with the middle of the 18th c., that is when the first industrial revolution took place (with the introduction of mechanical production) and up to the last third of the 20th c. (which coincides with the moment when automatic production was gradually or partially introduced).

Therefore, the present research focuses on *mining heritage*, understood as the sum of components of the *historical/archaeological mining heritage*, made up of those tangible and intangible elements and manifestations (activities) produced by the individual – community – society that are defined and differentiated by their unique character (Fig. 3). Given the evolution of the field at an international level, this endeavour[7] analyses the acute necessity for inventorying, preserving, putting to good value and advertising the products of historic metal mining susceptible of being part of the national cultural heritage, many of which are in danger of being destroyed without the proper investigation.

State of the research after 2000 on ancient mining heritage in the area of the "Golden Quadrilateral"

At the beginning of the 21st c. V. Boroneanț published a work (2000) in which the author synthesized the information available at that time on natural and artificial caves, mines, salt mines and stone quarries, as well as new information provided by the author's own research. In the chapter dedicated to mining (p. 117–131), 60 galleries, surface works and traces of alluvial deposits processing are repertoried, most of the dated to the Roman, medieval and modern periods.

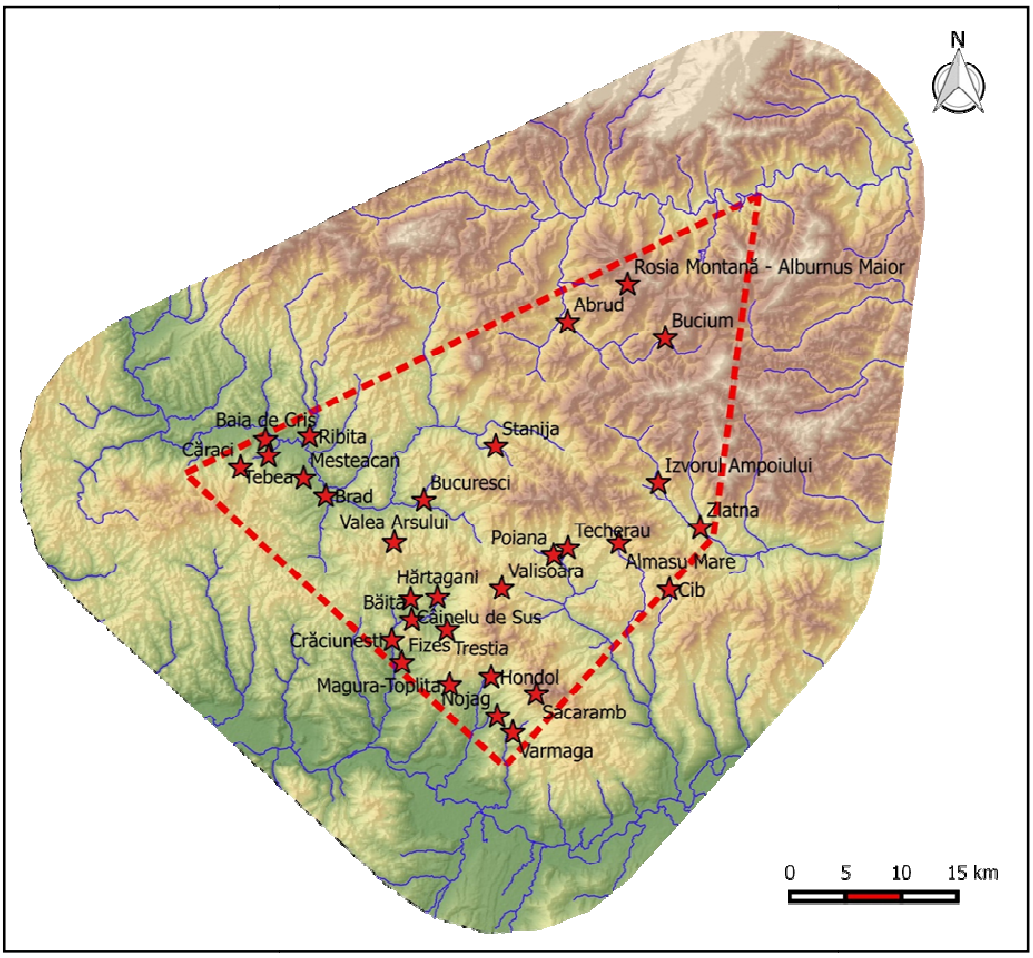

Fig. 4 – The main Roman mining sites in the "Golden Quadrilateral" (after M. Simion *et al.*, 2008)

Over 15 years ago, in 1999 at Roșia Montană[8] (Fig. 4), the largest (proper) mining archaeology research started, later to become the "*Alburnus Maior*" National Research Program, instituted in 2001 by the Ministry of Culture. This important endeavour to investigate in the field ancient mining vestiges had a multidisciplinary character, uniting – under the coordination of the Romanian National History Museum – archaeologists, historians and geologists from different institutions in the country (Alba Iulia, Bucharest, Cluj and Deva), and it also had an essential research component in the underground investigation, led by Beatrice Cauuet (I. Opriș, 2003, p. 10; B. Cauuet *et al.*, 2003, p. 472; P. Damian, C. Borș, 2008, p. 489–502, annexes 1–2 and 4). A first stage of the mining archaeological research at Roșia Montană was a survey of the historical vestiges preserved underground, in the Cârnic, Cetate, Zeus, Găuri, Țarina, Orlea, Păru-Carpeni, Coș and Jig-Văidoaia Mountain Massifs (Fig. 5), which lead to the exploration of over 70 km of mining networks that bore the marks of recent (20th c.), modern (18th c. – beginning of the 20th c.) and old works (Roman and medieval). Soon after the beginning of this large-scale research, from 2003[9], the first results of the mining archaeology campaigns in the Roșia Montană area started to be published (B. Cauuet *et al.*, 2003; B. Cauuet *et al*., 2003b; B. Cauuet, C.G. Tămaș, 2012; B. Cauuet *et al*., 2013; B. Cauuet, 2014), and they were analysed in the larger context of the mining technology analogies from the Roman world (B. Cauuet, 2004b; B. Cauuet, 2008; B. Cauuet, 2011). We must also mention a distinct research direction, regarding the effort to establish the origin of elements of gold and silver in prehistoric and ancient artefacts discovered in Romania, which saw the analysis of 29 ore samples from the Roșia Montană area (especially from the Roman galleries), and the results were compared with the other gold and silver deposits in the Apuseni Mountains and the Maramureș (Baron *et al*., 2011).

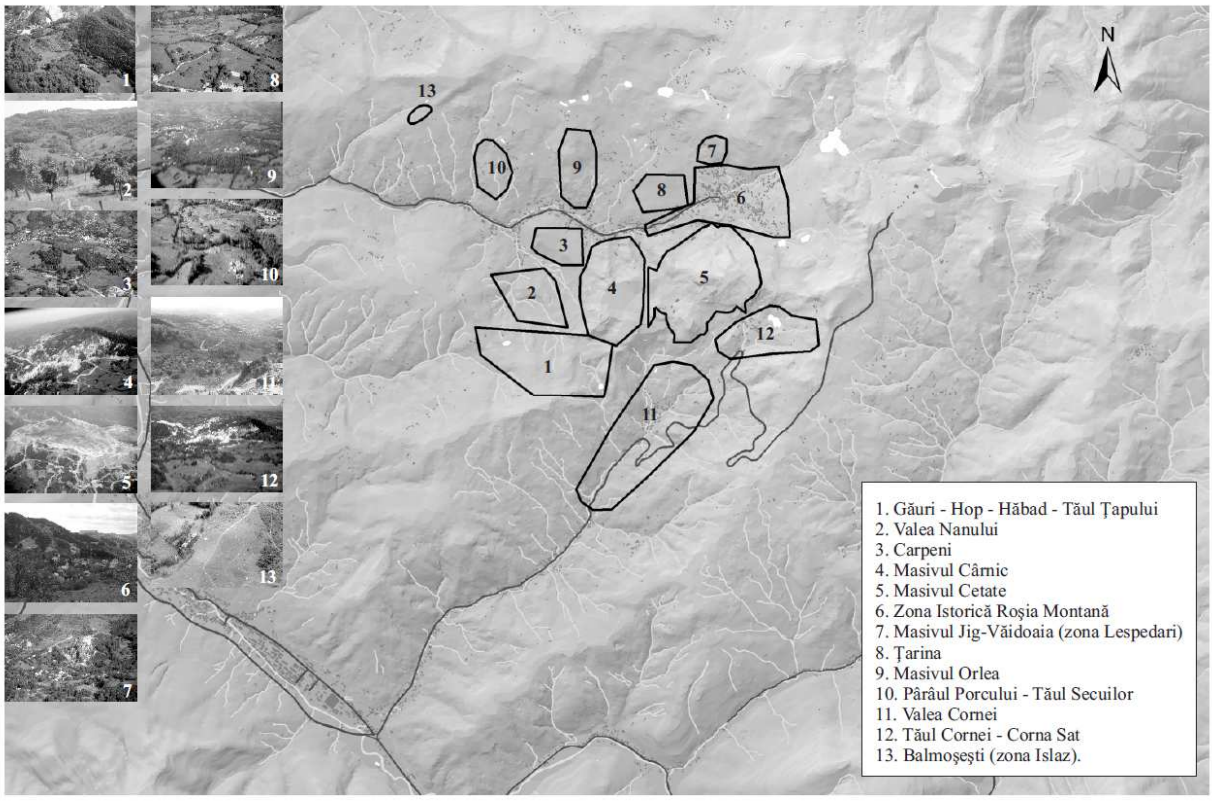

Fig. 5 – Archaeological sites from Roșia Montană outlined during the "*Alburnus Maior*" National Research Program (after P. Damian, C. Borș, 2008, fig. 3)

In the over 10 years of mining archaeology research (2000–2013), a series of gallery segments were researched, where over 7 km of ancient works were documented, occasion on which were identified and preserved systems for water evacuation (wooden wheels and connected elements)[10] and ventilation systems; important information was gained on systems for excavating the different types of rocks and on the practice of reinforcing the galleries. Unfortunately, as Béatrice Cauuet remarked, "*the emptied underground space was weakened by the removal of the supporting backfilling and should be reinforced and not abandoned as such*" (B. Cauuet, 2014, p. 103), more precisely – the research of these structures was not immediately followed by a medium- and long-term conservation strategy, deemed absolutely necessary given the high historical and cultural value of such ancient structures.

At the same time with the underground mining archaeology research undertaken at Roșia Montană, there were also research efforts on a much smaller scale, focusing on ancient ferrous and non-ferrous mining works in Roman Dacia. Thus, literature specialized on mining archaeology in Romania benefits from a series of works published starting with 2000, but which were, as V. Wollmann well put it[11] (1996, p. 23) "often debatable from the perspective of new information or interpretation[12].

Starting with 2002, H. Ciugudean[13] (in 1999 member of the team for the research of the gold alluvial deposits in the Pianu Valley) (H. Ciugudean *et alii,* 2000, p. 75–76) made a series of field surveys aimed at (re-)identifying certain historical mining works in the area around Bucium, Zlatna and Roșia Montană (H. Ciugudean, 2012). He listed previously-mentioned mining works (as early as the end of the 19th c.) located both on the surface and underground (H. Ciugudean, 2010, p. 263–268). In this context, the author emitted the hypothesis according to which some of these mining works could have started as early as the end of the Late Bronze Age, namely that "*Roman mining was nothing more than a reorganization and enlargement by improved technology of earlier mining activity in this area*" (H. Ciugudean, 2010, p. 268), without providing solid arguments to back it up though.

Another contribution to this field, owing to her interests in metallurgy during the Roman period, belongs to Prof. Doina Benea, who took up again (without any new information though) the problem of organizing Roman mining and the importance of mining in the "Golden Quadrilateral" (D. Benea, 2008a, p. 12–25; D. Benea, 2013, p. 253–267). The author also analysed the rich metal deposits in the Banat (Bocșa, Ocna de Fier, Berzovia, Eftimie Murgu, Dognecea, Moldova Nouă, Sasca Montană and Ciclova Română), from where large quantities of lead, copper, iron, silver and gold were extracted in Antiquity. Concerning the origins of the lead there is no clear information, given it was most probably extracted along with other metals (D. Benea 2008b, p. 231) in Moldova Nouă and probably all over Southern Banat. Gold mining was also approached by C. Timoc (2008), without bringing any new information though. The author treats especially the problem of the centre of the Roman mining administration at *Ampelum* (present-day Zlatna) based on epigraphic information. A synthesis of the archaeological activity in the "*Alburnus Maior*" National Research Program was published in 2008 (P. Damian, C. Borș, 2008). In it are presented the settlement's history, chance discoveries before 2000 and the main results of the archaeological research between 2001–2006. Along with the strategy for research and conservation, protection and proposals for putting to good value the archaeological discoveries, there is also a list of partner institutions, as well as a series of considerations regarding the publication and dissemination of the results.

Among the most important publications on mining and technology during the last 15 years we must mention the series *Silber und Salz in Siebenbürgen*, the result of a Romanian-German historical research under the coordination of Deutsches Bergbau-Museum Bochum. Apart from a detailed account of the information on the Roșia Montană area (V. Wollmann, 2002, p. 91–124), we must mention the volume dedicated to ancient mining works in the area around Brad, Baia de Arieș, Băița and Baia de Criș (V. Wollmann, 2010a, p. 35–80; 2010b, p. 223–274; R. Slotta, V. Wollmann, 2010, p. 518–542;). V. Wollmann published detailed studies on the mining works in the above-mentioned areas, focusing on signalling Roman mining works. This endeavour also includes data obtained through the study of archives regarding historical doscuments such as

travel journals, technical reports of certain geologists and mining technicians starting with the 18th c. and up to the first half of the 20th c.

Based on recent research[14], including the corroboration of the data in older specialized literature, M. Simion (M. Simion *et al.*, 2010) drew up a catalogue of ancient mining works signalled in the "Golden Quadrilateral", which are classified according to several criteria (presence of settlements/dwelling environment, necropolises or funerary areas, galleries and underground mining installations, epigraphic and monetary discoveries). Based on preliminary field observations and an analysis of the documentation, she formulated the hypothesis according to which there could be in this area a series of sites with an archaeological potential similar to that of Roșia Montană, such as the ones at Ruda-Brad, Stănija, Bucium, Băița, Certej and Săcărâmb (M. Simion *et al.*, 2010, p. 39).

Another work was published the same year, this time a synthesis essential for the history of mining in the Roman Empire by A.F. Hirt (2010); this book pays due attention to the ferrous and non-ferrous mining works in Roman Dacia, analyzing the organization of mining districts based on the relevant epigraphic material. A synthesis with the latest data (2011) on the given subject was published by D. Vleja[15]. The perspectives for putting to good value the recent discoveries at Roșia Montană are also discussed by C. Borș (2012). Another synthetic approach is taken by H.A. Pundt (2012), by studying the organizing of Roman Dacia and its ethnic groups, based on the analysis of the funerary rite and behaviour, especially in the area around ancient *Alburnus Maior* (Roșia Montană).

As far as field research is concerned, namely surveys on ancient mining vestiges, in 2014 a series of preliminary observations was made around Băița (Hunedoara County), covering the villages Băița, Câinelu de Sus, Trestia, Crăciunești and Hărțăgani. These led to the identification of new Roman mining galleries, some of them in an advanced state of degradation. The results of these investigations were updated through the National Archaeological Repertoire[16] (that contained a national map server for archaeological sites and monuments), thereby completing the list of ancient mining works signalled in the "Golden Quadrilateral". Unfortunately, in this case also, as in others mentioned in different works, there is no precise data on the location of these objectives, which would constitute an essential element for investigating and preserving such vestiges.

The repertoire of ancient mining sites in the "Golden Quadrilateral"-a pluri-disciplinary endeavour

As was previously shown, with the exception of Roșia Montană, ancient mining vestiges in the Golden Quadrilateral were not properly researched through mining archaeology, and they were not even adequately repertoried. In many cases, the specialized literature has simple mentions of such structures or indirect clues concerning them (e.g. mining tools – hammers, stone hammers, etc.[17]), given the use of mines, shafts and washing installations in following periods. Starting from these conclusions, the object of the research undertaken during the doctoral stage is gold, silver, copper and iron exploitation from the earliest periods up to the Roman period, including a presentation of the techniques and tools used for it, a documentation based on direct field observations on the present state of conservation of such vestiges, and the creation of a digital repertoire. The relatively significant number of artefacts (tools, weapons and jewellery) that can be indirectly associated to ancient mining works should have stimulated a detailed research of the primary sources and emplacement of metal exploitation areas. But their study in Romania is still in its infancy, when compared to similar research in other countries.

A first and necessary step for documenting this category of vestiges is creating a repertoire, by corroborating historical-archaeological data with geological data. Thus, the starting point for the repertoire I am creating is the location of all potential settlements and areas with mineral deposits, starting from Rădulescu and Dimitrescu's comprising book (1966), V. Brana (1958), of course with the updates made following later geological research (Tămaș-Bădescu, 2010, p. 30–42; Cristea, 2012, p. 8–37). The necessity of this approach is obvious only if we consider that only for copper we have 636 deposits (J. Emsley, 1991) in the world known until now (with copper purity of between 100% and 0.07%); thus our analysis for developing the database of the above-mentioned repertoire contains only the sites of interest for

prehistoric mining and which are located only in Romania[18]. We applied the same perspective for silver, gold and iron components.

Another direction for the structure of the information to be comprised by the repertoire is the beginning and development of mining in time, including the Roman period. One of the most difficult challenges will be to correlate the places of discovery for certain mining tools (prehistoric and ancient) used for exploiting ferrous and non-ferrous deposits, taking into account the fact that some of these could be used also in those times for salt or construction material extraction. Thus, it becomes necessary to also integrate these *indirect proofs* concerning ancient mining vestiges in the repertoire that I am developing, because by corroborating this information with geological data we can obtain indications for the existence of prehistoric or ancient mining works. Also, this inventorying of the mining sites contains references to elements of fixed heritage (shafts, galleries, mines, areas for exploiting alluvial deposits etc.), as well as the location of objects that constitute indirect proofs for mining in a certain area. In essence, drawing this complex repertoire of the prehistoric and ancient mining works can offer a new perspective on mining vestiges in the area under scrutiny.

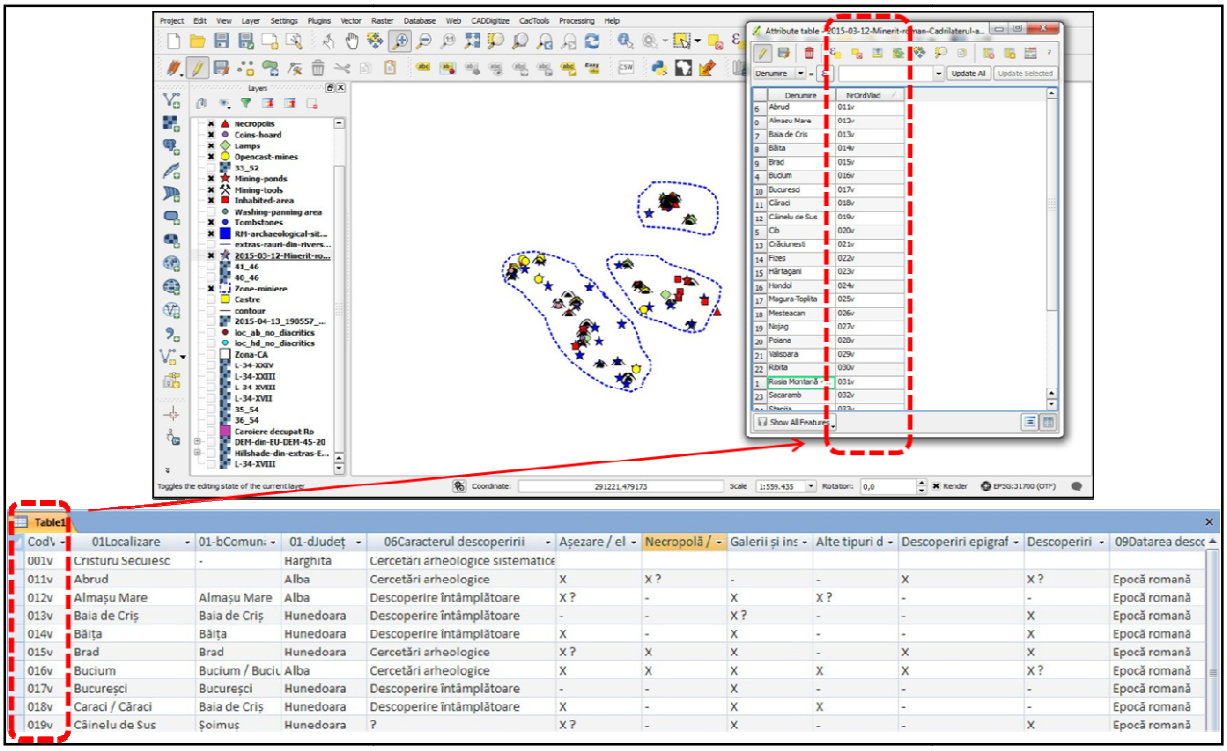

Fig. 6 – Combination of unique codes from MS Access database with the dedicated programs for Geographic Information System (Quantum GIS)

The database created for this purpose includes several criteria, namely:

1. Administrative location;
2. Toponym or toponyms of the places of discovery;
3. Topographical location according to landmarks provided by the bibliography, completed in several case studies with data obtained during my own field surveys (including GPS measurements);
4. Type of discovery: shaft, gallery, mine, washing installation, object;
5. Category of ore/deposit in the area
6. Character of the discovery: systematic, salvage / preventive archaeological excavation, surface research, field survey, archaeological test trenches, chance discoveries etc.;
7. Short history of the research;
8. Present location of the archaeological material;

9. Chronological data of the discoveries;
10. Signalling exploitations from other historical periods;
11. Bibliographical references;
12. Code in the National Archaeological Repertoire (Repertoriu Arheologic Național – RAN);
13. Code in the List of Historical Monuments (Lista Monumentelor Istorice – LMI);
15. Information on the current state of preservation.

Thus, in order to integrate the available data in specialized literature and to precisely locate the main vestiges connected to the exploitation of the ferrous and non-ferrous resources in the "Golden Quadrilateral" in Prehistory and Antiquity, starting with 2013 a GIS (*Geographic Information System*) database was designed and developed, the information structured according to the criteria mentioned above (Fig. 6). The endeavour is difficult, given that most times in specialized literature the information are descriptive and are not accompanied by plans or maps.

Fig. 7 – Georeferencing a map (Baron 2012), using as ground control points the top of the hills from a military map

One example is the situation at Brad, where Roman period mining vestiges are signalled in the Muşari (Muşariu) mine, on the Dealul Fetii, in the Barza mine (gallery named *Treptele romane* – "the

Roman steps", near the Ruda village), in the *Sf. Ana Gallery*, in the Ruda-Brad mine (galleries *12 Apostoli* and *Zdrahonț – Sf. Ioan*) or on the Muncelul hill – near Ruda (V. Wollmann 1996, p. 134–136, 187–188; M. Simion *et al.*, 2010, p. 42). In order to map all these discoveries we used maps of contemporary exploitations (M. Baron, 2012, fig. 1), geo-referenced with the aid of the Quatum-GIS software, using as control points the peaks of surrounding hills (Fig. 7, 8) There are similar situations on other ancient mining sites in the Golden Quadrilateral.

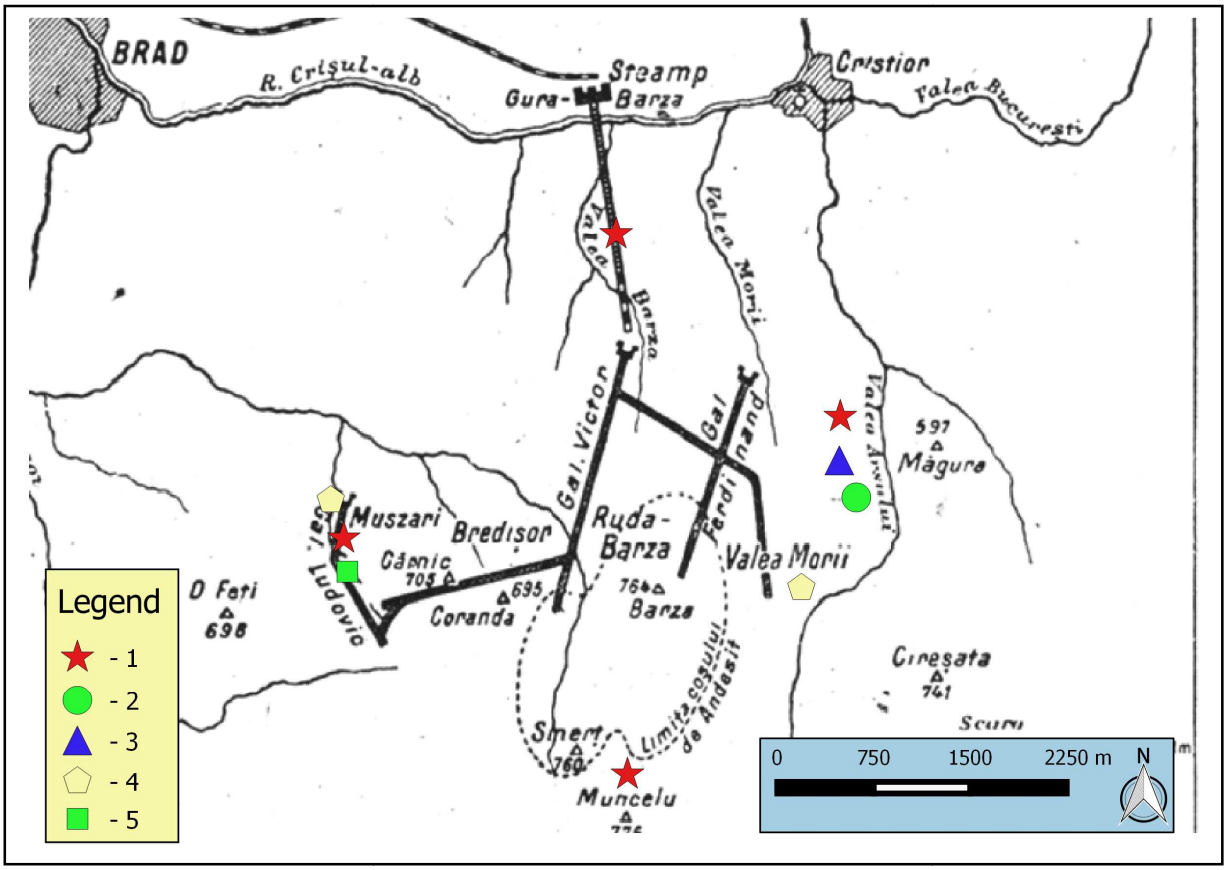

Fig. 8 – Brad area and the main Roman mining discoveries: 1 – underground works; 2 – monetary hoard; 3 – opencast mines; 4 – mining tools, 5 – waste dumps

Even if it is an on-going project, this repertoire is a very useful tool that will contribute to the better knowledge and preservation of a heritage category that is rather neglected in Romania, but which has a significant potential for both scientific research and for cultural tourism.

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Notes

1. Different epigraphic monuments from the mining areas were also mentioned by chroniclers and antiquarians such as Ioannes Mezerzius (1470–1517), Stephanus Taurinus (1485–1519), Martin Opitz (1597–1639), Samuel Köleséri (1629–1683), who published a series of inscriptions from the Apuseni Mountains in a book called *Auraria Romano-Dacica*; the Jesuit monk Ioannes

Fridwaldssky approached the same topic in his work *In Romano-Transilvanicae honoribus comiti Andreae ab hadik oblatae ab Josepho Thoroczay de Thoroczko*, published in 1767 (V. Wollmann, 1996, p. 11–13; 17–19; D. Vleja, 2011, p. 88–91).

2. *Corpus Inscriptionum Latinarum*, available on-line at http://cil.bbaw.de/cil_en/index_en.html. Also, the wax tablets discovered at *Alburnus Maior* were published in volume I of the series *Inscriptiones Daciae Romanae* (1975), while the epigraphic material from the *Alburnus Maior – Ampelum* area discovered up to '80s of the last century was published in volume III/3 of this series (IDR III/3, 1984), along with translations and comments (V. Wollmann, 1996, p. 12–13).

3. In this context we must mention the work of Téglás Gábor (1848–1916), a nature scientist and self-taught archaeologist who, at the end of the 19th – beginning of the 20th c., published many articles concerning Roman mining works in Transylvania. Recently, his biography was published (E. Gáll, 2014), containing a list of all the works on mining. The same interest for archaeology came out in his brother, István Téglás (1853–1915), who managed to gather unique information concerning gold processing, salt and construction material extraction in Roman Dacia (I. Bajusz, 2005).

4. For a history of these discoveries in the Roșia Montană area see P. Damian, C. Borș, 2008, p. 482–486.

5. At the present moment, in Romania, industrial heritage is protected by Law no. 422/2001 for the protection of historical monuments. We must mention the organizing of international workshops on industrial archaeology in our country: 2001 (in Bucharest), 2002 (Banatul Montan), 2003 (Cluj-Napoca), 2004 (Baia Mare) and 2007 (Bucharest). See information available on-line at http://www.cimec.ro/patrimoniuindustrial/, where there is a short presentation of the above-mentioned workshops, as well as an international definition of *industrial heritage*; the information has not been updated after 2007.

6. International interest for the study and preservation of industrial heritage dates to the 1970', when the The International Committee For The Conservation Of The Industrial Heritage (TICCIH) was created. Starting with 2000, this committee became a specialized institution of the ICOMOS – International Council on Monuments and Sites – that provides consulting on industrial heritage and the inclusion of such sites in the UNESCO List of World Heritage.

7. Since 2013, in the Doctoral School of the "Valahia" University in Târgoviște, I focused my research on the possibility of exhibiting to the public the historical mining heritage in central and north-western Romania, a first step in this direction being a GIS (*Geographic Information System*)-based repertoire of all discoveries connected to prehistoric and ancient mining.

8. A survey of mining works in the gold-bearing alluvial deposits of the Pianu Valley (Alba County) was undertaken in 1999 and 2000, occasion in which three such works were identified on a surface of 320 km^2. These were vast and long works, aligned and regular on the slope, and small pits, together with the mounds of debris (H. Ciugudean *et al.*, 2000, p. 75–76; B. Cauuet *et al.*, 2003, p. 472).

9. In 1999–2001 annual reports were published, initially presented by the University of Toulouse (B.Cauuet, 1999, 71 p., 55 fig.; B. Cauuet, 2000, 156 p., 133 fig.), given the fact that this university financed all mining archaeology research in 1999, and later by the Romanian Ministry of Culture, when the *Alburnus Maior* National Research Program started (B. Cauuet, 2001, 216 p. + illustration). In 2000, 60% of the expenses for the mining archaeology research at Roșia Montană was covered by the French state (*Ministère des Affaires Étrangères* and *Unité Toulousaine d'Archéologie et d'Histoire – U.T.A.H*), the rest of 40% by S.C. Roșia Montană Gold Corporation – RMGC. From 2001, the financing of the program for the research of ancient mining vestiges at Roșia Montană was provided by the private company and the French university (Béatrice Cauuet *et alii*, 2003, p. 471). Starting with 2002 and up to 2013, the funds for this research were provided exclusively by the mining company, with the reports transmitted to the Romanian Ministry of Culture and the Romanian National Archaeological Commission, according to the laws passed since 2000 concerning the protection of archaeological heritage (B. Cauuet, 2002, 243 p., 233 fig.; B. Cauuet, 2003, 219 p., 146 fig.; B. Cauuet, 2004, 219 p., 160 fig.; B. Cauuet, 2005, 244 p., 233 fig.; B. Cauuet, 2006, 239 p., 841 fig.).

10. During the archaeological campaign in 2013, two rooms equipped with hydraulic wheels – in their original position – for the evacuation of the water from lower galleries were discovered in the *Cătălina Monulești* Gallery in the Coș Mountain Massif (B. Cauuet *et al*., 2013, p. 114–115, 339; B. Cauuet 2014, p. 98–99). There were also older mentions of such ancient installations preserved in the galleries at Roșia Montană, made by Fr. Pošepny (P. Damian, C. Borș, 2008, p. 485, n. 30 și 31; p. 485–486, n. 38).

11. Single author or co-author of over 90 studies and 12 books on ancient Dacia, mining, metallurgy and history of technology (Ardevan R., 2012, p. 11–17), V. Wollmann managed through his PhD thesis (defended in 1983, published only in 1996 though) to offer a relatively complete image of the mining activities in Roman Dacia (V. Wollmann, 1996). We must mention another series of articles published as single author before 2000 (1976; 1999) or published together with A. Sântimbreanu (1974; 1989), concerning ancient mining works.

12. In the study dedicated to Roman mining in the Zlatna-Stănija area, N. Ludușan (2003) uses entirely the text, illustrations and references of V. Wollmann (1996, p. 136–140, pl. XXXIX, LXVI, LXXXVII), with only a few minor changes. We also mention the work of D. Fodor (2005), intended to be a "history of mining" from the oldest times up to the beginning of the 3rd millennium. Unfortunately, in the 39 pages dedicated to "mining in Dacia under the Roman rule" (p. 71–110), there are entire phrases – slightly reformulated – taken from the works of N. Maghiar, Șt. Olteanu (1970, p. 47–92), without even updating or verifying the information, and off course with no new information. The same goes for the illustration, all taken from the above-mentioned work.

13. Preoccupied by the earliest information concerning the exploitation of mineral resources in Transylvania, together with V. Wollmann, he published an article on the problem of prehistoric mining hammers made of stones. But the use of these artefacts cannot be connected only to mining, given the fact that some of the objects were discovered in areas lacking any mineral resources (V. Wollmann, H. Ciugudean, 2005, p. 96). The problem posed by these tools was also analysed by C. Schuster (1998; 2000), and new examples were more recently mentioned (I. Mareș, 2002, p. 59–60, fig. 72/4–5; N. Boroffka, 2006, p. 74–76; B. Seculici, 2008; C.A. Tulungea, M. Blăjan, 2009; Al. Hegyi, 2012).

14. In the "*Alburnus Maior*" National research Program, in the area of Roșia Montană, several dwelling areas were researched (at Hop-Găuri, Hăbad, the Tăul Țapului area and Dealul Carpeni), as well as sacred areas (Hăbad, Nanului Valley, Carpeni, Pârâul Porcului-Tăul Secuilor), 5 necropolises (Hop, Tăul Cornei, Jig-Piciorag, Țarina, Pârâul Porcului-Tăul Secuilor) and two funerary areas located on the Dealul Carpeni and in the Nanului Valley (P. Damian, 2003; M. Simion *et al.*, 2005; P. Damian, C. Borș, 2008, p. 499–502).

15. "*Exploatarea și prelucrarea metalelor în Dacia romană. Interferențe etnice și culturale*", PhD thesis defended at the University of Bucharest. A series of issues are approached, regarding mining techniques for exploiting gold in Antiquity, as well as everyday life, religion and funerary rite in the mining community, to which is added a list of the main ancient discoveries in the area of the Metaliferi Mountains, in the Banat and in Oltenia. We must also mention the fact that, starting with 2006, D. Vleja was part of the research team from the University of Toulouse, led by Beatrice Cauuet, PhD, and took part in underground excavations in the Cârnic and Orlea Mountain Massifs, as well as in surveys in the Bucium area, Alba County. In 2010 he took part in a series of surveys in the ancient mining areas in central and southern Serbia, led by Vera Bogosavljević Petrović (D. Vleja, 2011, p. 78).

16. Resource available at http://www.cimec.ro/scripts/ARH/RAR-Index/sel.asp (accessed on 28.09.2015).

17. See above n. 12.

18. Copper (100% Cu), Cuprite (88.82% Cu), Tenorite (79.89% Cu), Chalcopyrite (34.63%), Azurite, Bornite, Copper sulphate, copper sulphide, Malachite, Melaconite in D. Rădulescu, R. Dimitrescu (1966, p. 52, 71, 79, 83, 118, 119, 288).

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