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ABSTRACT

Roman Gold and Silver Mining in the Central Balkans and Its Significance for the Roman State

Dragana Mladenović

This paper offers a reassessment of the archaeological evidence for the organization, scale and significance of the Roman silver and gold mining in the Central Balkans. The focus is on two provinces, Dalmatia and Moesia Superior, which contained the majority of the region's mineral resources, roughly corresponding to the modern states of Bosnia and Herzegovina, Serbia, and Kosovo. In contrast to Iberia or Dacia, the Central Balkans have thus far been underrepresented in mining syntheses in the Roman Empire, and, consequently, the importance of the region in the metal supply of the Roman Empire has been critically underestimated. This paper argues that the Central Balkans were the Roman Empire's main source of silver bullion from the second half of the second century until at least the first half of the fourth century A.D.

KEYWORDS

Dalmatia, Moesia Superior, Roman mining, gold, silver, metal supply

DRAGANA MLADENOVIĆ

Roman Gold and Silver Mining in the Central Balkans and Its Significance for the Roman State

1 Conquered in the last decades of the first century B.C. and first years of the first century A.D.[1], the Central Balkans remained in Roman possession continuously for the next five centuries[2]. In Dalmatia and Moesia Superior, the two administrative units into which the region was divided (Fig. 1), mining was quite possibly the most important aspect of provincial economy, undertaken on an industrial scale[3]. Despite of that, the Central Balkans have thus far been underrepresented in the syntheses of mining in the Roman Empire, and consequently, the importance of the region in the metal supply of the empire has been critically underestimated. While administrative arrangements of Roman mining in the Balkans have received some attention in the past, it is the archaeological evidence that has been very much ignored. This paper will thus first bring together and summarise the archaeological evidence for the organization, technology, and scale of Roman silver and gold mining in the Balkans, before offering a reassessment of significance of these operations for the supply of precious metal to the Roman state.

1 This article stems from a paper presented at the Oxford Conference on Mining, Metal Supply and Coinage in the Roman Empire (1–2 October 2010), which was submitted in 2011 for publication in the »Oxford Studies on the Roman Economy« vol. 5 (eds. A. K. Bowman and A. I. Wilson). The current iteration of the paper represents an updated version, created in 2023 following the apparent cancellation of the planned volume. I thank the JdI editors and the anonymous reviewers for the critical reading of the manuscript; their comments and suggestions helped improve and clarify it.

2 On historical background of the area, see Wilkes 1969; Mócsy 1974.

3 Škegro 1999; Mladenović 2009, 70–81.

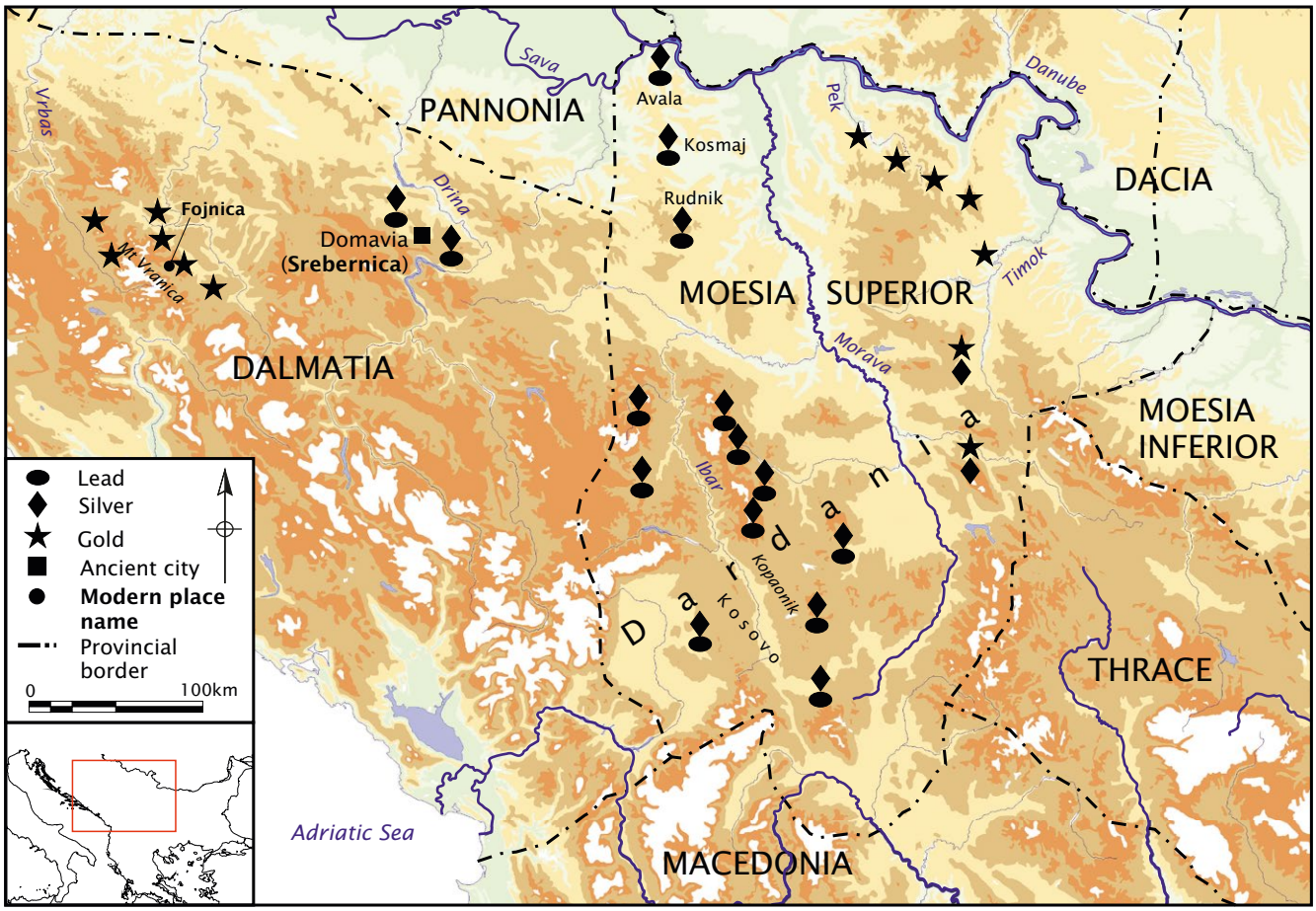

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Fig. 1: Dalmatia and Moesia Superior: gold and silver resources

Geology

2 Owing to complex geology, metalliferous deposits are plentiful in the region (cf. Fig. 1)[4]. Gold and silver mineralization appears in various districts and only sources that were exploited in Roman times will be mentioned here.

3 In Dalmatia gold occurs in gold-bearing pyrite veins, as attested in the vicinity of Fojnica and Mt Vranica (see also Fig. 3). The gold grades of these deposits can vary from 2–3 g/t to over 60 g/t of ore[5]. Furthermore, the diluvial and alluvial deposits of central Bosnia, in the valleys of the Vrbas, Laštva, Fojnička Reka, and Neretvica, contain gold, with a recovery rate of 0.1 to 2 g/t of ›washed‹ material[6]. Two potential sources of gold can be found in the territory of Upper Moesia. First, the valleys of the Timok and the Pek in the north-east, where gold was washed out of the alluvial deposits. The richness of gold-bearing gravels of the Pek valley has been estimated at 288.8 mg of 86 per cent gold per cubic metre of gravel[7]. Further south, in the area of Kopaonik and the plain of Kosovo, gold can be found in the lead-zinc deposits at 6 g/t. Here, silver and gold are found together with a silver grade of 108 g/t and a gold grade of 2.7 g/t of ore[8].

4 Silver is much more plentiful in the region, and, in all cases, silver is linked to tertiary lead-zinc deposits, largely associated with galena and lead sulphosalts, with

4 BRGM – UNESCO 1982, Sheets 5 and 8; Moores – Fairbridge 1997, Bosnia and Hercegovina: 86–93, Serbia: 786–789; Heinrich – Neubauer 2002. On metallogeny of the study region more specifically, see Janković 1997; Palinkaš et al. 2008.

5 Ramović 1999, 10.

6 Ramović 1999, 11.

7 Simić 1951, 321 f. and table 86.

8 Savić 1954/1955, 287. The figures represent mean values.

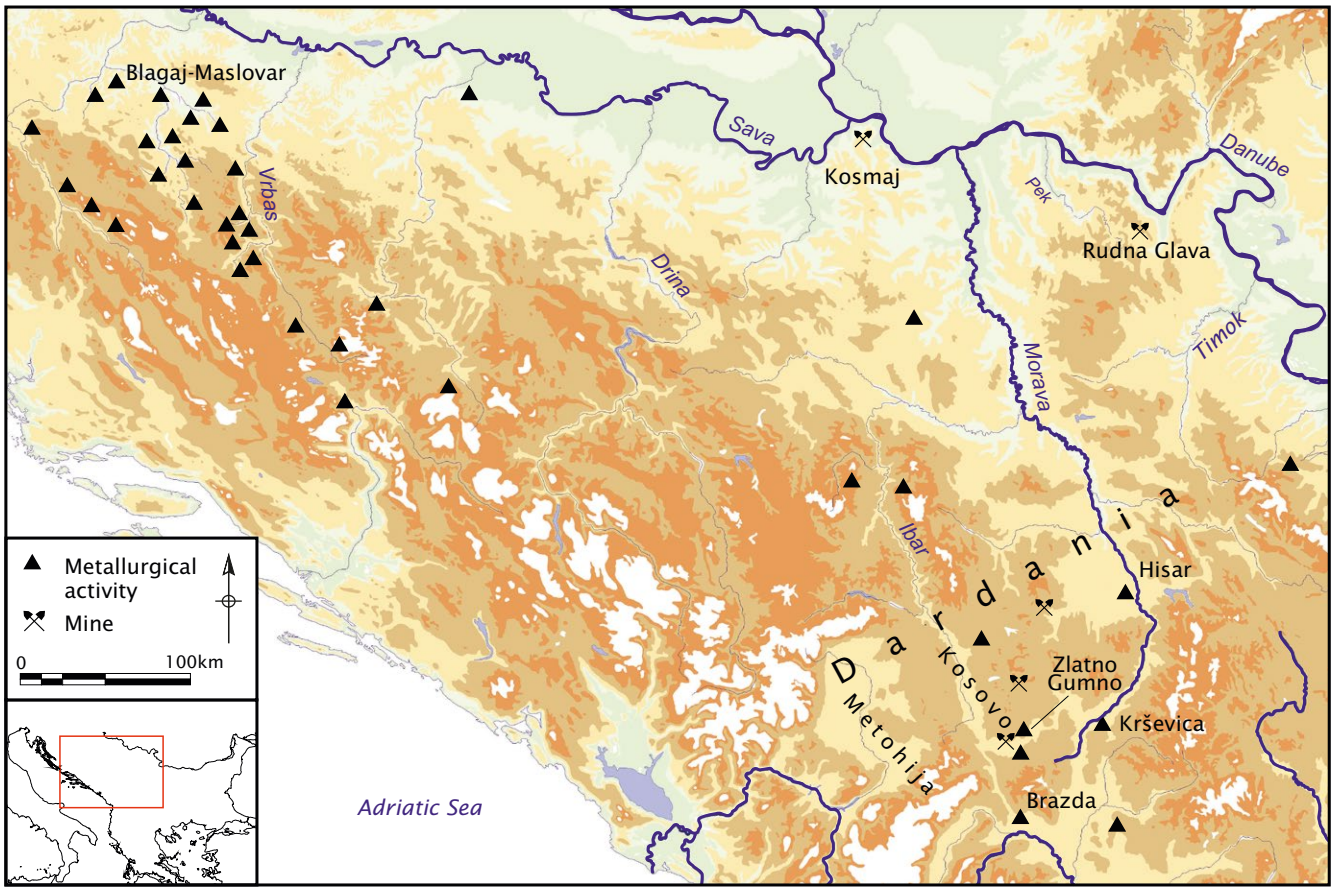

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Fig. 2: Evidence of PRIA mining and metallurgy in the Central Balkans

only the former being used in the Roman period for the extraction of silver. Silver grades vary significantly between ore deposits, with cited values ranging from 100 g/t (Srebrenica) to 1,000 g/t (Kosovo) and up to 2,400–4,000 g/t (Rudnik)[9]. In the area of Srebrenica, lead ore appears in an oxidized form, which is easier to smelt and is close to the surface, making it a very attractive, easily accessible source[10].

Pre-Roman Mining

5 The described mineral wealth fostered an early development of metallurgy in the region (Fig. 2), in particular relating to lead, copper and bronze. The Central Balkans is, in fact, a cradle of some of the earliest metallurgy in Europe[11]. During the second half of the sixth millennium B.C. copper metallurgy developed on several Vinča culture sites in Serbia and Bosnia, with metallurgical production evidence displaying very advanced technical characteristics[12]. The ore was clearly mined locally and a number of early copper mines have been registered, the oldest and best studied being that of Rudna Glava in eastern Serbia. Over forty investigated shafts yielded material belonging to

9 Ramović 1961, 36; Monthel et al. 2002, 40 f., though it is not always clear if authors are presenting mean or maximum values. Monthel et al. 2002 represent an official government ore database and one would assume that mean values are being given, though the figure for Rudnik seems extremely high. For an alternative assessment of the Rudnik ore, see Stojanović et al. 2018.

10 Simić 1973, 71 f.

11 Jovanović – Janković 1982, 29–35; Bogosavljević-Petrović 2006. For a recent overview of early Balkan metallurgy and relevant archaeometallurgical research, see Radivojević – Roberts 2021.

12 Radivojević – Rehren 2016.

the Gradac phase of the Vinča culture, radiocarbon-dated between the late sixth and mid-fifth millennium B.C., making Rudna Glava the oldest documented copper mining site in Euroasia[13].

6 While mining and metallurgical traditions were carried on and further developed[14], closer to the time of the Roman conquest the evidence of metal production becomes scarce and largely indirect. This is not to say that metal production did not continue through the Iron Age and up to the time of the Roman conquest; there is sufficient circumstantial evidence to show that it did, as will be presented below. In fact, it is highly likely that the competition for and control of the metal sources was one of the factors that gave rise to the formation of the Iron Age tribal federations and proto-urbanization in the region[15]. The physical evidence cited in support of local metal production claims is, however, not as unambiguous as is often presented.

7 In Dalmatia, the rise of new Early Iron Age groups such as the Glasinac cultural complex has been linked to the exploitation of rich deposits of iron. Evidence of iron metallurgy of the first millennium B.C. is identified at twenty-seven sites, mostly in eastern Bosnia (cf. Fig. 2)[16]. Slags and other metallurgical residue are reported, but details are sometimes too vague to be able to confidently attribute this evidence to ore smelting. Remains of pre-Roman mining have not been registered; it is probable that later works destroyed any traces. The site with workings closest to the Roman occupation is Majdanište in Blagaj-Maslovar, with ironworking slag dated to the second and first centuries B.C.[17].

8 Regional extraction of silver likely started in the fifth century B.C., judging by the appearance of locally produced belts and plaques with a distinct decorative style (Mramorac type objects)[18], at the time when silver ornaments were almost completely absent from neighbouring cultural circles. Some of the partially investigated fortified sites have been linked to ore smelting, like Krševica-Kale, Brazda-Gradište, and Hisar[19]. The processing of silver-rich ore is postulated based on the remains of kilns, slag, and mills of ›hopper-rubber‹ type[20]. Such mills are known from Thasos and Olynthos, where their identification as ore mills rather than grain mills is based on residue analyses[21], and have been associated with mining operations elsewhere in Greece[22]. None of the cited evidence can be taken as straightforward proof of ore smelting, however, and even if it were, the scale of such activities thus far documented is insufficient to account for the regular metal output that would have been required to support local silver coinages that appear in the last couple of centuries B.C. We must therefore conclude that much of the Pre-Roman Iron Age (PRIA) metal production took place away from the hillforts, likely in some of the same locations as later Roman and medieval extraction, the workings of which destroyed earlier evidence. PRIA material has indeed been noted in the area of

13 Jovanović – Janković 1982, esp. 75; Stanojević 1990; O'Brien 2015, 40–47.

14 Mehofer et al. 2021.

15 In Dalmatia, it was the control of iron sources that drove these processes (Garašanin 1982), while, in the area that was later to become Moesia Superior, the key metal was silver (Vasić 1987, 659; Mladenović 2009, 184).

16 Čović 1999, esp. 81; Škegro 2000, 56–59.

17 Basler 1999, 103.

18 Vasić 1987, 664; Cvjetičanin 1994.

19 Other such sites include Pezovo- Vukosija, Jošanička Banja, Cernica, and Djerekare (Čerškov 1969, 16–18; Sokolovska 1992, 415; Bogosavljević-Petrović 2006; Mladenović 2012, nos. 171. 245. 306. 617. 794. 853. 1168). Some of the claims recently made about the metallurgical evidence from the hillfort of Hisar, alleging iron production datable to the fourteenth/thirteenth century B.C. (Stojić 2006, 105), have proven controversial and cannot at present be taken as reliable (for a reassessment, see Kapuran 2017).

20 A recent survey of millstones from Krševica-Kale does not relate them to ore grinding (Popović – Kapuran 2007), but early excavators report some being found in the vicinity of a preselected ore deposit (Mikulčić – Jovanović 1968); without a residue analysis both grain and ore remain likely alternatives.

21 Robinson – Graham 1938, 326–334; Moritz 1958, 42–52; Muller 1979.

22 e. g. in the Laurion district (Conophagos 1980, 220–222).

Roman mining activities on Kosmaj and in the Pek valley[23], as well as at several locations in ancient Dardania (modern southern Serbia and Kosovo), such as Lece-Rimski Cirk, Novo Brdo and Vrbovac[24]. The Hellenistic site of Zlatno Gumno/Gumnishtë, in the vicinity of Novo Brdo mine[25], was a likely centre of PRIA metal extraction in the area, judging by a silver-rich metallurgical debris in the surface scatter that surrounds it; the site remains uninvestigated.

9 While we lack direct archaeological evidence of PRIA metal production, circulation patterns and recent research into Ag isotope signatures of locally minted coins attest to not only continued but likely also intensified mining activity in the Central Balkans. The earliest local coinage is that of Damastion, dated between 395 and 325/320 B.C. (or 280 B.C. at the latest)[26], minted under clear first Greek and later Paeonian influence, both in technical characteristics and iconography[27]. Although the sequence of issues and chronology of minting is well established, the location of the city remains unknown and various theories have been put forward[28]. Most scholars today agree that it is in the interior of the Balkans, and more precisely in the territory of Dardania, that one should look for Damastion[29]. The only source to mention Damastion is Strabo (7, 7, 8; 8, 6, 16) who places it in the Illyrian lands and refers to Greeks from Chalcidice as having settled there. Since Damastion coins bear certain similarities to the coinage of Olynthos, and Greek material and Olynthian-type mills were found in Dardanian settlements, this statement could well be true[30]. Novo Brdo has been identified as a likely source of silver used in Damastion coinage[31], based on the Ag isotope and trace metal composition.

10 From the end of the third and the beginning of the second centuries B.C., the Central Balkans were swamped by imitations of the tetradrachms of Philip II. The coins of the earliest type, the so-called Serbian group[32], were made of high-purity silver, weighing 12–13 g. The largest number of individual finds and the only known hoard come from Kosovo and Southern Serbia, with only single specimens known from the rest of the Balkans. The authority behind these issues is not clear, and there is no space here to talk about the nature of this and other local coinages, but, judging by their distribution, they certainly used some source of the Central Balkan silver – mines in eastern Bosnia[33], northern Serbia[34], and Kosovo[35] have all been suggested.

11 The last century and a half prior to the formal Roman takeover of the Central Balkans was a time of intensive warfare, details of which remain largely obscure[36]. No community issued its own coins in this period, and it is possible that general insecurities and political turmoil caused a disruption in mining operations. It is also equally possible that a right to mint independently was lost following one of the many defeats, but that silver was still extracted and handed over as tribute. Currently, we simply have no way of knowing. Future isotope and trace metal composition analyses of local coinage

23 Davies 1938, 408; Todorović 1968, 14.

24 Simić 1951, 240; Čerškov 1969, 18, 79 f. n. 28; Mladenović 2012, nos. 845. 1063. 1743.

25 Alaj 2019, 297–303; Gassmann et al. 2022, 16.

26 May 1939, 45. 187.

27 The weight standard was a 3.40 g Paeonian drachm (May 1939; Ujes – Romić 1996).

28 For an overview, see Ujes – Romić 1996; Škegro 2000, 64–67; Ujes 2002.

29 Mirdita 1975; Sokolovska 1990, 22; Ujes – Romić 1996. Coin circulation seems to indicate a Dardanian provenance as well (cf. May 1939, 7. 200; Popović 1987, 27; Sokolovska 1990, 16; Ujes – Romić 1996, 82–86; Ujes Morgan 2011).

30 cf. May 1939, 31.

31 Westner et al. 2023. Coinage of Paeonian rulers can also be potentially linked to the Novo Brdo ores; Zletovo, which has a similar isotope signature, remains an alternative silver source for either coin emission.

32 Popović 1987, 39–41 table 3.

33 Jovanović 1995.

34 Pink 1939, 127–129.

35 Saria 1924/1925, 99.

36 Mócsy 1974, 31–52; Papazoglu 1978.

circulating in the wider Balkan area, like the later series of the Philip II tetradrachm imitations attributed to the Scordisci, could provide a clue.

Roman Takeover of Mining Works

12 One would expect that the Romans did not waste much time in taking possession of the local mining resources, of which they must have been aware. In Macedonia, Britain or Dacia, the Roman state moved in with impressive speed to explore precious metal mines and take control of already developed mining systems[37], and evidence from Germany and Hispania Citerior suggests that metal resources were used even before Roman rule was established there in full[38].

13 Though there is little physical evidence of Roman mining operations in the Central Balkans that can be archaeologically dated to the first half of the first century A.D., the existence of gold mining in Dalmatia (nat. 33, 67) and Dardania (nat. 33, 12) is, however, mentioned already by Pliny the Elder. Furthermore, an Augustan date has recently been proposed for several lead ingots that have either been found in the region or can be linked to the local sources via isotope analyses[39]. If interpreted correctly, these objects indicate that the mines were taken over and exploited while the conquest of the Central Balkans was still ongoing, mirroring contemporary practices in Spain and Germany. Though tight and direct imperial control of mining resources will become the trademark of imperial exploitation in the Central Balkans, in these early conquest years several notables might have received a mining concession as a sign of imperial gratitude for their role in the conquest, or have independently pursued private mining investments in the region[40].

14 Gradually, the mines of Dalmatia and Moesia Superior were organized into a number of mining districts under Roman control, the exact extent of which is highly speculative[41]. Some believe that the mining districts bore the names of the resident native groups, and that this should be taken as an indication of a gradual takeover of the mining works by the state[42]. Under such scenario, it is highly likely that local communities were forced to work the mines, as a part of their service obligation or *munera*. Florus seems to provide a confirmation of such development when he states that during the time of Augustus the defeated Delmatae were forced to extract gold for the Roman state (epit. 2, 25)[43].

Physical Remains of Roman Precious Metal Mining

15 It should be stressed that no mining region of the Central Balkans has ever been the subject of a systematic survey. The reasons for this are multiple. The fact that Dalmatian and Upper Moesian mining districts belong to different administrative entities, both in Roman times and in recent history, has had an impact on their study, as the

37 Liv. 45, 18, 3. Burnham et al. 2004, 329 f.; Zmudzinski 2007, 59–90; Hirt 2010, 334.

38 Germany: Cass. Dio 56, 18, 1–3, Eck 2004; Spain: Liv. 34, 21, 7, Curchin 1991, 31.

39 This includes ingots from Kuršumlija (IMS IV, 136), Jasenovik (IMS IV, 135), and the *Metallo Messallini* ingot from a private collection that has recently became available for study (Rothenhöfer et al. 2018).

40 Dušanić 2008; Rothenhöfer et al. 2018.

41 Dušanić 1977a, 69–79; Dušanić 1980, 26–37. Hirt's survey of imperial mining organization provides a detailed account of different interpretations and supporting evidence, to which this paper would have very little to add (Hirt 2010, 56–74).

42 Dušanić 1980, 41, though many of the names are not attested pre-conquest and some could equally be topographical.

43 The reliability of Florus could be questioned, as he was writing a century later (cf. den Boer 1972, 1–18), but similar fate of defeated communities has also been recorded for Spain (Flor. epit. 2, 33, 52; 2, 33, 59–60, Cass. Dio 54, 11, 5, cf. Alföldy 2000) and Britain (Tac. Agr. 32, 4), and was certainly not an unusual imperial strategy (Hirt 2010, 147. 334 f.).

experts who studied them tended to stay within their own areas (ancient or modern). The fact that past scholars on the topic were mostly historians has led to the administrative side of the Roman occupation being best understood, but at the same time material evidence was largely ignored. Furthermore, Roman mining took place in some of the most inhospitable landscape of the Balkans, which poses serious limitations on access to evidence. Today, after the tragic events of the 1990s, yet new divisions and the remains of military operations and landmines represent further obstacles to systematic study.

16 As with all of ancient mining, much evidence was systematically destroyed in the course of later extraction. This is particularly true for the region of Kosovo and silver mines of eastern Bosnia. In such areas one is forced to rely on records of early modern travellers and mining companies for details of earlier works that have since disappeared; these are unfortunately far from perfect, as they rarely distinguish between Roman and medieval workings. The best quality evidence comes from areas that were not worked after antiquity, such as central Bosnia and the Kosmaj area, the latter even allowing for the tentative quantification of Roman operations.

17 While only gold and silver mining will be presented here, it should be remembered that there were other significant Roman mining enterprises in the two provinces that left substantial remains, like iron mining in the valley of the Japra (north-western Bosnia)[44], and on the eastern slopes of the Stara Planina mountains in south-east Serbia and Bulgaria[45]. These works will be touched upon only to provide further evidence on regional mining and metallurgical technology, but their workings will remain outside the scope of this paper. Another area omitted from this survey is the Osogovo range, on the border between Serbia, North Macedonia and Bulgaria, though it is customarily listed as one of the regions of Roman precious metal mining in the Balkans[46]. It seems, however, highly unlikely that this mining area provided precious metal in any great quantities – while it is true that argentiferous galena occurs in the Blagodat-Osogovo district, the silver content in the ore is so low that any mining there would have been primarily for lead[47]. Furthermore, evidence of Roman mining in this region is little more than anecdotal, with older works being overwhelmingly of a Saxon date, thus offering little to aid our understanding of Roman operations.

Gold Mining

18 The gold mines of central Bosnia, the *aurariae Delmatae*[48], were the most celebrated Central Balkan gold-producing region (Fig. 3)[49]. Gold was washed out of alluvial deposits of the river Vrbas and its tributaries, and mined out of pyrite and quartz veins in the surrounding mountains. Unfortunately, our knowledge of remains in this area rests almost entirely on accounts of late nineteenth-century Austro-Hungarian surveyors, sent by the imperial administration to assess the mining potential of this newly acquired land. All subsequent studies, with an exception of Wilson, either repeat their information or provide fewer archaeological details[50]. Although non-systematic in approach, these nineteenth-century accounts are of unique value; they present the only

44 Basler 1999; Škegro 2000, 113–136.

45 Giorgetti 1983, 22.

46 cf. Davies 1935, 227 f.; Davies 1938, 412.

47 A conclusion reached by Westner et al. 2023, 12 in a recent survey of possible silver sources in the prehistory of the Central Balkans.

48 CIL III, 1997.

49 Imamović 1976; Bojanovski 1982; Škegro 1999; Škegro 2000, 69–82.

50 The most detailed account is in Škegro 2000, 73–78. Wilson forthcoming provides a reassessment of the evidence though usage of modern satellite technology and current knowledge of Roman hydraulic mining techniques; conclusions obtained this way have been largely confirmed by Wilson's later visit to the sites (Andrew Wilson, personal communication 25.10.2023).

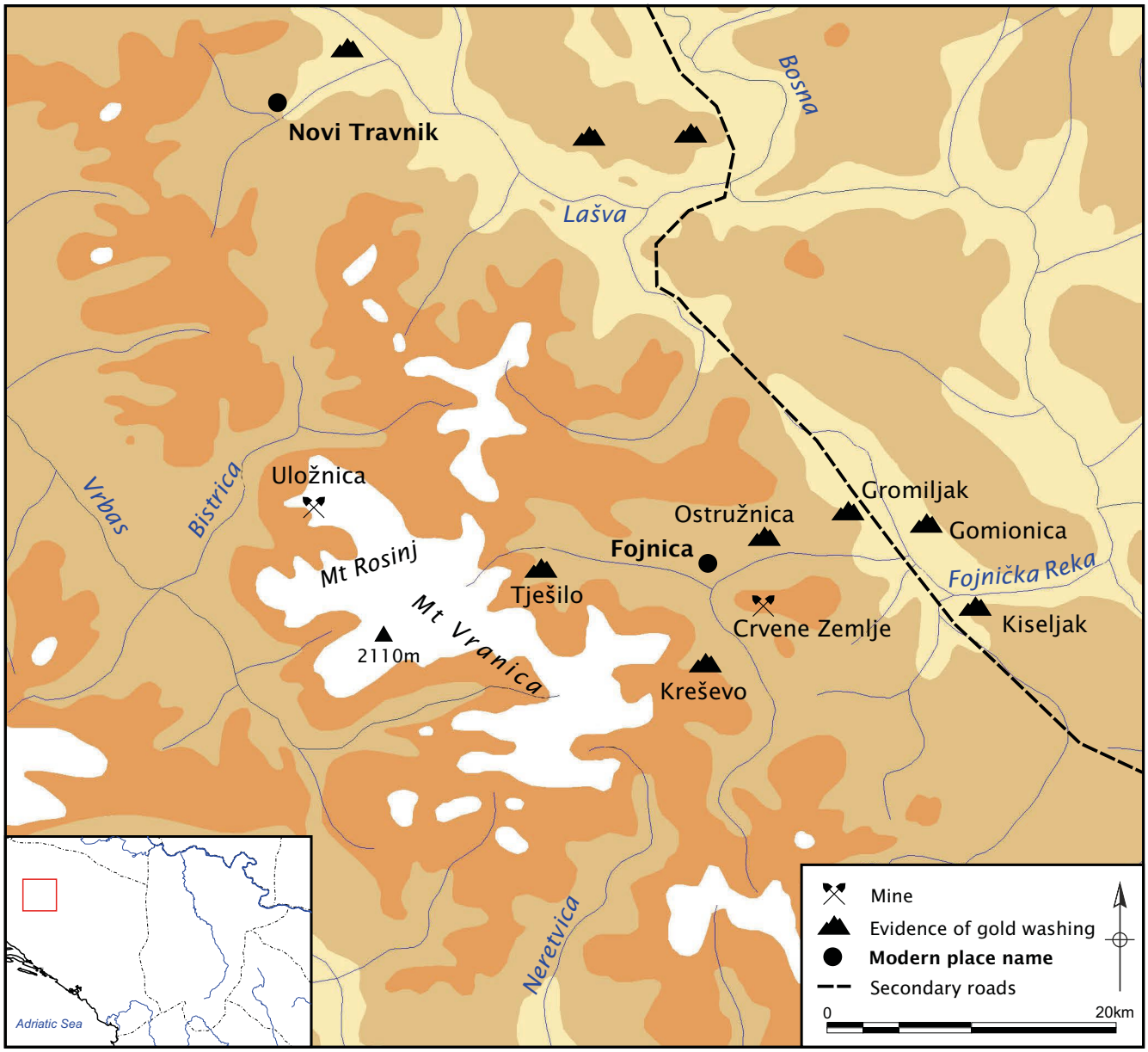

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Fig. 3: Evidence of Roman gold mining in central Dalmatia

existing first-hand descriptions of the remains, and are written with a mining engineer's expertise and insight. Wilson's research has proven them to be highly accurate.

19 The large deposits of river gravel accumulated along river banks bear evidence of gold washing (panning) out of alluvial deposits. Such sterile dumps have been recorded in the valleys of the Vrbas, Lašva, and Vrela[51]. Rücker reports some of the gravel heaps to be up to 200 m long, 30 m wide and 8 m high[52]. Gold-washing heaps cover an area of ca. 300 ha in Gomionica, near Fojnica, with other significant quantities being reported from neighbouring villages[53]. Another concentration can be observed in the vicinity of Kiseljak, in Ostružnica and Gromiljak, the latter spreading over a thousand hectares[54]. Both Rücker and von Foullon describe water channels in relation to placer workings, as well as gravel dumps which lay in rows, which as I will argue later,

51 Rücker 1896, 19–33.
52 Rücker 1896, 29.
53 Conrad 1870, 222; von Foullon 1892, 42. 44; Rücker 1896, 19 f. 61–64.
54 Škegro 2000, 77.

represents evidence of sluicing. Though gravel dumps must have been a striking feature of this landscape in the past (toponyms Gomionica and Gromiljak both stem from words for a pile or a heap), today much of what the early mining engineers have described is obscured either by vegetation or modern development[55].

20 In the same region but at higher altitudes, gold-bearing pyrite and quartz veins were explored by opencast mining. Interestingly, underground prospecting seems to be limited to the bottom of the opencasts, and does not occur on its own. Such opencasts have been recorded in the vicinity of Fojnica and Novi Travnik, and on Mts Vranica and Rosinj. Conrad, in his 1870 account, reports several hundred mines on the slope of Mt Rosinj alone[56]. Twenty years later, in a more systematic survey, von Foullon determined many of these to be prospecting pits (Fig. 4), between 6 and 12 m in diameter and up to 12 m deep. He further recorded between sixty and seventy larger opencast mines in the 2-km zone between the river valley and the mountain ridge[57]. Clearly, the landscape of Mt Rosinj was an intensively worked one, where numerous attempts were made to locate ore veins, many unsuccessful.

21 The largest gold mine in the area is at Uložnica, on Mt Vranica, where Walter reported a large opencast nearly 1 km long, 10 to 150 m wide, and up to 10 m deep; from the floor of the mine thirty-one mining shafts were dug, ranging between 3 and 5 m in diameter[58]. The author also described an 850-m long water channel and a water basin at the edge of the opencast that is still clearly visible today (Fig. 5)[59]. Glicksman proposed identifying the remains described by Walter as an installation for hydraulic mining, that is a hushing tank with water channels running between it and the opencast[60], which appears the only plausible interpretation.

22 Hushing seems to have been used to excavate another large opencast in the vicinity, Crvene Zemlje (250–300 m long, 50–60 m wide, and up to 30 m in depth). Walter records two parallel aqueduct channels that bring water to the edge of the opencast, the higher one running in a rock-cut channel and the lower one through a pipe[61]. At the lower end, large stone clearance dumps, still visible today, testify to washing operations that were subsequently performed within the opencast by means of ground-sluicing (Fig. 6).

23 I would furthermore propose that placer deposits higher up the mountains were sometimes also attacked by sluicing. In the vicinity of Tješilo and Kreševo, both in the area of Fojnica, similar large dumps of sterile gravel have been observed, separated by deep ditches, at times as much as 10 m deep. Although identified as possible evidence of sluicing for gold very early on[62], this has been rejected since »such a technique could not be employed at high terraces without a source of running water«[63]. Knowing that the Romans had means of bringing water to these higher altitudes, there is no reason to reject the original interpretation of these deposits as a result of sluicing for gold

55 I would like to thank Rick Spurway for making the recorded material from his upcoming documentary on Roman gold mining shot on locations in Central Bosnia in September 2023 available to me and for permission to use an aerial image of Uložnica remains in this paper (Fig. 5). I am also grateful to Andrew Wilson for sharing with me his observations from that expedition and allowing me to reproduce his photographs from Mt Rosinj and Crvene Zemlje here (as Fig. 4 and 6).

56 Conrad 1870, 221.

57 von Foullon 1892, 23–26.

58 Walter 1887, 154.

59 Walter 1887, 155.

60 Glicksman 2009, 101; Wilson forthcoming is of the same opinion.

61 Walter 1887, 159.

62 Skarić 1935, 27 f.

63 Andjelić – Ibrahimpašić 1999, 223.

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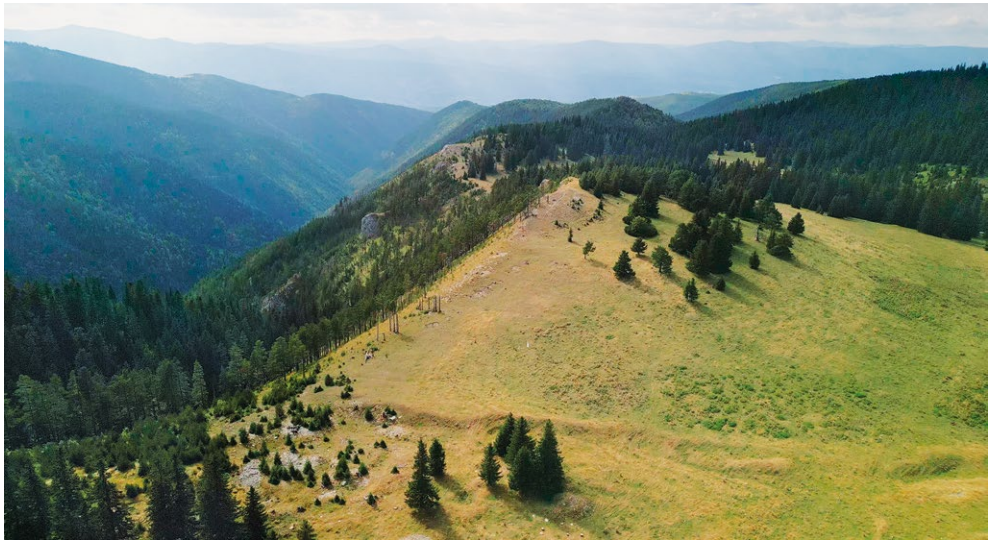

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Fig. 4: A prospecting pit on the south slope of Mt Rosinj

Fig. 5: Uložnica, remains of a water channel running along the edge of a series of small opencasts; stone clearance dumps are visible on the bottom left of the image

prospection. As mentioned before, judging by their position, some of Rücker's accounts also relate to sluicing, particularly those in the upper reaches of the Lašva[64].

24 It is hard to be specific when it comes to the second gold-mining region, the valleys of the Pek, Mlava, and lower Timok in eastern Serbia, north-eastern Moesia Superior; this region is believed to comprise the *metalla Aeliana Pincensia*, with a centre in Pincum (Fig. 7)[65]. Unfortunately, this area is under-researched, and while there is plenty indirect evidence in the form of metallurgical sites, as well as vague general references to remains of gold washing[66], no detailed account of the remains and their scale can be provided[67].

64 Rücker 1896, 19–33, see esp. figs. 14. 15.

65 Hirt 2010, 73.

66 e. g. Wellisch 1917, 148.

67 A pilot survey of archaeological remains of Roman mining in this area was undertaken in 2011 under the leadership of Gerda Sommer von Bülow (Römisch-Germanische Kommission, DAI, Frankfurt) and Gabriele Körlin (Deutsches Bergbau-Museum, Bochum), but was soon discontinued due to limited funding and the

6

Fig. 6: Stone clearance dumps from washing operations within the opencast at Crvene Zemlje

25 The region of the Pek and its tributaries is dotted with ancient mines that provided a variety of metals (Zlot, Bor, Majdanpek, Kučajna, Rudna Glava, and Brodica are some of the mines with confirmed Roman-period works)[68], but the main value of the region lay in its auriferous deposits. Gold was recovered on the surface from auriferous sand and placer deposits of the Pek and Brodica, and on a much smaller scale from primary deposits, mainly the auriferous quartz veins, as indicated by a number of mills for ore-grinding found in the area[69]. Gold was washed on the Pek, its tributaries, and the Timok as well, as evidenced by large deposits of river gravel along the river banks[70]. Wellisch, an Austrian mining engineer sent to evaluate Serbian gold sources during the First World War occupation, reports »traces of opencast gold mining and panning, slag-heaps and decayed tunnels« in the vicinity of Majdanpek that he attributes to Roman activities, but, unfortunately, gives no further details[71]. To what extent these remains can be attributed to Roman-period prospection is hard to tell without further research, since gold washing on these rivers has persisted, in the traditional way, through the Middle Ages into modern times. Stone troughs found in Roman layers show almost no difference in shape from the wooden ones still used today[72].

26 Most of the sites investigated in the area seem to be from Late Antiquity, although coin finds indicate exploitation as early as the first century A.D. Fortified metallurgical sites dominate, of which the site Kraku'lu Jordan was the only one to be significantly excavated. Furnaces and other evidence of gold smelting were discovered within the fortification, as well as workshops for the production of metal tools, pottery, and possibly window glass[73].

complexities of the work. No updated records were created (Gabriele Körlin, personal communication 10.03.2014; Marija Jovičić, Museum of Mining and Metallurgy, Bor, personal communication 16.08.2023).

68 Dušanić 1977a, 74–76.

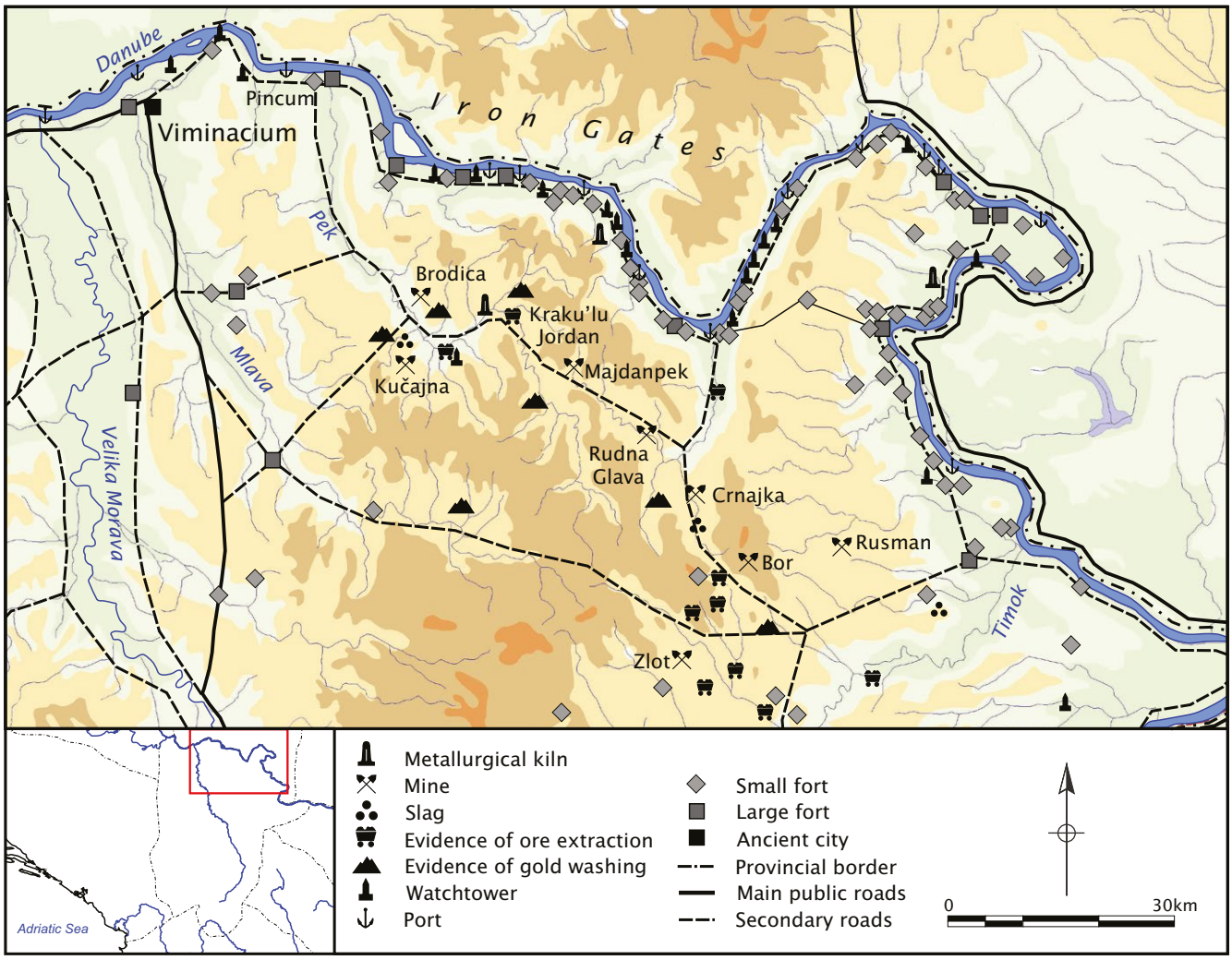
69 cf. Tomović 2000, n. 23.

70 Dušanić 1977a, 74–76; Tomović 2000, n. 23.

71 Wellisch 1917, 148.

72 Djokić 1987–1990, 137 f.

73 Bartel et al. 1979; Werner 1985; Tomović 2000. For other investigated sites in the area, see Kondić 1982; Petković 2009.



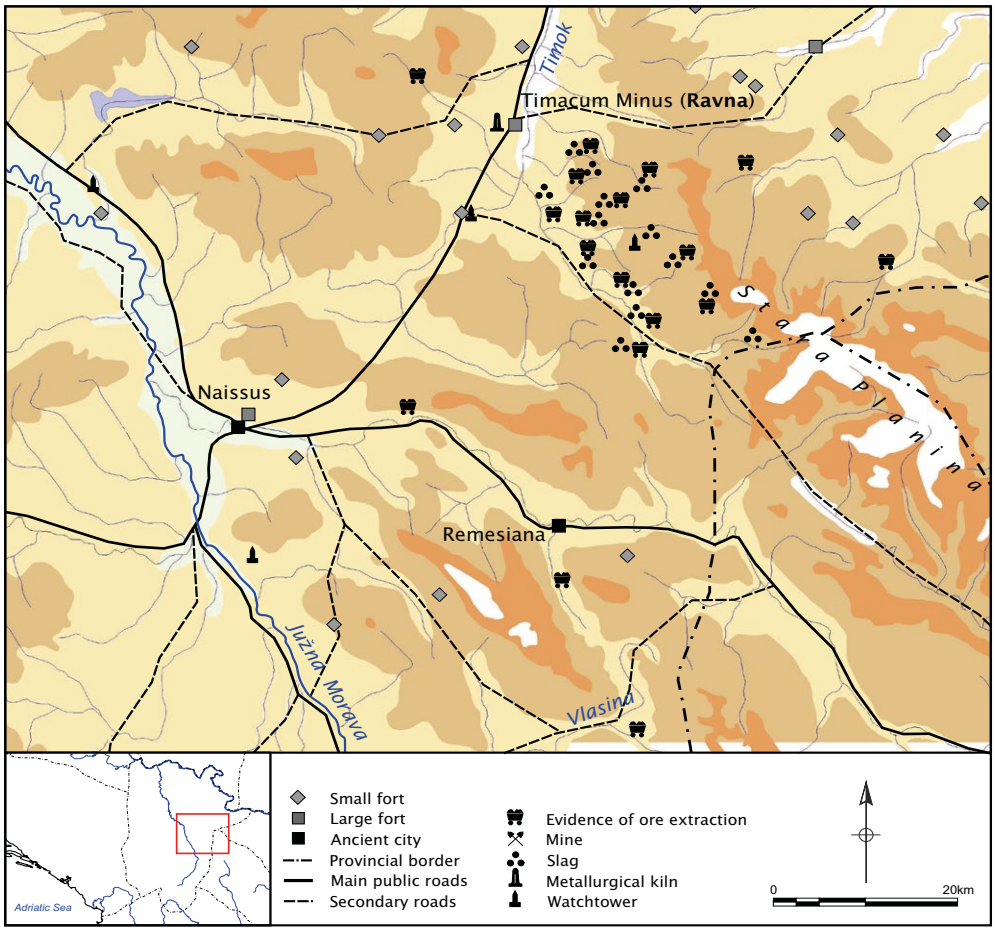
7

Fig. 7: Evidence of Roman mining in north-east Moesia Superior

27 Further south, other mining clusters can be identified in the hinterland of Naissus, on the north-western slopes of Stara Planina and in the Vlasina valley (Fig. 8). Texts from Late Antiquity indicate sources of iron[74] and gold[75] in the Remesiana area. In the upper Timok valley, archaeological investigations have been directed towards fortified metallurgical sites, which can be found in abundance on the slopes of Stara Planina. Some of these are positioned so that they provide protection for the mining operations and the traffic along the valleys. Many of them, as well as the auxiliary fort at Ravna (Timacum Minus), show metallurgical processes taking place within the forts. In the case of Ravna, ore was possibly brought from further away to be smelted[76]. The smelted ore was rich in gold, silver, copper, and iron, while analyses of the slag indicate primarily gold and silver extraction[77].

28 Dating of the gold-mining works described is notoriously difficult and there is almost no direct datable evidence from the mines themselves. Chronology is therefore based on literature, epigraphy, and finds from the related settlements. The earliest evidence from the Pek valley dates from the first century A.D., but intensification of the works does not seem to take place until the early or mid-second century. A particular

74 Prok. aed. 4, 4.
75 Paul. Nol. carm. 17, 269; Nicetus of Remesiana, *De symbolo*, fr. 3.
76 Petrović 1995.
77 Jovanović 1986.



8

Fig. 8: Evidence of Roman mining in south-east Moesia Superior

rise can be observed in the years after the *aurariae* of Dacia were abandoned in 272, with some indications that experienced gold metallurgists might also have come over from Dacia at that point[78].

29 As for Dalmatia[79], if Florus can be trusted, gold was extracted even during the conquest period (epit. 2, 25). As mentioned before, there are several first-century A.D. sources that refer to gold mining in Dalmatia[80], which would speak in favour of an early date. One can also suppose that mining was still intensive under Trajan, as one of his mining coins of the *metalli Ulpiani Delm* reverse type, dated to A.D. 112–114, was found in a mining context at Ilidža[81]. This is the last datable piece of evidence, and it is impossible at this point to say for how much longer gold mining continued in Dalmatia.

Silver Mining

30 The main silver-mining region of Dalmatia was in eastern Bosnia, between the Jader and the Drina, in the area of Srebrenica (Domavia), belonging administratively to the *argentariae Delmaticae et Pannonicae* (Fig. 9)[82]. Roman mining activity was particularly concentrated on the north-east slopes of Mt Kvarac, where numerous

78 Tomović 2000.

79 For a detailed account of Dalmatian mining chronology, see Glicksman 2009, 113 f.

80 Mart. 10, 78; Plin. nat. 33, 67; Stat. silv. 1, 2, 140–157; 3, 3, 85–110; 4, 7, 13–16.

81 Bojanovski 1982, 96.

82 Dušanić 1977a, 66 f. Further silver extraction took place in the upper reaches of the Drina, as well as in the valleys of the Lim and Čeotina (Škegro 1998, 94 f.; Škegro 2000, 87–91), and while these works follow the chronology of the works around Srebrenica, they are on a much smaller scale, less exclusively concerned with silver, and poorly known.

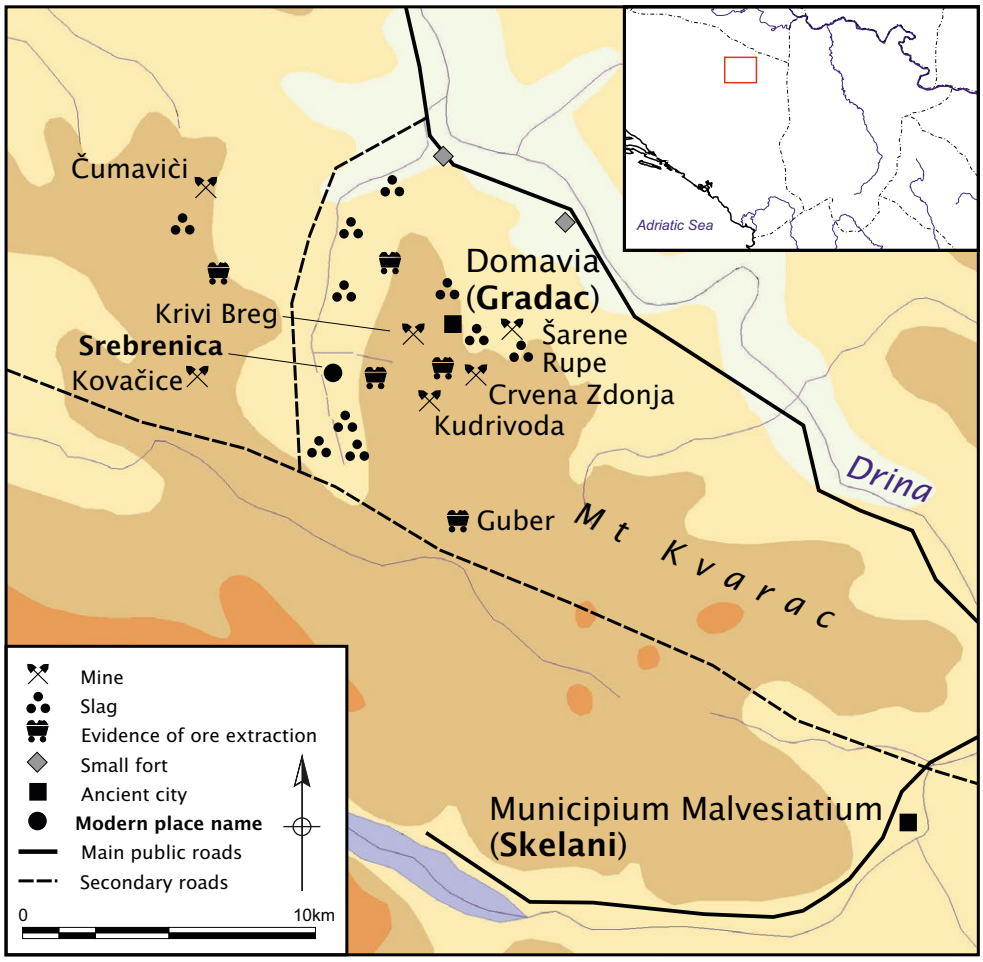


Fig. 9: Evidence of Roman mining in the vicinity of Domavia

9

mining shafts and galleries were recorded, as well as traces of smelters and slag heaps. We owe our knowledge of these remains primarily to mining prospectors sent to record them when workings were relaunched at the beginning of the last century[83] and in the 1950s[84]. In this case, earlier researchers did make a distinction between Roman and Saxon works based on the morphology of the remains[85] and associated archaeological finds[86].

31 Roman works in the surroundings of Domavia seem to follow the veins in regular rows[87]. Walker conducted the most detailed survey of Roman galleries, and describes galleries of trapezoidal, rectangular and elliptical cross-section with a height of 1.1 to 2 m and 0.5 to 2 m wide (Fig. 10). In the upper parts of the mines, they had a falling gradient of 15–20°[88], while some galleries descended to more than 200 m under the ground[89]. Pogatschnig confirms the large size of some of the galleries, and their entrances; a mine at Kovačice had an entrance 3 m high and 2.5 m wide[90]. The regularity, size and style of Roman galleries amazed twentieth-century mining engineers, who de-

83 Walter 1886; Pogatschnig 1890; Pogatschnig 1894; Rücker 1901.

84 Ramović 1961; Ramović 1963.

85 Shape, size and organization of galleries (cf. Walter 1886, 14; Pogatschnig 1890, 128 f.; Davies 1935, 192).

86 At Krivi Breg, a Roman lamp was found, near the village of Dimnići a second-century lamp and three coins of Caracalla, two inscriptions dedicated to Alexander Severus were found in an unspecified local mine (Radimsky 1891), while a bronze coin of Constantius II came out of one of the shafts at Crvena Zdonja (Walter 1887, 134).

87 Walter 1887, 134; Davies 1935, 192.

88 Walter 1886, 14.

89 Ramović 1981, 89.

90 Pogatschnig 1890, 128 f.

scribe them as »so well carved as if they were entrances to underground buildings«[91]. Galleries were well appointed as well, with channels for draining water[92], regular lamp niches (at Šarene Rupe, every two feet, ca. 60 cm), and small alcoves that may have allowed for two-way traffic in the tunnel (at Kudrivoda such widenings were observed every 30 yards [~ 27 m], within a trapezoidal gallery 2 m high, 1.5 m wide at the bottom, and 1 m wide at the top)[93]. Only one opencast mine was recorded, also at Kudrivoda by Davies, as being 200 feet wide and 50 feet deep (~ 61 × 15 m)[94]. Kudrivoda seems to be an exception, as this technique has apparently not been otherwise used in silver mining in the region.

32 Remains of metallurgy can be found all around the area in the form of furnaces and slag heaps mapped first by Pogatschnig and later by Ramović[95]. These remains tend to be grouped in the valley of the Čičevac and Majdanski Potok, around modern Srebrenica, between Sase and Gradina, and among the Roman ruins at Gradina. The whole area is well connected by roads that all converge at Gradina (ancient Domavia), the settlement related to mining works that eventually gained first municipal and then colonial status[96]. The site has been partially investigated and a bath complex, metallurgical and public buildings, residential areas, and cemeteries were uncovered[97].

10

Fig. 10: Gallery of a Roman mine at Čumavići

33 The chronology of silver mining in Dalmatia is uncertain, particularly its beginnings. The earliest graves at the Domavia necropolis are dated to the first century A.D.[98], while the earliest numismatic evidence comes from A.D. 70s[99]. Finds intensify through the second century, with an imperial procurator being epigraphically attested from the mid-second century A.D.[100]. The profile of both numismatic and epigraphic material indicates that the second half of the second and the third centuries were the time of the greatest activity in this region[101]. A bronze coin of Constantius II reportedly found at Crvena Zdonja mine[102] indicates that some works were carried over into the fourth century, but their intensity is significantly decreased, and settlement finds indicate gradual abandonment of the area.

34 Several clusters of Roman silver-mining activity can be identified in Moesia Superior, the largest ones being in ancient Dardania and organized into *metalla Dardaniae*[103]. This is the area of greatest mineral wealth and at the same time the area

91 Ramović 1999, 16.
92 Ramović 1999, 16.
93 Davies 1935, 192 f.; Basler 1999, 95.
94 Davies 1935, 193.
95 Pogatschnig 1890; Pogatschnig 1894; Ramović 1961; Ramović 1963. See also Rücker 1901, 53.
96 Municipal status was granted in the late second century (CIL III, 12741); colonial by the middle of the third (CIL III, 12728).
97 Radimsky 1893; Radimsky 1896; Rücker 1901; Pašalić 1954.
98 Srejović 1965.
99 Škegro 1998, 93.
100 Bojanovski 1982, 104; Škegro 1998, 93 n. 11; Glicksman 2009, 114.
101 Škegro 1998, 93; Bojanovski 1999; Šačić Beća 2022.
102 Walter 1887, 134.
103 Dušanić 1977a, 73 f.; Parović-Pešikan 1987–1990.

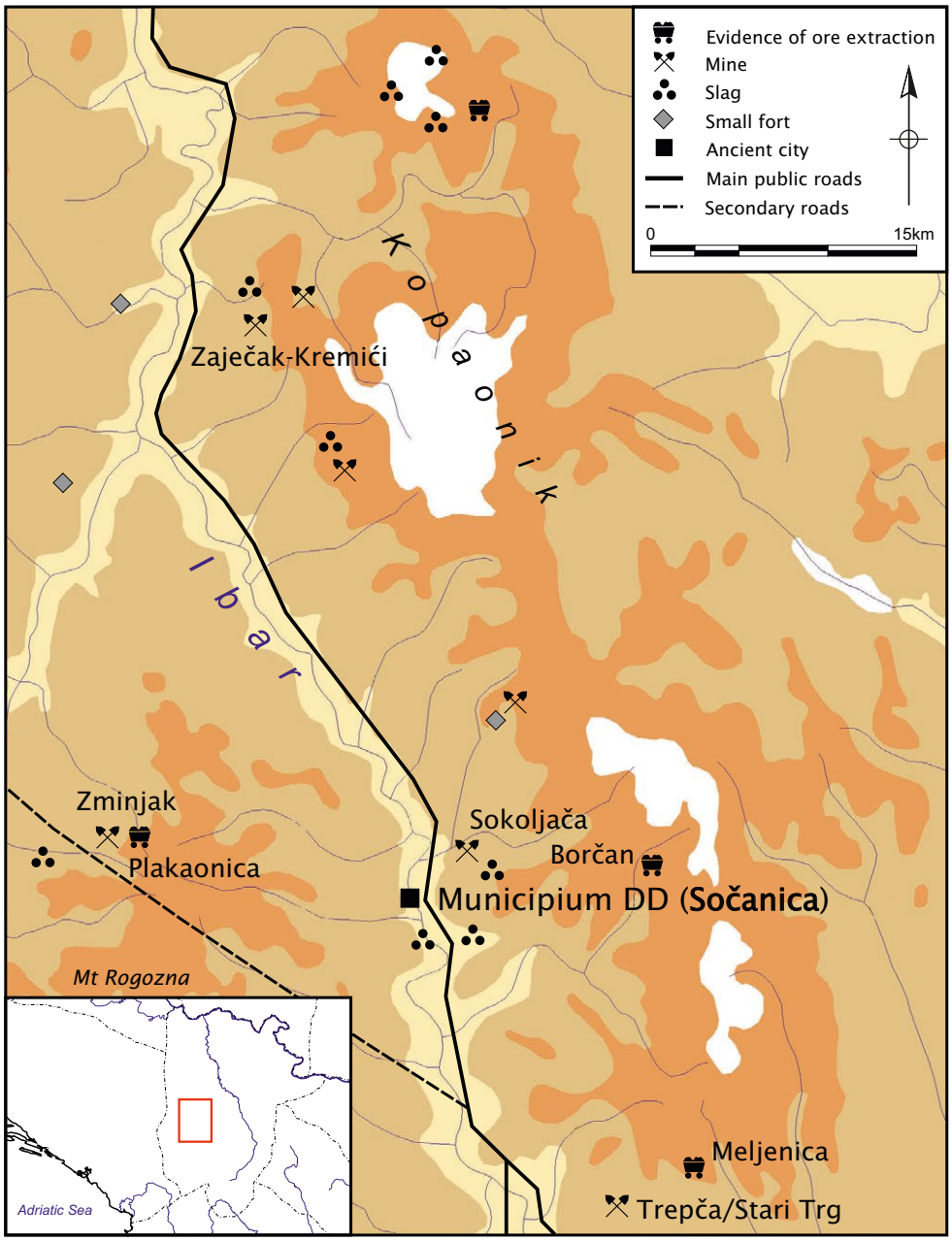


Fig. 11: Evidence of Roman mining in the vicinity of Municipium DD

11

where remains of Roman mining are worst preserved, due to intensive exploitation in medieval and modern times (in the fifteenth century the output of this area comprised one fifth of the total European silver production[104]). As with central Bosnia, one has to rely upon patchy and at times anecdotal evidence, often preserved by travellers and mining engineers, but even this kind of evidence is scarcer as post-Antiquity workings were infinitely more exhaustive.

35 The first cluster of remains of Roman works can be found in the valley of the Ibar, centred around Municipium DD (Sočanica/Soqanicë) (Fig. 11). Both banks of the Ibar have been reported to contain evidence of mining and ore processing and have yielded inscriptions mentioning *procuratores*, but systematic investigations have not been carried out[105]. In the area of Sočanica, throughout the eighteenth and nineteenth centuries, peasants were finding »pieces of pure lead up to 50 okas [~ 60 kg] in

104 Ćirković 1981; Spremić 1999, 690, with older bibliography.

105 Dušanić 1977a, 72; for remains in the wider area, see Popović 1983; Marić 2019.

weight«[106] which they sold on, indicating possible Roman ingot finds. A note from the beginning of the century mentions ancient slag covering an area of 6,500 m² in the vicinity of the ruins of the Roman town in Sočanica[107]. Two groups of mines can be associated with this centre: one in the region of Sokoljača and Borčan, clearly separated from the medieval mining complex to the west and linked to Sočanica by a road that was visible until recently; the second on the slopes of Mt Rogozna. In this area, on the hills of Zminjak and Plakaonica/Pllakanicë, large ore tailing dumps were recorded (at the site of Zminjak alone ca. 33,000 tonnes of lead-zinc ore were recorded in 1926)[108].

36 Once modern works were activated in the area, many galleries, whose construction indicated Roman workings, were exposed and destroyed, with only few incomplete testimonies surviving. The Selection Trust, which in the 1930s acquired the Stari Trg mine in Trepča/Trepça, the largest and wealthiest mine in the area, left some accounts of the ›old works‹ that they encountered, but without attempting any distinction between Roman and medieval remains[109]. They report encountering around 10,000 ancient shafts in the territory of their concession, some descending 200 m below ground, with old workings having been found 300 m below the surface at one time[110]. The fact that galena seems to have been the mineral most sought by the old works[111] is consistent with, but not exclusive to, the Roman practice. Some of the old shafts that were cleared and prospected were »found to connect with extensive galleries and many-chambered stopes, the latter often of impressive size«[112]. Slag heaps, spoil-dumps, adits, and occasional opencast working were also recorded, as were discoveries of ›pig-lead‹, but without any further details or photographs. Old works spread to the hills all around: at Meljenica/Melenicë (1 mile, ~ 1.6 km, north-east) a »maze of old galleries and stopes« was observed, and at Trepča Hill, 1.5 miles (~ 2.4 km) from Stari Trg, still larger stopes have been entered. The Stari Trg mine itself was found to be an old opencast associated with many shafts; an old adit was cleared, enlarged and remained in use as a drainage adit in the new mine[113]. It is impossible to tell to what extent these descriptions relate to Roman mining works, as no associated finds are mentioned and no detailed illustrations are provided. A single photograph survives of the ›old works‹ that were encountered (Fig. 12), depicting an entrance to a shaft that in its properties resembles Roman shafts from the Srebrenica and Lece area, rather than less regular medieval Saxon works, but this does not help with attribution of the rest of the record.

12

Fig. 12: Stari Trg mine, locality Madjera/Maxhera, a photograph from 1927

106 Popović 1906, 218. An ›oka‹ is an old Turkish weight measure of approximately 1.25 kg.

107 Čerškov 1970, 55 n. 97.

108 Simić 1951, 224; Čerškov 1970, 71.

109 Full documentation is held in the London School of Economics archives, ref. GB 0097 Selection Trust.

110 Selection Trust Archive ADD/23, Misc. 2. Also in Titcomb et al. 1936.

111 Brammall et al. 1930, 1.

112 Brammall et al. 1930, 1.

113 Selection Trust ADD/23 contains a cross-section of the mine showing some of the old opencasts, adits, and galleries that were cut through. Unfortunately, this does not aid their dating.

37 On the lower reaches of the Ibar, archaeological surveys in the central area of Mt Kopaonik have revealed a spectrum of settlement types, including hillforts, metallurgical sites, settlements, and necropoleis[114]. At Zaječak-Kremići, a late antique metallurgical centre was excavated revealing at least eight furnaces for smelting ore rich in iron, gold, and copper. Slag at the site was estimated at 630 m^3 or around 1,000 tonnes, but that is much less than its original quantity. Records from the past fifty years show large amounts being taken away for reprocessing with modern methods, and without any records for previous periods the original quantity is impossible to determine. Remains of shafts, galleries, and opencast works were discovered in the immediate vicinity as well, so the site provides evidence of the entire process of metal extraction. Though this is a primarily ironworking site, its development and chronology can serve to supplement what we know for silver-works, as it has been noted that ironworking on Kopaonik through all of the periods never developed on its own, but complemented and depended on the fortunes of silver mining further up the Ibar[115]. Dating of these works could thus serve as an additional indication that the extraction of silver in the area continued throughout the fourth century.

38 Further south, another mining concentration can be identified around the *municipium* of Ulpiana (Fig. 13), where a metalsmithing complex and an ore mill have been discovered[116]. Silver and lead mines in the vicinity, at Novo Brdo/Novobërdë and Janjevo/Janjevë, are among the richest in the Balkans and have been continuously worked since Antiquity. In the Middle Ages, the riches of primarily Novo Brdo enabled the rapid economic rise of the Serbian kingdom from the thirteenth century onwards[117]. Silver from these mines, the so-called *argentum de glama*[118], has a high proportion of gold (16.6 per cent today, while medieval sources speak of silver containing 25 to 29 per cent gold)[119]. Gold was certainly extracted from this ore in the past, in significant quantities[120], and it is most likely that Pliny refers to the products of this area as Dardanian gold[121]. In the area to the northeast, along the valleys leading towards Naissus, clusters of Roman mining activity have been observed in the vicinity of Lece and Tulare. Several metals occur in locally present ores, including gold, lead, copper, zinc and silver, while preliminary analyses of the present slag seem to indicate that, beside precious metal, iron was particularly targeted[122]. It is unknown if a similar dependence, and one suspects a symbiotic relationship, existed between these ironworks and precious metal extraction in the surroundings of Ulpiana, as was the case with analogous mining centres in the Ibar valley.

39 Unfortunately, constant exploitation has left few traces of older works in this region. We know that some galleries discovered in the Janjevo mine were Roman, based on Roman coins found in them[123]. Hofmann, travelling in the late nineteenth century, describes remains of mining works around Novo Brdo, traces of opencast mining, galleries, and vast amounts of slag. He estimated the total slag quantity around Novo

114 Bogosavljević-Petrović 1989; Bogosavljević-Petrović 1995; Mihailović 1997.

115 Simić 1975, 77.

116 Parović-Pešikan 1987–1990; Parović-Pešikan – Stojković 1995.

117 Dinić 1962, 27–95.

118 Simić 1951, 36–38; Voje 1970.

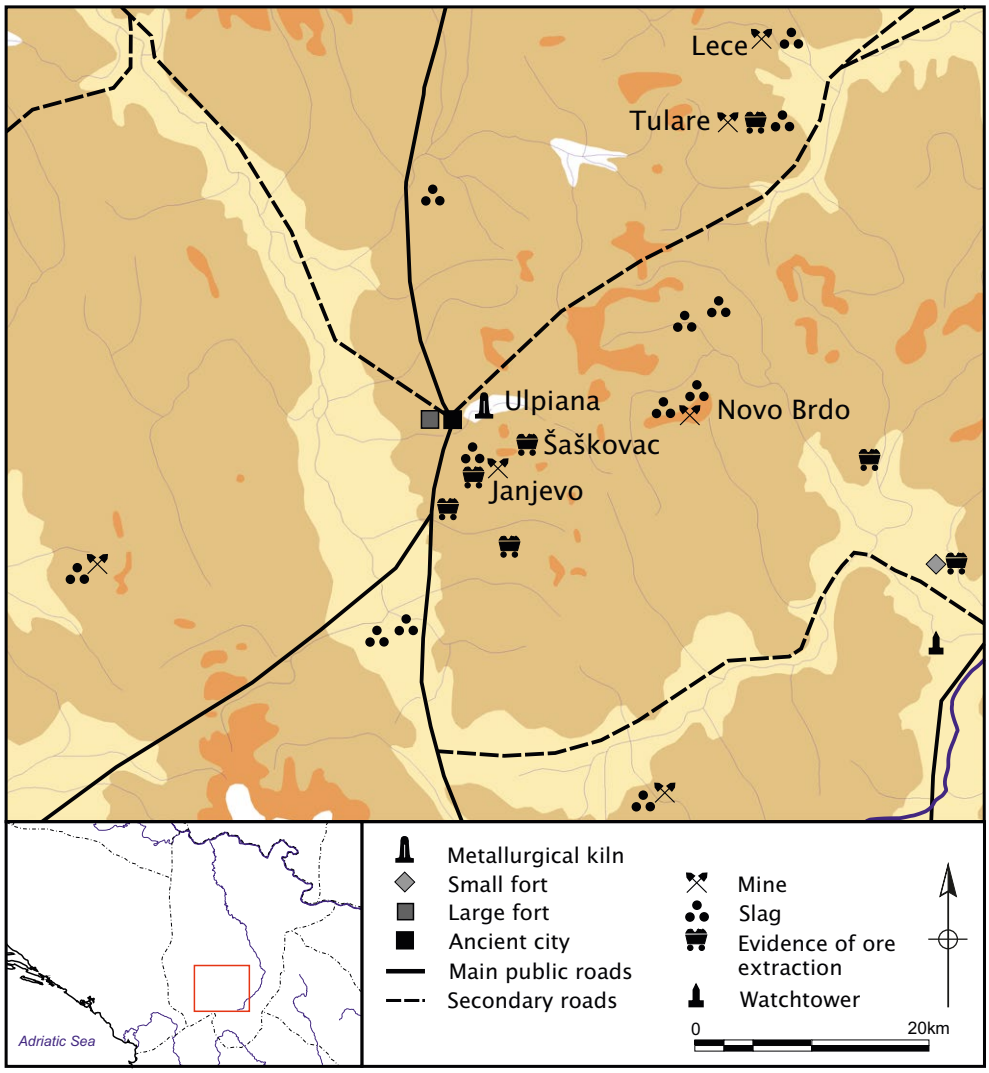
119 Savić 1954/1955, 287; Vinaver 1960, 499–501.

120 The income of the Serbian despots in the thirteenth century has been estimated to be between 120,000 and 200,000 ducats annually, from just one mine alone (Novo Brdo, which was likely also worked in the Roman period, as discussed further in the text); assessments are by Giovanni da Capistrano (1455) and Bertrandon de la Broquière (1433), cf. Fermendžin 1892, CMLIV; Bertrandon de la Brocquière 1972, 214.

121 Plin. nat. 33, 12, 39.

122 Stamenković 2009, 228–232; Stamenković 2013; Bugarski et al. 2018; for the preliminary analyses of iron slag, see Stamenković 2013, 87.

123 Simić 1951, 229; Čerškov 1969, 34. 83 n. 75.



13

Fig. 13: Evidence of Roman mining in the vicinity of Ulpiana

Brdo to be more than 100,000 tonnes[124], while Savić, writing in the 1950s, found around 40,000 tonnes still remaining[125]. The fact that some of the recorded foundries were located on higher ground or where water supply would have to be augmented by artificial means[126] could indicate their Roman date, but this is highly circumstantial evidence and not enough to attribute the recorded slag to Roman operations. Roman dating of workings at Novo Brdo and Lece currently rests solely on finds from the vicinity of the mines[127] and the recent attribution of the early first century A.D. Messallini ingot to the Novo Brdo metal source via lead isotope signatures[128].

40 In the recent years, a systematic field survey aiming at understanding the entire *chaîne opératoire* of historical metal extraction has taken place in the hinterland of Ulpiana (Fig. 14)[129]. Years of work by a multidisciplinary team have led to mapping

124 Hofmann 1893. About three decades later, Hiessleitner surveyed the same region providing further details on geology, but without quantifying the surviving remains of slag; evidence of old mining works and tools are mentioned in passing, without sufficient detail that would allow for their characterisation or dating (Hiessleitner 1927).

125 Savić 1954/1955, 285.

126 Hofmann 1893, 599; Savić 1954/1955. For analogous positioning of Roman works in Bosnia, see Rücker 1896, 25; Andjelić – Ibrahimpašić 1999.

127 Simić 1951, 240; Čerškov 1969, 18. 79 f. n. 28.

128 Rothenhöfer et al. 2018.

129 Körlin – Gassmann 2016; Gassmann et al. 2022.

Fig. 14: Mining debris on the slopes of Šaškovac/Shashkoc, Janjevo area

14

of extensive mining and metallurgical remains. Their efforts have unavoidably been largely diachronic, however, comprising evidence from Roman/late antique, medieval and Ottoman periods. Reliable chronological attribution of the described material was not always possible, though work on dating is ongoing. Typology and analogy, however, indicate that much of the recorded works are later in date, and, in many cases, it was clear that the observed works have obliterated earlier ones, the extent of which was thus impossible to estimate.

41 Roman coins discovered in the Janjevo mine belonged to Trajan, Constantine I, and Leo I[130], dating these works from the second to the beginning of the fifth centuries. First-century activity should be supposed as well, as ingots stamped *metallum Dardanicum* were discovered in a Domitianic shipwreck at Caesarea Maritima in Israel[131]. Since this was the area of intensive PRIA silver exploitation, one can only assume that the Romans took over the works relatively swiftly, as the early first-century AD Messallini ingot likely confirms[132]. If one can judge by the material from the associated settlements of Ulpiana and Municipium DD, the period of greatest activity was between the second and the fourth centuries A.D.

42 The last significant silver source in Moesia Superior was in the north-western part of the province, consisting of the workings on the Mts Kosmaj, Rudnik, and Avala (Fig. 15)[133]. The principal ore in the area is argentiferous galena[134]. Although probably not the most intensively worked of the Roman mining regions, it is in this area that the archaeological evidence is the strongest, since few activities in medieval or modern times affected its survival[135].

43 The area of Kosmaj has been surveyed on a number of occasions, revealing an entire hierarchy of sites: mines, metallurgical centres, forts, villas, and abundant

130 Čerškov 1969, 34, 83 n. 75.

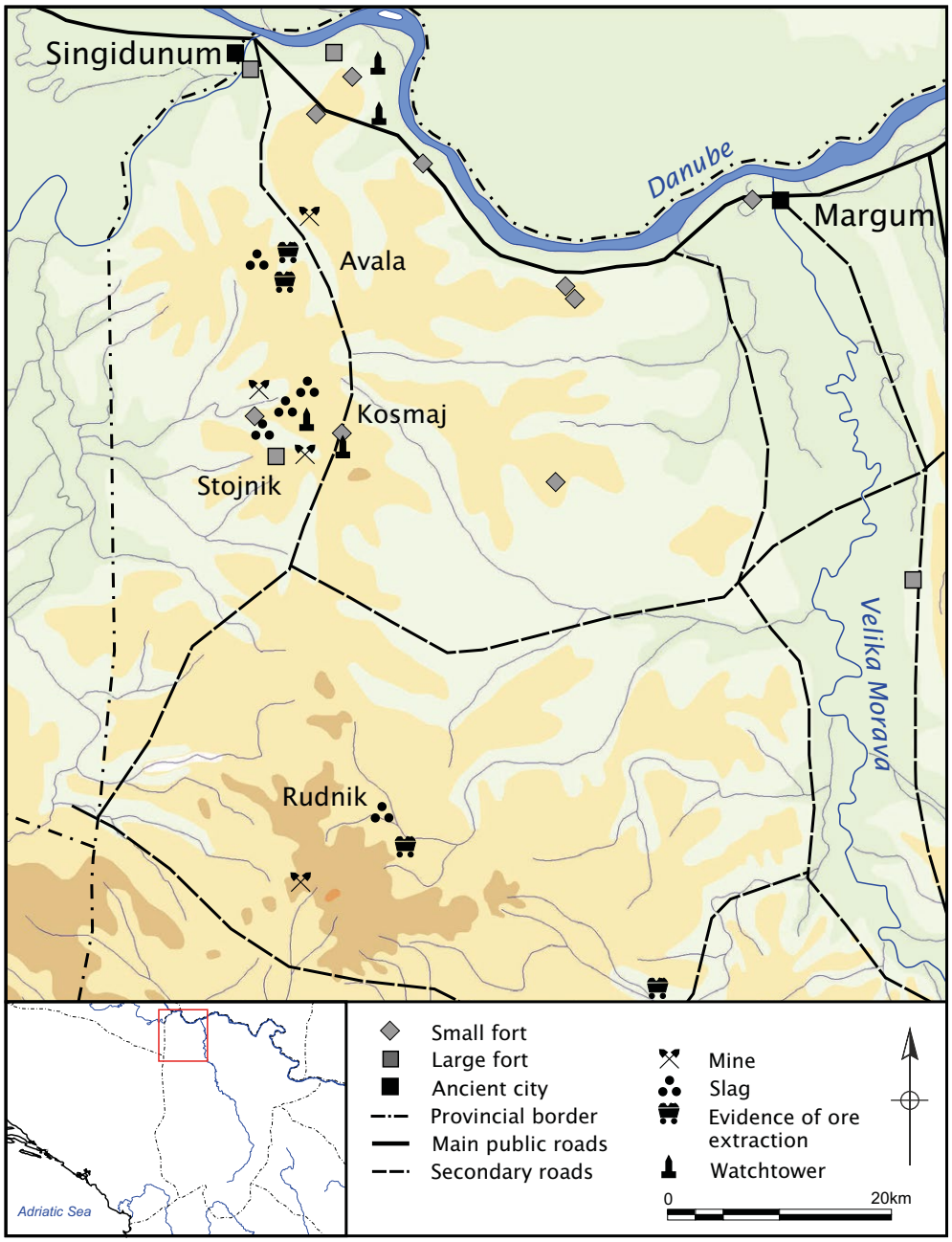
131 Raban 1999.

132 Rothenhöfer et al. 2018.

133 Davies 1935, 215 f.; Simić 1957, 71 f. It is not clear to which *territoria metallorum* this area belonged (cf. Dušanić 1977a, 79; Škegro 1998, 90; Marić 2015).

134 Davies 1935, 216 f. The mineral is occasionally auriferous.

135 For Kosmaj, see below; for Rudnik, see Jovanović – Mrkobrad 1986; Jovanović et al. 1989; Jovanović et al. 1990.



15

Fig. 15: Evidence of Roman mining in north-west Moesia Superior

evidence of silver and lead extraction, primarily located between villages Stojnik, Babe, and Guberevac[136]. At the beginning of the twentieth century, around 5,000 mining shafts were recorded. The pits on the surface seemed to be leading to galleries below, a row of them evidently guiding an adit. The outcrops were attacked by opencast trenches and the workings follow down veins[137]. Some of these shafts were surveyed and cleared in the 1990s (Fig. 16), with small-scale excavations carried out in the vicinity. These produced Roman and no medieval material, confirming the works to be of exclusively Roman date[138]. The abandonment of the mines in later periods was probably due to their exhaustion, as very small quantities of silver ore remain today.

136 The greatest concentration of finds is observed at Glavčine and in the wider Pruten valley; locations of the sites mentioned in the text can be found in the Appendix. For the topography of the area, see Dušanić – Mirković 1976, 111–117; Crnobrnja – Borić-Brešković 2015, 38–41; Crnobrnja 2017 (who provides the most up-to-date map of the Kosmaj mining evidence).

137 Davies 1935, 214 f.

138 Tomović 1995, 209.

Fig. 16: Roman mining shaft at Brailovac, Mt Kosmaj

16

Fig. 17: One of many slag fields in the Pruten valley, between villages Babe and Guberevac, Mt Kosma

17

44 While the fort of Stojnik and the nearby necropolis have been partially investigated in the past, it was the large heaps of slag that attracted the most attention (Fig. 17). In 1875, when first recorded, the remains of ancient slag spread over 5 km² and were distributed in 158 smelting-refuse heaps[139]. In 1966–1967 geologists undertook

139 Simić 1951, 193.

sampling of the heaps, estimating their quantity at 2,002,750 tonnes[140]. I will return to the implications of this evidence later.

Technology

45 In the Roman period, both surface and underground mining was practised in the Central Balkans. Hydraulic surface mining seems to have been used extensively in central Dalmatia, where Roman prospecting for gold consisted of washing, sluicing, hushing, and opencast mining on a large scale. One can only speculate to what extent various techniques had roots in pre-Roman practices, as evidence of PRIA ore extraction technology is extremely limited[141]. Ramović proposed that both gold and silver mining in Dalmatia followed an Illyrian precedent, but without offering any proof[142]. Rücker similarly claimed that gold washing (under which term, as discussed above, he seems to include ground sluicing) was present already in pre-Roman times, but gives no details in support of his claim[143]. The efficacy of extraction operations undertaken by the defeated people that Vibius Postumus used to mine for gold in the conquest period[144] could be taken as indicative of a developed local knowledge of gold-mining techniques already prior to the Roman conquest, but it is impossible to know for certain. All of the observed hydraulic mining techniques are known from elsewhere in the Roman world, and unless evidence is found for the proposed advanced mining techniques of the local communities prior to the conquest or for early dating of the works, we must assume a technology transfer from either Spain or Italy[145].

46 More research is also needed to understand the extent and complexity of the hydraulic surface mining arrangements. In addition to sluicing around Kreševo and Fojnica and the two thus far identified examples of opencasts with hushing tanks, at Uložnica and Crvene Zemlje, that were discussed earlier, isolated reports speak of other aqueducts in the wider area[146]. In absence of any civic or military agglomerations in the vicinity, these water conduits must have been used for mining, making it clear that what we have identified so far is just a part of a larger system; further survey, including remote sensing, would be needed to bring out more details. It does seem clear, though, that hydraulic surface mining in Dalmatia was neither as extensive nor as systematic as workings in Spain or Dacia[147].

47 Water-power might have been used for other stages of ore processing as well. The closest evidence comes from an ironworking site at Stari Majdan, near Sanski Most, dated to the late third and fourth centuries A.D. The site was destroyed in the 1960s, in the process of collecting and re-smelting ancient slag. Archaeologists present at the time recorded an »elevated water channel that ran on a top of a wall«; based on its position within the complex, they speculated that water-power was used for some of

140 Vuković – Vuković 1988.

141 The only evidence of PRIA mining activity relates to underground mining, where a technique of fire-setting has been observed, present from the earliest periods of mining in the region: e. g. at the cinnabar mine of Šuplja Stena, Mt Avala (Hofmann 1886), the Bronze Age Bosnian mines of Mračaj and Maškare (Čović 1999, 131), or likely Iron Age galleries at Lece/Rasovača (Bugarski et al. 2018, 110), cf. Jovanović 1999.

142 Ramović 1981, 79–97.

143 Rücker 1896, 1–18. 27.

144 They are said to have »sought gold with such zeal and diligence that you would think they were extracting it for their own purposes« (Flor. epit. 2, 25).

145 Sluicing is an older technique, practiced by the Salassi of northern Italy in the last two centuries B.C., while hushing has been documented in Spain from the mid-first century A.D. (Wilson forthcoming).

146 e. g. Walter managed to trace a 9.3 km stretch of an aqueduct on the west slope of Mt Rosinj (Walter 1887, 161), and Rücker recorded an aqueduct leading from the Bistrica, a right tributary of the Vrbas, to various opencast mines (Rücker 1896, 85). Owing to its vicinity to Uložnica, the latter example may represent a part of that same system, or a completely different set of works.

147 cf. Wilson forthcoming.

the mechanical works, for driving bellows or the crushing of ore[148]. Unfortunately, the complex was not documented prior to its destruction. In the 1930s, Davies saw just south of Sočanica Roman furnaces and indications of water-driven bellows with uncertain traces of a water channel[149]. In 1891, at Frankoviči on the left bank of the Krupa in Bosnia, a stone was found with two regular holes, 58 cm in diameter and 80 cm deep, which was interpreted as being used »as a mortar to grind the ore«[150]. Their size and regularity make it tempting to see this evidence as an anvil of a water-powered mechanical ore-crusher[151].

48 Judging by the scale of the works (to be discussed in more detail below), it seems surprising that no direct evidence has been found of mining machinery, the preservation of which is not so uncommon[152]. At Kosmaj and Srebrenica, where some of the Roman galleries are today submerged due to accumulation of ground water[153], some technological solution for the drainage of the mining shafts and galleries must have been in place. Various water-lifting wheels were employed in such cases, and are archaeologically attested elsewhere, notably in neighbouring Dacia[154]. Ore was removed from galleries using specially designed wagons, which, judging by the preserved grooves in Kreševica near Vranci, were 92 cm wide[155]; the great weight of the burden would have necessitated a narrower axle construction than normal carts.

49 More on technology can be deduced from the analyses of slag and ingots. Several Roman lead ingots that can be traced back to the Central Balkans are known today, all from Moesia Superior[156]; they can be attributed to the Central Balkan mines by their epigraphy, find-spots and most recently through isotope analyses[157]. Interestingly, all of the ingots found in the area of Kosmaj are exceptionally large: of about forty-four found in total (all but one now lost), none was under 100 kg, fourteen were described as being »300 kg in weight«, with the one surviving example weighing 257 kg[158]. To this number should be added ingot CIL XV, 7915, the largest recorded Roman lead ingot (606 lb, ~ 275 kg), pulled out of the Tiber in 1879; while its Balkan provenance has been speculated upon before, based on epigraphy[159], recent lead-isotope analyses have now confirmed its Kosmaj origin[160]. For comparison, the standard weight of a lead pig was 200 Roman pounds in Britain (ca. 65.6 kg)[161], and most Gallic and Spanish pigs

148 Bojanovski 1999, 158. The authors then go on to dismiss this reconstruction, based on their belief that such water-driven machines were unknown to the Romans, which we know to be false; on water-driven machines in the Roman period, see Wilson 2002, 9–17. 21–24.

149 Davies 1938, 406.

150 Rücker 1896, 26, without illustrations and lost since.

151 Such as those found in the Iberian Peninsula and Wales (Wilson 2002, 21–24).

152 e. g. the finds from the Rio Tinto district in Spain (Curchin 1991, 138).

153 For Srebrenica, see Ramović 1963, 16 f. At Kosmaj, the author could survey the mineshaft known as Brailovac (cf. Crnobrnja 2017, 250) for only about 10 m in 2006, before ground water blocked further progress.

154 Davies 1935, 26 f.

155 Basler 1999, 91. 96.

156 Only one find of a lead ingot was reported from Dalmatia, found in Domavia and weighing 67 kg (Renner 1896, 156); this nineteenth-century find has since been lost.

157 These include two *metalla Dardaniae* ingots found in Caesarea Maritima (Raban 1999), two ingots found in southern Serbia and now in the Museum of Niš (Petrović 1995, 199), an ingot from Sarmitsegetuza (Piso 2005; Piso 2006, 220–222), and an ingot found at Kosmaj now in the Helsingborgs Museum, Sweden (HeM 23–36). These ingots, as well as the CIL XV, 7915 ingot mentioned below, have been the subject of a study by the author and Matthew Ponting (University of Liverpool), including lead-isotope analyses and atomic absorption spectroscopy, which confirmed their provenance. Though the full results of these analyses remain unpublished, selected data will be reproduced in the *Corpus of Roman Lead Ingots*, currently prepared by Peter Rothenhöfer, Michael Bode, and Norbert Hanel, to appear as a supplement in *Der Anschnitt*, the journal of the Deutsches Bergbau-Museum Bochum.

158 Tomović 1995, 206 and cf. IMS I, 160–165; Spomenik 47, 1909, no. 110; Helsingborgs Museum archive (Per-Magnus Johansson, personal communication 28.09.2010).

159 Dušanić 1977b.

160 Unpublished research by Matthew Ponting and the author, see n. 157 for details.

161 Stewart 2002, 221.

weighed about 100 pounds (30–35 kg)[162]. While some Upper Moesian ingots are close to the average (those found in Caesarea are ca. 60 kg, ca. 200 lb[163]), others are larger (for example, the Niš ingots are close to 90 kg, ca. 300 lb[164], the ingot from Sarmitsegetuza is 93.4 kg[165]). Roman ingots were produced mostly by uninterrupted tapping[166], which has been confirmed for the largest ingots found on Kosmaj and the CIL XV, 7915 ingot from the Tiber[167]. Their considerable size indicates a sophisticated production technique, involving high temperature and exceptionally large smelting furnaces.

50 This was confirmed by analyses of Kosmaj slag, which shows evidence of silver recovery by cupellation, aided by the use of iron ore as a flux. The Kosmaj slag displays such a high percentage of silver extraction that reworking this slag would not have been very profitable, and a remarkable consistency of slag composition indicates that the technology was introduced in its final form at the site, rather than being gradually developed there[168]. Analysis of metallurgical residues and by-products of the extraction activities in the vicinity of Ulpiana confirm many of these observations[169]. Sophisticated technology was not reserved for the extraction of silver. Slag found at the gold- and iron-production site of Kraku'lu Jordan was also analysed[170], indicating the use of smelting reagents and tapping in several stages. The result was a low carbon steel, which further indicates that the procedure of air-blowing was employed in the last smelting stage.

Scale of Operation

51 The exceptional size of the ingots brings us to the question of scale of Roman works in the Central Balkans, and the silver and lead mines at Kosmaj provide us with a unique insight into the scale of exclusively Roman works: there is no evidence of later mining or habitation in the area (possibly because the Romans exhausted the source to the level of the ground water)[171], and the analyses of the slag have confirmed its metal content and composition to be consistent with Roman rather than medieval or modern metallurgical methods[172]. The only evidence of the re-smelting of the slag is from the end of the nineteenth century onwards (for which there are some preserved records, though clearly incomplete), and there is no indication of a similar practice in the Middle Ages[173]. These are the known quantities of slag that have been removed:

1878, 1880s, Austrian concession	336.7 t
1907–1908, Swedish concession	42,245 t
1909, Swedish concession	38,170 t
1911, Swedish concession	»a small quantity«
First World War, Austrian occupation	41,286 t re-smelted
	186,400 t taken away[174]

162 Besnier 1920; Besnier 1921.

163 Raban 1999, no. 1. 2.

164 Calculation based on ingot measurements; weighing of the ingot was unfortunately not possible.

165 Piso 2006, 220.

166 Whittick 1961.

167 Täckholm 1937, 172 f. That ingot CIL XV, 7915 is also a result of continuous pouring is an observation of the author from autopsy in 2010.

168 Merkel 2007.

169 Westner 2017; Roman dating of the analysed samples is only provisional though.

170 Bugarski et al. 1982.

171 Simić 1951, 194; Tomović 1995, 209.

172 Vuković 1988; Merkel 2007.

173 Fragmentary evidence for the nineteenth-century, and possibly earlier, reworking of the Kosmaj slag is presented in Simić 1981; Simić 1982.

174 Wellisch 1917; Milić 1970, 161 f. 384–386. 464 f.

52 Prior to 1939, several other mining enterprises undertook exploration in the area of Kosmaj, but details of their activities are not known[175]. During the Second World War, German occupation forces re-smelted possibly quite a considerable quantity of slag, but no records of these operations survive; and from 1956 onwards, smaller quantities were also taken away[176]. The quantity of 2,002,750 tonnes of slag estimated in 1966–1967[177] could, then, easily have been far greater originally, while probably not reaching the 6–7 million tonnes estimated for the ancient workings at Rio Tinto[178].

53 With the known quantities of the removed slag added, the total quantity of Roman slag comes to at least 2,311,187.7 tonnes. Using the average content of lead and silver in the slag, it was calculated that just the 2,002,750 tonnes still present in the 1960s would have yielded 588,710 tonnes ± 10 % of lead and 4,754 tonnes ± 10 % of silver[179], or 679,375.5 tonnes of lead and 5,486.15 tonnes of silver if the known quantity of slag removed in historical times is taken into account as well. Since the slag was a result of exploitation from the second into the fourth century A.D., an annual average over 250 years would be ca. 2,717 tonnes of lead and 22 tonnes of silver. Bearing in mind that the unknown quantity of slag removed by the Nazis during the Second World War could have been significant, the estimate must be taken as conservative to say the least.

54 To offer some comparisons, the Laurion mines, at the peak of their production in the fifth century B.C., yielded around 20 tonnes of silver annually[180]. Chronologically closer comparison would be the output of silver mines around Cartago Nova that Polybius puts at ca. 35 tonnes of silver per annum in mid-second century B.C.[181], likely the most productive period of local extraction. Comparatively, the Kosmaj quantities are still impressive. Furthermore, the Kosmaj figures assume a uniform intensity of mining works, which we know varied during the period in question: the peak of production can be observed from the mid-second to the early fourth century[182], and the annual yield in those decades must have been greater than the calculated average.

55 The Kosmaj output figure is for only one small mining area alone, one that, by the extent of the works and the richness of the ore, could never have compared with the resources of silver mines of Dardania. An assessment made at the re-opening of the Trepča-Stari Trg mine estimated that the quantity of metal extracted in the ›old works‹ equates to 30–45,000 tonnes of lead, 60–90 tonnes of silver, and 2–3 tonnes of gold[183]; this is a tantalizing figure, from a single mine, but it represents both Roman and medieval workings. Equally enticing are the already-mentioned nineteenth-century reports of 6,500 m² of slag heaps from the ruins of the Roman town in Sočanica, or 100,000 tonnes from the vicinity of Novo Brdo, but to what extent they testify to Roman works one will never know for sure. The medieval and modern exploitation of the same sources has deprived us of any possibility of asserting the scale of Roman works, and comparably reliable data for Kosovo will unfortunately probably never be available.

56 There are two estimates for the quantities of silver obtained from the region of Srebrenica. Ramović, a geologist whose doctorate involved prospecting older works, first assessed that in the Roman and medieval works around 780,000 tonnes of ore

175 e. g. Société Minière et Métallurgique de Peñarroya and a certain Mr Antonijević (Tunningley 2014, 10), but no records of their activities survived.

176 Simić 1951, 192–194.

177 Vuković – Vuković 1988.

178 Although originally estimated at 15–16 million tonnes (Jones 1980), more recent estimates of slag at Rio Tinto place it around 6–7 million tonnes (Rothenberg et al. 1989).

179 Vuković – Vuković 1988.

180 Conophagos 1990.

181 Pol. 34.9.8–9 and Kay 2014, 44 f.

182 cf. Tomović 1995, 208.

183 Ramović 1981, 134.

were removed from the surrounding hills, which would have yielded 50,000 tonnes of lead and 120 tonnes of silver[184]. Later the same author estimated that out of that quantity 40,000 tonnes of lead and 80 tonnes of silver were extracted by the Romans[185], but unfortunately does not give details of this assessment.

57 It is regrettable that we cannot say anything more concrete about the gold production. No quantitative data exist for the remains of gold prospecting in central Bosnia, other than an anecdotal episode that Pliny relates, according to which on an occasion during the reign of Nero 50 *librae* (16–17 kg) of gold were retrieved in a day from a single sand deposit in Dalmatia (nat. 33, 21, 67). Even if Pliny's figure is accurate, this was surely an exceptional occurrence; otherwise, at that rate the Dalmatian mines would equal the yearly Spanish output within two months[186]. Dalmatia certainly had the reputation of a gold-bearing land in the first century A.D. and was as such immortalized by contemporary poets[187], but the promise of riches might have been short-lived, and taking a poetic turn of phrase as an indicator of actual output is certainly misguided and overly optimistic[188]. Though central Bosnia offers evidence of large-scale investments in hydraulic works, and although gold in this area is close to the surface and easily recoverable, the quality of deposits is not great: 2–3 g and only exceptionally up to 60 g per tonne of auriferous pyrite ore (Fojnica, Vranica, Novi Travnik), and about 0.1/0.4 to 1.5/2 g of gold per tonne of washed sand in the watersheds of the Vrbas, Lašva, Neretva, and Fojnica[189]. The poor quality of secondary gold deposits has made gold prospecting in this area unprofitable in modern history, and, indeed, it was noted as more probable »that the relative cheapness of labour in former days, rather than the abundance of gold, accounts for the extensive workings in the Vrbas valley«[190]. It is of course possible that Roman and smaller-scale medieval works exhausted the resources[191], but it is equally likely that early successes (*n. b.* Pliny) might have given rise to large-scale investments which turned out not to be justified. Numerous abandoned prospection shafts on Mt Rosinj are a telling sign of a questionable productivity of this enterprise. Inaccessibility, high altitudes (Mt Vranica is 2,110 m high, and some of the works are close to the summit), and the fact that the region sees substantial annual snow coverage lasting for months would also not have helped. The fact that gold mining in these parts ceased during the reign of Hadrian, for no apparent reason, likely reflects the insufficient profitability of these works, or their exhaustion by this period.

58 At the moment it is hard to put any figure on the scale of gold production in the *metalla Pincensia* district, though a study of preserved washing heaps could provide more data in the future. The richness of the gold-bearing gravels of the Pek valley has been estimated at 288.8 mg of 86 per cent gold per cubic metre of gravel. From these sources, 3 tonnes of gold were obtained between 1904 and 1918 alone[192]. Gold would also have been obtained from the Kosovo mines, particularly those in the vicinity of Ulpiana where the silver-rich ore contains 2.7 g of gold per tonne[193], and, as here gold

184 Ramović 1961, 38 f.

185 Ramović 1981, 97.

186 Observation by Glicksman 2009, 86, based on an assessment of the annual production of the Iberian mines as just under a tonne of gold (Wilson 2007a, 113).

187 cf. Mart. 10, 78, Stat. silv. 1, 2, 140–157; 3, 3, 85–110; 4, 7, 13–16.

188 cf. Škegro 1999, 42; Škegro 2000, 71 who uses Stat. silv. 3, 3, 89–90 to argue that the yields of Dalmatian and Iberian mines were comparable.

189 Lakatoš 1931, 82; Ramović 1999, 10 f.

190 Wray 1921, 50.

191 Glicksman 2009, 125.

192 Simić 1951, 321 f. and table 86.

193 Savić 1954/1955, 287.

is obtained alongside significant quantities of silver, this might have made gold production even at this rate more profitable; individual mines in this area today produce up to 250 kg of gold per year[194].

Some Specifics of the Roman Administration of the Central Balkan Mines

59 Despite administration being one aspect of the Roman mining in the Balkans that has been thoroughly researched, some aspects remain controversial. What we know is based on epigraphic material, administrative offices that are attested, and a reconstruction of their jurisdiction, none of which is straightforward. Furthermore, Roman managerial apparatus was flexible, changeable and with a certain degree of local autonomy, and the Central Balkans offered a broad range of metals, with a variety of extraction techniques and scale of mining operation, all of which posed different challenges. Even if our suppositions are correct, our conclusions might only be valid for the given place and restricted periods of time. This evidence has been discussed at length by others[195]; here I will merely point out some peculiarities of the Central Balkan arrangements that are relevant for the assessment of the importance of these mining operations, reassessing the validity of some of the common claims where appropriate.

Ownership and Administration of Mines

60 All of the silver-mining regions of Dalmatia and Moesia Superior were imperial domains, as attested by the presence of imperial officials and moulded inscriptions on the ingots[196]. For the gold-mining areas of the Pek and central Bosnia there is no explicit evidence of direct imperial control, but it seems most likely that these mines were owned by the state. For both regions there is some evidence of *damnati in metallum* being used, which is a practice restricted to state-owned mines[197]. In Dalmatia this supposition is based primarily on Florus' account describing prisoners of war working the gold mines (epit. 2, 25); in the valley of the Pek and Timok it is supported by numerous finds of fetters[198].

61 Silver sources seem to be singled out in an administrative respect, possibly due to the scale of their output. The administrative reform of the mid-second century, usually attributed to Marcus Aurelius, resulted in the silver mines being governed separately from other types of extractive operations. We have evidence of a separate procurator for silver mines by the end of the A.D. 180s[199], likely a reflection of their growing importance by this date.

62 The status of imperial procurators in the silver-mining districts of Dalmatia and Moesia is also curious: after the mid-second century, equestrians headed all the major *metalla*[200], rather than freedmen as was common in Spain[201]. The same is true in Dacia from the mid-second century onwards, but for the Danubian lands this might have been standard from the beginning, as the attested freedmen procurators are not explicitly recorded as being in charge of mining[202]. There are a sufficient number of

194 Monthel et al. 2002, 41.

195 Pašalić 1965; Dušanić 1977a; Dušanić 1980; Bojanovski 1982; Dušanić 1989; Škegro 1998, 95–104; Škegro 2000; Hirt 2010; Šajin 2014; Šačić Beća 2022.

196 Hirt 2010, 48–82.

197 Hirt 2010, 97 f.

198 Dušanić 1980, 52 n. 357; Tomović 2000.

199 Hirt 2010, 139 f.

200 Dušanić 1997, 37 n. 30; Hirt 2010, 130–136.

201 On status of Roman mining procurators, see Hirt 2010, 107–149.

202 cf. ILJug 504.

procurators recorded to indicate a clear appointment policy, one evidently dictated by the scale of the works and the importance of the task at hand[203].

63 Leasing the state mines out to contractors does not seem to have been practised on any significant scale in the Central Balkans[204], further underlining the state's wish to maintain tight control over the precious metal extraction. Southern Spanish copper, lead and silver mines, Gaulish iron mines, Dacian gold mines, the silver mines of Pannonia, the copper mines of Cyprus and Palestine, and certain lead mines of Britain were all leased to mining contractors[205]. However, we have very little evidence of such a practice in the gold and silver mines of Dalmatia and Moesia Superior, while at the same time other local mines, like the iron mines in Bosnia, were leased out until the third century[206]. Only four inscriptions mention *coloni*[207], and although these inscriptions are found within mining regions, the nature of these *coloni* is uncertain, with only one explicitly mentioning *coloni arg(entariarum)*[208]. If there were concessions, they were probably not on a large scale, and private mining of precious metals took place relatively late, allowing a rapid rise up the social ladder[209].

64 Certain aspects of the provincial administration seem to have been subjected to, or at least shaped by, the state interest in mines[210]. A case has been made for *civitates peregrinae* being incorporated into mining territories and probably forced to work in them[211], and that autonomous cities were under obligation to provide administrative support to the imperial mines in their vicinity[212]. In the case of Ulpiana it has even been suggested that extraction of precious metal content though cupellation was undertaken in the city from raw metal brought in from the wider mining district, securing greater administrative control of the process[213].

65 It has further been repeatedly argued that legal practice in Moesia Superior was uniquely influenced by its richness in metal, a conclusion that has been drawn based on an unorthodox reading of an extract from the Digest, according to which forging money was more severely punished in Moesia than elsewhere, the severity of the crime being compared to that of burning grain fields in Africa[214]. Though frequently cited, this reading is highly controversial and not entirely correct[215]. Moesia Superior

203 Hirt 2010, 147.

204 The Roman state worked its mines either directly, as with the gold mines of north-western Spain, or by ›indirect control‹, i. e. by leasing them out, a practice which was quite common (Domergue 1990, 303–306. 337).

205 Domergue 1994, 103.

206 Glicksman 2009, 97 f.

207 Inscriptions mentioning *coloni*: Sočanica: ILJug 501. 503; Spomenik 71, 1931, 93 no. 217; Rudnik: IMS I, 168; Kosmaj: IMS I, 103.

208 ILJug 501.

209 Throughout the third century Central Balkans gave a high number of senators, for the first time in its history; the fact that their attestations group around the Dardanian mining district suggests that involvement in the extraction or metallurgical activities was the probable economic base of their rise. The solidity of their financial basis secured them prominence into the Byzantine period, cf. Šašel 1982.

210 Dušanić 1989.

211 Dušanić 1977b, 170 f.; Dušanić 2000, 344 n. 10.

212 Municipium DD and the colony of Domavia being cases in point (Dušanić 1971b, 249–253; Dušanić 1980, 43 f.; Bojanovski 1999, 147). It has recently been suggested that the arrangement was primarily fiscal (Šačić Beća 2022, 191 f.).

213 Westner 2017, 172 f. The same equally centralized process is believed to have been overseen by the military in the Kosmaj mining area (Merkel 2007).

214 Dig. 48, 19, 16, 9–10: *... ut eadem scelera in quibusdam provinciis gravius plectantur, ut in Africa messibus incensores, in Mysia vitium, ubi metalla sunt adulteratores monetae.*

215 This interpretation rests on two premises: that *Mysia* refers to Balkan Moesia, rather than the region in Asia Minor, and on the reading of *vitium* to mean ›a crime‹, not ›vine‹, so the meaning would be: »in Africa setting fire to grain fields, in Moesia, where there are mines, the crime of forging money.« That *Mysia* refers to Balkan Moesia is in my opinion clear, despite the spelling. Other than here, *Mysia* appears in the Digest two more times: in *provinciae Mysiae Inferioris* (Dig. 49, 15, 9), and in the treatise of Aemilius Macer, *De officio praesidis*, when a division of certain provinces into two districts under separate governors is discussed:

and Dalmatia would have both been regions where money forging was more severely punished than elsewhere, being provinces where bullion was extracted locally, but the legislation does not single out Moesia specifically.

The Military Involvement

66 The employment of the army serves as another indicator of strict imperial control. The mining works always enjoyed military protection, with different arrangements being put in place over time. The very design and development of the military *limes* in Moesia Superior indicates particular concern for the mines. The tributaries of the Danube were the main communication routes out of the major mining districts in northern Moesia Superior, with entrances to their valleys closely watched and protected[216]. Tiberius had already stationed auxiliaries on this section, and major forts retained their garrisons even when this was no longer a frontier zone. Two legions always remained in Moesia Superior, and although it is sometimes claimed that when this stretch of the Danube ceased to be the border, after the conquest of Dacia, the *limes* fortifications in this region were abandoned[217], the archaeological evidence testifies otherwise[218]. The Severi further invested in the strengthening of this stretch of the *limes*[219], in a unique move as other parts of the Danubian *limes* were not affected. There seems no other way to explain the protection of this stretch of the Danube, if not to regulate and protect the primarily metal-carrying river traffic.

67 In addition to these more generic security arrangements, we learn of a number of primarily mounted cohorts being posted in the vicinity of extraction operations between A.D. 70 and 169[220], at times receiving reinforcement from units stationed in other provinces. Trajan thus despatched a cohort from Pannonia to Kosmaj and soldiers from Macedonia to the Dardanian mining region to provide additional protection during his Dacian campaigns[221]. A systematisation of security arrangements and a more permanent solution were sought by Marcus Aurelius when, in ca. 169, he created new cohorts in Dalmatia and Moesia Superior[222]: two *milliaria Delmatorum*, two *Aureliae Dardanorum* (*Prima* probably in Naissus, *Secunda* at Ravna), and two *Aureliae Novae* (*Prima* in the lower reaches of the Pek or Timok, *Secunda* at Kosmaj), the distribution

»*velut Germania, Mysia*« (Dig. 1, 22, 3). In both cases it is clear the province of Moesia is being referred to. Furthermore, the spelling *Moesia* never appears in the Digest, and *Mysia* was evidently the accepted spelling on the Balkan province's name at the time when the compendium was compiled. The reading of *vitium* as ›a crime‹ is much more problematic. Although such a meaning is possible, it would be unprecedented in the Digest, where it is used in the meaning of a corporal defect (cf. Dig. 50, 16, 101, 2). The positioning of the punctuation, though flexible, does not help either. It seems thus more likely that the passage does refer to vines, while the forging clause is not specific, but applies to everywhere where there are mines (thus reading »in Africa setting fire to grain fields, in Mysia [setting fire to] the vines, and forging coins where there are mines«). It remains puzzling that the significance of wine production in Moesia is equated to that of grain production in Egypt, as in Moesia Superior it was only small-scale (Mladenović 2009, 66), and in Moesia Inferior certainly not as extensive as the passage would suggest (cf. Brun 2004, 65–69). Perhaps an explanation could be found in the background of the jurist, Ti. Claudius Saturninus, who, if identified correctly as a *legatus Augusti pro praetore* in Moesia Inferior in A.D. 144/145 (cf. AE 1916, 65; ILS 2475), must have specifically wanted to use an example from his own judicial practice. I thank Michael Crawford and Georgy Kantor for an interesting discussion of this extract; this discussion is indebted to them, but reflects my views only.

216 cf. Werner 1986.

217 Mirković 2002.

218 At only one fort, Boljetin, can one find any signs of abandonment, cf. Mladenović 2012, 16.

219 On phases of the Upper Moesian *limes*, see Vasić 1986; Petrović – Vasić 1996; also Mladenović 2012, 16–22.

220 Dušanić 2000, 352. Deployment of mounted cohorts in the mining areas is a phenomenon known from elsewhere: Sardinia (Le Bohec 1992, 261 f.), Trêsminas area of north Portugal (Tranoy 1981, 223), and possibly Wales (Simpson 1964, 139).

221 The strength report of the *cohors I Veterana Hispanorum equitata* stationed at Stobi (the British Museum Papyrus 2851 dated to September 100/105), marks absence of several men as being sent »*in Dardania ad metella (!)*« (Fink 1958, no. 63 col. II 21–22). For the garrison at Kosmaj, see Ferjančić 2014.

222 SHA Aur. 21, 7.

of which clearly shows concern for the mines and roads[223]. Their deployment was not a temporary measure, and the cohorts remained at their posts at least until the end of the third century, without ever moving from the interior of the province (not even after Aurelian's evacuation of Dacia left the Danube section of Moesia Superior exposed again).

68 As elsewhere, the main task of the army would have been to provide protection, assist execution of procuratorial decisions, and secure transportation of metal[224]. Military involvement in Upper Moesian mining, however, seems to have extended further. At Ravna (Timacum Minus), the military seems to have supported local extraction operations with their technical expertise, with metallurgical work and washing of the ore done inside the military fort[225]. Furthermore, the army likely provided administrative support, possibly in the form of the *librarii* (book-keepers)[226], while other management operations might have been run by legionaries themselves[227]. In addition, some argue that the army was in direct control of an Upper Moesian mining district or its parts[228]. Evidence from Ravna of a soldier of *VII Claudia* serving as a *librarius offici(i) praef(ecti) ter{r}it(orii)*[229] has been interpreted by Dušanić as proof of military involvement, presuming that *ter(r)itorium* includes parts of the imperial mining domain, as the fort at Ravna is either in it or in its very vicinity, and seems to have been involved in its running (see the evidence of ore smelting above). Though possible, this supposition is highly speculative, and thus far without analogies.

Portoria, the Customs System

69 The mines of Dalmatia and Moesia were part of a customs system, the *publicum portorii Illyrici*[230]. Customs posts were particularly dense in the mining areas; eight posts in Dardania make the south of Moesia Superior »the best controlled, from the customs aspect, of all the parts of the Empire«[231].

70 The distribution and function of these *portoria* is far from clear. None of them are very close to provincial borders, so they seem to be internal toll stations. Assuming that *portoria* were placed on the borders of mining districts, Alföldy has used their locations to demarcate the extent of mining districts in Noricum[232]. Using the same hypothesis, Dušanić reconstructed mining districts in Moesia and Dalmatia[233], the result being huge tracts of apparently extra-provincial territories that include military installations and cities[234], which although not impossible does not seem very likely. According to the *lex portorii Asiae*, customs posts did not have to be on the borders of customs territories but in their vicinity[235], which further undermines the precision of this venture. Some

223 Dušanić 1977c. The location of the permanent forts of the two Dalmatian cohorts is unclear, but deployment of their detachments can be linked to the transport routes of metal, particularly in relation to mines at Domavia, see most recently Cesarik – Glavaš 2017, with further literature therein.

224 On the role of the army in imperial mines, see Hirt 2010, 185–201.

225 Petrović 1995; for examples of the army providing technical support to the mining industry in Lusitania, see Edmondson 1987, 69.

226 IMS III 2, 31; IMS VI, 227.

227 Dušanić 2000, 354 f.

228 Dušanić 1990; Dušanić 2000, 354 f.; Hirt 2010, 68–70.

229 IMS III 2, 31.

230 de Laet 1949; Vittinghoff 1953; Ørsted 1985.

231 Dušanić 1989, 152; cf. also de Laet 1949, 224 f.

232 Alföldy 1970, 170 f.

233 Dušanić 1989, 151; his hypothesis rests solely on an analogy with Noricum, without any further supporting evidence. It should also be noted that Dušanić equated any mention of a *beneficiarius* with an existence of a *portorium*; *beneficiarii*, however, could perform a number of duties, beyond collection of tax, cf. Nelis-Clément 2000.

234 Hirt 2010, 56–67.

235 Engelmann – Knibbe 1989, 166.

portoria appear to be on main roads, *viae publicae*[236], and could therefore serve to extract tolls for the use of the road, but many are not. Had the metal not been owned by the emperor, the *portoria* could have served to tax it as ingots came out of the mines, but this way their purpose is less straightforward. There is no evidence that any *portoria* were ever leased out.

71 Though the exact function of these custom stations is not clear, and quite possibly varied, it is clear that the *portoria* in the Danubian provinces were related to the mining districts and their activities, turning them effectively into extra-provincial territories. Nowhere else does evidence survive for such stations being installed near mines or quarries, and this system of extracting tolls from mining areas was limited to the Danubian provinces (Pannonia, Dalmatia, Moesia Superior, and Thrace)[237]. All of the attestations of the *portorium Illyrici* are from the late second and early third centuries (possibly all Severan), although it could have been established earlier. If they are indeed limited to this period, they might relate to a (short-lived?) administrative reform, possibly Severan, that we do not know about. Interestingly, the few attestations of the *coloni*, mentioned earlier, are roughly contemporary, and the *portoria* might represent the state's effort to tax their activities. The density of the posts is still unprecedented and a clear evidence of how keenly the state supervised any movement of metal from these areas.

Coins of the Mines (nummi metallorum)

72 Under Trajan, Hadrian, and Antoninus Pius, series of brass semisses and copper quadrantes were minted bearing reverse legends referring to some Danubian and Balkan mining regions (Pannonia, Dalmatia, Noricum, Pincum, Ulpianum, and Dardania)[238]. Despite their local reference, these *nummi metallorum* were centrally minted – most probably in Rome (their chemical composition is the same through the series and corresponds to that of the contemporary metropolitan *aes*[239]).

73 The purpose and circulation of these coins is uncertain. Few come from archaeological contexts, and the majority of the known specimens found their way into numismatic collections worldwide without clear record of their provenance. That the coins originally circulated within the mining districts for which they were intended seems now clear[240], but whether they were accepted as currency only within the regions specified on the coins, or more widely, is at the moment hard to assess without good distribution data, which on the other hand limits possible interpretations of their function.

74 The *nummi metallorum*, as quarter and half *as*-coins, had a very low purchasing power: in first-century A.D. Pompeii an *as* would buy half a pound of bread flour or a litre of cheap wine[241], while in A.D. 111 in Vindolanda, for the same amount, over 11 pints of beer could be purchased[242]. The supply of these coins could then be interpreted as a measure intended to alleviate a shortage of small change needed in retail, a problem perhaps especially pressing in the mining districts. The greater wear of coins observed in both the Upper Moesian mining regions and that of Rio Tinto[243], as well as

236 e. g. Gračanica/Ulpiana, Lapje Selo, and Kuršumlijska Banja, see Hirt 2010, 56–67, though often it is based on such inscriptions that road routes are reconstructed in the first place, so this might be a circular argument.

237 Hirt 2010, 66.

238 For the most extensive recent study, see Woytek 2004a; Woytek 2004b; Woytek 2010, 608–618, with bibliography of older scholarship. On *nummi metallorum* of Moesia Superior and Dalmatia, see Dušanić 1971a; Alföldy 1974, 114; Dušanić 1977a, 56–63; Dušanić 1980, 9–18; Škegro 1995; Peja 2000; Glicksman 2009, 109–113.

239 Simić – Vasić 1977; Simić – Vasić 1985.

240 *Contra* Woytek 2004a, 50–55, who has modified his position since (Woytek 2004b, 139; Woytek 2010, 163), particularly as more circulation evidence from secure archaeological contexts has come to light (Mladenović – Woytek 2012; Mladenović – Woytek 2020).

241 Breglia 1950, 50–53.

242 TV II, no. 186 and Birley 1997, 279.

243 Davies 1935, 13.

the frequent practice of counter-marking intended to prolong their lifespan, is used in support of this assumption[244]. Perhaps the existence of the customs posts resulted in a smaller influx of regular currency into the mining districts and these issues were minted specifically to tackle this problem. Under this scenario, once introduced into the mining areas, the coins could freely circulate across the provinces.

75 The other interpretation sees this currency being used exclusively within the mining areas, making these areas autonomous[245]. Owing to their low value, the coins would in this case function as tokens, or scrip currency, redeemable for certain goods and services. Glicksman has suggested, based on the functioning of private scrip currencies in the coalmining communities of early twentieth-century America, that *nummi metallorum* may have allowed for a sort of credit system or an advance on wages already earned before payday, which would have ensured that the majority of wages paid would have been recycled through an economic system of the mines[246].

76 There could have been other reasons for the introduction of separate coinage inside a customs system, one that was based on a fear of forged coins getting into circulation out of the mining areas, where both the material and the expertise necessary for forging existed. By preventing large-scale circulation of higher-value currency in the area, one denies the mining personnel access to the models for copying, as well as the opportunity of easily putting forged coins into circulation. Tokens, on the other hand, were of small value and invalid outside the mining district, which makes their forging useless. It is for a reason that provinces with mines were singled out in Roman legislation as places where debasing coinage is subject to a harsher punishment than elsewhere[247], and the finds of forged dies from the Upper Moesian mining districts indicate the threat was real. The counterfeit dies were found in the Kosmaj and Pek mining districts, both of which yielded bullion, and include dies for *denarii* and in some cases possibly *aurei* of Titus, Trajan, Hadrian, and Antoninus Pius[248]. Both of these interpretations demand the existence of a closed and controlled system, the logistics of which would be exceptionally complex. The high density of *portoria* could aid its implementation, but without further evidence all interpretations remain conjectural.

77 Analogies are hard to find in the Roman world, as there are no known parallels for large-scale production and use of mining tokens. A few coins interpreted as mining tokens come from the mines of Lusitania[249], while other types of supposedly ›mining coins‹ were found in south-eastern Spain[250]. While the Iberian examples followed imperial metrology, they were locally produced in small series, nothing like the systematic issue of *nummi metallorum*. There are also no further examples of official currency carrying reference to other mining districts. The imperial issues relating to Danubian and Balkan mining regions remain a unique case in Roman numismatics, thus highlighting their contemporary significance.

244 Mihailović 1994; Mihailović 1998.

245 Dušanić 1971a; Dušanić 1977a, 62 f.; Dušanić 1980, 9–18; Škegro 1995; Peja 2000.

246 Glicksman 2009, 113.

247 Dig. 48, 19, 16, 9–10; on problems surrounding interpretation of this passage, see n. 215 above.

248 Dušanić 1989, 153; Dušanić 1995a.

249 Edmondson 1987, 59 n. 5.

250 e. g. a small series of locally minted Augustan ›SC‹ coins found exclusively in the vicinity of El Centenillo in southern Spain has been linked to the mines owing to their distribution (Hill – Sandars 1911; Villaronga 1979, 251. 301 f.). For a survey of possible mining tokens from Spain and their reassessment, see Martínez Chico 2021.

Migrations

78 As mentioned earlier, it would seem that initially the dependent population was incorporated into mining territories and forced to work in them, as *munera*[251]. Local human resources would have, however, been insufficient to support the large scale works in often isolated locations, the maintenance of which would have necessitated some population movement. It has thus been argued that the needs of the mining industry were satisfied through large-scale forced resettlement of immigrant populations in the mining districts[252], using the state actions in north-western Spain as an analogy[253]. Epigraphic evidence is offered in support of a large number of people from Asia Minor, primarily Phrygia and Bithynia, being settled early on in the mining districts of Dardania and possibly Domavia[254]; the same was allegedly repeated with the Dalmatians and Thracians at the mines of Kosmaj, the valley of the Timok, Remesiana, and Kuršumlija[255], as well as Dardanians and Dalmatians who were settled in Dacia[256]. These conclusions are based on epigraphic evidence and onomastics, primarily tracing attestations of people with Illyrian names of known provenance in foreign lands. Such evidence is not without problems, and it is not always beyond any doubt that these people were involved in mining; nor are numbers always high enough to indicate a large-scale influx[257].

79 The only real concentration of evidence is that for the Dalmatian communities in Dacia, primarily from the gold-mining area surrounding Alburnus Maior, where in the second century A.D. their presence is recorded on inscriptions and wax tablets, through names, *origines*, and toponyms. Out of 177 individuals attested here, more than half have been identified as Illyrian, onomastically linked to the population of central Dalmatia[258]. The majority are of *peregrine* status, although the social and financial situation of some of the immigrant Dalmatians seems to have been significantly better, which has led some to dismiss the idea that they were a forcibly exiled, dissident population[259].

80 While the Balkans were the scene of large-scale forced re-settlement, primarily of barbarians, in the first century A.D.[260], it is hard to prove that the movements of populations described above were forced. That significant migrations into the mining areas of the Balkans took place is beyond doubt, and that they were imperially backed is quite likely as well[261], but alternative scenarios to forced relocation could be envisaged. Immigrant mining communities are not rare, and were present in the history of the region until recently[262]; there is also evidence in Iberia of regional migrational patterns related to mining[263]. For experienced mining communities newly opened mines in Dacia would have been very attractive, particularly if we keep in mind that the last datable evidence of gold mining in Dalmatia is from A.D. 112–114. If there was indeed a collapse

251 Dušanić 1977b, 170 f.; Dušanić 2000, 344 n. 10. On *munera* as a mode for securing workforce, see Hirt 2010, 147, 334 f.

252 Mrozek 1969, 140–145; Dušanić 1977a, 93; Mrozek 1977, 99; Noeske 1977, 275–277; Škegro 1998, 94 f.; Dušanić 2000, 348.

253 In Asturica Augusta, Almudena, etc., cf. Orejas 1994; Orejas 1996; Orejas 2002; Hirt 2010, 229–231.

254 Ulpiana: Parović-Pešikan 1981; Parović-Pešikan 1990; Municipium Dardanorum: Dušanić 1971b; Kosmaj: Petković 1997; Domavia: Alföldy 1965, 154–156; Srejović 1965, 26.

255 Kosmaj: Dušanić – Mirković 1976, 108–110; Timok: IMS III 2, 54. 55; Remesiana: Dušanić 1977a, 74 n. 137; Kuršumlija: Dušanić 1994/1995.

256 On Dalmatians: Protase 1978; Zaninović 1995; Ciobanu 1999; Piso 2004; on Dardanians: Daicoviciu 1961; Mrozek 1968; Tudor – Vladescu 1972; Noeske 1977, 275–277.

257 For a discussion of evidence regarding Dalmatians, see Glicksman 2009, 118–121.

258 Piso 2004, 273; Mihăilescu-Bîrliba 2011, 13–19 and table 9.

259 Glicksman 2009, 118–120.

260 cf. Strab. 7, 3, 10; CIL XIV, 3608.

261 Hirt 2010, 332–335.

262 e. g. the state-supported immigration of Saxons in the Middle Ages (Dinić 1955; Dinić 1962), or small-scale migrations of specialized mining communities across Bosnia and Serbia, crossing borders of empires, last attested in the early twentieth century (Simić 1973, 76 f.).

263 Hirt 2010, 273 f.; Holleran 2016.

of the gold-mining operations in Dalmatia in or soon after that period, abandoning the failing prospects and relocating to the newly opened ventures in Dacia, where their expertise would have been sought-after, would have been an attractive prospect[264]. It would seem that opportunities that the opening of new mining works presented for those coming from areas with developed mining tradition triggered significant regional migration over considerable distances in the second-century Balkans. The evidence at hand suggests that these were voluntary movements of free labour, likely imperially backed through privileges and incentives, rather than forceful deportations.

The Relative Importance of the Dalmatian and Upper Moesian Precious Metal Mines

81 Despite numerous ambiguities in the evidence presented in the last section, the fact remains that there were a number of peculiarities that attest to an unprecedented level of state control and interference in the Central Balkan precious metal mining operations. The tight control of the works and the way that the socio-economic structures of Moesia Superior were fundamentally reshaped and subordinated to the interests of the mines must have been brought about by their strategic importance for the Roman state. The scale and nature of the metals extracted certainly played a part. Yet the true significance of the Central Balkan metal output becomes evident only when put into a wider chronological context.

82 Throughout Roman history, one can construe the existence of centralized state politics in the exploitation of different mining regions at one time, especially when bullion is concerned. This is evident through the shifts in intensive metal exploitation in different parts of the empire[265]. Although evidence for the exploitation of the mines in Dalmatia and Moesia Superior dates from the first century onwards, the intensification of the silver-works begins from the time of Hadrian and reaches its peak in the third century[266]. This dating based on archaeological evidence seems to be confirmed by research into levels of atmospheric lead pollution preserved in a regional peat bog that indicates a particular surge of metallurgical activity in the Central Balkans from A.D. 180 with a peak in ca. 240[267]. In that same period, several changes took place empire-wide: mining at Rio Tinto and in southern Spain in general came to a sudden end in ca. 160–170[268]; important gold mines in Dacia were abandoned after the Marcomannic invasion in 167 and further seriously disrupted by Gothic incursions and the Antonine plague[269], while gold mines in north-west Spain declined from the beginning of the third century as well[270]. Supply of bullion to the treasury would have been severely hampered by these events, and the central administration must have been under pressure to secure continuous provision.

83 Growing evidence suggests that in such circumstances the state shifted its focus to the Central Balkans, intensifying operations and tightening their control over the resource. It is not only the dating of mining works but also the timing of specific administrative measures that speaks in favour of a deliberate policy shift in this period:

264 As pointed out by Glicksman 2009, 120 f., using the dating of earliest evidence of Dalmatians in Alburnus Maior from A.D. 131 to support her interpretation. Bearing in mind that the same type of hydraulic surface mining was used in both locations (Wilson forthcoming), the expertise of these men would have been highly desirable.

265 Edmondson 1989, 95 f.; Wilson 2007a.

266 For Kosmaj, see Merkel 2007; for the Pek valley: Kondić 1982, 106; Werner 1985; Tomović 2000; for Dalmatia: Bojanovski 1999; Glicksman 2009, 114–116; for Dardania, see the discussion of chronology above.

267 Longman et al. 2018.

268 Jones 1980; Domergue 1990, 215–223.

269 Davies 1935, 201. 205.

270 Domergue 1990, 217.

Trajan, Hadrian, and Antoninus Pius minted coins that bore the names of these mining districts; in ca. A.D. 169, six additional cohorts were created for their protection; by the end of the A.D. 180s, silver mines were separated from other types of extractive operations and governed separately, exclusively by knights after the mid-second century; and by the late second century the new customs system, the *portorium Illyrici*, was created around them.

84 While the need for bullion was an obvious cause, there must have been other reasons that made inland Dalmatia and Moesia Superior more attractive venues for mining operations in the late second century than re-opening works in contemporary Portugal and Spain. It is hard to argue that prospecting for silver or gold in the Central Balkans would have been any less technically demanding. Underground shaft-mining rather than surface opencast was the technique predominantly used in this period, making the workings both very challenging and labour-intensive[271]; furthermore, even at Srebrenica, where the ore is relatively shallow and oxidized, making both its mining and metallurgical extraction easier, ground water was encountered at shallow depths, complicating the extraction process.

85 I would argue that it was human resources that might have given the Central Balkans an edge at this point. While opinions vary on the extent of the effect that the ›Antonine plague‹ had on the Roman economy and on the extraction works in Iberia and Dacia[272], it is quite likely that the Central Balkans were significantly less affected. There is no evidence that either of the Upper Moesian legions, *IV Flavia* and *VII Claudia*, took part in the eastern campaigns of A.D. 160s, whose returning soldiers supposedly spread the plague[273], and the large numbers of veterans discharged from them in this period[274] testifies to their numbers staying strong. Both Moesia Superior and inland Dalmatia, furthermore, had one of the lowest population densities in the empire[275], being also without cities of great size[276]. Regardless of the nature of the disease that we today refer to as ›the Antonine plague‹ (that is, regardless of whether it was airborne, bacterial, or viral), density of settlement is an important factor as many diseases require a critical population mass in order to be sustained and become an epidemic[277]. The Central Balkans, and mining regions in particular, would struggle to provide the population threshold below which an infectious disease becomes naturally self-extinguishing, or comes in fewer waves that are dependent on constant re-introduction from elsewhere[278]. The mining areas were, furthermore, completely landlocked, which left the area only mildly affected when a couple of centuries later the ›Justinianic plague‹ ravaged the coastal cities of Illyricum[279]. Marcus Aurelius, who was forced to seek further in order to replenish his military ranks precisely because of the plague, seems to have identified the same yet untapped human potential when he initiated the first legionary recruitment in Moesia Superior[280]. The Central Balkans therefore not only provided precious metal resources and relative safety but possibly also the manpower, which consequently would have

271 See Hirt 2010, 44–46 on organizational implications of this mining technique.

272 For the impact on the mining works, see Wilson 2007a, 114 f.; Wilson 2009, 78 f.; Silver 2011.

273 Amm. 23, 6; SHA Verus 8, 3, though they may have contributed to vexillations.

274 cf. IMS II, 51. 53.

275 Scheidel 2007, 48 table 3.1.

276 Wilkes 1969; Mladenović 2012, 24.

277 Smallpox and measles, two diseases most widely accepted as being behind the ›Antonine plague‹ (Littman – Littman 1973; McNeill 1977, 131 f.; Sallares 1991, 248), require a population threshold of 250,000 people to ensure continuous transmission (Cliff – Haggett 1990, esp. 96).

278 See Cliff – Haggett 1990, esp. 98. 100 f.

279 cf. Prok. BP 2, 22, 8; Grmek 1998.

280 SHA Aur. 21, 6–7.

come at a lower labour cost[281], exactly the economic factor that seems to have been prevalent in the closure of the Spanish mines[282].

86 The inclusion of a new distinct source of silver that has been detected in the *denarii* of Marcus Aurelius and Commodus[283] could be the first sign of the bullion supply shift that I propose. There is also no other currently known source that could account for a sudden surge of silver coins in the time of the Severi[284]. A shift of the state metal supply to the Central Balkans could explain the increasing reliance of the Severi on the eastern mints in striking imperial coins[285], as the decision to place the minting closer to the metal source. The attention and favour that the Severi paid to the region could further corroborate this: while the whole of the wider area of the Lower Danube benefited from the imperial Severan visits[286], the only significant imperial building munificence that Moesia Superior and the interior of Dalmatia ever received was from the Severi[287], and many of the structures that they built or reconstructed were in the mining areas[288]. Septimius Severus toured the region twice, and Caracalla was declared a Caesar during his first visit to Moesia Superior[289]. Judging by the locations and dates of inscriptions erected in their honour, it has been argued that the Severi made an effort to visit major mining regions, although many of them lay off the beaten track[290]. Furthermore, Severan repair works attested at Kostol, Saldum, Smorna, Veliki Gradac, Brza Palanka, Karataš, Drobeta, Čezava, Singidunum, and Viminacium speak of a strategic policy of strengthening the Upper Moesian section of the *limes*. While the majority of the developments on the Danube *limes* tended to involve large tracts of this cross-provincial border, the rebuilding of military installations under the Severi is unique to the Upper Moesian area and is clearly a reflection of a local concern – for the safety of the mining areas, the entries to which were up the tributaries of the Danube, and for the transport of metal.

87 The state efforts were certainly giving results, as the mining works in the Central Balkan districts continue almost without disruption into Late Antiquity, despite the logistical challenges that civil wars and enemy incursions must have caused[291]. With the decline of the gold mines in north-west Spain from the beginning of the third century[292]

281 On the influence of the plague on manpower and wages in Roman Egypt, see Bagnall 2002; Scheidel 2002.

282 Silver 2011.

283 Butcher – Ponting 2012. Much work has been conducted since using lead and silver isotopes and trace element systematics to determine geological provenance of Roman silver coinage (e. g. Westner et al. 2020; Albarède et al. 2021; Milot et al. 2022), but none is directly relevant, concentrating either on earlier periods of history or non-Balkan ore sources. On issues complicating identification of ore deposits exploited in the production of Roman silver coinage and possible futility of the endeavour, see Wood et al. 2023. Comparable work on gold denominations' provenance is still in its infancy (cf. Green – Smythe 2021), and likely to be susceptible to the same pitfalls.

284 While discussing the graph showing the fluctuation of the money supply in the Roman Empire, Jones commented that »if Rio Tinto declined as sharply as suggested, one must ask whether this decline is mirrored by a development elsewhere, to make good for the shortfall and support the expansion of the silver coinage under Severus and his immediate successors?« (Jones 1980, 163), and the Central Balkans might just hold an answer to this question.

285 Crawford 1975, 574 f. The location of these eastern imperial mints is not certain, cf. Bickford-Smith 1994/1995.

286 cf. Wilson 2007b, 322–324.

287 Moesia Superior: IMS VI, 25 (Scupi); IMS II, 55 (Viminacium); IMS I, 168 (Rudnik); ILJug 505 (Municipium DD/Sočanica) (see also Mladenović 2011); Dalmatia: CIL III 2, 12758 (Usora); ILJug 1521 (Domavia).

288 e. g. a temple to Terra Mater at Rudnik (IMS I, 168), an unknown structure at Sočanica (ILJug 505), and a structure at Domavia (ILJug 1521).

289 cf. Mirković 1968, 64; Bojanovski 1972; Bojanovski 1999.

290 e. g. CIL III, 8359 = CIL III, 12720a; CIL III, 8360 = CIL III, 12720b (Domavia) (cf. Fitz 1959; Bojanovski 1972; Bojanovski 1999, 138 f.). The imperial attention was not limited to the precious metal mining and also included iron extraction operations in Dalmatia.

291 Lead pollution data seems to suggest that the only observable lull in metal production came after the peak in ca. 240, a brief decline before levels of activity rose again. The authors attribute this temporary disruption to the plague of Cyprian (Longman et al. 2018), but a political event cannot be discounted as a cause.

292 Domergue 1990, 217.

and final abandonment of the Dacian sources in 272[293], the Central Balkans likely became the single most important source of bullion in the empire. With state experiencing metal shortage in the third century[294] and the control of bullion being clearly crucial for any monetary reform in the Late Antiquity[295], it is not surprising that the state was not giving up its direct control: precious metal mining in the Central Balkans seems to have remained in imperial possession through the third century and under the Tetrarchy, as attested both by epigraphy and ingot markings[296].

88 It is certainly no coincidence that among those who attained the imperial purple through the third century there were many whose military base and personal ties linked them to the Central Balkans[297]. At the time when loyalty was often secured and maintained through payouts, control of the most significant sources of bullion in the empire was likely as important as military prowess, if not more so. Several third-century emperors showed interest in the working of the mines, investing into their infrastructure and communication links[298]. At some point during the reign of Decius or Claudius Gothicus, the administration of the Central Balkan mines was further consolidated by an introduction of a *curator Illyrici metallarius*[299]. Claudius II and Aurelian must have both used local metal sources in their attempts to restore the purity of the coinage[300]. For the first time imperial mints were opened in the Balkans[301], in a clear effort to move the mint closer to the metal source, and many *antoniniani* series were likely supported by Central Balkan silver.

89 It is hard to say for how long the Central Balkan mines remained of critical strategic importance for the Roman state. It has been suggested that Constantine's monetary reform that placed gold *solidus* in the centre of the monetary system was to some extent prompted by the disruption of silver output from the Central Balkan mines and ongoing security concerns in this region[302]. It is hard to see evidence of such an early disruption to the fourth-century mining operations though. Through the fourth century, imperial *donativa* kept being produced locally, at the imperial workshop in Naissus[303], likely indicating that at least Dardanian silver resources were still of significant importance.

293 Davies 1935, 201. 205.

294 Depeyrot – Hollard 1987.

295 Bransbourg 2020, esp. 35–38, with older bibliography.

296 Dušanić 1989/1990; Dušanić 1995b. The last attested imperial procurators at Domavia and Kosmaj date from the second half of the third century and the late third/early fourth century respectively (cf. Škegro 1998, 102–104), with their apparent disappearance likely due to the decline in the epigraphic habit rather than privatization of the operations.

297 Syme 1973; Mócsy 1974, 266–296.

298 e. g. milestones reveal that much of the road network connecting main mining regions of the Central Balkans has been almost completely renewed between the A.D. 230s and 270s (Dalmatia: CIL XVII 4, 368. 383. 411. 416. 419. 420. 422. 423. 426. 429. 436. 443; ILJug 1026. 2972; Moesia Superior: IMS VI, 198. 203–205; AE 1977, 723 (B); AE 1998, 1117; IMS IV, 123–127; IMS I, 175; ILJug 593. 1465).

299 SHA trig. tyr. 15, 2, 4. On the dating of this reform, see Šačić Beća 2022, 194.

300 Their improvements were minimal and short-lived, cf. Harl 1996, 131. 133. 143–148.

301 All of the confirmed imperial Balkan mints were opened in the late third/early fourth century: Viminacium is the probable location of the mint that issued *antoniniani* for Pacatianus, Trebonianus Gallus, Volusian, Aemilian, Valerian, and Gallienus; Siscia was opened by Gallienus and issued gold and silver coins from Claudius II until A.D. 383; Sirmium was opened by Gallienus when it issued *antoniniani*, as well as gold and silver coins in the fourth century; Serdica coined first under Aurelian and issued gold for Probus and the tetrarchs; the Thessalonica mint was established by the tetrarchs and was operational throughout the fourth century, as was Heraclea; Constantinople's first output was obviously under Constantine. cf. Carson 1989, 262–268.

302 Šajin 2014, 141; Šačić Beća 2022, 199.

303 At the beginning of the fourth century, Naissus produced commemorative imperial silver-plate, the most famous being silver bowls for Licinius' *decenallia* (published a number of times in different catalogues and period overviews, and for the first time together in Beyeler 2011, cat. 15–19, with detailed earlier bibliography); the only confirmed later fourth century products are silver ingots (Wiegels 2003, cat. 50. 86).

90 It is, however, clear that effective running of mining operations was increasingly coming under pressure through the fourth century, undoubtedly due to security threats. The central authority made several restorative efforts, including yet another administrative consolidation of regional precious metal mines in the second part of the fourth century[304]. The problem of dwindling mining labour force was felt throughout the empire, necessitating new regulations to be passed making it illegal for mining workers to abandon their posts, while also making the obligation hereditary; Illyricum is explicitly mentioned in this legislation a number of times[305]. In 386, similar measures had to be put in place for the superiors as well, when an edict was issued demanding that mining procurators of the Central Balkans who had forsaken their duties out of fear of the enemy should be made to return[306]. While the state was evidently still keen to protect its interest in the Balkan mines, it is clear that, despite all the efforts, the second half of the fourth century witnessed a declining output of the local mining areas[307]. By this stage, mining operations seem to be organized around fortified settlements within which metallurgical activities took place[308], indicative of the security challenges faced.

91 According to the patchy dating evidence at our disposal, it is only silver mines of Dardania that continued their operations during the fifth century[309], likely maintaining some level of activity into the sixth century as well. Little else could explain the continued prosperity of the city of Ulpiana and the imperial patronage it enjoyed under Justinian, who endowed the city while renaming it *Iustiniana Secunda*[310]. It was most likely the Avar raids that spelled the end of the imperial extraction operations in Dardania sometime around the end of the sixth century, when the Empire eventually ceded power in the Central Balkans[311].

Appendix

92 Precious metal mining sites of Dalmatia and Moesia Superior mentioned in the text:

Site name	Region	Province	Geographic location	Main metal extracted
Gomionica	Fojnica, Bosnia	Dalmatia	43.966667 18.066667	Au
Ostružnica	Fojnica, Bosnia	Dalmatia	43.966667 17.933333	Au
Gromiljak	Fojnica, Bosnia	Dalmatia	43.966667 18.05	Au
Uložnica	Fojnica, Bosnia	Dalmatia	43.98689 17.68866	Au
Crvene Zemlje	Fojnica, Bosnia	Dalmatia	43.97575 17.69362	Au

304 They were now headed by *comes metallorum per Illyricum* (Not. dign. or. 42, 26), cf. Hirt 2010, 209.

305 Cod. Theod. 10, 19, 5. 6. 7. 9. 15; Šajin 2015.

306 Cod. Theod. 1, 32, 5.

307 cf. Longman et al. 2018.

308 Tomović 2000; Marić 2019.

309 As attested by the recovery of coins of Leo I from the mine at Janjevo (Čerškov 1969, 34. 83 n. 75). It has been argued that a revival of Bosnian gold mining took place in the fifth century (Škegro 2000, 81 f.), a supposition based solely on historical circumstances of the time (the wider region paying a tribute in gold), but without any archaeological confirmation.

310 Hajdari et al. 2011; Teichner 2015.

311 Kardaras 2018, 20–87.

Site name	Region	Province	Geographic location	Main metal extracted
Tješilo	Fojnica, Bosnia	Dalmatia	43.959 17.864	Au
Kreševo	Fojnica, Bosnia	Dalmatia	43.865617 18.034589	Au
Krivi Breg	Srebrenica, Bosnia	Dalmatia	44.110957 19.35248	Ag
Kovačice	Srebrenica, Bosnia	Dalmatia	44.094983 19.281020	Ag
Crvena Zdonja	Srebrenica, Bosnia	Dalmatia	44.100194 19.360299	Ag
Šarene Rupe	Srebrenica, Bosnia	Dalmatia	44.120724 19.355222	Ag
Kudrivoda	Srebrenica, Bosnia	Dalmatia	44.099007 19.354741	Ag
Čumavići	Srebrenica, Bosnia	Dalmatia	44.12444 19.24639	Ag
Sokoljača	Sočanica/Soqanicë, Kosovo	Moesia Superior	43.069484 20.841052	Ag
Borčan/Borçan	Sočanica/Soqanicë, Kosovo	Moesia Superior	43.074444 20.917222	Ag
Zminjak	Sočanica/Soqanicë, Kosovo	Moesia Superior	43.076047 20.701888	Ag
Plakaonica/Pllakanicë	Sočanica/Soqanicë, Kosovo	Moesia Superior	43.074569 20.708917	Ag
Trepča/Stari Trg	Trepča/Trepça, Kosovo	Moesia Superior	42.93694 20.92056	Ag
Meljenica/Melenicë	Trepča/Trepça, Kosovo	Moesia Superior	42.95952 20.92608	Ag
Novo Brdo/Novobërdë	Kosovo	Moesia Superior	42.61600 21.43200	Ag, Au
Janjevo/Janjevë	Kosovo	Moesia Superior	42.60399 21.20711	Ag, Au
Šaškovac/Shashkoc	Janjevo, Kosovo	Moesia Superior	42.586335 21.231235	Ag
Lece	Medvedja, Serbia	Moesia Superior	42.908154 21.531887	Au, Ag, Fe
Tulare	Medvedja, Serbia	Moesia Superior	42.794495 21.461770	Au, Ag, Fe
Stojnik, Gradište	Mt Kosmaj, Serbia	Moesia Superior	44.531660 20.492082	Ag
Pruten, slag fields	Mt Kosmaj, Serbia	Moesia Superior	44.529534 20.499570	Ag
Glavčine, mines	Mt Kosmaj, Serbia	Moesia Superior	44.540103 20.489421	Ag
Glavčine, slag	Mt Kosmaj, Serbia	Moesia Superior	44.536027 20.508572	Ag
Brailovac	Mt Kosmaj, Serbia	Moesia Superior	44.532517 20.509097	Ag

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