

# Gold and Silver Mining in the Roman Empire

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## 1. Introduction

The decline in silver from Spanish mines in the second century AD has acquired explanatory power at least in some scholarly narratives on debasement of silver coinage in the Roman Empire.<sup>1</sup> Extracted silver, it is presumed, flowed directly to the mint and the ‘exhaustion’ of the silver mines at Rio Tinto by AD 170 was heralded by Barri Jones as a key factor in pushing the empire into the monetary crisis of the third century AD.<sup>2</sup> Even without the most recent results based on the analysis of the silver coinage issued under Nero, the Flavians, Nerva, and Trajan, it is self-evident that such an explanation assigns too much significance to one specific site. What is more, the analysis of trace elements conducted by Matthew Ponting challenges the notion of (a) an exclusive reliance of the Roman mints on Spanish silver, and (b) the importance of freshly mined silver in the production of denarii.<sup>3</sup> The general picture emerging is that trace element signatures for denarii minted at Lugdunum under Augustus and for some of Tiberius seem to fit a Spanish origin of the silver used. But under Tiberius and certainly under Caligula and Claudius there appears to be a shift: trace elements of denarii minted at Lugdunum seem to fit the signature of silver hailing from the Massif Central in France. Both Spain and Gaul seem to have provided bullion for the coinages produced in Western mints after Nero’s reform during the Civil War of AD 68/9 and in the early years of Vespasian.<sup>4</sup> Furthermore, trace element signatures seem to indicate a major shift towards the Balkans in the supply of silver in the second century AD.<sup>5</sup> These new insights merit a survey of silver and gold mining throughout the Roman empire during the Principate. This paper does not cover the import or recycling of gold and silver for purposes of the Roman state.

A systematic analysis of gold and silver mining within the Roman Empire would need to answer the following key questions if it were to be relevant for the study of debasement of coinage in the Roman empire: When did the extraction of metal at a mining site commence? How much output did a specific mine deliver and for how long? Why did exploitation stop? Any attempt at answering these pertinent questions outright ends, as of yet, in disappointment. The written and material sources suffice in providing a narrative of mining undertaken since the Late Republic down to the third century AD, but the story told remains superficial and spotty. We know almost nothing about the amount of gold or silver produced in the known mining districts, nothing about fluctuations in output, little on shifts in the metals processed from a given source of ore (e.g. lead not being de-silvered), and nothing substantive about why exploitation at specific mines ceased. Only in rare occasions do we learn when a mine was opened and when it was shut down.

The lack of information is explained in part by the training and focus of those examining ancient mines, and, in part, by the written and material evidence connected with mining ventures in the Roman Empire. As for the former, the archaeologists exploring Roman mines have been more concerned with the technological aspects of mining than the economic

<sup>1</sup> Butcher & Ponting 2014: 33 f. with further bibliography.

<sup>2</sup> Jones 1980: 162 f.; Burnett 1987: 48; Harl 1996: 129; Butcher & Ponting 2014: 33 f. with further bibliography

<sup>3</sup> Butcher & Ponting 2014: passim.

<sup>4</sup> Butcher & Ponting 2014: 688 f.

<sup>5</sup> Personal communication M. Ponting.

implications, whereas some of the historians dealing with ancient mining were, overall, more interested in the organizational aspects of exploitative operations.<sup>6</sup>

## 2. Dating Methods

Timber props, or remnants thereof, provide samples which allow for dendrochronological or, at least, carbon 14 dating of tunnel sections. The excellent condition of timbers found at gold mining sites in the Massif Central, such as La Fagassière (Château-Chervix, Haute-Vienne) allowed for the examination of samples, suggesting exploitation of the mines during the late 2<sup>nd</sup> and early 1<sup>st</sup> century BC. Evidently, this gold mine had been run prior to the Roman conquest of Gaul.<sup>7</sup> Scientific dating methods aside, small finds in underground mining shafts and tunnels provide us with a rough idea of when ore was extracted. Inscribed artefacts deposited in shafts rarely offer the opportunity to date mining activities, as is the case with Alburnus Maior, today's Roşia Montană in Romania, where a collection of tablets dated to the mid-second century and not later than AD 167 was discovered. More common are oil lamps and fragments thereof used for lighting; at Alburnus Maior so-called *Firmalampen* of the Loeschke 10 variety suggest mining activity in the second century AD.<sup>8</sup>

Opencast mines are more difficult to date: the vast gold mines at Las Médulas, for example, have been understood to be Roman, given that the hydraulic technology employed in removing the large overburden and extracting the secondary gold deposits is thought to be an “import” by Roman (army) mining engineers.<sup>9</sup> Although the general validity of this conjecture still needs to be tested, some of the aqueducts tapping into brooks and rivulets more than 100kms away yield Latin graffiti indicating the period when these canals were built and, consequently, when Las Médulas was mined with hydraulic measures.<sup>10</sup>

For most mining sites, though, it is the material evidence and stratigraphy deriving from settlements understood to be associated with the mine—either by proximity and/or by evidence for metallurgical activity in the shape of furnaces and slag—which provide a time frame for which the extraction of ore occurred. This rests on the supposition, of course, that there is a correlation between settlement and mining activity. In the municipality of Fuenteobajuna in the province of Corduba in Southern Spain Claude Domergue and others discovered three trenches, so-called rafas, containing a polymetallic ore (sphalerite, galena, and pyrite), from which copper, lead, or silver may have been extracted and processed. The French-Spanish team excavated the settlement in the immediate vicinity of these trenches, named La Loba. The excavations yielded a set of rectangular houses and finds such as picks and other tools as well as ore deposits, slag, furnaces, axes, all indicating metallurgical activity. These finds were associated with a significant amount of stratified coins, high-end Campanian wares, common wares, imported amphorae, oil lamps etc. which strongly suggested a period of occupation from

<sup>6</sup> It also needs to be noted that most sites are excavated under duress because a modern mining company is developing the site.

<sup>7</sup> Cauuet 2001:134 f.

<sup>8</sup> Writing tablets: Noeske 1977: 336-347; 386-415; lamps: Cauuet 2005: 269.

<sup>9</sup> E.g. Sánchez-Palencia et al. 2012: 161.

<sup>10</sup> A barely readable inscription scratched into the rock near a water supply canal (C1) to Las Médulas at Arroyo de Valdecorrales/Llamas de Cabrera, which has been read by Antonio Rodríguez Colmenero as *Placi(dio) / interciso / Seur(r)roru(m) / i(nstruendam) t(itulum) c(uravit) / Susicus*, ‘to Placidius of the Seurri, who cut (this canal); Susicus attended to the monument he ordered’ Matías 2008: 40 no.2; *HEp* online 19301. Further rather crude rock inscriptions hail from another channel (C 0) at Valle de Valdefrola/Castroquilame naming an *Endius Caranc[...]* and from Arroyo de Valdecorrales - Llamas de Cabrera (C1), which Colmenero reads as *Con(so) / M. Eutr(opius) / [ar]am [ex / vo]to po[s](uit) / iuxta*. Matías 2008: 40 no.1; *CIL* II 2612 = *IRPL*e 314 = *HEp* online 8423.

the late 2<sup>nd</sup> century BC to the first quarter of the first century BC. La Loba seems therefore to have been occupied only relatively briefly, and in consequence, the polymetallic ore veins would only have been exploited over a brief period.<sup>11</sup>

Heaps of slag in the vicinity of hardrock or opencast mines can incorporate coins or pottery which indicate when smelting activity may have taken place and, indirectly, shed some light on mining activity close by.

The connection of settlements to mining operations is not always as evident as at La Loba. A vast opencast goldmining region in Northwestern Spain to the southwest of Astorga has been the object of an archaeological survey published by Almudena Orejas in 1996. The hydraulic features of these operations are still visible in the landscape today. Only few of the 90 settlement sites within the survey region, however, have been excavated; if at all, chronological pointers are provided by surface finds. Only two sites in the area were partly excavated – the Corona de Quintanilla (CND-12), a settlement erected in typical castro-style, i.e. a fortified hill settlement, and Huerna (CND-09), an unfortified site, both of the Roman period. The Corona de Quintanilla is located amidst the remains of a hydraulic system of aqueducts and gullies intended for the exploitation of alluvial deposits of gold which has been taken to suggest a close connection to mining operations. The partial excavation of the site indicated settlement activity between AD 15/30 at the earliest and AD 70. The other site, Huerna, seems to have been occupied from AD 45 onwards until AD 200, perhaps with an interruption in the Flavian and Trajanic/Hadrianic period.<sup>12</sup> Surface finds from other sites in the survey area, including stray finds of coins, are understood to corroborate settlement activity from the early first to the mid second century AD, but the absence of any further stratified finds raises doubts as to the accuracy of this picture. What is more, dating of Roman goldmining activity in the Spanish Northwest, in general, relies almost exclusively on the observations made at Corona de Quintanilla and Huerna.<sup>13</sup>

On rare occasions, the epigraphic record can be marshalled in determining the duration of mining activity: the series of inscribed stele with consular dates set up by army vexillations at Villalís and Luyego amidst the goldmining zone southwest of Astorga, provides further corroboration for continued mining operations between AD 163 and 190.<sup>14</sup> Why else would a sizeable detachment of the local army garrison be present in this remote area? Apart from army presence, the synopsis of dated honorific and funerary inscriptions listing the procuratorial careers of imperial officials helps identify administrative activity related to mining in the provinces. However, for some mining zones in the Roman empire the epigraphic evidence adds little to the dating of extractive operations: the silver- and goldmining operations of the Massif Central in France, for instance, leave hardly any traces in the epigraphic record.

### 3. Silver Mining

Most silver was gained from smelted argentiferous galena (lead sulphide) through a process known as cupellation, in which lead was heated to 1,000 °C and subjected to a blast of air, causing the argentiferous lead to oxidize to lead oxide. The molten silver, however, did not oxidize but floated on top of the molten lead oxide (cf. Pliny *nat. hist.* 34.159). After cooling,

<sup>11</sup> Blázquez Martínez et al. 2002.

<sup>12</sup> Survey of the Northern Duero Basin, cf. Orejas 1996: 115 f., 220; Corona de Corporales: Domergue & Silieres 1977; Huerna: Domergue & Martin 1977.

<sup>13</sup> Orejas 1996: lam. 10. With the exception of Corona de Corporales excavation reports from other sites such as settlements around Las Médulas have not been properly published.

<sup>14</sup> Hirt 2010: 120, 186 f.

a lump of silver was removed from the broken litharge.<sup>15</sup> With silver containing ores such as jarosite (e.g. Rio Tinto) lead was added to the smelting charge to make up for the absence of lead in the ores.<sup>16</sup> The silver containing galena or jarosite extracted from mines was thus processed in furnaces near the mine and unused residue deposited in slag heaps on site, which, depending on the subsequent mining history, is still present at some sites today, at times covering ancient structures (e.g. Aljustrel).

### 3.1. Spain

Most scholarly narratives on mining and metal processing see Spain as one of the main hubs of activity within the Roman Empire. Soon after the capture of Carthago Nova by Scipio Africanus in 209 BC, archaeological evidence suggests mining activity in the immediate hinterland of the city, in the Sierra de Cartagena, was quickly expanded.<sup>17</sup> El Gorguel, clearly linked to the silver/lead mining activity nearby by a battery of four smelting furnaces, witnessed a first phase of settlement from around 200 BC to 110 BC (according to pottery finds), and a second phase lasting from the late 2<sup>nd</sup> c. BC to the first quarter of the 1<sup>st</sup> c. AD.<sup>18</sup> Another site in Sierra de Cartagena, Cabezo del Pino, yielded what have been described as ‘washeries’ for silver and lead, alongside ovens; the establishment of this complex dates to around the late 3<sup>rd</sup> and the early 2<sup>nd</sup> c. BC with major activity unfolding throughout the 2<sup>nd</sup> c. BC; after a brief hiatus the washeries were seemingly in operation down to the mid-first century BC, the complex abandoned in the third quarter of the 1<sup>st</sup> c. AD.<sup>19</sup> In the foothills of the Sierra de las Moreras, at Coto Fortuna, Mazarron, to the west of Carthago Nova, material and epigraphic evidence for the mining of argentiferous galena also dates activities to the 2<sup>nd</sup> and 1<sup>st</sup> c. BC, and attests the presence of a *societas argentifodinarum Ilucronensium* on site.<sup>20</sup> The archaeological evidence for lead-silver mining in the area of Mazarron fits the general trajectory of mining activity in the Sierra de Cartagena during the late 2<sup>nd</sup> and early 1<sup>st</sup> c. BC.<sup>21</sup> This is also in line with the finds of marked lead ingots originating from Carthago Nova and found on shipwrecks off the coast, which date mostly to the first half of the 1<sup>st</sup> c. BC and provide an insight into the strata of Late Republican society involved in the trade of lead ingots.<sup>22</sup>

To what degree the argentiferous lead mines in the Sierra de Cartagena were still exploited for silver in the late 1<sup>st</sup> c. BC and subsequent periods is not quite clear. It has been suggested that a change in legal status may have had an impact on mining activity there; the Sierra de Cartagena had been public land, *ager publicus*, but with Carthago Nova being turned into a veteran colony the Sierra might have become part of the colony’s territory with land being apportioned to the new settlers (Cic. *leg. agr.* 1.5, 2.5.1; Strabo 3.2.9f.). Possible consequences of this may have been an initial decline of mining activity, but the major mining centres, now within colonial territory, were still active until the 1<sup>st</sup> c. AD, with the colony

<sup>15</sup> Craddock 1995: 221-228; Craddock 2008: 104.

<sup>16</sup> Craddock et al. 1987; Craddock 2008: 104

<sup>17</sup> For pre-Roman mining activity in the area, cf. Domergue 1990: 167f.; Díaz Ariño & Antolinos Marín 2013: 536 f.

<sup>18</sup> Antolinos Marín 2012:64-74.

<sup>19</sup> Antolinos Marín & Rico 2012: 74-89, esp.89.

<sup>20</sup> Antolinos Marín et al. 2013 with further bibliography; on the activities of this *societas*, cf. Antolinos Marín & Díaz Ariño 2012.

<sup>21</sup> Domergue 1990: 179-191; Antolinos Marín et al. 2010.

<sup>22</sup> Domergue 1990: 253-277 with further bibliography; Hirt 2010: 274 f.; Díaz Ariño & Antolinos Marín 2013: 539-547, with Díaz Ariño 2008 and Koch 1993. Now also Domergue et al. 2012.

producing its own lead (with the stamp ‘NOVA CARTHAGO’), and perhaps another district being farmed out to a *societas montis Ilucronensis*, as stamps on lead ingots indicate.<sup>23</sup>

In the Sierra Morena, the region to the North of the Upper Guadalquivir Valley, the repeated wars in Central Spain against the Celtiberians and Lusitanians may have stifled mining activity until the late 2<sup>nd</sup> c. BC, the earliest mining sites possibly exploited being situated around Castulo.<sup>24</sup> The Cerro del Plomo, a processing site for argentiferous galena near the mines at El Centenillo, provides the most complete stratigraphic sequence related to mining activity in the area and reaching from the late 2<sup>nd</sup> c. BC to the early 2<sup>nd</sup> c. AD.<sup>25</sup> Habitation of the site experienced a hiatus in the mid 1<sup>st</sup> c. BC, which was thought to have been caused by the civil wars of Sertorius against Metellus and Pompey and of the Pompeians against Caesar.<sup>26</sup> The hiatus in the second half of the 1<sup>st</sup> c. BC appears to hit most mines in the area, and mining only fully resumes in the early Principate. By the end of the 1<sup>st</sup> c. AD mining activity went into gradual decline down to the Late Empire, whilst agricultural production seems to have increased during the same period.<sup>27</sup>

A similar picture emerges in the Huelva: at the chief archaeological site of this mining region, at Riotinto, one of the two settlements excavated by a Spanish team in the late 1980s, Corta del Lago, yielded strata going back as far as the Late Bronze Age. The Roman period settlement seems to commence in the 1<sup>st</sup> half of the second century BC but the site is abandoned in the late 1<sup>st</sup> c. BC, possibly as a result of military conflict under Sertorius and the civil war between Pompeians and Caesar. The second settlement at Riotinto, Cerro del Moro, is briefly occupied under Augustus and Tiberius, before Corta del Lago is resettled again under Tiberius only to be abandoned in the second half of the 2<sup>nd</sup> c. AD — possibly in connection with the Moorish incursions under Marcus Aurelius. Later activity attested at Riotinto from the late 2<sup>nd</sup> century onwards appears to focus on copper production.<sup>28</sup>

Similar issues may have plagued mining at Vipasca / mod. Aljustrel, where an honorary monument was set up by the *coloni metalli Vipascensis* for a Beryllus, an imperial freedman, and procurator. He is also called a *restitutor metallorum* in reference to his extraordinary brief. The inscribed stone is likely to be dated to the reign of Marcus Aurelius and may well date to the aftermath of the Moorish raids of 172/3 AD.<sup>29</sup> The limited traces of a settlement at Azinhal at Aljustrel, covered under tons of slag and excavated between 1984 and 1989, seems to indicate early exploitation of copper in the late 1<sup>st</sup> c. BC with mining starting properly in the Imperial period; this is further supported by the little epigraphic evidence and the Vipasca tablets written during Hadrian’s reign. We hear of a freedman procurator in charge of mining district of Vipasca at the end of the 2<sup>nd</sup> century AD, and it seems that mining activities might have ended in the third century (?) (although there is no indication why these activities ceased).<sup>30</sup> According to the Vipasca tablets, copper and silver were mined, and the discovery of a battery of furnaces for the treatment of copper ore at Azinhal (within the Vipasca district) of the first century AD supports the exploitation and processing of former; as for silver, the

<sup>23</sup> Orejas & Sánchez-Palencia 2002: 583-589; Orejas & Rico 2015; Arboledas Martínez et al. 2017: 880-885.

<sup>24</sup> Domergue 1990: 183; Arboledas Martínez 2010: 112 f.

<sup>25</sup> Domergue 1971: 337-347; Arboledas Martínez 2007: 450-461; Arboledas Martínez 2010: 60 f. no. 22.

<sup>26</sup> Arboledas Martínez 2010: 113. For other site in the eastern Sierra Morena, cf. the catalogues in Arboledas Martínez 2007: 339-727; Gutiérrez Soler 2012; Arboledas Martínez 2010: 53-76 with p. 114, fig 71, and Annex 1.

<sup>27</sup> Arboledas Martínez 2010: 118; Arboledas Martínez et al. 2017: 885-889.

<sup>28</sup> Domergue 1990: 206 f.; Pérez Macías 1998: 137-14. For Riotinto region cf. Pérez Macías & Delgado Domínguez 2012: 53-62

<sup>29</sup> Hirt 2010: 124

<sup>30</sup> Habicht 1969: 88-92, no. 44, cf. AE 1933: 273. Christol & Demougin 1990.

existence of a freeman procurator still in charge of the district at Vipasca would suggest that silver was still being mined, but is in itself not conclusive.<sup>31</sup>

### 3.2 Gaul

Further sources of silver have been located in the Massif Central of France; the wooden remains in some of the argentiferous lead mines there have been carbon dated which provides rough indications when a mine was up and running, but not enough on the duration of operations, given that associated settlements have rarely been identified. For instance, a mine near the hamlet of Mercoeur in the Haute Loire where a polymetallic ore containing copper, lead, and silver was extracted, yielded timber, which provided carbon-14 dates in a narrow range of the 1<sup>st</sup> and 2<sup>nd</sup> c. AD. Remains of a settlement nearby and thought to be closely linked to these mining operations yielded stratified finds, mostly *terra sigillata* produced at La Graufesenque between 30 BC and 50 AD, but also La Tène D2 pottery from the 1<sup>st</sup> half of the 1<sup>st</sup> c. BC, suggesting earlier exploitation by local tribes.<sup>32</sup> The argentiferous galena mine at Pontgibaud in the Puy-de-Dôme region near Clermont Ferrand, for instance, yielded some 160 pieces of timber each around 1.70 m in length. The carbon dates of three selected pieces fell within a range from the 2<sup>nd</sup> half of the 1<sup>st</sup> c. AD to the 4<sup>th</sup> c. AD. In short, there is no clear indication of the longevity of the mine or the reasons for its abandonment. An associated settlement revealed finds from La Tène D2 (1<sup>st</sup> half 1 c. BC) and *terra sigillata* from La Graufesenque (30 BC – AD 50).<sup>33</sup> The mining of argentiferous galena in the Rodde region at Ally in Haute Loire seems to reach as far back as the Hallstatt period, as carbon dated timber suggests, and is continued, perhaps with interruptions (?), down to the 2<sup>nd</sup> c. AD.<sup>34</sup> Further argentiferous lead mines in the Cévennes yielded Roman finds in the 1950s.<sup>35</sup>

Surveys of the silver-lead mines in northwest Aveyron around Kaymar, Villefranche-de-Rouerge, Peyrusse-le-Roc, etc., offer evidence for mining activity starting as early as the 2<sup>nd</sup> c. BC (La Maladrerie) and reaching its heyday in the mid 1<sup>st</sup> c. BC to late 1<sup>st</sup> c. AD. It is the mines in the Cévennes and the Aveyron which Strabo of Amasia, the Augustan geographer and historian, notes for their silver output and which he situates in the lands of the *Ruteni* and *Gabales* (3.2.8; 4.1.12; 4.2.2, likely citing Posidonius). Cicero mentions the wealth of the *Ruteni* in his speech *Pro Fonteio* (3.4.) as a well-known fact. At Lascours, a settlement in the vicinity of mining operations in the Upper Orb Valley, in the heartland of the *Ruteni*, the establishment of an Italian diaspora from the early 1<sup>st</sup> c. BC onward is reflected in the stratified finds of Campanian wares, Arretine pottery and Dressel 1A amphorae. During the heyday of mining activity in this area from the late 1<sup>st</sup> c. BC to the first third of the 1<sup>st</sup> c. AD operations were under the auspices of a *societas Rutenensis* or *Rutenensium*, as abbreviated letters on lead tesserae seem to suggest. The inscribed plate (*CIL* 13:1550) from a monument set up at Puech-de-Serre near Villefranche-de-Rouerge in the Aveyron by slaves of the *familia Caesaris* of emperor Tiberius to a Zmaragdus, a *vilicus* and also quaestor and magister of the collegium formed by the imperial slaves in this mining zone, attests the presence of imperial officials and staff in the area at least under Tiberius.<sup>36</sup> To the Northwest of the Massif Central, on the Rhine frontier, silver may have been mined on the Rösraath-Lüderich some 20km east of Cologne. The pottery fragments discovered on site allow for a rather tentative dating of the associated

<sup>31</sup> Cauuet et al. 1999; C. Domergue, in: Orejas 2001: dossier IV 1A.

<sup>32</sup> Cauuet et al. 2005: 432-434.

<sup>33</sup> Cauuet et al. 2005: 430-432, with further bibliography.

<sup>34</sup> Cauuet et al. 2005: 434-436.

<sup>35</sup> Cauuet et al. 2005: 436.

<sup>36</sup> Cauuet et al. 2005: 436 f.; Pilier 2011.

settlement remains to the first and perhaps second decade of the first century AD.<sup>37</sup> Further sites of lead and silver mining might be situated at Hennef-Uckerath and Engelskirchen-Bliesenbach but there is not much archaeological material which supports this.<sup>38</sup> Most mining sites in the Eifel and the Sauerland appear to produce lead with low silver content.<sup>39</sup>

### 3.3 Britain

Amongst the *praetia victoriae* from the conquest of Britain, Rome is provided with gold and silver (Tac. Agr. 12.6: *fert Britannia aurum et argentum et alia metalla, pretium victoriae*). More importantly silver mines, *argentariae*, are noted on British lead ingots: the mould inscription *Imp(eratoris) Vesp(asiani) (plumbum) Brit(annicum) ex arg(entariis) Veb* ( ) was stamped on lead pigs found at Charterhouse on Mendip (*RIB* 2:2404.4), Bossington (Somerset; *RIB* 2:2404.3), Green Ore /Wells (Somerset; *RIB* 2:2404.7-10) and Bitterne (*Clausentum*; *RIB* 2:2404.5-6), and London<sup>40</sup>, likely hailing from the argentiferous lead mines at Charterhouse.<sup>41</sup> Lead pigs found in Derbyshire also note the term *metalli Lutudarensis*, ‘from the Lutudarensian mine’ or render the addition *ex arg(entariis)* together with a personal name or *socii* followed by *(plumbum) Britannicum Lutudarensis* or simply *Lutudarensis* (*RIB* 2.2404.39-60). Given the find spots of these, their production in Derbyshire near Matlock close to where the lead ore was mined seems likely.<sup>42</sup> The term *argentariae* might be misleading as the silver content in the lead ore might not have been rich enough to merit cupellation and, therefore, de-silverisation, or lead mined in Roman Britain was not de-silvered on a regular basis.<sup>43</sup>

### 3.4 Balkans

The vast slag heaps at Mt. Kosmaj in northern Moesia Superior —estimated originally at some 1,000,000 tons, supposedly hailing from 5,000 pits<sup>44</sup> — appear to indicate extensive mining and processing of the argentiferous lead ore with the aim of extracting silver. The site was guarded by an auxiliary camp.<sup>45</sup> Coins found in the slag heaps in the camp’s vicinity during soundings in 1984 and 1985 suggest intensification of metallurgical activities in the mid-2<sup>nd</sup> c. AD.<sup>46</sup> Almost no mining sites in the Danube provinces have received proper attention beyond the registration of slag finds, remains of furnaces, and mining tunnels by mining engineers of the late 19<sup>th</sup> and early 20<sup>th</sup> century<sup>47</sup> — with the exception of mining near Ulpiana. A survey in the mining area around Ulpiana / mod. Pristina in Kosovo has yielded interesting finds such as evidence for shaft entrances and slag deposits at Shashkoc and Janjevo, dating to the Roman/Late Roman and Medieval/Early Modern period; pottery in settlement remains dates to the 4<sup>th</sup> c. AD. Examination of the slag suggests that the ore mined was processed for silver

<sup>37</sup> Körlin & Gechter 2003.

<sup>38</sup> Bode 2008: 77, 79.

<sup>39</sup> Domergue et al. 2006: 138 f.; Bode 2008: 59-83.

<sup>40</sup> Hassall & Tomlin 1996: 446-448, nos. 11, 12, 13.

<sup>41</sup> Another lead pig, from Syde (Gloucestershire; *RIB* 2:2404.13) is worded slightly different, only rendering *ex ar(gentariis)*.

<sup>42</sup> Barnatt 1999: 22-26; Jones & Mattingly 2002: 181.

<sup>43</sup> Tylecote 1986: 54-80, esp. 68-70 with Table 38; Jones & Mattingly 2002: 189 f.; Ponting 2018.

<sup>44</sup> Davies 1935: 213 fn. 4; Dušanić 1977: 78; Tomović 1995: 205; or criticism of the estimate, cf. Merkel 2007: 44-46; for a recent survey of the Kosmaj mining area, cf. Crnobrnja 2017; for military and administrative presence, cf. Hirt 2010: 131 with 166f., table 1; 193 f., with further bibliography.

<sup>45</sup> Werner 1986: 22; Tomović 1995: 206 f.; Merkel 2007: 41-43.

<sup>46</sup> Merkel 2007: 49.

<sup>47</sup> See Dragana Mladenovic, ‘Roman Gold and Silver Mining in the Central Balkans and its Significance for the Roman State’, (unpublished), for a detailed account.

and lead.<sup>48</sup> It appears likely that silver continued to be mined, esp. in Moesia superior, well into the 5<sup>th</sup> and 6<sup>th</sup> c. AD.<sup>49</sup>

Datable evidence for the duration and scale of silver mining in the Danubian provinces is less than promising so far; there is some evidence for a Roman presence, but no recent examination of actual mines.<sup>50</sup> A more general indication for silver extraction in the Roman provinces of Dalmatia and Pannonia is provided by inscribed stele set up along the wall of the *basilica* in Domavia/mod. Srebrenica.<sup>51</sup> These and other inscriptions allow us to draw up a list of imperial procurators in charge of mines in Dalmatia and Pannonia who, under Commodus, are specifically called *procurator argentariarum Pannoniarum et Dalmatiarum*, thus procurator of silver mines in these two provinces. As early as the mid 2<sup>nd</sup> c. AD procurators for silver mines are known for Pannonia only. From this we may infer that silver mining in the two provinces was ongoing at least since the mid-2<sup>nd</sup> to the late 3<sup>rd</sup> c. AD, if not earlier.<sup>52</sup>

Further to the East, in Thrace, recent archaeological interest is focussed on prehistoric mining in the Eastern Rhodopian mountains, whereas for Western Thrace again travel reports and economic mining surveys from the late 19<sup>th</sup> and early 20<sup>th</sup> centuries provide, at best, an idea of where silver and gold might have been mined under Roman rule.<sup>53</sup> Lucian of Samosata makes rather general mention of Thrace as a province providing silver and gold (*fug.* 24). Circumstantial evidence points towards the territory of Pautalia/mod. Kjustendil (BUL) which may have incorporated silver mines<sup>54</sup>: Pautalia emitted a coin showing Iulia Domna, on the obverse and, on the reverse, a nymph or river god, thought to represent the source of Strymon river, laying the right arm around a mountain, the left hand holding an urn; next to the river god/nymph four small figures who collect and offer the natural wealth of the Pautalian territory such as wine from vineyards or grain from fields. Of interest is the depiction of one figure carrying a bag of silver ore from a mining shaft and another panning for gold in a river. The activities of all four figures are illuminated by the captions βότρυς (bunch of grapes), στάχυς (ear of corn), ἄργυρος (silver), and χρύσος (gold).<sup>55</sup> Further evidence for mining hails from a fragmentary plaque discovered in a Late Roman context near the baths of Pautalia which is dated to the mid 2<sup>nd</sup> c. AD and mentions a μεταλλικός. The editors of the inscription interpret the μεταλλικός as a ‘mining engineer’, given the man seems in charge of constructing the water conduits.<sup>56</sup> Argentiferous lead ore is presumed to have been exploited to the southwest of Pautalia in the Osogovo and Kratovo mountains, with finds of slag heaps made near Grizlievci (MK).<sup>57</sup> Silver might have been exploited elsewhere in Thrace under Roman rule but there is little in substantive data in support of this apart from a few potential sites throughout what is now Bulgaria.

<sup>48</sup> Gassmann et al. 2011; Körlin & Gassmann 2016; for a study of the slag see now the thesis by Westner et al. 2016; Westner 2016.

<sup>49</sup> Petkovic 2009.

<sup>50</sup> Mladenović (forthcoming), with further bibliography; Davies 1935: 189-195.

<sup>51</sup> Radimsky 1893; Radimsky 1896; Wilkes 1969: 279.

<sup>52</sup> Hirt 2010: 133-136, with further bibliography. Reservations regarding the accuracy of the term ‘argentaria’ apply.

<sup>53</sup> Jireček 1886:75-85; Davies 1935: 227-230; Velkov 1971: 185-192; Wolff & Velkov 1990: 607.

<sup>54</sup> On the territory of Pautalia, cf. Katsarova 2005: 264-266.

<sup>55</sup> For discussion cf. Imhoof-Blumer 1908: 163 f. no. 459; Ruzicka 1932-1933: 129, no. 473; Velkov 1971: 186 f.; Peter 2005: 107 fn. 5. Another Pautalian coin with the head of Septimius Severus on the obverse and our motif on the reverse seems displayed on coin Ruzicka 1932-1933: 110 no. 360. The motif emerges again on a Pautalian coin issued during the reign of Caracalla, again with similar captions. Ruzicka 1932-1933: 159 no. 634.

<sup>56</sup> *AE* 2004: 1313 = *SEG* 54: 648 = *BE* 2006: 269

<sup>57</sup> Jireček 1886: 77 f.; Davies 1935: 227 f.; Gaul 1942: 400 f.; *TIR* Naissus 60, with further bibliography; Petrović 2013: 40.



As for mining in Southern Macedonia, silver mining may not have been continued on Mt. Dysoron (Hdt. 5.17) under Roman rule.<sup>58</sup> The suggestion has been made that the slag at Skouries in the Kassandra district on Chalkidiki was produced in the Late Roman period, although the evidence is based on unreliable thermoluminescence dates for pottery sherds.<sup>59</sup> Whether the Pangaeum was mined for silver under Roman rule is not indicated beyond the literary sources. Strabo claims that “Mt. Pangaeum has gold and silver mines as well, as does the country across and the country this side of the Strymon River as far as Paeonia”.<sup>60</sup> Strabo is likely to repeat older sources, rather than current accounts of mining in the area.<sup>61</sup> There seems to be little evidence from Pangaeum itself in terms of Roman or Late Roman exploitation, although the guess is that silver was exploited there nonetheless.<sup>62</sup>

### 3.5 Greece

With the expanse of the Roman empire into the Hellenistic East during the 2<sup>nd</sup> c. BC, potential sources of silver fell under the control of the new Roman masters. Some of the famed silver mines on the Greek mainland and in the Aegean had gone into decline by the Hellenistic period or were perhaps not as productive anymore. The silver mines at Laurion, providing the backbone to Athenian wealth in the 6<sup>th</sup> and 5<sup>th</sup> c. BC, may have still been exploited in the 4<sup>th</sup> c. BC, at the end of which extraction appears to have ceased.<sup>63</sup> Strabo notes that by his time the mines had stopped yielding any silver (3.2.9; 10.1.9). Whether silver mining at Laurion experienced a revival in the early 2<sup>nd</sup> c. BC is debatable; the silver used to issue ‘New Style’ tetradrachms in the first half of the 2<sup>nd</sup> c. BC must not necessarily derive from a new mineral source, but could hail from the reprocessing of dross and slag during the period, a procedure Strabo refers to in his *Geography* (9.1.23).<sup>64</sup> The silver and gold deposits on the island of Siphnos so celebrated by Herodotus (3.57) may have been in decline by the late 5<sup>th</sup> c. BC.<sup>65</sup> Pausanias, who wrote his *Periégesis Helládos* probably in the second half of the 2<sup>nd</sup> c. AD, claims ‘the sea flooded their mines and hid them from sight’ for not paying their tithe at Delphi (10.11.2). Whether the literary narrative accurately reflects silver mining on the island is a different question.<sup>66</sup>

Thasos receives similar praise by Herodotus as to its riches in gold (6.46), but silver extraction is not mentioned. The radiocarbon dates of charcoal from two galleries (M10, M11) in the Marlou region have been understood to suggest lead and silver mining activity in the Late Roman period; thermoluminescence dating of ceramic fragments found in a slag heap nearby at Skoridia was thought to underpin this.<sup>67</sup> A slag deposit at Skres further yielded

<sup>58</sup> Davies 1932: 152f.; Davies 1935: 233; Pernicka 1987:677.

<sup>59</sup> Wagner et al. 1986: 172 f.; Pernicka 1987: 669.

<sup>60</sup> 7. 34: καὶ αὐτὸ δὲ τὸ Παγγαῖον ὄρος χρυσεῖα καὶ ἀργυρεῖα ἔχει μέταλλα καὶ ἡ πέραν καὶ ἡ ἐντὸς τοῦ Στρυμόνος ποταμοῦ μέχρι Παιονίας.

<sup>61</sup> Velkov 1971:

<sup>62</sup> Davies 1935: 234-237; Unger & Schütz 1980: 44; Schütz & Unger 1981: 32; Domergue 2008: 85 table IV with Photos et al. 1989 (non vidi). On whether a Gamicu[s] noted as conduct[or] in *AE* 1986: 629 was involved in mining near Philippi, cf. Samsaris 1985; Dušanić 2006: 92 f.; Brélaz 2014: 386 f.

<sup>63</sup> For recent excavations cf. Morin & Photiades 2005; Morin & Photiades 2012.

<sup>64</sup> Habicht 1997: 243-245; Panagopoulou 2007: 319. There is some evidence for activity in mining shafts at Thorikos where Late Roman lamps were supposedly discovered in a mining gallery, cf. Butcher 1982.

<sup>65</sup> Pernicka 1987:662 f.

<sup>66</sup> Wagner & Weisgerber 1985; Pernicka 1987: 662-664. Trace elements of Siphnian silver show up in some Mark Antony denarii; this might be either explained by the mines still being exploited in the late 1<sup>st</sup> c. BC or by old silver bullion or coins being recycled, cf. Butcher & Ponting 2014: 167.

<sup>67</sup> Pernicka et al. 1981: 236. Carbon dates: Gialoglu et al. 1988: 84 f with table 1.

material finds which dated to the Hellenistic-Roman and Byzantine period, and slag from the mound at Padia yielded a thermoluminescence date in the Roman period.<sup>68</sup>

### 3.6 Anatolia

Argentiferous ore deposits in Anatolia are hardly ever the source of extensive literary treatment.<sup>69</sup> Silver might have been won to the east of Mount Ida at Argyria, but Strabo debates the validity of this claim (13.1.45).<sup>70</sup> Evidence for silver mining in Northwestern Turkey, addressed as ‘Hellenistic’, possibly Roman, by German surveyors was encountered at Altınoluk (Çanakkale), Karaaydın (Balıkesir), Avcılar (Balıkesir), Güre (Balıkesir), Maden Adası (?) (Balıkesir), and Gümüşköy (Küthaya); in terms of archaeological material there is very little in support of this.<sup>71</sup> Galen (9.3.22 ed. Kühn 12, p.230) indicates that between Pergamum and Cyzicus zinc oxide and lead was won at the *kome* Ergasteria, but no mention of silver is made.<sup>72</sup> Magie thought these to be located near *Pericharaxis* in Mysia, which has been identified with Balya Madeni, the site of modern lead-silver mines. Theodor Wiegand presumed the numismatic, archaeological, and epigraphic material attested on site related to Hellenistic and Roman silver and lead mining operations.<sup>73</sup> Strabo notes that in the territory of the Chaldaeans/Chalybians in Paphlagonia silver used to be won in the past (12.3.19).<sup>74</sup> And Pliny (*nat. hist.* 34.173) locates the source of the most esteemed galena at Zephyrium in Cilicia.

A survey of mining sites in Eastern Anatolia undertaken by a research team at the Max Planck Institute in Heidelberg in the summer of 1984 identified further argentiferous ore mining sites where Hellenistic and/or Roman/Late Roman activity appears possible, based on the archaeological material associated with the extractive operations: Işık Dağ (Ankara province), Gümüş (Amasya), Tirebolu (Giresun), Gümüşhane (?), Zankar (?) (Gümüşhane), and Keban (?) (Elazığ).<sup>75</sup> One might add Pınarbaşı Boğaz (Niğde) as a potential site for Roman/Late Roman silver mining.<sup>76</sup> The vast Bolkardağ area (Niğde), also known as Bulgar Dağ or Bulgar Maden, may attest Roman/Late Roman silver mining as well<sup>77</sup>, as do Akdağmadeni or Kurşunlu Köy (Sivas).<sup>78</sup>

<sup>68</sup> Hauptmann et al. 1988: 92, 109. Thermoluminescence dates are not particularly exact,

<sup>69</sup> For a gazetteer of mining sites in Anatolia in De Jesus 1980.

<sup>70</sup> Magie 1950: 44, 803 n.27; Shepherd 1993: 224. Perhaps silver was still being mined at Argyria in the Troad, but Strabo (13.45) believes the site to be a fabrication in order to support the statement in the Iliad (2.856) that there was the birthplace of silver.

<sup>71</sup> Altınoluk: Pernicka et al. 1984: 535-537; Wagner et al. 2003: 151 f.; Karaaydın: Pernicka et al. 1984: 538; Wagner et al. 2003: 153; Avcılar: Pernicka et al. 1984: 549; Wagner et al. 2003: 154; Güre: Pernicka et al. 1984: 550-553; Wagner et al. 2003: 155; Maden Adası: Pernicka et al. 1984: 561 f.; Wagner et al. 2003: 155; Gümüşköy: Kaptan 1983: 61; Pernicka et al. 1984: 567 f.; Pitarakis 1998: 155 f.; Wagner et al. 2003: 156.

<sup>72</sup> Schlange-Schöningen 2003: 284 n. 112.

<sup>73</sup> *BCH* 38 (1894), p. 541 = *AM* 20 (1895) p. 236 f. = *AEM* 18 (1895), p.228 f., cf. Wiegand 1904: 269-272; Hasluck 1910: 114; Magie 1950: 44 with n. 28. See Pernicka et al. 1984: 540-549; E. Pernicka in Wagner et al. 2003: 152 f.

<sup>74</sup> For Byzantine period mining of silver cf. Bryer 1982: 138-

<sup>75</sup> Seeliger et al.1985: 600 f. (Işık Dağ), 606-612 (Gümüş), 614-616 (Tirebolu), 616-618 (Gümüşhane), 619 f. (Zankar), 621-629 (Keban); Pitarakis 1998: 163 ff.

<sup>76</sup> Wagner et al. 1989: 672 f.

<sup>77</sup> Hild 1977: 109, 122; Hild and Restle 1981: 64, 138; Wagner et al. 1989: 673-675.; Pitarakis 1998: 169-174; Cooper & Decker 2012: 72 f.

<sup>78</sup> Akdağmadeni: Hild 1977: 109, 122; Hild and Restle 1981: 64, 138; Pitarakis 1998: 167. Kurşunlu Köy; Pitarakis 1998: 167.

## 4. Gold Mining

### 4.1 Northwestern Spain

The Cantabrian Wars, ending in 15 BC, opened up the possibility of exploiting the secondary alluvial gold deposits by hydraulic methods and the primary deposits by traditional hard rock mining techniques. Evidence for both can still be seen throughout León, Asturias, Galicia, and Northern Portugal today but only few sites have been subjected to a more rigid archaeological examination.<sup>79</sup> More importantly, there seems to be little evidence beyond the end of the 2<sup>nd</sup> c. AD to support extensive goldmining in the Spanish Northwest.<sup>80</sup>

Although the gigantic opencast mining zone of Las Médulas in León has been extensively studied, there is little in terms of archaeological excavations of nearby sites. To my knowledge, none of the Roman period hill settlements have been excavated. Soundings have been undertaken at two non-hillfort sites, La Malladica and Los Chaos de Mourán; both seem to have been occupied between the mid 1<sup>st</sup> and the first half of the 2<sup>nd</sup> c. AD. Of these, no extensive publication of finds and contexts have been published.<sup>81</sup> The opencast goldmine of Três Minas in Portugal has been the focus of much recent attention as well, although most of the datable evidence derives from lamps discovered in the Galeria do Texugo and inscribed funerary and votive monuments from the settlements and necropolis nearby. The aggregated data suggests an occupation and therefore exploitation of the mines during the first and second c. AD.<sup>82</sup>

Recent attention has been on remains of Roman mining along the Duero/Douro River in the area of the Spanish-Portuguese border where the site of Pino del Oro has been the object of further scrutiny: spreading out to the NW of the modern village of Pino del Oro a quartz outcrop and primary deposit of gold was extracted in opencast mines; the gold ore was processed on site, i.e. ground to powder in order to minimize dross when smelted in a kiln and there are traces in rock surfaces documenting the use of grindstones.<sup>83</sup> Gold was possibly extracted already in the Late Iron Age, given that a pre-Roman *castro*, La Ciguadueña, is attested on the Río Douro close by. This *castro* was possibly abandoned for the settlement of El Picón, remains of which date to the first half of the first century AD, at the earliest, and run through to the second half of the 4<sup>th</sup> century AD.<sup>84</sup>

### 4.2 Britain, Gaul, and the Alpine Belt

Goldmining in Britain, so far, seems only to be attested at Dolaucothi in South Wales, where Roman exploitation may well have continued earlier workings on the site. The main evidence for commencement and duration of Roman control of mining procedures is provided by an auxiliary camp located in the immediate vicinity. The excavated site was likely occupied from around AD 70 to the mid-120s; the associated settlement is attested only through a geophysical survey and has not been examined further. It is presumed that the mines were exploited during the same period.<sup>85</sup>

<sup>79</sup> For a catalogue of sites, see entries *sub* ‘Coruña’, ‘León’, ‘Lugo’, ‘Orense’, and ‘Oviedo’ in Domergue 1987;

<sup>80</sup> Domergue 1990: 215, with respective entries in Domergue 1987; Orejas 1996: 183 f.

<sup>81</sup> Sánchez-Palencia 1990: 259; Sánchez-Palencia et al. 1996: 106 f.

<sup>82</sup> Redentor 2010; on the mines cf. Hirt 2010: 35 f., with further bibliography.

<sup>83</sup> Sánchez-Palencia & Currás 2014: 15-38.

<sup>84</sup> Romero 2015. The find of *tabula hospitalis* on site, dating to 27 AD suggesting the renewal of *hospitium* between the *senatus populusque Bletisamensis* and an unknown individual certainly underlines the early date of Roman presence in the area *HEp* 18: 479 = *AE* 2009: 607; Sastre et al. 2009;

<sup>85</sup> Burnham & Burnham 2004.

Of the 250 goldmining sites in the Limousin area in the Massif Central in France, which were operational from the 6<sup>th</sup>/5<sup>th</sup> to the late 1<sup>st</sup> century BC, none seems to have been continued much into the early 1<sup>st</sup> century AD. Goldmining was abandoned upon the Roman conquest. Beatrice Cauuet argues that this was not the result of exhausting the ore lodes, but perhaps the consequence of new sources of gold being exploited in Northwestern Spain.<sup>86</sup>

In the *regnum Noricum*, a territory in the eastern Alpine belt likely annexed by Rome under Augustus in 15 BC, gold might have been washed or mined: stone moulds for gold ingots from the reign of Caius strongly suggest that the Magdalensberg in Carinthia where the moulds were found, was at least an important trading hub if not administrative centre for gold mining in the region.<sup>87</sup> As for the source of the gold, scholarly attention is focused on placer gold from Klienbach near Wiesenau or hard-rock mines in the Hohen Tauern. As of yet, there is no convincing archaeological evidence for Roman mining activity in Carinthia itself.<sup>88</sup> To the north of the Alps, southwest of Neunkirchen in Lower Austria, aqueducts and basins were discovered in the 'Karth' which seem to belong to a hydraulic system put in place to exploit secondary deposits. Numerous finds of tools, pottery, and of two coin hoards suggest Roman exploitation during the 2<sup>nd</sup> and 3<sup>rd</sup> century.<sup>89</sup> Further West, in the Piedmont, the Salassi are said by Strabo to have used hydraulic methods to wash gold (4.6.7); evidence for such activities have been observed at La Bessa (Biella) in Italy dated to the late 2<sup>nd</sup> and early 1<sup>st</sup> c. BC with aqueducts, basins, and traces of ground sluicing being in evidence on the western bank of the Elvo river.<sup>90</sup>

### 4.3 Dalmatia and Dacia

In Dalmatia gold was apparently mined as well: the 2<sup>nd</sup> century historiographer Florus claims that following the establishment of military control under Augustus, the governor C. Vibius Postumus (Florus 2.25.12) put the ignorant Dalmatians to work in the goldmines. There seems to be at least some truth in the account of Florus that the Dalmatians took up gold mining with zeal (*studium*) and diligence (*diligentia*). The onomastic material from the inscriptions on stone monuments and from the wooden tablets found at Roşia Montăna indicates a strong presence of Dalmatians at the 2<sup>nd</sup> century gold mining site in Dacia, and the place names chosen to name the various settlements copy tribal names in Dalmatia. In other words, Dalmatian immigrants created their own 'Little Dalmatia' in faraway Dacia. This raises the question whether by the mid-second century goldmining in Dalmatia had gone into decline or had been consolidated at a few sites, freeing up experienced miners who migrated in groups to Dacia.<sup>92</sup> Epigraphic evidence for gold mining activity in Dalmatia is provided by a 1<sup>st</sup> c. AD funerary inscription from Salona naming an *a commentariis aurariarum Delmatarum* (CIL III 1997), who dealt with a set of documents containing legal decisions and letters of the financial procurator of Dalmatia in charge of state revenues. The existence of an administrative post specifically for goldmining suggests a considerable paper trail which needed to be dealt with by a designated official.<sup>93</sup>

<sup>86</sup> Cauuet et al. 2005: 426-430.

<sup>87</sup> Piccotini 1994.

<sup>88</sup> Veters 2010; Pichler & Gleirscher 2014.

<sup>89</sup> Cech et al. 2013.

<sup>90</sup> Sánchez-Palencia & Vaudagna 2009; Brecciaroli Taborelli 2011: 25-32; Sánchez-Palencia et al. 2014. Pliny the Elder provides a rather detailed account of mining operations in the Northwest which he might well have observed himself (33.66-78).

<sup>92</sup> Noeske 1977; Piso 2004; Ciongradi 2009; Hirt, forthcoming.

<sup>93</sup> Hirt 2010: 74, 162. On gold mining in Dalmatia, cf. Hirt 2010: 73 f. with further bibliography.

The gold and silver mining site at *Alburnus Maior* / mod. Roşia Montăna has yielded some 6 km of ancient mining tunnels with remnants of timber, oil lamps, and consul dated writing tablets which seem to confirm exploitation of ores in the second century AD.<sup>94</sup> The analysis of the archaeological evidence from the hamlets in the immediate vicinity of the mining sites around *Alburnus Maior* has done little to clarify the duration of settlement.<sup>95</sup> As for the inscribed funerary stele and votive altars set up at these sites—often for immigrants from Dalmatia, as the onomastic material suggests — they offer little help in dating settlement activity more precisely than the second and early third century AD.<sup>96</sup> A series of inscribed monuments from *Ampelum* / mod. Zlatna, the administrative headquarters of gold mining districts in Roman Dacia, at least allows us to postulate a more general chronology for gold mining in the province. Imperial freedmen and later equestrians supervised goldmining operations as *procuratores* almost continuously from the early second century to the early third century AD.<sup>97</sup>

Extractive operations ended with the evacuation of the province under Aurelian in AD 271. As a consequence, gold and silver mining may have flourished in the third to fifth century south of the Danube in what is now eastern Serbia (in the Pek and Timok valleys) — or so some scholars claim with providing little archaeological evidence.<sup>98</sup> The only site that was excavated in recent years in the vicinity of mining operations, is the Late Roman (?) fortified site of Krakul Jordan; it may yield evidence for the processing of gold ore, although the evidence is not quite straight forward.<sup>99</sup>

### 4.3 Thrace and Anatolia

The Bessi, a Thracian tribe situated in Eastern Thrace around Mt. Haemus, are said by later authors to have developed special skills in exploiting gold and silver lodes (Veg. 2.11; Paulin. Nol. *carm.* 17 (PL 61, 488, ll.213-216); Claud. 17.38-41; Pacatus, *Paneg. Theodos.* 28.2). The Codex Theodosianus yields two decrees by emperor Valentinianus in AD 370 or 373 which highlights the fact that miners absconded from Thracian gold mines (10.19.7, 1.32.5); according to Ammianus, some of these Thracian gold miners joined the Goths in AD 377/8 (31.6.6).<sup>101</sup> There are some indications in local archaeology around Pautalia and Philippopolis for gold mining in hardrock mines but also for placer in the Upper Strymon Valley.<sup>102</sup>

Whether gold was still mined in the Pangaeum and on nearby Thasos in the Roman period cannot be answered with any certainty; on Thasos the evidence seems to point towards the 5<sup>th</sup> and 4<sup>th</sup> century BC. Skapta Hyle or Scaptensula, located in the Pangaeum, still finds mention

<sup>94</sup> Cauuet & Tamas 2012.

<sup>95</sup> Damian 2003.

<sup>96</sup> Ciongradi 2009.

<sup>97</sup> Hirt 2010: 126-130, with further bibliography.

<sup>98</sup> Petković 2009: 188 f.;

<sup>99</sup> Tomović 2000.

<sup>101</sup> Velkov 1971: 190 f.

<sup>102</sup> For gold mining near Pautalia and Philippopolis see entries in TIR K 34 Sofia Naissus-Serdica-Thessalonike for Gorno Ujno, Gorno Kobile, Dolno Kobile, Dolemo Selo, Bistrice, Gorublijane, Pancharevo with Gerov 1998: 98, 140 f., 314. See also Avdev & Tsankov 2008: 253 f. and Bachmann & Tsintsov 2003, for mining of placer gold in the Upper Strymon Valley. For ancient mining to the north of Philippopolis /mod. Plovdiv in Sredna Gora mountains in general and at Kolyu Marinovo and Babyak in particular, see Nenov 2008 and Tonkova 2008.

with Roman authors, but almost certainly does not reflect any actual exploitation of gold ores there (Lucretius 6.808-810, Festus [ed. Lindsay] 442 f.).<sup>103</sup>

Across the Bosphorus, archaeological data for gold deposits in Anatolia is even sparser: it may have been mined in Arap Dağı (?) (Izmir).<sup>104</sup> Strabo notes gold mines at Astyra near Abydos, which at his time were exhausted (13.23, 14.28); archaeological evidence suggests Hellenistic activity at the site.<sup>105</sup>

## 5. Concluding Remarks

This brief survey of the chief evidence for gold and silver mining in the Roman empire under the Principate answers almost none of questions posed initially. As for the duration of mining activity, the preliminary and final excavation and survey reports published recently have provided additional dates for a few sites (La Loba, Pino del Oro), but we still do not have a very good idea of the chronological spread of mining operations and associated settlements in a given region, fluctuations in mining outputs, and shifts in processing strategies – when and why lead was de-silvered or not, for instance.

More often than not there are no clear indications when and why a mine was opened and abandoned. Exhaustion of the argentiferous galena or the secondary gold deposits, the flooding of mining shafts, or the outbreak of war may explain why some mines were shut down, but there might be other possible explanations for ceasing exploitation altogether.<sup>129</sup> Pliny the Elder (34.164) claims that “in Spain and throughout the whole of Gaul (lead) is extracted with considerable effort; in Britain, however, it is so abundant within the upper layers of the earth that there is a law forbidding its production beyond a certain amount”.<sup>130</sup> If Pliny can be taken by his word, there seems to have been some recognition by the imperial centre that rich ore lodes, combined with low exploitation costs, could impact market prices to the disadvantage of other producers like Spain or Gaul. Perhaps for strategic reasons (?) production in Britain needed to be stifled in order to keep other producers in business. Whatever the reason for this *lex*, mining could be halted by a central order.<sup>131</sup>

Market forces have been brought into play to explain the demise of mining elsewhere: Beatrice Cauuet assumes that gold lodes in the Limousin were not exhausted at the end of the 1<sup>st</sup> century BC, but perhaps opencast goldmining in Northwestern Spain in combination with easy access to forced labour in the initial stages of exploitation may have made continued extraction of gold in the Limousin less competitive. In Roman Egypt, too, the remarkable decline in gold mining in the Eastern Desert, as observed by the Klemms, has been explained along similar lines.<sup>132</sup> Gold mining only picks up in the Byzantine and Arab period again: the site of Bir Umm Fawakhir, for example, was mined in the fifth and sixth century for gold,

<sup>103</sup> Thasos: Pernicka 1987: 651 f.; Wagner & Weisgerber 1988: 26 f., 113-197. Pangaeum: Unger & Schütz 1980: 44; Domergue 2008: 85 table IV with Photos et al. 1989 (non vidi). For gold mining at Palaia Kavala, cf. Vavelidis et al. 1996.

<sup>104</sup> Wagner et al. 1986: 731 f.

<sup>105</sup> Pernicka et al. 1984: 553-557; Pernicka in Wagner et al. 2003: 149.

<sup>129</sup> Domergue 2008: 215 f.

<sup>130</sup> ... *laboriosius in Hispania eruto totasque per Gallias, sed in Britannia summo terrae corio adeo large, ut lex interdicit ut ne plus certo modo fiat.*

Plutarch (1st–2nd C. AD), Caesar, 23.3

<sup>131</sup> This is already evidenced in the 167 BC when the Roman senate prohibits the exploitation of gold and silver mines in the partitioned former Macedonian kingdom, but allows for the exploitation of iron and copper mines which it further supports by lowering the vestigial collected from them (Livy 45.29.11).

<sup>132</sup> Klemm & Klemm 2013: 15 ff.;

despite the low yield of 2–3 g of gold per metric ton of ore.<sup>133</sup>

A further reason suggested for the decline of mining was the change in legal status of land in the Sierra de Cartagena from *ager publicus* to colonial land to be redistributed to veterans. One could speculate that the transaction costs of renegotiating access to mines formerly in possession of small scale mining associations might have been too high for the Italic families well known from the epigraphic record of Carthago Nova, leading to the decline and consolidation of mining activity on a lower level in the second half of the 1<sup>st</sup> century BC.<sup>134</sup>

Hardrock mining and the processing of ores likely required high levels of expertise. This must have limited the pool of personnel throughout the empire available for the exploitation of hardrock mines. We therefore might hypothesize that the transfer of miners from Dalmatia to the newly established gold mining areas of Dacia in the early second century AD might have been prompted by the decline or led to the decline of mining in Dalmatia.<sup>135</sup> With the cessation of gold mining in the Limousin in France by the early 1<sup>st</sup> century AD and the demand for silver by Roman mints it is well possible that the available mining knowhow was put to good use elsewhere in the Massif Central.<sup>136</sup>

Whatever the reasons for why mines were abandoned, we are left with Cyprian's vision of a decrease of mining for gold and silver in the third century AD.<sup>137</sup> In an apologetic letter to Demetrianus in AD 252/3 he notes that less gold and silver were being mined and poor lodes being exhausted every day.<sup>138</sup> Whether his perception has any merit or is simply guided by his the urge to convince his opponent (or rather his readership) of the overall decline in an age of imperial crisis and persecution is a matter for future deliberation.

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<sup>133</sup> Meyer 1995:199.

<sup>134</sup> Orejas & Rico 2015.

<sup>135</sup> Hirt 2015.

<sup>136</sup> Cauuet et al. 2005

<sup>137</sup> Domergue 2008: 216.

<sup>138</sup> *Cypr., ad Demetr.* 3.2: *Minus argenti et auri opes suggerunt exhausta iam metalla, et pauperes uenae breuiantur in dies singulos.*

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