

## On the Composition and Processing of Precious Metals Mined in Medieval Serbia

**Abstract:** Accounting books of the Caboga (Kabužić) brothers 1426–1433 (*Squarço/Reminder, Journal and Main Ledger*) kept at the Historical Archives of Dubrovnik provide new evidence for the composition and advanced levels of processing of precious metals from Serbian medieval mines. Notably, that the residue left after the process of obtaining fine silver was copper. Even the price of the refining process is specified. Two items of a transaction entered in the *Squarço* in 1430 contain some previously unknown data about auriferous silver (*argento di glama*). Besides gold, it also contained copper and, moreover, the ratio of the two per pound is specified. Apart from the Caboga brothers' accounting books, neither the other written sources nor geological research have provided any indication about the presence of copper in the auriferous silver mines.

**Keywords:** Serbian mines, medieval Serbia, silver, auriferous silver, gold, copper, Accounting books of the Caboga (Kabužić) brothers, Ragusa (Dubrovnik), Kotor (Cattaro), Venice

The production and trade of precious metals from Serbian mines has been the subject of many studies because of their role in the vigorous development of the medieval Serbian economy, society and culture. These studies have paid attention to a number of topics concerning the mining, processing and types of the precious metals.

This paper is an attempt to learn more about these topics from the business records of the Caboga (Kabužić) brothers kept at the Dubrovnik Archives, taking into consideration the data contained in their *Squarço* (Reminder) which, unlike the Journal and the Main Ledger, has not been published.

The extraction of precious metals from ores was a craft in its own right. After the long and complex smelting process, there would remain in the hearth the silver which was called *plich* silver. However, the silver obtained by the primary smelting was not completely pure and had to undergo a further refining process. This final step in the process was called *affinatio* in Latin sources or *finjanje, žeženje* in old mining law.<sup>1</sup> It was only the silver obtained in this way, *argento fino* or fine silver, that became an important commodity, much more expensive than unrefined silver.

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<sup>1</sup> V. Skarić, *Staro rudarsko pravo i tehnika u Srbiji i Bosni* (Belgrade: Serbian Royal Academy, 1939), 87–88.

It has been long believed that metals were exported from Serbia and that they were refined only in Venice. However, in the autumn of 1320, there is in Kotor a Venetian, Luca Baldaria, an *afinator*, employed on a one-year contract and paid nine pounds of Venetian grossi. His employment had certainly something to do with the refinement of a metal.<sup>2</sup>

In Ragusa, the refining of one's own silver was permitted until 1421. However, in June 1421, the Major Council of Ragusa decided that a place for silver refining should be set up at the mint. Goldsmiths were permitted to refine up to ten pounds of silver for their own needs.<sup>3</sup> It is known that the mints accepted only fine silver (*argento fino*), the only to be used for coinage. Thus, for example, on 28 July 1428 the company of the Caboga brothers purchased for the mint 4 pounds of fine silver at the price of 22 *perpers* per pound.<sup>4</sup>

The process of refining silver was set up early on in the mines and mining towns of medieval Serbia as well. This is suggested by the presence in 1276 of silver coins from Brskovo, while the earliest reference to a mint at Brskovo comes from 1280.<sup>5</sup> Over time, Priština, an important trading centre in the vicinity of the main mines, comes to be frequently referred to as one of the places where silver is being purchased and refined. In 1418, the Milinović brothers of Ragusa are referred to as owners of a device for silver refining (*affinatio argenti*).<sup>6</sup> Silver was also refined at Srebrenica.<sup>7</sup> The Serbian rulers and nobility sought to have control of the process. Thus, Djurdj Branković, son of Vuk Branković, decrees that all silver be refined at his customs.<sup>8</sup>

<sup>2</sup> V. Ćuk, *Srbija i Venecija u XIII i XIV veku* (Belgrade: Prosveta, 1986), 104, n. 35, 136.

<sup>3</sup> I. Voje "Argentum de glama", *Istorijski časopis* 16–17 (1970), 34; M. Rešetar, *Dubrovačka numizmatika I* (Belgrade: Serbian Royal Academy 1924), 157.

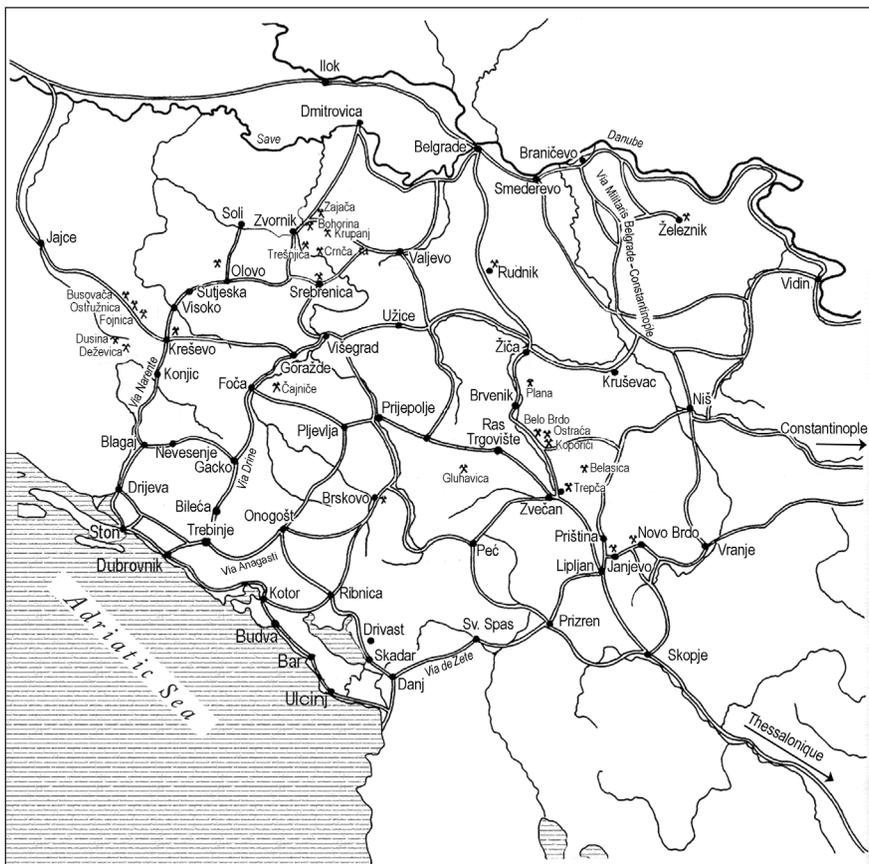
<sup>4</sup> D. Kovačević Kojić, *Trgovačke knjige braće Kabužić (Caboga) 1426–1433, Spomenik*, Serbian Academy of Sciences and Arts 137, Department of Historical Sciences 11 (1999), 230. There is a reference in 1430 to a silver refinery in Ragusa where the silver imported from Serbia and Bosnia was processed and refined. Cf. Voje, "Argentum de glama", 34; V. Simić, *Istorijski razvoj našeg rudarstva* (Belgrade 1951), 41.

<sup>5</sup> Ćuk, *Srbija i Venecija*, 23–24, n. 14. According to a document (ibid. 29), the intrinsic value of the Serbian currency corresponded to the value of refined silver.

<sup>6</sup> K. Jireček, *Istorijska Srba II* (Belgrade: Naučna knjiga, 1952), 425.

<sup>7</sup> M. Dinić, *Za istoriju rudarstva u srednjovekovnoj Srbiji i Bosni II* (Belgrade: Serbian Academy of Sciences, 1962), 86; S. Ćirković, "Proizvodnja zlata, srebra i bakra u centralnim oblastima Balkana do početka novog veka", *Rabotnici, vojnici, duhovnici. Društva srednjovekovnog Balkana* (Belgrade: Equilibrium, 1997), 87; D. Kovačević Kojić, *Srednjovekovna Srebrenica (XIV–XV vijek)* (Belgrade: Serbian Academy of Sciences and Arts, 2010), 32.

<sup>8</sup> Simić, *Istorijski razvoj*, 44.



Mines in medieval Serbia

The technology of silver refining may be largely reconstructed. Apart from the main smelters, there were, sometimes in their vicinity, smaller refining facilities (so-called *čistilo* or *čistilja*). These smaller refining furnaces could also be at a distance from the mine. Some of the refining methods were used, similarly to Ragusa, at goldsmith shops or at mints.<sup>9</sup> The Latin term for the person engaged in refining precious metals was *afinar*, *afinator* or *čistilac* (finer) in old mining law. Our knowledge of this activity is quite scant. That it was a lucrative profession is shown by the offer made in June 1429 to the Ragusan government by a precious metal refiner from as far

<sup>9</sup> The reconstruction by V. Skarić (*Staro rudarsko pravo*, 81–88) has been corroborated by newly-discovered sources. Cf. Ćirković, “Proizvodnja”, 87, n. 35; S. Ćirković in S. Ćirković, D. Kovačević Kojić and R. Ćuk, *Staro srpsko rudarstvo* (Belgrade: Vukova zadužbina & Novi Sad: Prometej, 2002), 59.

away as Naples. There is no doubt that there were in Serbia, apart from Ragusans, locals who mastered the technology. For example, an *afinar* from Srebrenica whose name has come down to us is Radin.<sup>10</sup>

The process of refining crude silver entailed a weight loss. Thus, a certain amount of silver measured *ad pondus de Srebreniza* lost an ounce of silver per pound, or 8.5 percent of the original weight.<sup>11</sup> According to an Ottoman document of 1488, the silver contained about 16.6 percent of metal impurities, which is to say that it lost 16.6 percent of the original weight in the refining process.<sup>12</sup>

Apart from the abovementioned example from Srebrenica, the contemporary sources do not specify the loss caused in the process of refining the precious metals from the Serbian mines. Still less known is the metallic composition of the resulting waste. It has been widely accepted that precious metals were extracted from ores by means of lead. The contemporary geological examination of the slag waste recovered around the mines has not been helpful in this respect. Nor is there any clue to this in various types of written sources or even in the ample source material from the Dubrovnik Archives which otherwise contains the most significant information on all areas of the Serbian mining production.

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Of the accounting books of the Caboga brothers, it is mostly the *Squarço*, or the Reminder, that contains information which sheds a new light on the processing and composition of precious metals. The Reminder is a daily record of business transactions. The daily notes were sorted out and transferred to the Journal every evening, omitting data deemed irrelevant to further bookkeeping. It is these omitted and neglected data that are of particular interest to our topic.

An entry of 28 October 1427 states that *afinia L. 56 o. 1 s. 4 d'argento trasi d'argento fino L. 50 o. 2 s. 4*, i.e. that *L. 50 o. 2 s. 4* of fine silver was obtained by refining an amount of *L. 56 o. 1 s. 4*. On the left side of the entry is recorded: *pagia per afinar a rame pp. 3 go 4*, i.e. that the separation from copper was paid *pp. 3 go 4*.<sup>13</sup> This entry was posted to the Main Ledger, where it

<sup>10</sup> B. Hrabak, "Dubrovačko' srebro u Italiji i Kataloniji u XIV, XV i XVI veku", *Istorijski glasnik* 1–2 (1980), 63; Kovačević Kojić, *Srednjovjekovna Srebrenica*, 32.

<sup>11</sup> Ćirković, "Proizvodnja zlata, srebra i bakra", 87, n. 37; Dinić, *Za istoriju rudarstva* II, 86.

<sup>12</sup> N. Beldiceanu, *Les actes des premiers sultans conservés dans les manuscrits turcs de la Bibliothèque Nationale à Paris, II Règlements miniers 1390–1512* (Paris: Mouton, 1964), 83.

<sup>13</sup> Historijski Arhiv u Dubrovniku (HAD), Privata, Libro di negozio Nicolo Luca Caboga, 28/3; Squarço, fol. 18', 28 Oct. 1427.

is stated that the Company should pay per *afinatura a rame duc. 1*.<sup>14</sup> An entry made in the *Squarço* a day later, 29 October 1429, states that the amount of *argento fino in 2,5 peçe L. 50 o. 2 s. 4* was sent to Pesaro and delivered to *ser Bartolo and Francesco Ardovini*.<sup>15</sup>

In the process of posting this entry from the *Squarço* to the Journal and then, a few times, to the Main Ledger, it is stressed that the silver in question is *argento fino L. 50 o. 2 s. 4*, and that the amount has been obtained by refining *L. 56 o. 1 s. 4* of silver. Upon the sale of the silver in Pesaro, *Peroçi de la Luna*, through *Pircho di Tanus*, transferred the money from the sale to the Caboga brothers by a bill of exchange.<sup>16</sup> So, the Company of the Caboga brothers itself arranged for the refining of the silver, which explains why this is the only piece of information about the process.

It is from these entries that we can reliably learn for the first time that silver contained copper and that fine silver was obtained by removing copper. In fact, copper was a waste product of refining, and it accounted for about 10.5 percent of the original amount. Another piece of information of particular interest is that the price of refining was 3 *perpers* and 4 grossi, or one ducat.<sup>17</sup>

The difference in price between fine and crude silver (*ca* 7.5 ducats and *ca* 6.5 ducats respectively) was about one ducat, exactly the price paid for refining silver (*affinatura*) as recorded in the *Squarço*.<sup>18</sup> Consequently, the prices allow us to know reliably what type of silver, crude or fine, was in question even when it is not expressly stated. This disproves the assumption that there was a price oscillation on the market or that the silver was of lower quality. What follows from all this is that the Caboga brothers traded in fine silver in much larger quantities than previously believed, which is corroborated by the information about fine silver in the *Argentum* records contained in the Main Ledger.<sup>19</sup> If the price of a specified amount of silver was lower than that of fine silver, the silver was in fact unrefined, *plicho* silver, as expressly stated in some cases.

The Caboga brothers also traded in the silver from mines in central Bosnia. In their business books it always figures as *plicho* silver. Namely, the

<sup>14</sup> Kovačević Kojić, *Trgovačke knjige*, 197, 24 Feb. 1428.

<sup>15</sup> Libro di negozio, *Squarço*, fol. 19, 29 Oct. 1427.

<sup>16</sup> Kovačević Kojić, *Trgovačke knjige*, 46, 5 Nov. 1427; 183, 5 Nov. 1427; 188, 5 Nov. 1427; 196, 15 March 1428; 197, 15 March 1428.

<sup>17</sup> Cf. notes 15 and 16 above.

<sup>18</sup> Cf. notes 13 and 14 above.

<sup>19</sup> Kovačević Kojić, *Trgovačke knjige*, 156, 158, 172, 198, 208, 228, 252, 280, 282, 320, 322.

entries refer to it as *plicho di Bosnia*, *argento di Bosnia* and *viago di Souisochi*.<sup>20</sup> The *Viago di Souisochi* and *Plicho di Bosnia* transaction records also contain information about the prices paid for *plicho* silver. On average, the price was about six ducats,<sup>21</sup> exactly the price the Caboga brothers usually paid for this type of silver. The fact that they exported only unrefined silver suggests that the refining process was not practised in central Bosnia, which then suggests that metallurgical techniques there were not as developed as in other mining areas.

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At first the separation of gold from silver was carried out in Venice. However, a document created in mid-October 1353 states that silver can be assayed to determine its gold content in Ragusa, Serbia or Venice. The same year, there is a mention of a Raden in Kotor, a person specialized in the craft (*Raden, magister divisionis auri argenti*).<sup>22</sup> Gold was also separated chemically, and the agents which were used for bonding individual chemical elements were known.<sup>23</sup> In April 1424, Marin Adamović, a Ragusan goldsmith of Kotor origin, hired a certain Bartol to separate gold from silver using the wet chemical method, i.e. to prepare aqua and all other necessary things for the process (*partire oro d'argento zoe di fare aqua et tote cose che bisogna per detto*).<sup>24</sup>

Especially interesting for the question of refining auriferous silver in Ragusa are some observations of local chroniclers. Thus, an anonymous annalist records in 1279 that a good portion of the large amount of auriferous silver was secretly reshipped from Ragusa to Venice, so that the Venetian merchants are making a profit of 200 percent on investment. Much later, in the seventeenth century, another chronicler expressly states that Ragusan merchants made unusually high, 250-percent, profits compared with the price of auriferous silver in Serbia, and then sold the refined silver in Venice.<sup>25</sup> Notwithstanding their exaggerations, these Ragusan annals show that such transactions were taking place, and this example certainly was not an exception.

<sup>20</sup> D. Kovačević Kojić, "Pliko srebro iz Srednje Bosne u trgovačkim knjigama braće Kabužić (1426–1433)", in *Spomenica akademika Marka Šunjića (1927–1998)* (Sarajevo: Filozofski fakultet, 2010), 59–68.

<sup>21</sup> *Ibid.* 63.

<sup>22</sup> R. Ćuk in *Staro srpsko rudarstvo*, 71.

<sup>23</sup> B. Hrabak, "Dubrovčani u rudarstvu i uvozno-izvoznoj trgovini Kosova 1455–1700", *Vranjski glasnik* 17 (1984), 4.

<sup>24</sup> Voje, "Argentum de glama", 34, n. 109.

<sup>25</sup> Hrabak, "Dubrovačko' srebro u Italiji i Kataloniji", 68–76.

As mining developed, information about gold parting in Serbia becomes more frequent. Ragusan merchants are involved, and of them Nikola Glavić, son of Tvrtko, is especially prominent. In 1428, he and his partner Nikola Živolinović contract with the goldsmith Vlatko Radetić to go to Priština and other places in Serbia, to apply his know-how.<sup>26</sup> The following year Glavić imports saltpetre, which is necessary for the gold parting process. Saltpetre was imported into Serbia through Ragusa.<sup>27</sup>

Apart from the price of silver refining, the business books of the Caboga brothers contain information about the costs of gold parting. Thus, for every shipment of auriferous silver, in addition to the percentage of gold, a deduction of 10 grossi per pound is taken *per partidura*, i.e. the costs of parting gold from silver are deducted.<sup>28</sup> There where *abatando go. 10 per L.* stands alone, it was also a *partidura*, even though the word *partidura* is omitted.<sup>29</sup> It is frequently expressly stated that this expense will be met from the earnings the Caboga brothers are going to make with a partner, such as, for example, Marcho di Ratcho.<sup>30</sup>

The *Squarço* contains previously unknown information about the composition of the auriferous silver. Namely, a transaction entered on 28 January 1430 states that *Radouan die aver per argento L. 1 o.5 s.4 tine in rame o.2 s.1 per L. tine in oro o.3 s.ch.10*. The price of this auriferous silver was 25 ducats and 10 grossi per pound.

Another item in the same transaction also specifies an amount of auriferous silver: *L.3 o.8 tine in rame o.2,5 per L. tine in oro o.2 s.3 ch.4*, at a price of 21 ducats and 23 grossi per pound.<sup>31</sup>

From these two cases we are able for the first time to learn that the auriferous silver also contained copper, as well as the exact content of both copper and gold per pound. The price of a pound of auriferous silver obviously depended on the copper to gold content ratio.

In the first case, where the content of copper was lower, the price was higher (25 ducats and 10 grossi per pound). And reversely, in the second case, the price of auriferous silver was lower (21 ducats and 23 grossi per pound) because the copper content was higher.

<sup>26</sup> D. Kovačević Kojić, "Nikola Tvrtka Glavić i Nikola Živolinović u trgovačkim knjigama braće Kabužić", *Istorijski časopis* 40–41 (1995), 9.

<sup>27</sup> *Salnitrium et alia necessaria pro dividendo aurum ab argento*, Cf. Jireček, *Istoriya Srba* II, 425; Ćirković, "Proizvodnja zlata, srebra i bakra", 87–88; Kovačević Kojić, "Nikola Tvrtka Glavić", 9.

<sup>28</sup> G. Boerio, *Dizionario del dialetto veneziano* (Venice: G. Cecchini, 1856), 477.

<sup>29</sup> Kovačević Kojić, *Trgovačke knjige*, 239, 256.

<sup>30</sup> *Ibid.* 256; Hrabak, "Dubrovačko' srebro u Italiji i Kataloniji", 63.

<sup>31</sup> *Libro di negozio*, *Squarço*, fol. 105, 28 Jan. 1430.

In the Journal and the Main Ledger the entries concerning some shipments of auriferous silver (*argento indorato*) contain both the price of gold per ounce (6 ducats) and the price of silver (7.5 ducats) per pound.<sup>32</sup> In some cases the previously rendered refining service is expressly stated. Thus, the *Scuarço* shows that on 25 September 1429 Živko Radić, a partner of the Caboga brothers, received from Vukosav *L. 1 0.6 s.2 afini resto L. 1 0.3 ch.5 tine 0.3 s.0* of auriferous silver.<sup>33</sup> So, after refining, the original quantity of auriferous silver was smaller by about two ounces per pound. Consequently, auriferous silver contained copper too. This is in fact the ratio of copper to gold in one pound of the auriferous silver, as expressly stated in the *Scuarço* on 28 January 1430.

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In addition to silver and lead, the deposits at the mine of Rudnik also contained copper, and in such quantities as to afford sufficient for exportation.<sup>34</sup> However, except for the books of the Caboga brothers, the sources make no mention of copper in the main mines of auriferous silver, such as Novo Brdo.<sup>35</sup> Fieldwork investigation has not proved otherwise.<sup>36</sup>

According to the research done by geologists, metallurgical techniques practised in Serbia were quite advanced.<sup>37</sup> There is a divergence of opinion between historians and geologists, however, geologists tending to underrate the quality and scale of mining products in Serbia, especially in the case of Novo Brdo, the largest medieval Serbian mine known for the production of silver and auriferous silver.<sup>38</sup> Although a vigorous mining activity at Novo Brdo has been attested by numerous slag dumps in the immediate and broader environs of the town, some geologists question even

<sup>32</sup> Kovačević Kojić, *Trgovačke knjige*, 218, 230, 239, 265.

<sup>33</sup> The Main Ledger, however, keeps record only of the amount of auriferous silver obtained after refining, i.e. *L. 1 0.3 s.5*. There is a single entry which reiterates that this amount of *L. 1 0.3 s.5 lo qual afini fo 0.18 s.5* was obtained by refining. Kovačević Kojić, *Trgovačke knjige*, 231–233.

<sup>34</sup> Dinić, *Za istoriju rudarstva* II, 10–11; Ćuk in *Staro srpsko rudarstvo*, 35.

<sup>35</sup> Ćuk, in *Staro srpsko rudarstvo*, 35; Dinić, *Za istoriju rudarstva* II, 88.

<sup>36</sup> V. Simić, “Rudnici zlata u srednjovekovnoj Srbiji prema savremenom poznavanju naših rudišta”, *Vesnik, Zavod za geološka i geofizička istraživanja* 19 (1961), 337. On lead, based on the investigations at Novo Brdo, M. Savić, “Šljakišta na Novom Brdu i Kačikolu”, *Starinar* 5–6 (1954–55), 291–292.

<sup>37</sup> Dinić, *Za istoriju rudarstva*, 43–45.

<sup>38</sup> Simić, “Rudnici zlata”, 342.

the accuracy of all written data, arguing that the mining value of Novo Brdo is highly overrated.<sup>39</sup>

Contrary to these views, V. Simić takes into account the information from the Ragusan documentary material about a high gold content of the Novo Brdo silver (as high as up to 25 per cent) and argues that the issue of discovering rich auriferous ores at some of the Novo Brdo ore deposits is becoming quite interesting for researchers; even more so because the research done so far has not paid attention to gold.<sup>40</sup> The newly-discovered information in the accounting books of the Caboga brothers about the presence of copper in silver and auriferous silver is likely to broaden the focus of geological research to include these elements.<sup>41</sup>

Briefly, except for the accounting books of the Caboga brothers, the other written sources or the geological research done so far do not give any indication of the presence of copper in the mines of auriferous silver.

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<sup>39</sup> Savić, “Šljakišta”, 283–294.

<sup>40</sup> Simić, “Rudnici zlata”, 342.

<sup>41</sup> At some lead-zinc deposits the metallurgy of copper developed as a secondary activity. Cf. Simić, Dinić, *Za istoriju rudarstva*, 19; Savić, “Šljakišta”, 287–291.

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