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THE HISTORY OF ROMANIAN GOLD IN THE MIDDLES AGES

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Abstract: *The work presents the history of Romanian gold during the Middle Ages, as well as the technology of gold extraction and processing in Europe during this period, illustrated in the writings of well-known authors, such as Biringuccio, Ercker, Fridvaldszky and Agricola.*
Keywords: *Middle Ages, gold mining and gold processing methods.*

1. Gold mining after the withdrawal of the Romans [3]

After repeated attacks by the Goths and Carpi, the Roman emperor Aurelian (270–271) decided to withdraw from Dacia, a fact accomplished in two stages, between 271 and 275. In the first stage, the Romans withdrew from Transylvania, and in the second, from Banat and Oltenia. In fact, Aurelian withdrew only the legions and the administration, the Daco-Roman population remaining in the places where it lived. Proof of the continuity of this population in the area abandoned by the army and administration is the discovery, in 1775, at Chinedru-Biertan (today in Sibiu County), of a votive tablet with a bronze disk (*donarium*), dating from the 4th century. The tablet contains an inscription in cut letters, in Latin – *Ego Zenovius votum posui* – meaning *"I Zenovius have offered this gift"*.

Fig. 1. Donarium from Biertan

The exploitation of precious metals on the current territory of Romania begins again in the eighth century, after the end of the migration of peoples and the assimilation of the Slavs. By 500 AD, the Slavs occupied a vast territory in the north-western part of the Black Sea, engaging in occupations specific to the stage of the disintegration of the primitive commune: agriculture, hunting, fishing and household crafts. Here is how the Byzantine historian Procopius of Caesarea (c.500–565) describes the Slavs in his work *The Wars* [*Book VII, Ch. 14:24–30*]: *They reverence, however, both rivers and nymphs and some other spirits, and they sacrifice to all these also, and they make their divinations in connection with these sacrifices. They live in pitiful hovels, which they set up far apart from one another, but, as a general thing, every man is constantly changing his place of abode. When they enter battle, the majority of them go against their enemy on foot carrying little shields and javelins in their hands, but they never wear corselets. Indeed some of them do not wear even a shirt or a cloak, but gathering their trews up as far as to their private parts they enter into battle with their opponents. In addition, both peoples have the same language, an utterly barbarous tongue. Nay further, they do not differ at all from one another in appearance. For they are all exceptionally tall and stalwart men, while their bodies and hair are neither very fair nor blonde, nor indeed do they incline entirely to the dark type, but they are all slightly ruddy in colour. And they live a hard life, giving no heed to bodily comforts, just as the Massagetae do, and, like them, they are continually and at all times covered with filth; however, they are in no respect base nor evildoers, but they preserve the Hunnic character in all its simplicity. In fact, the Slavs and Antae actually had a single name in the remote past; for they were both called Spori in olden times, because, I suppose, living apart one man from*

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another, they inhabit their country in a sporadic fashion. And, in consequence of this very fact they hold a great amount of land; for they alone inhabit the greatest part of the northern bank of the river. So much then may be said regarding these peoples [7].

The Slavs began to settle on the territory of the former Dacia in the 6th century, integrating into the local socio-economic complex and ending up being assimilated by the local population in the 9th–10th centuries. Over 100 place names on the current territory of Romania are of Slavonic origin. They did not impose their culture on the natives, being more primitive than the natives were, but they led the local population militarily and politically.

There are no known documents on the social and economic organization of the inhabitants of the gold-bearing regions during this period, but it can be assumed that they lived according to the customary law inherited from ancient times. With the emergence of feudal pre-state formations (princes and voivodeships), interest in the mining lands also increased, which became feudal domains, and their inhabitants serfs of the crown. The Hungarians then invaded these pre-state formations within the Carpathian arc, in which some rudiments of organized life had begun to take root. From the 10th century, the Romanian lands began to be incorporated into the medieval Kingdom of Hungary, which adopted a policy of colonization, settling the Szeklers in the east of the province, and the Transylvanian Saxons in its south and in the Bistrița area. The colonists' mission was to defend the borders and to develop the economic resources of the autonomous voivodeship. The conquest of Transylvania by the Hungarians ended in 1210, with the submission of the Land of Bârsa.

After Aurelian's retreat in 271–275, the intra-Carpathian territory was successively invaded, between the 3rd and 10th centuries, by Goths, Huns, Gepids, Avars, Slavs, Hungarians, Pechenegs and Cumans. The Goths, Germanic tribes from Scandinavia, ruled Transylvania for a century (271–380), being driven south of the Danube by the hordes of cruel Huns, who came from Asia, through the Kalmyk steppe (376–455). The most prominent leader of the Huns was Attila (434–453), known as *The Scourge of God,* after whose death Transylvania came under the rule of the Gepids (455–567), a tribe of Germanic origin, who later disappeared from history. Next came the Avars (567–827), a Turkic population from the steppes of Asia, related to the wild and cruel Huns, and then the Slavs, who coexisted for about five centuries with the native Daco-Roman population, borrowing some customs, habits and lexical elements from them. Towards the end of the first millennium, the Slavs were assimilated, which denotes the superiority of the native population, both numerically and in terms of level of civilization. South of the Danube, the speakers of the Proto-Romanian language, numerically inferior, were Slavicized, giving rise to the Bulgarians, Serbs and Croats. Towards the end of the 9th century (896) the Hungarians, a Finno-Ugric people from the Altai Mongol region, appeared. Dismounted in the Pannonian Plain under the leadership of Árpád, they then headed for Transylvania, where the Romanian princes Gelu, Glad and Menumorut ruled. The conquest of Transylvania by the Hungarians lasted until the end of the 12th century, thus ending a millennium of insecurity, harassment and regression.

What would have determined the Hungarians to come from the Pannonian Plain and occupy Transylvania? Exactly what had determined the Romans almost a thousand years earlier – the gold of the Apuseni Mountains – but also the salt that was completely lacking in the desert inhabited by them and the wealth of fruits with which God had blessed these lands. Thus, an anonymous notary of King Bela III (1172–1196) – a chronicler therefore designated in history by the name of *Anonymus* – referring to this in his chronicle from around the year 1200, writes: *The aforesaid Tuhutum, a most skillful man, sent a certain shrewd man, father of Opaforcos Ogmand, to spy out for him the quality and fertility of the land of Transylvania and what its inhabitants were like, so that he might, if he could, go to war with them, for Tuhutum wished thereby to acquire a name and land for himself. As our minstrels say: They take all the places for themselves and get a good name. What more? When the father of Ogmand, Tuhutum's scout, circling like a wolf, viewed, as much as the human gaze may, the goodness and fertility of the land and its inhabitants, he loved it more than can be said and returned most swiftly to his lord. When he arrived, he spoke much to his lord of the goodness of that land: that that land was washed by the best rivers, whose names and merits he listed, that in their sands they gathered gold and that the gold of that land was the best, and that they mined there salt and salt crystals, and that the inhabitants of that land were the basest of the whole world, because they were Vlachs and Slavs, because they had nothing else for arms than bows and arrows and because their duke, Gelu, was inconstant and did not have around him good warriors who dared stand against the courage of the Hungarians, because they had suffered many injuries from the Cumans and Pecheneg* [2, pp. 55–57].

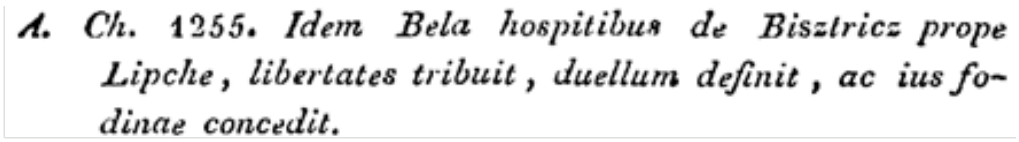
Let us also say that Tuhutum was one of the seven chieftains of the Hungarian tribes in Pannonia, that he lived in the 9th–10th centuries and defeated and killed the voivode Gelu in 904. The anonymous author of the chronicle *Gesta Hungarorum* claims that Tuhutum's grandson was Gyula, the voivode of Transylvania, whose daughter Sarolt would be the wife of Prince Géza, the father of King Stephen I of Hungary.

The beginning of the second millennium brought changes in the life of the population of Transylvania. The Hungarian tribes of the Pannonian Plain organized themselves into a kingdom under the leadership of Stephen I (997–1038). He initially oscillated, from a religious point of view, between Rome and Byzantium, but in 1001, he converted to Catholicism and was officially recognized by Pope Sylvester II (999–1003) as the Christian king of Hungary. In 1009, Stephen I established a Catholic bishopric in Alba Iulia and continued the conquest of Transylvania. At first, the Hungarians respected the rights of the native population, but gradually they changed tactics, enslaving the Romanians. In the 12th century, the southeast of Transylvania was colonized with Szeklers, a population of uncertain origin, probably descendants of the Huns, with the aim of defending the borders. Then followed the colonization of the Saxons, in the south and southeast of Transylvania, especially during the reign of King Geza II (1141–1162), who granted them numerous privileges. The colonization with ethnic Germans continued after the famous crusade of 1204, which resulted in the occupation and plunder of Constantinople by the crusaders, when the Teutonic Knights participating in this shameful expedition were brought to the Land of Bârsa. The concessions made to the Saxons increased in 1211, 1212 and 1222, especially for the removal of Cuman domination, and were then consecrated by the famous *Golden Bull* (*Freibrief der Siebenbürgen Sachen* or *Golden Charter of the Transylvanian Saxons*), given in 1224 by King Andrew II of Hungary (1205–1235). The privileges granted to the Saxons were maintained throughout the Middle Ages, some even until 1876. Among these, we mention the provision that half of the gold mined should be given to the treasury, and the other half should remain with the miners.

2. Romanian Gold Mining in the Early Middle Ages [3]

But let's go back and see what else happened in the homelands, after the dark millennium, from which written evidence is completely lacking. As mentioned above, in 1009, Stephen I of Hungary (Szent István) founded a Catholic bishopric in Alba Iulia, and, in 1035, he issued a decree by which the mining regions came under royal jurisdiction, and the native miners became serfs of the crown. But the king and his entourage had neither the means nor the knowledge necessary to administer the mining regions, so they began to lease these lands to the Catholic chapter in Alba Iulia or to royal partisans. The first written mention of the Apuseni Mountains region, after the arrival of the Hungarians, dates back to 1201, when the Hungarian king Emeric (1196–1204) granted the Transylvanian voivode Gyula Kán, *Terra Obruth,* i.e. the Abrud region. Gyula Kán had his residence in Alba Iulia and was twice voivode of Transylvania (1201–1202 and 1213–1214). The next document referring to Abrud dates back to 1271, in which Máté Csák II (1235–1283/1284), voivode of Transylvania, states that King Stephen V of Hungary (1270–1272) donated and registered on behalf of the episcopate, the chapter and the church of Saint Michael of Alba Iulia, the Abrud and Zlatna regions, together with several communes. The document further states that this land was previously owned, also as a royal donation, by voivode Gyula Kán, and then Zubuslaus the Szekler, who then bequeathed it to an abbot of the Cistercian monastery of Cârţa (*Kerch*) in Fagaras Country.

The revival of mining in the Apuseni Mountains was achieved by bringing skilled miners from Kremnica (*Körmöczbánya*) and Banská-Bystrica (*Besztercebánya*), gold-bearing towns located on the southern slope of the Tatra Mountains in present-day Slovakia. The first written documents that state many aspects of socio-economic life, including mining activity, date from that time. One such document (*Letter of Privileges*) was issued by King Bela IV of Hungary (1235–1270) in 1255 to the miners of Besztercebánya (present-day Banská–Bystrica), granting them a series of privileges. The document is also important for gold mining in the Apuseni Mountains, because German miners were brought from Besztercebánya and Körmöczbánya to Zlatna and Abrud. They retained the rights granted by Bela IV and fought for a long time to preserve them. From *The Letter of Privileges* from 1255 (*Fig. 2*), it appears that the miners in the mentioned area had certain economic, legal and religious advantages, based on which they could carry out a more sustained economic activity, in relation to the other inhabitants. They could prospect and exploit the noble metals from the subsoil and from the alluvium, but they were obliged to pay the royal treasury one eighth of the gold and one tenth of the silver extracted, with the stipulation that upon the discovery of metalliferous deposits, the king could take possession of the respective land. At the same time, the miners were exempted from paying customs duties on products of strict necessity and from financial and military obligations towards the local nobility. The privileges were also recognized and reconfirmed by the successors of Bela IV, Stephen V (1271), Ladislaus IV the Cuman (1287) and Andrew III the Venetian (1291) [4, tom IV, vol. 2, pp. 296–299]. It should also be remembered that Bela IV had previously granted the same privileges to the Saxons of Cricău and Ighiu, through a document of February 12, 1238, signed in Archita (today a village of Vânători commune, Mureş county), a locality founded by the Saxons around 1200.


A. Ch. 1255. Idem Bela hospitibus de Bisztricz prope Lipche, libertates tribuit, duellum definit, ac ius fodinae concedit.

Fig, 2. Title of the Letter of Privileges granted by Bela IV in 1255 [4]

It seems that the first Saxons were brought from Flanders and the region between the Rhine and the Moselle, following the floods and famine of the mid-12th century, with the aim of defending the Crown of Hungary. In the initial documents they were called *Flandrenses* (originally from Flanders), and starting with 1206 they were called *Saxones* (Saxons), in a document of the Catholic Church in Weissburh (Alba Iulia), referring to the inhabitants of Cricău, Ighiu and Romos, which called them *primi hospici regni* (the first guests of the empire). By the document of February 12, 1238, Bela IV granted them certain rights: *We have decided that our guests from the villages of Cricău and Ighiu have the privilege of choosing their own counties... exemption from paying any tribute... no serving voivode shall dare to stay with them, but our person, since she is royal, will be honored with all honor and with all dues and with all their kindnesses, when we arrive among them... and we leave them the land that they owned through the tribute of our ancestors to possess in eternal peace... and they shall not pay any tribute from the wine that they will have extracted from the vineyards they cultivated* [*Documente privind istoria României, vol. I, pp. 310–311*]. The Saxons from Cricău and Ighiu later received permission to exploit gold from Zlatna and Roşia Montană.

As a result of royal tributes, most of the mining region of the Apuseni Mountains came into the possession of the Catholic bishopric of Alba Iulia (*Gyulafehérvár*). The German settlers from Abrud, Zlatna and Baia de Arieş enjoyed the privileges granted to miners in their areas of origin, but the other miners were serfs of the Alba Iulia chapter. The mining serfs differed in many ways from the agricultural serfs, having more rights, but the Alba Iulia chapter did not consider these privileges. Under these conditions, it is not surprising that the miners rebelled against the clergy, surrounded the city, and, on February 21, 1277, stormed the church and slaughtered all the priests and their servants who fell into their hands. The uprising resulted in over two thousand deaths and many wounded, fallen from both sides. The rebels destroyed the church and burned the entire archive, but their situation did not change much, as the pious had become complacent, forgetting about Christian commandments and cunningly exploiting this massacre for their own interests.

The one who ensured a real development of mining in Transylvania was Charles Robert of Anjou, by elaborating a mining regulation, through a *Letter of Privileges,* signed in Visegrád, in the spring of 1327. Unlike the privileges granted by Bela IV, which referred only to certain mining communities, those granted by Charles Robert of Anjou concerned all miners in the Kingdom of Hungary. In addition, the lands where precious metals were discovered no longer entered the king's possession, but remained in the possession of the owners, on the condition that 2/3 of the proceeds were deposited in the royal treasury, the other third remaining with the owner: *We have mercifully decided to establish forever that if there were gold or silver mines on the lands and estates of anyone, be they prelates, churches, monasteries, laymen or nobles, they should enjoy and use forever the possession of the lands where gold and silver mines were found. They should even have the right forever to take the entire third part of the royal income from the gold and silver mines found on their lands, according to the usual custom of miners' income* [4]. The gold produced in the four mining centres of the Apuseni Mountains, Abrud, Baia de Arieş, Zlatna and Baia de Criş, had to be exchanged at the royal treasury in Sibiu, at the official price set by the king. As a result of this measure of co-interest, the gold mining of the Apuseni Mountains revived, many landowners starting a real campaign to exploit the riches of the subsoil. The privileges granted to the miners by Carol Robert of Anjou were reconfirmed by Louis I of Anjou (1351), Sigismund of Luxembourg (1405), Matthew Corvinus (1486), Vladislav II Jagiello (1492) and Louis II Jagiello (1523).

3. Romanian gold mining in the Late Middle Ages [3]

So far, we have only spoken about the gold mining practiced in the Apuseni Mountains. Important gold deposits are also found in Maramureş, which have probably been exploited since antiquity, but there is no evidence in this regard. The oldest written document that grants Baia Mare the status of *civitas* is a privileged letter given by Louis I of Anjou, in 1347, at the request of the judge Martin, the parish priest Ioan, the magistrate Petru and the notary Ulrich, jurors of Baia Mare and Săsar (*Rivulus Dominarum et Zazarbanya*), for the renewal of a similar document given by Carol Robert of Anjou, in 1329, burned in a fire. The 1347 charter established the city's boundaries and granted its inhabitants several rights: the election of the county,

the parish priest, and the jurors, the assurance of individual freedoms, the right to judge within the city *all the causes that arise between them, both large and small*, freedom of customs, as well as the free sale of wine, or the right to erect defensive walls against enemies. A distinct category of provisions refers to the organization of mining. Thus, the workers' community, together with the county and the jurors of the locality within whose radius the mine was located (the correspondents of today's mayor and councilors), elected for a period of one year *a skilled magister of the mountain* (the head of the mine), who was responsible for the proper functioning of the mine. He then appointed *the climbers* (today's mining foremen) and *the gold researchers* (today's sample collectors), with the approval of the county and the jurors. The climbers supervised the mining operations and collected the royal dues, and the gold prospectors took samples from the working faces and determined the precious metal content of the ore. The regulation provided for harsh punishments for those who evaded paying the royal dues, but it also protected the miners from the violence of their managers.

The thorough organization of mining activity, with a well-established administrative apparatus and clear delimitations of the gold reserves, but also with the mention that the private forests in the area had been exhausted, lead us to the conclusion that mining had been practiced in this region long before. The subsequent renewals in 1376 and 1391 of these privileges also pay important attention to the organization of gold extraction and processing. The best-known mines in the area were those at Băiţa, Dealul Crucii and Baia Sprie. In 1411 these were ceded to the Serbian despot Gheorghe Brancovici (1427–1456), who was also a baron of the Kingdom of Hungary, but in 1454 Iancu de Hunedoara occupied Baia Mare, also taking possession of the mines here. Later, Matei Corvin reorganized the gold mining in Maramureş through two acts issued in 1464 and 1468, leasing both the mines and the mint, for the sum of 13,000 gold florins.

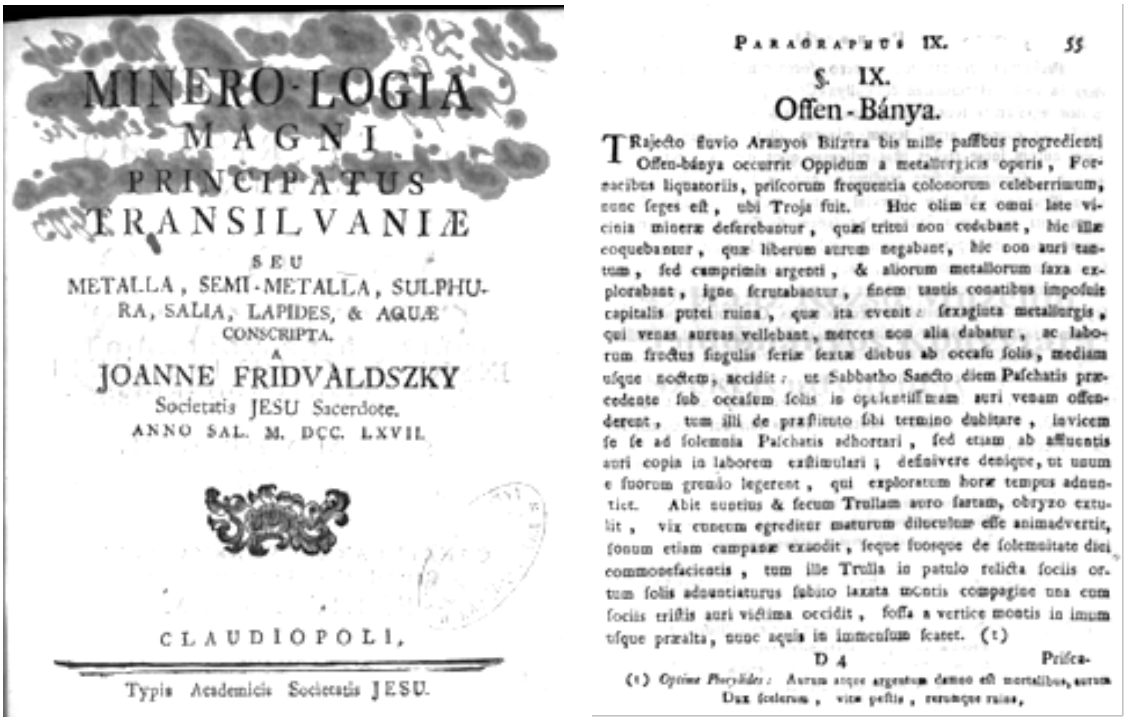
Two other mining towns mentioned in medieval documents are Baia de Arieş and Zlatna. Gold, silver and other non-ferrous metals were probably mined at Baia de Arieş since antiquity, but there are no documents or artifacts to attest to this. The first written document regarding the gold mining here dates from June 14, 1325, when King Carol Robert of Anjou granted *the miners of the aforementioned Aranyosbánya gold mine, after the advice of the prelates and barons of my kingdom, that they and their descendants should forever acquire the same freedoms that the miners of the other gold mines enjoy and that they should also be obliged to pay to His Royal Majesty the census, that is, one eighth of the profit taken from the said royal mine, as others also pay. In particular, however, the miners of the Aranyosbánya gold mine and all the inhabitants of its city called Ovounberg* [Baia de Arieş – o.n.], *should forever enjoy the freedom that neither they nor any of them should ever be judged by any of the judges of the country, that is, the palatine* [viceroy of medieval Hungary – o.n.]*, the voivode of Transylvania, the county commissioners or other judges of this kingdom, now or in the future in office, nor their deputies in any of their causes against anyone, but they shall be obliged to stand trial only before the Royal Majesty or before the judge of the royal court. We also allow that the land around the said mine, over an area of one and a half versts* [about 1.5 kilometers – o.n.], *shall belong to them, according to the custom of the other gold mines"* [D.I.R., C, Veac XIV, pp. 150–151 and Zimmermann–Werner, Vol. I, pp. 395–396].

Also, the Jesuit mineralogist from Cluj Johannes Fridvaldszky (1730–1784) says that in 1325 there were 36 gold smelters in Baia de Arieş, in the Hărmănesei Valley and the Ciorii Valley, and also mentions the names of the locality over time: Offenbánya (1325), Onungberg (1391) and Umberg (1417). Fridvaldszky also presents the letter of privileges granted to the miners and inhabitants here by Charles Robert of Anjou on 14 June 1325 [5, pp. 55–58].

In addition to Baia de Arieş, Fridvaldszky also mentions other localities in the Apuseni Mountains where gold has been mined since ancient times: Almaşu Mare, Baia de Criş, Bucium (with the Vulcoi deposit), Hărţăgani, Poiana Vaşcăului, Ruda, Săcărâmb, Stănija, Valea Pianului, Zlatna and others. Where he found medieval documents attesting to the rights of gold miners granted by the kings of Hungary, Fridvaldszky briefly presents them. This is also the case of a freedom granted by Louis I of Anjou, on November 28, 1357, by which Conrad and Nicolae, son of Candin from Zlatna, were to enjoy the same facilities granted to miners in other mining centers of Hungary.

On July 3rd, 1428, King Sigismund of Luxembourg (1387–1437) also reconfirmed the old privileges granted to the gold miners of Zlatna, drawing the attention of the Transylvanian authorities to refrain from injustices and abuses against them and to grant them the same rights enjoyed by other mining towns, especially those of *Crempniciens* (today's Kremnica in Slovakia) and *Bistricien* (today's Banská Štianvnica in Slovakia). It should be noted that the miners of Zlatna were then exploiting the gold deposits of Boteş–Vulcoi and Almaşu Mare. King Albert of Habsburg, although he had a short reign (1437–1439), took under his protection the mining towns of Abrud, Baia de Arieş, Zlatna and Baia de Criş, ordering that the freedoms and privileges of the miners here, granted by his predecessors, be respected and defended from the interference of the provincial authorities.

As for the miners of Abrud, King Vladislav II Jagiello (1490–1516), in a letter dated 5 October 1494, exempted them from being drafted into the war against the Turks and ordered the local authorities not to judge or condemn the miners in various cases, this being the competence of the royal jurisdiction.



MINERO-LOGIA
MAGNI
PRINCIPATUS
TRANSILVANIÆ
SEU
METALLA, SEMI-METALLA, SULPHURA, SALIA, LAPIDES, & AQUÆ
CONSCRIPTA.
A
JOANNE FRIDVALDSZKY
Societatis JESU Sacerdote.
ANNO SAL. M. DCC. LXVII.

CLAUDIOPOLI,

Typis Academicis Societatis JESU.

PARAGRAPHUS IX. 55

§. IX.

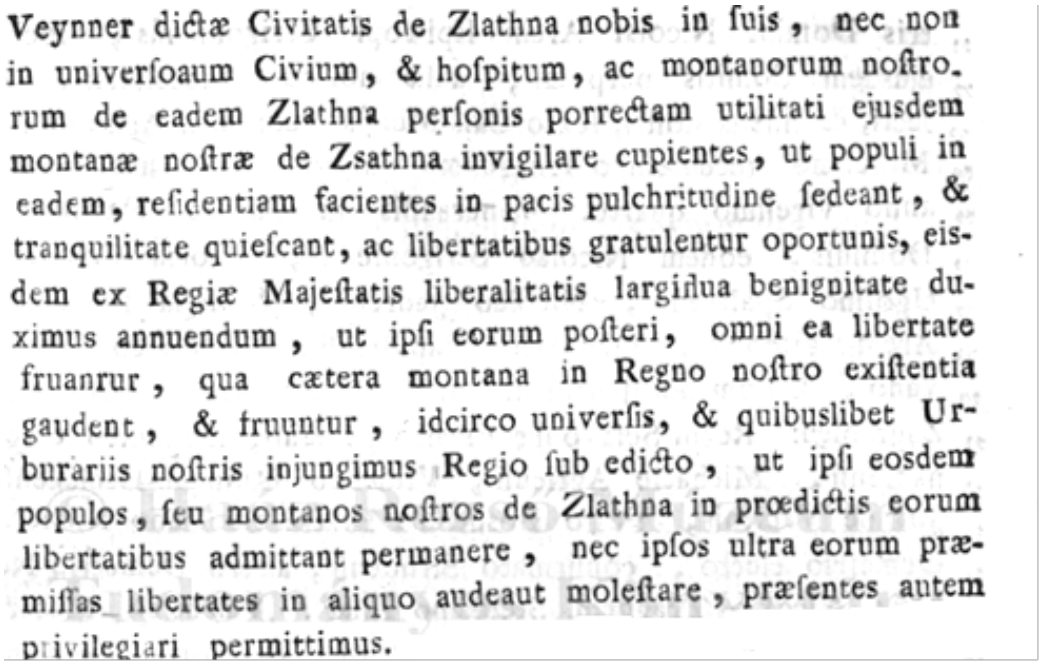
Offen-Bánya.

TRajecto fluvio Aranyos Bifztra bis mille paſſibus progredienti Offen-bánya occurrit Oppidum a metallurgicis operis, Fornacibus liquatoriis, priſcorum frequentia colonorum celeberrimum, nunc ſeges eſt, ubi Troja fuit. Hinc olim ex omni lote vicinia mineræ deferebantur, quæ tritoi non cedebant, hic illæ coquebantur, quæ liberum aurum negabant, hic non auri tantum, ſed cumprimis argenti, & aliorum metallorum ſaxa explorabant, igne ſcrutabantur, finem tantis conatibus impoſuit capitalis putei ruina, quæ ita evenit: ſexaginta metallurgis, qui venas aureas vellebant, merces non alia dabatur, ac laborum fructus ſingulis feriæ ſextæ diebus ab occaſu ſolis, mediam uſque noctem, accidit: ut Sabbatho Sancto diem Paſchatis præcedente ſub occaſum ſolis in opulentiſſimam auri venam offenderent, tum illi de præfixo ſibi termino dubitare, invicem ſe ſe ad ſolemnia Paſchatis adhortari, ſed etiam ab affluentis auri copia in laborem exſtimulari; definivere denique, ut unum e ſuorum gremio legerent, qui exploratum horæ tempus adnunciet. Abit nuntius & ſecum Trullam auro ſartam, obryzo extulit, vix cuneum egrediens maturum dilucuiſſe animadvertit, ſonum etiam campanæ exaudit, ſeque ſuoque de ſolemnitate diei commonefacientis, tum ille Trulla in patulo relicta ſociis orium ſolis adauntiaturus ſubito laxata montis compagine una cum ſociis triſtis auri victima occidit, foſſa a vertice montis in imum uſque prærupta, nunc aquis in immenſum ſcatet. (t)

D 4 Priſca-

(t) *Optime Phocylides:* Aurum atque argentum damno eſt mortalibus, aurum Dux ſcelerum, vitæ peſtis, rerumque ruina.

Fig. 3. The cover of Fridvaldszky's book and the beginning of the paragraph about Baia de Arieş [5]



Veynner dictæ Civitatis de Zlathna nobis in ſuis, nec non in univerſoaum Civium, & hoſpitum, ac montanorum noſtrorum de eadem Zlathna perſonis porrectam utilitati ejusdem montanæ noſtræ de Zsathna invigilare cupientes, ut populi in eadem, reſidentiam facientes in pacis pulchritudine ſedeant, & tranquilitate quieſcant, ac libertatibus gratulentur oportunis, eisdem ex Regiæ Majeſtatis liberalitatis largiſlua benignitate duximus annuendum, ut ipſi eorum poſteri, omni ea libertate fruanrur, qua cætera montana in Regno noſtro exiſtentia gaudent, & fruuntur, idcirco univerſis, & quibuslibet Urburariis noſtris injungimus Regio ſub edicto, ut ipſi eosdem populos, ſeu montanos noſtros de Zlathna in prædictis eorum libertatibus admittant permanere, nec ipſos ultra eorum præmiſſas libertates in aliquo audeaut moleſtare, præſentes autem privilegiari permittimus.

Fig. 4. Facsimile of the permission granted to some miners from Zlatna in 1357 [5]

If for Antiquity the quantity of gold extracted from Dacia is quite well estimated in published works, for the Middle Ages the data are relatively uncertain. Researching all the existing sources and corroborating them, it seems plausible to advance the figures in the table below, close to those presented by Ilie Haiduc in the book *Industria aurului din România* [6, p. 102]. In general, the quantity of silver is double that of gold, also considering the fact that in deposits the ratio between gold and silver is 1/2.

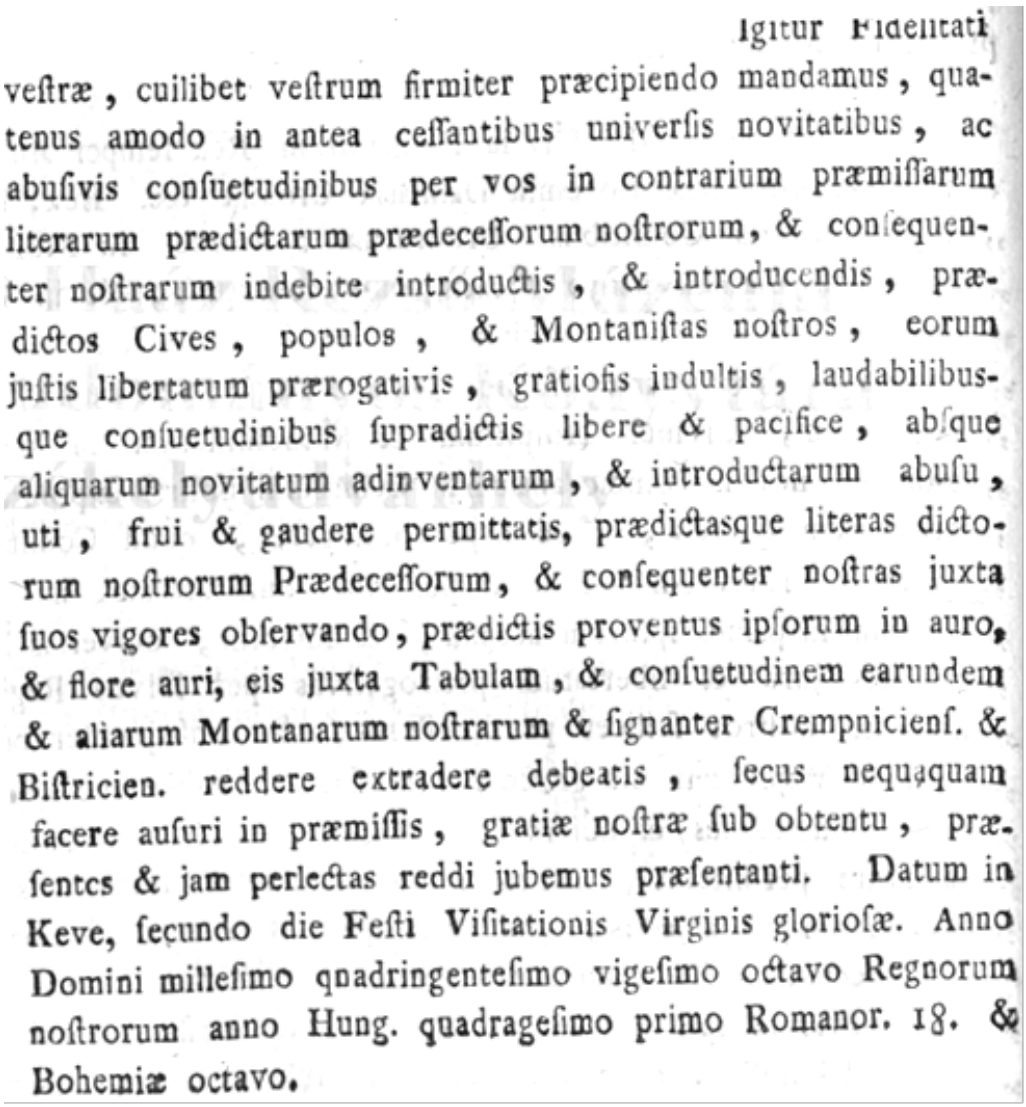

Igitur Fidelitati
veſtræ, cuilibet veſtrum firmiter præcipiendo mandamus, quatenus amodo in antea ceſſantibus univerſis novitatibus, ac abuſivis conſuetudinibus per vos in contrarium præmiſſarum literarum prædictarum prædeceſſorum noſtrorum, & conſequenter noſtrarum indebite introductis, & introducendis, prædictos Cives, populos, & Montaniſtas noſtros, eorum juſtis libertatum prærogativis, gratioſis indultis, laudabilibusque conſuetudinibus ſupradictis libere & pacifice, abſque aliquarum novitatum adinventarum, & introductarum abuſu, uti, frui & gaudere permittatis, prædictasque literas dictorum noſtrorum Prædeceſſorum, & conſequenter noſtras juxta ſuos vigores obſervando, prædictis proventus ipſorum in auro, & flore auri, eis juxta Tabulam, & conſuetudinem earundem & aliarum Montanarum noſtrarum & ſignanter Crempnicienſ. & Biſtricien. reddere extradere debeatis, ſecus nequaquam facere auſuri in præmiſſis, gratiæ noſtræ ſub obtentu, præſentes & jam perlectas reddi jubemus præſentanti. Datum in Keve, ſecundo die Feſti Viſitationis Virginis glorioſæ. Anno Domini milleſimo quadringenteſimo vigeſimo octavo Regnorum noſtrorum anno Hung. quadrageſimo primo Romanor. 18. & Bohemiæ octavo.

Fig. 5. Facsimile of Sigismund's letter of privileges to the miners of Zlatna [5]

Antiquity	Duration	Gold [t]	Silver [t]
From the end of the Neolithic to the Agatharsi	2000 BC – 300 BC	40	70
From Agatharsi to the Roman conquest	300 BC – 106 AD	165	330
Period of Roman occupation	106 – 271	450	900
The period after the Roman withdrawal	271 – 396	12	20
Middle Ages	396 – 1492	500	1000
Total	2000 BC – 1492 AD	1167	2320

4. Gold mining technology in the Middle Ages [3]

While there are numerous writings on applied technology for gold mining in Antiquity, they are almost completely absent for the Middle Ages. According to our knowledge, the first books on this topic appeared only in the 16th century. Thus, in 1505, Ulrich Rülein von Kalbe (1465–1523) published in Augsburg the work *Eyn wohlgeordnet und nützlich büchlein, wie man bergwerk suchen und finden soll* (*A well-ordered and useful little book on how to search for and find mines*). Kalbe studied medicine and mathematics in Leipzig, and in 1497 he was appointed physician in Freiburg, later being elected councilor and then mayor of the city. Here he also worked as a topographer, civil engineer and mining expert.

The Italian metallurgist Vannuccio Biringuccio (1480–1539) wrote the book *De la Pirotechnia, libri X* (*On the Casting, Separating, and Bonding of Metals*), published posthumously in 1540 in Venice. Born in Siena, in his youth he was taken under the protection of the nobleman Pandolfo Petrucci and sent to Germany to study engineering. Returning to Italy, he worked as a gunsmith and metallurgist in several cities, eventually

becoming head of the papal arsenal. His book is full of lavish woodcuts, which illustrate the processes and equipment used in his time and treat clear and practical notions of mining and metalworking by casting, thus constituting a precious source of information on the technology of the 15th–16th centuries. He is considered to be the founder of the science of metal casting.

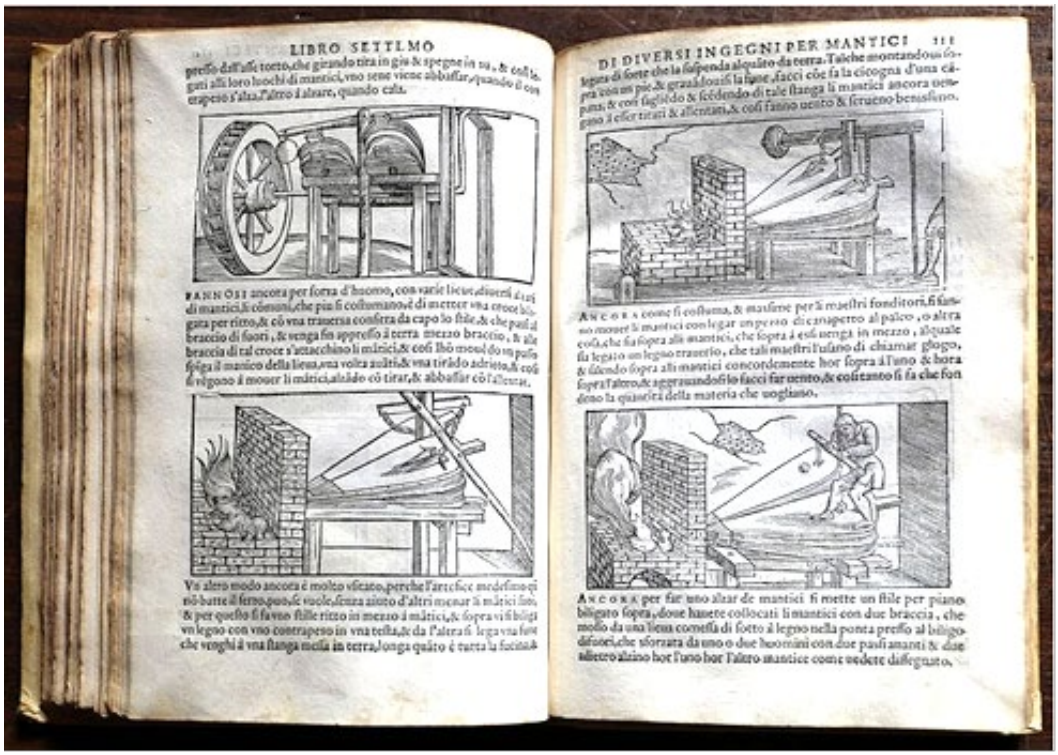


Fig. 6. Vannuccio Biringuccio's book *De la Pirotechnia, libri X*

Fig. 7. The covers of the 1662 and 1736 editions of Ercker's book

The third medieval author to write about mining was the Annaberg mines superintendent and mining advisor to Emperor Rudolf II (1576–1612), Lazarus Ercker von Schreckenfels (1528–1594). In his *Aula subterranea, domina donimantium, subdita subditorum,* published in several editions (*Fig. 7*), he gave a detailed description of the methods used to extract metals from ores, the book being in fact the first work on *docimasy* (method for determining the content of usable metals in ores). He also investigated the gold mines of Bohemia, Moravia and Hungary, and was for a time in the service of Emperor Maximilian II (1564–1576).

But the one who truly established himself in the science of mining and metallurgy, as no one had done since Pliny the Elder with his *Naturalis historia*, was the German humanist scholar Georgius Agricola (March 24, 1494 – November 21, 1555). He was born in the small town of Glauchau in Saxony, and was baptized Georg Pawer. Pawer is a vermicular form of the modern German term Bauer (farmer, peasant). His professor Petrus Mosellanus at the University of Leipzig convinced him to consider the common practice of Latinizing the name, particularly popular among Renaissance scholars, so Georg Pawer became Georgius Agricola. After studying classical languages and philosophy in Leipzig, he followed medical courses in Bologna and Padua, in Italy. There he met and became friends with the great Dutch humanist Erasmus of Rotterdam, who would write him an introduction to his mineralogy treatise *Bermannus sive De re metallica dialogus,* published in Bern in 1530.

In 1533, he became a physician in the city of Chemnitz, at the foot of the Ore Mountains, where he later became mayor. Knowing intimately the occupational diseases of miners, Agricola slowly approached minerals, treating his patients with mineralogical remedies known from ancient literature. There was a saying here that *If a German throws a stone or a piece of slag after a cow, it may be more valuable than the cow.* Moreover, while in Italy he had actively participated in the preparation of an edition of the works of the Greek physician and philosopher from Rome, Galen, published in Venice in 1525. In Chemnitz he deepened his knowledge of mining and metallurgy, and his book *De re metallica,* illustrated with 273 woodcuts, constitutes a quintessence of all that was known at the time about mining and metallurgy, being published posthumously in 1556 (*Fig. 9*). Agricola studied and knew well the contributions of the ancient authors Pliny and Theophrastus, referring to their writings on Roman mining.

Fig. 8. Georgius Agricola

In his monumental work, he described and illustrated the way in which the veins appeared, their prospecting, geology, topography, underground and surface constructions, water evacuation, mine aeration, testing, grinding and enrichment of ores, as well as the smelting and refining of gold. Among those who appreciated it were Erasmus, Goethe who compared him to Francis Bacon, Philip Melanchthon who praised the grace of presentation and the unprecedented clarity of the book, and mining engineer Herbert Clark Hoover, later the 31st President of the United States (1929–1933), who considered Agricola to be the initiator of the experimental approach to science and „*the first to found any of the natural sciences on research and observation, in contrast to the previous fruitless speculations".* Unrivalled in accuracy and complexity, the book was a reference work for over two centuries. Geologists consider him to be the father of mineralogy through his book *De natura fosilium,* published in Basel in 1546, in which he presents a classification of minerals, called fossils at that time. He was the first to distinguish between simple and compound substances, at a time when chemical knowledge was almost non-existent. In two other books – *De ortu et causi subterraneorum* and *De natura corum quae affluunt ex terra* – also published in 1546 in Basel, Agricola presents his hypotheses on the origin of the Philonian deposits, correctly intuiting their hydrothermal formation. He also describes in detail the erosive action of water and wind and their effect in shaping the mountains. His courage to renounce the authority transmitted to him by ancient classical authors, such as Aristotle and Pliny, considered immutable, is impressive.

Agricola published over 40 works, covering a wide range of subjects and disciplines: mining, geology, medicine, pharmacy, metrology, commerce, philosophy, history and others. His vast and innovative work, based on direct observations, constituted an important support and impetus for the understanding and learning of science in that obscure period. We will also use some illustrations from his book when we talk about the evolution of Romanian gold mining technology. Agricola did not visit the gold mines in Transylvania, but he mentioned in several places the gold extraction processes applied in the Carpathians, mentioning the mining towns of Zlatna, Abrud and Baia de Criş.

Fig. 9. The covers of the first edition of the book from 1556 and the American translation from 1912

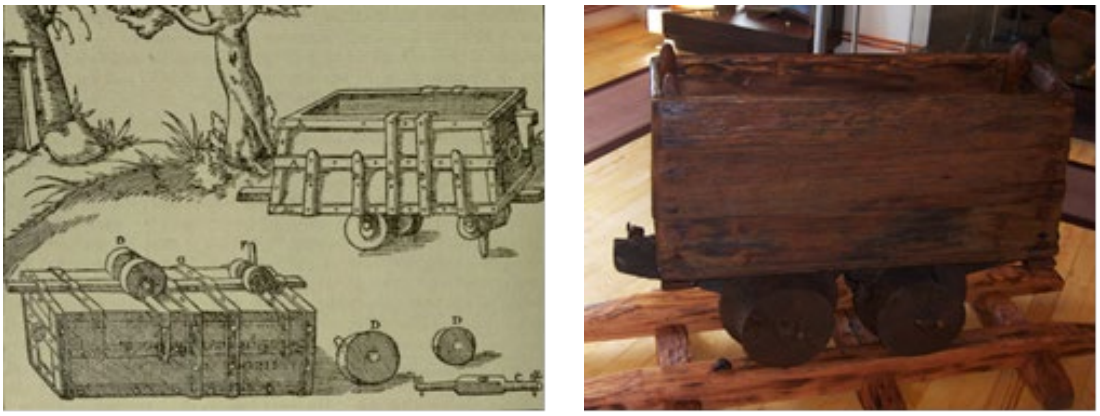
By the mid-14th century, most of the easily accessible gold deposits in Europe had been exhausted. As a result, it was necessary to introduce more advanced technological processes both for the deep exploitation of vein deposits and for increasing the extraction yield during processing. However, for a century, underground mining did not make any progress, due to historical events with severe socio-economic impact: the Great Famine of 1315–1317, which covered most of Europe due to prolonged drought and the death of cattle and sheep; the Black Death of 1346–1353, which decimated a third of the European population, resulting in 75–200 million deaths in Europe and North Africa; the Hundred Years' War between England and France (1337–1453). All of this led to a lack of labour and capital investment.

The revival of gold mining in Europe was mainly due to German miners who exploited gold in the Harz Mountains, in Bohemia and later in Transylvania, but also to those in France, Italy and Great Britain. They were free to move to various regions, then forming large groups and founding settlements near the mines. They were well received by local secular and ecclesiastical authorities, interested in increasing their income by giving them a share of the profits made from the exploitation of the metal-rich subsoil. In return, the miners received land for households, grazing and subsistence farming, as well as wood for reinforcing the galleries. In the late Middle Ages, metallurgical activity became independent of mining, being organized in guilds, with smelters usually located on the outskirts of cities. Both miners and metallurgists practiced their trades based on empirical observations and practical experimentation, most of the knowledge coming from the Roman era. After the exhaustion of surface resources, miners were forced to go deeper underground, where the biggest problem was the evacuation of water, thus having to make improvements to devices used in antiquity, such as the Archimedes screw and the water wheel or using augers to remove water from wells.

In the Middle Ages, on the territory of Romania, the exploitation of alluvial gold continued with the *sluice-box* and *gold pan*, but also of the vein gold, by the same exploitation methods used in antiquity. In fact, other methods could not be applied, and they continue to this day, considering the configuration of the veins. The displacement of rocks underground was still done manually, with a chisel and hammer or by the fire and water method, leading to low productivity and difficult smoke evacuation. Progress was made only in terms of ore transport, water evacuation, mine aeration and ore grinding.

The underground transport of ore was facilitated by the use of a wooden wagon, which had a rectangular shape, with a slightly smaller section at the top, locked with iron plates. At the bottom it had two metal axles, at the ends of which wooden wheels were mounted. The wagon moved on wooden tracks and in order not to derail while moving, in the middle of one of the axles it had a guide pin that entered the channel of the thick plank between the rails, on which it was driven. The wagon was pushed from behind both full and empty. The oldest wooden wagon in the world dates back to the 14th century and was discovered in the old mining works at Ruda–Brad, together with the conveyor line and a wooden switch. The original wagon is kept

at the German Mining Museum in Bochum (*Deutsches Bergbau-Museum*), and the switch at the Museum of Transport in Berlin (*Museum fur Verkehr und Technik*). The switch was invented around 1600 by miners from Brad. Similar wagons were also used in mines in England, but only at the beginning of the 17th century, almost 300 years later.



a **b**

Fig. 10. Wooden wagon: **a** – after Agricola [1, p.156]; **b** – museum piece (Bochum)

The evacuation of water at the height of the wells was done with water-bucket or with bullskin bellows. The first were the most used, having greater resistance. They were built from wooden staves, tightened with steel hoops, having a smaller diameter at the top, in order to lose as little water as possible when hitting the walls of the well. The loading of water-buckets *A* and *B* was done with the vessel *C,* tightened with hazel hoops, and the lifting was done with simple installations operated by people or horses.

Fig. 11. Evacuation of water with the water-bucket [1, pp. 158 and 161]

For lower heights, manually operated piston pumps with a handle or a rocker mechanism were used (*Fig. 12*). In principle, such a pump consisted of a wooden cylinder *1* in which a piston with several holes *2* moved, at the top of which there was a leather flap *3,* attached to the piston at a single point. The lower part of the wooden cylinder had several radial holes *4,* through which the water collected in a sump entered. During the downward stroke of the piston, manually operated with the rod *5* provided with the handle *6* or with a rocker, the water entered above the piston, through its holes. During the upward stroke, the weight of the water pressed on the leather flap, which sealed the piston, so that the water was raised to a drain trough, and then discharged into a canal or another intermediate sump. This is the principle on which water is still drawn from deep wells in the plains today, using instead of a piston a cylindrical vessel of great length and somewhat smaller diameter than that of the concrete well. On the downward stroke, water enters the vessel through its perforated bottom, and on the upward stroke, a rubber or leather flap seals the vessel, keeping the water inside.

The length of the wooden cylinders was limited to 3–3.5 m, so that they could be drilled with special drills. Usually, to achieve higher water discharge heights, two such cylinders were joined, one extending the other, and for a better seal between the piston and the cylinder, a funnel-shaped leather gasket was also used, connected with the narrow part to the piston and with the wider part sliding on the cylinder. In the medieval mining works at Roşia Montană, such a pump was found, with a length of 7 m and an external diameter of 22 cm. It is kept at the Gold Mining Museum in Roşia Montană.

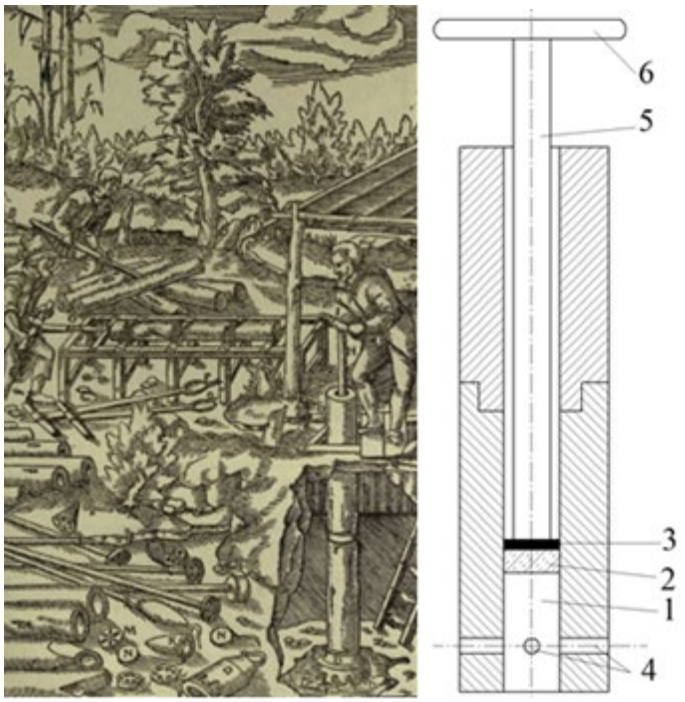


Fig. 12. Piston pump for water evacuation [1, page 177] and its operating principle

The ventilation of the mines (*Fig. 13*) was done by quite ingenious methods, combining the discharge and suction procedures. In the first case, the barrel *A* reinforced with iron hoops was used, mounted on the wooden pipe *D* that entered the ventilation shaft. The connection between the barrel and the pipe was made by a wooden disc that was fixed to the pipe through a square hole, allowing the barrel to rotate freely in both directions. The barrel rotated around a longitudinal axis, at the slightest breeze of wind, thanks to a fin *H,* always bringing the air inlet window in the direction of the wind. This construction is known today as the ventilation headgear. The fresh air entered the ventilation shaft by discharge, then washing the underground mining works and being evacuated in the form of stale air, to the surface, through a secondary shaft.

The suction process ensured the evacuation of foul air from the mining works with a single access route, simultaneously with the free entry of fresh air, by compensating for the depression created, but it required the use of a man to manually operate the installation. This consisted mainly of a chamber with a leather bellows *C* with pleated walls (bellows), operated by a system of levers.

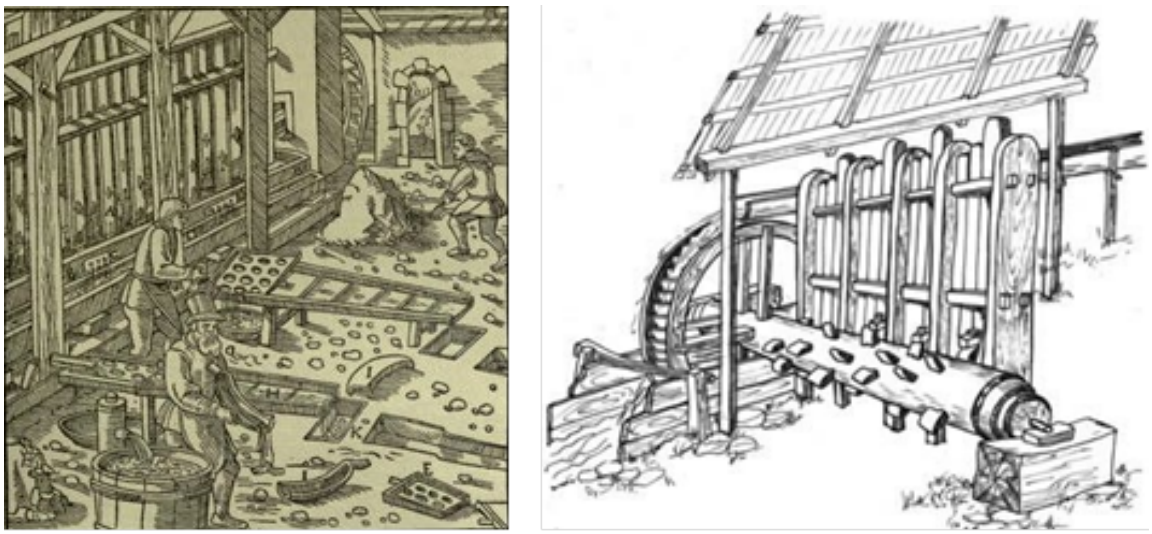
a **b**

Fig. 13. Mining ventilation methods [1, pp. 203 and 208]; **a** – exhaust; **b** – suction

The aeration shaft had two compartments separated by tightly joined boards, one with a smaller section, for the suction of foul air, and the second with a larger section, for the entry of fresh air. The bellows was mounted on the wooden flue with a rectangular section *B,* and the worker operated the leather bellows by a system of levers. Thus, the *stinky air* (Agricola dixit!) was sucked in and evacuated into the atmosphere through the mouthpiece of the bellows, which folded, due to the weight of a boulder mounted above it. The bellows had two valves that closed and opened alternately: the one on the mouthpiece closed when the stale air was sucked in, and the one on the wooden pipe closed when the bellows was folded, and vice versa. The suction ventilation system was applied to all types of mining works that did not have a second outlet, being today called *aeration in the bottom of the bag.*

The grinding of gold ore was done in Agricola's time with the help of water-powered stamps. These installations were invented by German miners in the 12th century, and were later taken over by the French (13th century) and Polish (14th century). Transylvanian miners began to use stamps also in the 14th century, first in the Apuseni Mountains, and then in Baia Mare, taking over the craft from German miners colonized here especially after the privileges granted by Charles Robert of Anjou and reconfirmed by his successors. Agricola says that these stamps were found in the Julian Alps (on the current territory of Slovenia and Italy) and the Rhaetian Alps (on the current territory of Austria, Italy and Switzerland), as well as in the Carpathian Mountains.

Stamps revolutionized the technology of gold extraction, replacing mortars and mills and remaining the only grinding equipment until the appearance of mills. A detailed description of their operation will be given in the next article.



a **b**

Fig. 14. Gold stamps: **a** – after Agricola [1, page 321]; **b** – schematic diagram

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