

APUSENI MOUNTAINS GOLD MINING DURING THE MIDDLE AGES

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Abstract: *The paper presents the organization and legal framework of gold mining in the Apuseni Mountains in the Middle Ages. At that time, the miners enjoyed a series of privileges granted by the Transylvanian voievodes or Hungarian kings. Mining technology refers to tools and installations intended to transport ore and sterile in the galleries, water evacuation, ventilation of workplaces and grinding the auriferous ore.*

Key words: *gold mining in the Middle Ages, organization of mining, mining methods*

1. Introduction

As it is known, the Romans captured from the Dacians 165.5 ton gold and 331 ton silver, and during the 165 years of occupation they extracted an additional amount of 500 ton gold and 950 ton silver. After the Romans withdrew from Dacia, the entire social-economic course of life went back to its rural character. Economy turned back to growing sheep, to extensive agriculture, craftsmanship declined, acquiring a predominantly household character. Mining was no exception. The local population used metals to make agricultural tools, arms and household goods. Auriferous mining in the Apuseni Mountains was probably limited to the exploitation of alluvium gold along rivers, and exploitation of meagre seams, close to surface, that were not worth to the Romans. It is hard to believe that the miners left behind would have abandoned their occupation and would have turned to sheepherding; agriculture couldn't have been an option. Gold and silver was potent money in those unstable times as well, about which we know little.

The mining technology of the Romans was so advanced, that in the following 1,500 years it remained almost unchanged, not only in our country but in Europe as well. In our country, barbarian incursions stopped the Dacian-Roman civilization for almost a millennium, the so-called dark millennium having been instated.

2. Mining organization [3]

Exploitation of precious metals in the Apuseni Mountains restarted in the 8th century, after the Slav people had been assimilated, the proof being *Zlatna* toponym, which replaced the name *Ampelum*, given to this ancient mining centre by the Romans, *zlato* meaning gold in Slavic. No documents are known referring to the social-economic organization of the people in the auriferous region of the Apuseni Mountains in that period, but one can assume that they lived according to the ancient

customary law. Alongside with the pre-state feudal structures (princedom and voievode's domains), the interest towards mining regions increased, they became feudal domains, and their inhabitants became serfs to the crown. Over these pre-state structures within the Carpathian Arch, with emerging rudimentary organizations of life, the Hungarians stormed in. From the 10th century on, the Romanian territories began to be enclosed in 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 the south and around Bistrița. The colonists' mission was defending the borders and putting to good use the economic resources of the autonomous voievode's domain. In the year 1210 the occupation of Transylvania by the Magyars was finished by conquering Țara Bârsei.

The first written documents appeared in this period, establishing many aspects of the social-economic life of the period, among which mining activity. Such a document is the *Letter of Privileges* given by King Bela the Fourth of Hungary (1235–1270), in the year 1255, for the miners of Besztercebánya (Banská-Bystrica from today), granting them a series of privileges. The document is also important for the auriferous mining in the Apuseni Mountains, since German miners from Besztercebánya and Körmöcbánya were brought to Zlatna, Abrud and Bucium. They kept the rights given by Bela the Fourth and fought for a long time to maintain them. The *Letter of Privileges* of 1255 states that the miners of the area mentioned above had economic, legal and religious advantages, based on which they could run a more sustained economic activity, compared to the other inhabitants. They could prospect and exploit noble metals underground and along the rivers, but they had the obligation to pay to the regal tax administration the eighth part of the gold and the tenth part of the silver extracted, and in case metaliferous seams had been discovered, the king could take possession of the respective terrain. Similarly, the miners were exempted from customs taxes for goods of strict necessity and financial and

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military obligations to local nobility. The privileges were acknowledged and reconfirmed by Bela the Fourth', Laszlo the Fourth' (1287), and Andras the Second's (1291) heirs. We should also mention that Bela the Fourth had previously granted the same privileges to the Saxons in Cricău and Ighiu, by a document (February the 12th, 1238), signed at, Archita (village belonging now to Vânători, Mureş County), established by the Saxons around the year 1200. The Saxons of Cricău and Ighiu received the right to exploit gold at Zlatna and Vulcoi.

Carol Robert de Anjou was the one that ensured a real development of mining in Transylvania, by developing mining regulations, through a *Letter of Privileges*, signed at Visegrád, in 1327. Unlike the privileges given by Bela the Fourth, referring only to certain mining communities, those granted by Carol Robert de Anjou covered all the miners in the Kingdom of Hungary. Moreover, the terrains where precious metals had been discovered did no longer become the king's property, they remained in the property of the owners, with the condition that 2/3 of the "urbura" be deposited in the regal Treasury, the other one third remaining to the owner. The gold produced in the four mining centres of Apuseni Mountains, Abrud, Baia de Arieş, Zlatna and Baia de Criş, had to be exchanged in the regal office in Sibiu, at the official price fixed by the king. As a result of making miners co-interested, auriferous mining in the Apuseni Mountains raised up, many landowners starting a campaign of exploitation of the resources of the underground. The privileges granted to the miners by Carol Robert de Anjou were reconfirmed by Ludovic I de Anjou (1351), Sigismund de Luxemburg (1405), Matei Corvin (1486), Vladislav II Jagello (1492) and Ludovic II Jagello (1523).

Based on these regulations, the functioning of the mines was submitted to a process of organization. A document dated September 20th, 1347, of the Hungarian Chancellor, for the miners of Baia Mare, shows very interesting data with this in view. Thus, the community of workers, together with the judge and the jury of the place to which the mine belonged, (today's mayor and councillors), chose for a year a *knowledgeable magister of the mountain* (chief of mine), responsible for the good functioning of the mine. In his turn, he appointed the "*steigers*" (today's foremen) and *gold examiners* (today's probers), with the approval of the judge and the jury. The "steigers" supervised the work in the mine and collected the "urbura" for the king, and the gold researchers took samples from the faces, establishing the metal content of the ore. The regulation stipulated severe punishments for those who avoided acquitting the "urbura", but also defended the miners in case of abuses.

A report on organizing auriferous mining and production of noble metals in Transylvania in the 15th and 16th centuries of Paul Bornemisza (Catholic Bishop of Veszprém) and Georg Werner, commissioners to King Ferdinand the First of Bohemia and Hungary (1526–1564), sent to analyze the worrying situation of the mines of that area, shows interesting data. In the first half of the 16th century, gold production in Transylvania decreased significantly. Mines became deeper and the methods of that time could hardly handle the evacuation of underground water, and in many cases the producers were too poor to cope with the situation. The report shows that Transylvania was richer in gold than in silver, but out of the four important mines only the one of Baia de Arieş belonged to the king, and this preponderantly extracted silver. The mines in Zlatna and Abrud, very rich in gold, belonged to Alba Iulia, Baia de Criş mine was submitted to Şiria, belonging to Matei Corvin. The decline in gold production was caused by the lack of cash of the Exchange office in Sibiu. The clandestine money changers, called *gozars* by the population in the Apuseni Mountains, dealt heavily with gold, eluding the regal monopoly and making huge profit. This is the reason why the small gold producers are scarce on the exchange tables, although they made the greatest gold production. Usually the gold exchange was leased to the Saxons in Sibiu, for 4,000–5,000 Florin per year, sometimes even more. By the end of the 15th century, the gold exchange was approximately 350 kg/year, decreasing to 300 kg in 1552. In order to correct the situation, the Transylvanian princes took a series of measures, among which reconfirmation of the old privileges of the mining towns, secularization of the bishop domains of Alba Iulia and introduction of foreign capital in auriferous mining.

3. Mining technology [1,3]

Interesting data referring to the technology applied in the gold mines near Zlatna and Abrud in the second half of the 16th century are displayed by foreign travellers visiting these places. Thus, the French Pierre Lescalopier, who visited Transylvania in 1574 visited Zlatna gold mine, where "*one goes far in under a high mountain, [Vulcoi – n.o.]. The miners take out some rock from here, then they burn it first as it were gypsum, then they grind it in a water mill that throws the burnt stones in a one foot wide, two pole long wooden gutter, where the rock is crushed with thick pestles that rise and fall one at a time, one after the other. The gravel is slowly carried by water, and spread over thick burlaps, laid out on a slightly inclined floor over a large trough. The gold is caught up on*

these burlaps, and what is not caught up falls in the trough, and the water flows down. Two times a day the miners raise these burlaps, wash them in other troughs, then take out the bits and pieces on large wooden cymbals, which then are shaken little by little, until the gold gathers in one side, and the useless sand on the other side of the cymbal. When a certain amount of gravel with gold is amassed, they put a little quicksilver in an alembic where, by the action of fire, the quicksilver reduces the gold to bars, then the quicksilver evaporate" [7, pp. 140–143].

The Austrian nobleman Felician de Herberstein, who took on a lease the goldmines in Cavnic next to Baia Mare, visited the mining region of the Apuseni Mountains by the end of the year 1585, at the request of the king of Poland Ștefan Báthory (1575–1586), drawing up a thorough report regarding the mines of Bucium, Almaș, Ruda and Băița. The report gives interesting details referring to the technology of extraction and processing of gold ores there, completing the information in the report of the imperial commissioners sent to Transylvania in 1552. Herberstein's report might have been a little biased, presenting the situation more worthless than it was in reality, considering his intention to take these mines on a lease, which happened indeed. After his death, the contract of lease was prolonged by Prince Sigismund Báthory by his diploma of July the 1st, 1591, given to Heberstein's sons, Sigismund and Friedrich, where the villages affected to the mines were also mentioned. The contract was dissolved in the summer of 1597.

The most complete information related to ore extraction and processing in the middle of the 16th century were shown in detail by the German scientist Georg Agricola, Georg Bauer his real name (1494–1555), in his famous book *De re metallica libri XII (On Mining and Metallurgy)*, published in 1556, shortly after the author's death. Written in Latin, the book was translated to German, with many errors in its content and language. In 1912 an excellent translation was made by the American mining engineer Herbert-Clark Hoover and his wife Lou Henry-Hoover; the mining engineer became later the president of the U.S.A. (1929–1933). A physician by profession, Agricola approached minerals little by little, treating his patients with mineralogical remedies, known in ancient literature; therefore he settled in Chemnitz, in the Metaliferous Mountains in Eastern Germany, very rich in nonferrous metals. There was a saying in those parts, "If a German throws a stone or dross after a cow, it might be more precious than the cow". It was there that Agricola deepened his knowledge on mining and metallurgy,

being considered the father of mineralogy, and his book, *De re metallica*, with 273 illustrations, is a quintessence of all that had been known at that time about mining and metallurgy.

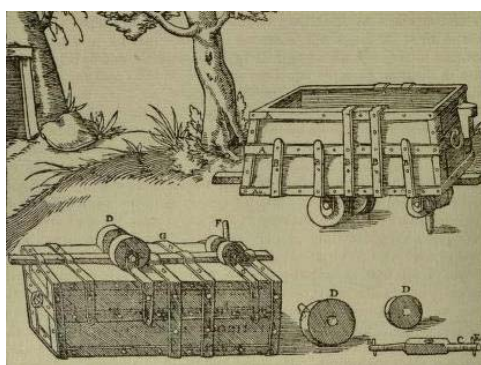
Clearly, Agricola visited the gold mines in the Apuseni Mountains, he mentioned more than once the gold extraction procedures from the ore applied in the Carpathians. At that time, gold was extracted and processed only in the Western Carpathians. Besides, Agricola mentioned Zlatna, Abrud and Baia de Criș in other two works related to mountains and mineralogy (*De natura fossilium, libri III* and *De veteribus et novis metallis, libri II*). He also had good knowledge of the mining technology applied in the ancient world from the writings of Plinius the Old, whom he frequently mentioned. After 1,300 years, gold extraction methods remained the same, while mines had become deeper. In hard rock the *method of fire and water* was used, progress was only made in ore transportation, water evacuation and mine ventilation. Certainly, to grind auriferous ore stamps were used.

Wooden wagons had rectangular shape, the upper part being slightly narrower, fastened by and iron strips. At the lower part there were two metal shafts, and at their extremities wooden wheels were mounted. The wagons ran on wooden paths, and to avoid derailing, in the middle of one of the shafts, there was a guiding pivot that entered in the canal of the thick plank between the rails, which was also used by people to walk. The wagons were pushed from the back, full as well as empty. Since during the travel the wagons made a squeaking sound, like a puppy, the German miners called them *hunt* (*Hund* = dog), becoming *hont* in the language of the people living in the area.

The oldest wooden wagon in the world goes back to the 14th century, and had been discovered in the old mining workings in Ruda-Brad, together with the transport line and a switch, also made of wood. The original wagon is found at the Museum of Mining in Bochum (Deutsches Bergbau-Museum), and the switch at the Museum of Transport in Berlin (Museum für Verkehr und Technik). The line switch was invented around the year 1600 by the miners in Brad. Similar wagons were used in the mines in England, but only at the beginning of the 17th century, that is almost 300 years later.

Water evacuation was made by pumps with piston, manually driven by a handle or a balancing mechanism. In principle, such a pump was made up of a wooden cylinder, wherein a piston with several holes in it moved, and on its upper part there was a leather choke, attached to the piston in only one point. The lower part of the wooden cylinder had

several radial holes, by which water collected in a sump entered. At the descending stroke of the piston, manually driven by a rod with a handle or a balancer, water entered above the piston, through its holes. At the upstroke, the water weight pressed on the leather choke, which sealed the piston, so that water was lifted up to a flow gutter, being then discharged in a canal or in another intermediary sump. This principle is used nowadays to take out water from deep fountains in flat areas; instead of the piston, a long, cylindrical vessel is used, with diameter slightly smaller than that of the concrete fountain. At the descending movement, water enters by its perforated bottom, and when the vessel moves up, a rubber or leather choke seals the vessel, keeping the water inside.



a

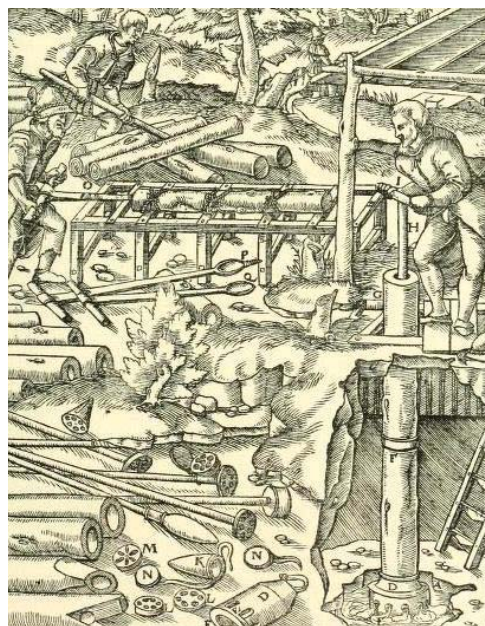


b

Fig. 1. Wooden wagon:
a – in Agricola's work; **b** – reconstitution

The length of the wooden cylinders was limited to 3–3,5 m, so that special drills could be used to make the holes. Usually, for higher water evacuation, two such cylinders were joined, one lengthening the other, and for a good sealing, a funnel shaped leather gasket was used, tied with the narrower part to the piston, the larger part sliding along the cylinder. In the medieval workings at Roșia Montană a 7 m long pump was found, with 22 cm outer diameter. It is kept at the Museum of Auriferous Mining at Roșia Montană.

Mine ventilation was made by rather ingenious methods, combining forcing ventilation with induced ventilation. In the first case, an iron circle reinforced barrel was used, mounted on a wooden duct that entered the ventilation shaft. The link between the barrel and the duct was made by a wooden disk, fixed to the duct by a square hole, allowing the free rotation of the barrel in both senses. The barrel rotated around a longitudinal axis, at the slightest wind, due to certain wings, always bringing the air entering window in the direction of the wind. This construction is known today as *ventilation hat*. The clean air forced itself in the ventilation shaft, flushing the underground mine workings, the vitiated air being evacuated afterwards to the surface through a secondary shaft.



a

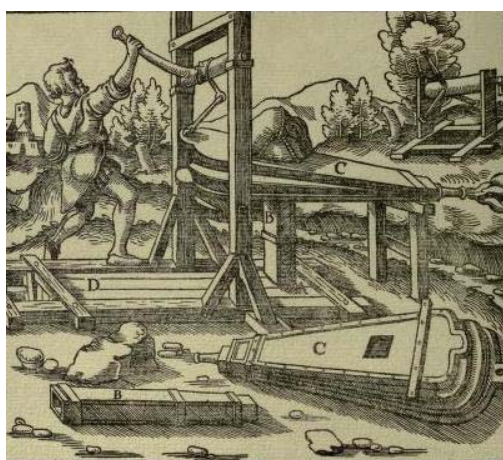


b

Fig. 2. Water pumps with piston (Agricola):
a – with handle; **b** – cu balancer



a



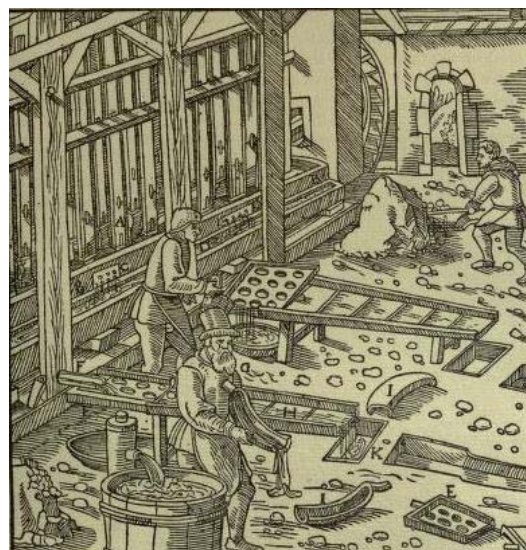
b

Fig. 3. Mine ventilation methods (Agricola):
a – forcing; **b** – induced

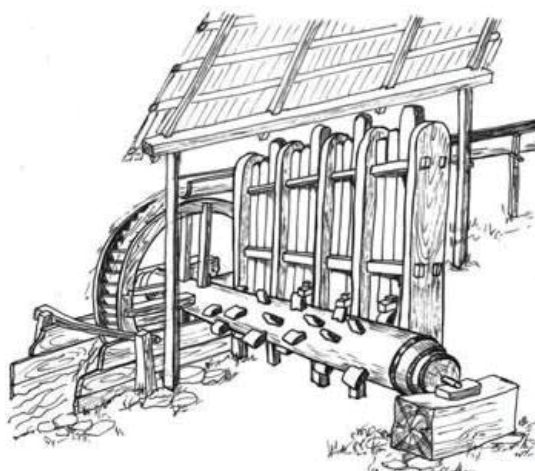
Induced procedure ensured the evacuation of the vitiated air from the mine workings with only one access way, simultaneously with the unrestricted entering of the clean air, by compensating the created depression, but it involved the use of a man to manually drive the installation. It was mainly made up of a chamber with leather windbag with creased walls (bellows), driven by a system of levers. The ventilation shaft had two compartments separated by tightly joined planks, one with a smaller section, to aspire vitiated air, and the other with a larger section, to let clean air come in. The windbag was mounted on a wooden rectangular funnel, and the worker actuated the leather windbag by a system of levers. Thus, the „stinking air“ (Agricola dixit) was aspired and evacuated into the atmosphere by the mouthpiece of the windbag, which folded due to the weight of a boulder mounted above. The windbag had two vents that closed and opened alternatively: the one of the mouthpiece closed when the vitiated air was aspired, and the one of the wooden funnel closed

when the windbag folded, and vice versa. The induced ventilation system was applied with all types of mine workings that had no second outlet, today it is called *dead-end ventilation*.

Grinding auriferous mineral was made in Agricola's time with stamps driven by the force of water. These installations were invented by the German miners in the 12th century, being taken over by the French miners (13th century) and the Polish (14th century). The miners in Transylvania also began using the stamps in the 16th century, first in the Apuseni Mountains, then in Baia Mare, taking over the craftsmanship from the German miners colonized there, especially after the privileges granted by Carol Robert de Anjou and reconfirmed by his heirs. The stamps revolutionized the gold extracting technology, replacing the pestle and grinders, remaining the only grinding tool until the coming about of the mills.



a



b

Fig. 4. Auriferous stamps:
a – in Agricola's work; **b** – scheme of principle

4. Conclusions

After the Romans withdrew from Dacia, auriferous mining declined, due to the invasion of the migrant populations. Exploitation of precious metals restarted in the 8th century, after the assimilation of the Slavs and intensified in the 10th century, after the establishment of princedoms and voievode's domains. Later, these pre-state formations were enclosed in the medieval Kingdom of Hungary. The Hungarian kings colonized the conquered territories, to protect the borders, and to put to good use the underground resources.

Miners were granted economical and legal privileges for the exploitation of precious metals from underground or alluvium, on the condition that they would pay part of the winnings as taxes. The most important privileges were given in 1327 by Carol Robert de Anjou, by a mining regulation, which was reconfirmed by his heirs until the end of the Middle Ages.

As far as precious metal extraction technology from underground is concerned, it was very much like during the Roman period. Auxiliary mining activities experienced however innovations. Thus in the 16th century at Brad wooden wagons and switches were used for the first time in history, and manually driven piston pumps were used for water evacuation. Mines were ingeniously ventilated, using wind or manual actuation of a chamber with windbag. During this period auriferous stamps were used to grind ore. All these were described in detail by the German scientist Georg Agricola in his famous book *On Mining and Metallurgy*, but tools had also been discovered in the old mines in the Apuseni Mountains, being now exposed in museums.

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