# History of Mining


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**Abstract** This paper has as purpose the presentation of the activities of extraction and valorisation of the deposits of solid utile mineral substances on the territory of Romania, along four historical periods comprised between Paleolithic Era and the end of the Millennium II A.D. For each period of time, the exploited and valorised deposits are shown, presenting the utilised exploitation methods, utilized work technologies and the obtained economic results. Within paper, a special importance is given to the presentation of the main operations from the production process: ore excavation from the massif, loading and transport of the extracted material, water evacuation, ventilation and lighting of the mines, ore processing and utile substance obtaining. The evolution and spreading of the technical knowledge about mining was sustained by the activity of applicative research and by the specialty education and therefore the paper presents the existence and development of the research and mining medium and superior education of Romania. The chapter ends with the presentation of some actual tendencies of the Romanian mining industry.

## 1 From the Beginnings of Mining to the First World War

The extraction and processing of solid mineral raw materials have been known since ancient times on the territory of Romania. The archaeological research conducted across the country has highlighted man's work in extracting and making use of various minerals and rocks ever since the Paleolithic. Vestiges related to the exploitation and processing of flint, opal, obsidian, quartz, and various other rocks have been found in numerous Paleolithic sites that have come to light.

Mining activities intensified in the Neolithic. This is the age that marks the beginning of the exploitation and processing of metals. The first metals to be used were copper and gold.

The Bronze Age (Almăşan 1984, 1965; Abrudeanu Rusu 1933; Baron 1999; Fodor 2005, 2003, 1780; Haiduc 1940; Maghiar et al. 1970) is the time when, aside from

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extracting and processing stone, people move on to making bronze (copper + tin), an alloy which is superior to copper and gold in terms of hardness and potential uses. During the same period, gold, silver, amber, salt, and various hard rocks were exploited in various regions on the territory of Romania.

The Iron Age constituted a step forward in the development of human civilisation. The exploitation and processing of iron on current Romanian territory are attested as far back as 1000—900 BC in settlements in today's Dobruja (Babadag and Dervent).

After the conquest of Dacia by the Romans, the exploitation of underground resources registered a strong upsurge. Thus, during the Roman rule, over 20,000 people came to work in Dacian mines. The Romans, who were the greatest military force of the time, focused on the exploitation of iron in particular, thus maintaining the already known mines (Teliuc, Ghelari, Ocna de Fier), while also opening new ones. However, Rome's economy was in need of Dacian gold and silver. Given that the yearly production of pure gold was of 3,000 kg and that of silver double as much, during the 166 years of occupation, the Romans probably exploited approximately 500,000 kg of gold and 950,000 kg of silver (Wollman 1996; Roman et al. 2017) from the Apuseni Mountains.

The exploitation of metal ores in Dacia registered an unprecedented level of development after the Roman occupation, due to the opening of numerous mines and the introduction of perfected work tools and methods, as well as to the use of a vast specialised workforce recruited from among slaves and free men.

The Romans exploited other metals as well: lead, copper, mercury, etc. and the salt deposits in Transylvania and Maramureș.

Salt was mined both above and below ground. The former method was employed when the deposit was close to the surface or in the form of an outcrop; after the overlying soil or rock was removed, the excavation was initiated and advanced downwards, taking away bottom strips. Such a system had the advantage that it was inexpensive and allowed for massive extraction, but it could not expand to great depths and was subject to weather changes. The second method, that of underground exploitation, involved digging a vertical shaft in order to cross the gangue and then excavating the salt through the same descending method, as seen in Fig. 1 (von Fichtel 1780).

The Romans made openings into mines mainly through adits and inclines, which enabled them to reach the deposit. In the vicinity of the deposit, they continued their work either through directional galleries advancing along the direction of the lode, or through cross-cuts.

The galleries (*cuniculi*) were mostly carved through hard, compact rock by using a chisel and hammer or the fire method.

In those times, the main operations of the underground part of the production process were carried out as follows:

Water drainage was one of the most difficult and challenging technical issues given the day's technology. The Romans either designed special drainage galleries to collect the water, or equipped galleries with drainage canals. The water which gathered in the mine at one end of a gallery or at the bottom of a shaft was evacuated

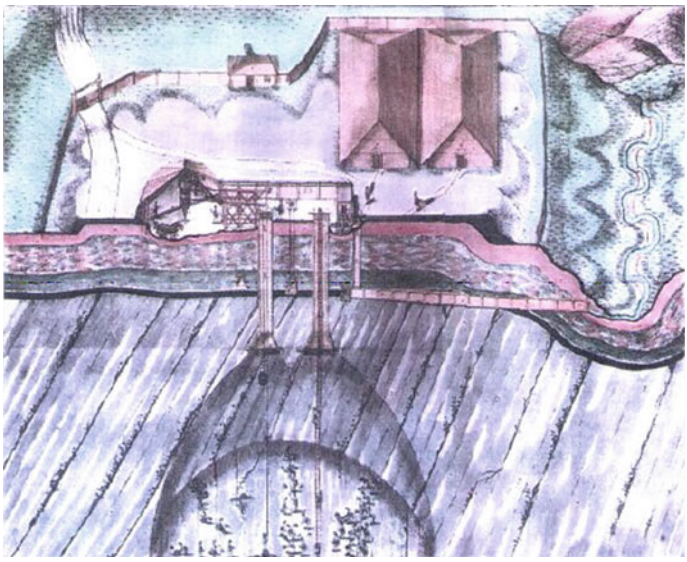

**Fig. 1** Cross section through the salt mine from Turda (von Fichtel 1780)

with the aid of pails, buckets, cowhide waterskins, Archimedes' screw, or a hydraulic scoop wheel, as in Fig. 2 (Wollmann 2017).

The ventilation of mines in Roman times was carried out using three methods: carving secondary shafts alongside the central one, which ensured the access of fresh air inside and the evacuation of foul air; building parallel, overlaying galleries in combination with moving pieces of canvas or fabric—this system was mainly used in mines where the fire method was employed for dislocation purposes, as water vapours and smoke were evacuated via the currents generated by the movement of the pieces of canvas; maintaining a fire at the mouth of the shaft, which created the necessary depressurisation for the air inside the shaft to rise and for the masses of air inside the galleries to be set into motion.

The lighting of mines was achieved with the aid of oil lamps (*lucernae*). They were equipped with a tank—in which the oil or animal fat was kept—and one hole for taking out the wick and another for pouring the fuel into the tank.

Ore transportation and processing In the case of both above-ground and underground mining, the dislocation of the ores was immediately followed by an initial sorting of the pay-ore from the gangue at the bottom of the excavation, gallery, or stope, after which the pay-ore was transported in wooden troughs or baskets made of wicker or wood.

While iron or copper ores were carried directly to the furnaces and put through the reduction process, gold ores were submitted to a string of operations: first, they were crushed in stone troughs, then they were taken to the grinders to be milled; the resulting powder was then taken from the grinders by specialised workers who washed it on a slightly slanted plank covered in wool fabric to catch the specks of

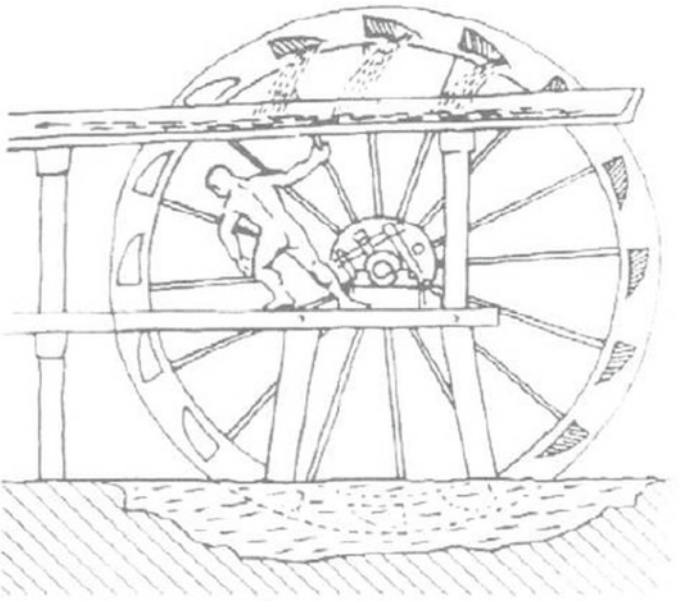

**Fig. 2** Graphic reconstruction of the components of the water-evacuation installation, with its manually-operated scoop wheel (courtesy of Dr. V. Wollmann)

gold. In order to retrieve the gold found in alluvial sands, buddles were used. The specks obtained through washing were melted in white-clay crucibles and, in order to be purified, the gold was melted again mixed with salt and lead.

The withdrawal of the Roman troops from Dacia (271–275 AD) had a significant impact on the entire economic and social situation of the north-Danubian province. Deprived of the organisational framework previously provided by the Roman state, mining activities shrank. However, they did carry on in the field of iron and copper extraction for the crafting of tools and weapons, as well as in that of salt extraction.

It was not until the 11th century AD that a significant level of activity was registered on Romanian territory in the way of extracting useful mineral substances.

Circa 1300 years after the Roman withdrawal from Dacia, the methods of exploitation for gold and metal ores in general remained the same, the only noteworthy difference being that the mines were much deeper and more extended horizontally.

For hard rocks, the chisel and hammer continued to be used, and so did the fire and water method, yet notable progress was made in terms of ore transportation, water evacuation, mine ventilation, and ore processing.

In the 16th century, several more significant changes occurred regarding extraction and preparation technologies, which led to an increase in production and work productivity. For shaft-based extraction, animal-powered basic wooden winches (*crivac*) appeared, while inside mines, wooden-railway mine cars with wooden wheels were used, as well as points.

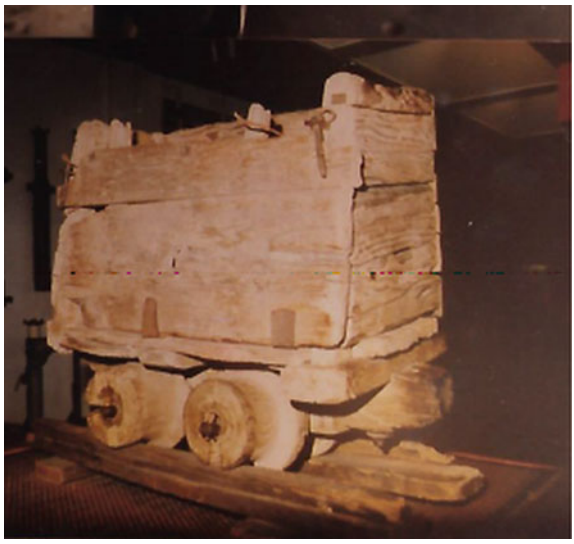

**Fig. 3** Wooden mine car used to transport ores in the mines of the Apuseni Mountains (courtesy of Dr. V. Wollmann)

Wooden mine cars were rectangular in shape, featuring a slightly smaller section at the top and were bound with sheet-iron strips, as shown in Fig. 3. The bottom part was equipped with two metal axles at the ends of which wooden wheels were attached. Mine cars travelled along wooden tracks.

The oldest wooden mine car in the world dates from the 17th century and was discovered during mining work at Ruda-Brad, along with the transport line and a point, also made of wood. The original mine car is kept at the German Mining Museum in Bochum, while the point is found at the Transport Museum in Berlin.

The point was invented around the year 1600 by the miners of Brad. The use of explosives to extract rocks and hard ores, thus increasing work productivity, dates back to the 14th century as well.

In order to grind gold ores, the miners of Transylvania started using STAMP MILLS as early as the 14th century, first in the Apuseni Mountains, then in Baia-Mare, having borrowed the method from German miners sent to colonise the region. Stamp mills revolutionised gold-extraction technology by replacing mortars and grinders, thus becoming the only grinding machine to be used until the appearance of the mill. Figure 4 shows a stamp mill which was employed in the gold exploitation work in Săcărâmb.

The fierce battle against the hard rocks, the fouled air, and the greatest enemy of underground work—infiltration water—, the added difficulty of putting the extraction and processing installations into operation, particularly in times of draught, permanently stimulated and kept up miners' inventiveness. Aside from the specialists trained in mining and forestry academies, one cannot overlook the contribution to the field of simple people with a long-going tradition and experience in this kind of work, who, through their skill and abilities, added their valuable input to the

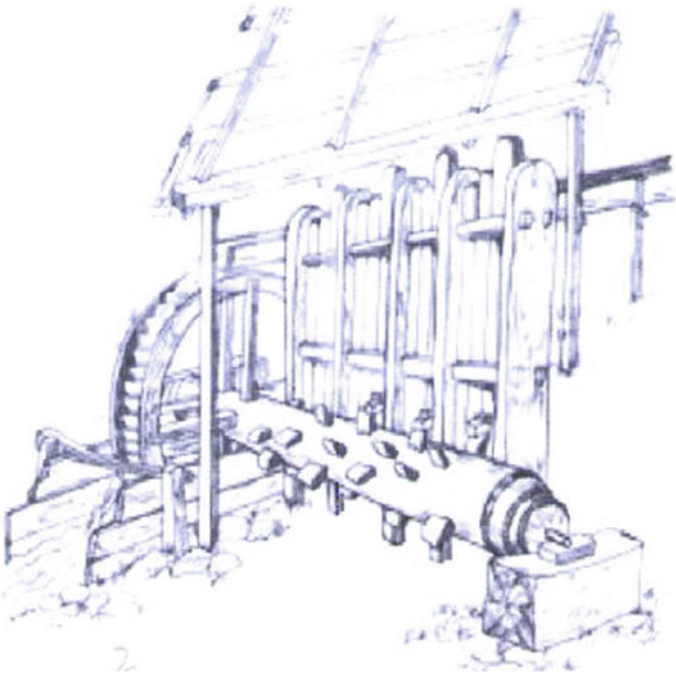

**Fig. 4** Hydraulic stamp mill for grinding gold ores, used in Săcărâmb

development of mining technology, some of them making their mark as veritable innovators.

In the early 19th century, wooden stamp mills began to be replaced by metallic ones, called Californian stamp mills. Both the troughs and the stamps of these stamp mills were made of highly wear-resistant manganese steel.

New iron deposits were discovered and put into service all across Transylvania, Banat, Maramureș and Bucovina. The exploitation of complex ores in the Maramureș and Apuseni Mountains area continues, in a better organised form, while, in Banat, copper ore exploitation begins at Moldova Nouă and Sasca-Ciclova-Oravița (in 1719), as well as bituminous coal exploitation at Doman (in 1780), Secul (in 1782), and Anina (in 1790).

In 1838, the first steam-powered machine in Transylvania starts operating in Zlatna (power of 14 HP), shortly followed by the one in Baia Mare (of 30 HP). In 1843, the first attempts to reduce iron ores from Govăjdia-Hunedoara using bituminous coal extracted from Valea Jiului are made, while the first coal-mining sites are organised around Brașov in 1838.

The Valea Jiului mining basin started to be known for its coal deposits as early as 1780. The first mining activities are not conducted until 1840 and the first batches of coal are produced in 1868 (853 tons).

The technological revival of gold and silver mining was due, on the one hand to the introduction of electricity, extraction machines, explosives for hard-rock extraction, pumps, ventilators, and pneumatic drills and, on the other, to the modernisation of above-ground work through the use of Californian stamp mills and new types of shaking tables.

In the early 20th century, substantial progress is registered as to the modernisation of some of the basic departments of mining work. An important factor in that respect is the introduction into mining of new sources of energy to replace physical human and animal power: steam power—1838, electricity—1894, pneumatic energy—1900. Changes occur in the excavation and dislocation technique for rocks and useful mineral substances, as the use of explosives, drills, and scaling hammers gains widespread application. Important achievements are registered in the coal industry, where a series of exploitation methods specific to thin and medium beds, as well as to thick one, are applied, which involve the use of dry or hydraulic filling. The opening of mines via vertical and inclined shafts becomes increasingly common and great changes are made in underground and above-ground transportation.

Wooden winches are gradually replaced by hoists or high-capacity extraction machines equipped with steam-powered or electric engines. After 1900, electric, Diesel, compressed air, or steam locomotives are used for horizontal transportation. For transportation over uneven terrain, cableways are increasingly employed.

In the metal-ore extraction and efficient-use sector, changes occur in the crushing, washing, sorting operations, etc. Thus, old stamp mills are modernised by increasing the weight of the stamps and through the virtually general assimilation of Californian stamp mills, which featured greater battering force and frequency. Later on, jigging was introduced and modern preparation plants were built in Gurabarza and Maramureș.

The existence of a solid infrastructure and a large number of specialists and readers interested in learning useful information for their activities made it possible for the first technology book published on Romanian territory to be issued in Sibiu in 1717. It was titled *Auraria Romano-Dacica*, authored by Transylvanian scholar Samuel Köleseri (1780), himself an inspector of the Abrud-region mines, and comprised a short history of the old gold-mining sites in Abrud, Bucium, Vulcoi, Zlatna, Almaș, Hărțăgani, Trestia, Brad, Țebea and Baia de Criș, while also mentioning the method used to exploit gold through mining work and alluvium washing (Abrudeanu Rusu 1933; Haiduc 1940; Wollman 1996; Wollmann 2017).

The 20th century provided the most favourable conditions for the development of mining. Due to the accelerated rhythm of production, the rise in the number and size of mining companies, the increase of the exploitation depth, the large-scale introduction of mecanisation, and the need to ensure adequate work conditions, the science of mining is faced with a series of bigger and more complex problems than ever before.

## 2 The Interwar Period

During the interwar period, the Romanian state proceeded to rationalise and modernise the process of extraction and efficient use of deposits of useful mineral substances.

The production of various such substances increased constantly from year to year, new coal an ore deposits began to be exploited, the number of mining companies rose, and so did their level of technology and equipment.

In 1929–1930, the preparation plants in Petrila and Lupeni are modernised through the introduction of rheo washers into the technological process stream. The coal silts that result from both plants are processed through flotation. A briquette factory and a low-temperature carbonization installation are built in Petrila.

During the economic crisis of 1929–1933, the Vulcan, Dâlja, Petroșani Vest, Victoria and Carolina mines in Lupeni were closed. After the crisis, production recovered and reached its climax in 1943 of 2,755 thousand tons from Valea Jiului alone.

The economic crisis marked a new stage in the process of concentration and centralisation of production and capital. The crisis imposed a series of technical and orgnaisational reconsiderations, which were governed by the principle of 'rationalisation' and resulted in the implementation of certain modern technical elements (Baron 1999).

Following a drop in ore prices, iron-ore mines adopt the strategy of closing small mines and concentrating production exclusively in Ghelar-Teliuc, Ocna de Fier in Banat, and Lueta-Vlăhița. Precious-metal mines, most of which had been abandoned during the First World War, were gradually brought back into operation.

Rock extraction in galleries and stopes was conducted through drilling and blasting, or with the aid of coal augers and drill hammers, while using wood for support in underground mining. The transportation of coal through galleries was carried out by means of mine cars drawn by electric accumulator locomotives, electric winch locomotives, and Diesel locomotives. For shaft-based extraction, steam-powered extraction machines were employed. Power plants were built for the mines and preparation plants in Baia Mare and Brad. Water was evacuated from the mines by means of centrifugal pumps or piston pumps. The ventilation of mines was carried out with the aid of ventilators powered by electric or compressed-air motors, while the lighting of work spaces was ensured by gasoline safety lamps.

In the field of massif extraction, the drilling method for making shot holes became generalised in both coal and ore mines, and scaling hammers were introduced into most coal mines.

Chain coal-cutters were introduced in 1926 at the Lupeni mine for the extraction of thin beds and, from 1932 onwards, coal augers began to be used in salt mines as well.

During that time, mechanised items such as belt loading carriages, scraper loaders, and shovel loaders were used, which made it possible to attain a gallery-digging speed of up to 150–200 m/month.

During the interwar period, exploitation methods suitable for the specific characteristics of the deposits in Romania were developed and perfected. Thus, for the exploitation of hard-coal deposits, for thin or medium beds, either horizontal or low-dip, the method employed was that of the rance longwall, in the form of either strike or dip face. In the case of thick, high-dip beds, the exploitation method applied was that of horizontal slicing, with the coal being extracted in slices or by means of completely mechanical longwalls. For thick low- or average-dip beds, the dip slicing method was employed, combined with longwall-based coal extraction.

As far as ore deposits are concerned, the method of horizontal upward slicing combined with the filling of the mined space was used. When speaking of exploitation methods, it is also worth mentioning that the magazine mining method was introduced at the Săsar mine in 1938, having been applied in America merely a few years before.

In terms of stope support, one could name the building of powered support shields and their testing at the Petrila mine in 1942. The rise in stope efficiency at the Valea Jiului mines, combined with the concentration of production, imposed the increasing of the transportation capacity in order to evacuate the production, which gave rise to the intense use of modern extraction shafts and mechanisms.

In 1937–1938, a cyaniding installation was built at Săsar—Baia Mare, which was intended for the direct processing of green ore through cyanidation. Thanks to the new machines on the market, all the crushing, grinding, and classification departments in all the plants throughout the country proceeded to be modernised. At the same time, an electromagnetic preparation installation was built for the ores at Ocna de Fier.

In 1936, at Gurabarza, Societatea Anonimă Română 'Mica' (the Mica Romanian Anonymous Society) built a gold-refining installation, which was the second of its kind in Romania. The same society constructed a new flotation installation in 1938.

In 1937, the production of ores extracted and processed at the mines in the Apuseni Mountains tripled compared to the levels of 1928, thus registering the largest amount of noble metals ever attained in a European province, namely 5,465 kg of gold and 25,645 kg of silver. The total quantity of gold obtained throughout the centuries via the exploitation of the gold deposits on Romanian territory amounts to the significant level of over 2,200 tons of pure gold.

To summarise, one may conclude that, during the interwar period, mining made great progress in Romania, resulting in a series of technological achievements, of which we would like to mention the following as the most important: introducing electric mechanical-rotating drilling and pneumatic percussion drilling in both ore and coal mines; the generalisation of the exploitation method using large trapezoidal rooms in salt mining and the introduction of coal-cutters for the cutting of salt; applying the longwall mining method in the coal mines of the Valea Jiului basin; the extraction of coal in stopes using coal-cutters, drilling and blasting; the use of oscillating chutes and push conveyors to transport the production in stopes; using rings and prefabricated-block walls for gallery support and metal pillars for stope support; introducing the magazine mining method for certain deposits; building modern coal preparation plants in Valea Jiului and the ore cyaniding installation at Săsar; the introduction of electromagnetic separating devices in iron-ore preparation plants; the use of intermittent excavators in quarries.

## 3 From the Second World War to 1990

In the span of merely three years, from the end of the Second World War until 1948, the year of the nationalisation of the mining sector, almost all the useful mineral substances exploited reached the pre-war production levels of 1938.

Immediately after the nationalisation of the main means of production in Romania, a growth and development strategy was elaborated for the mining branch of the national economy (Almăşan 1984, 1965). However, what lay at the foundation of that strategy was an immense geological research, prospecting, and exploration effort, which spanned several decades. Thus, IGEX (Întreprinderea Geologică de Explorări—the Geological Exploration Enterprise) was created and tasked with conducting operations all over the country, while Institutul Geologic (the Geological Institute) was reorganised in the form of a government body called Comitetul de Stat al Geologiei (the State Geology Committee), which functioned as such for 16 years.

From the beginning, the geological research was conducted along three lines: improved knowledge of the reserve potential of the mining basins under exploitation; previously abandoned mining perimetres and areas; new, yet unresearched areas.

The great investments in the studying of Romania's underground resources were made until the 1980s. In view of identifying the reserves of useful mineral substances and of gaining better knowledge of the deposits, in 1950–1980, several thousands of surface drilling operations were conducted throughout the mining basins in Romania, adding up to a total of over one million linear metres in auger holes. Combined with the geological research carried out underground, these led to the accumulation of sufficient data to ensure good knowledge of the country's subsoil and its resources.

The greatest accomplishment in the field of 20th-century extractive industry was the fact that, from the exploitation of three useful mineral substances—coal, precious metals, and salt, seven sub-branches of the extractive industry were organised and developed, namely the extraction and preparation of coal, salt, ferrous ores, non-ferrous ores, precious-metal ores, non-metalliferous ores, rare-metal and radioactive-metal ores.

Iron ores continued to be exploited in Ghelari, Teliuc, Ocna de Fier and Lueta, while new mines were opened in Căpuș-Șatra and Băișoara. The exploitation of manganese ores expanded as a result of the efficient use of new sectors of the Vatra Dornei-Iacobeni deposit.

In the field of non-ferrous ores, the production capacity of extant mines was increased, while also opening new mines (Rușchița, Dognecea, Burloaia, Toroioaga, Muncelu Mic, Șuior, Ilba, Valea Blaznei, Deva, Baia de Arieș, Leșul Ursului, Moldova Nouă, Gura Băii, Fundul Moldovei, Altân-Tepe, Catarama, Băița Bihor, Pădurea Craiului).

The carbon sector registered a significant development, as did the sector of non-metalliferous ores. The most noteworthy increases occurred in the production of solid fuels: bituminous coal, brown-coal, and lignite. Some of the old mines in the Valea Jiului basin were modernised (Jieț, Petrila, Aninoasa and Lupeni), others were reopened (Cimpa, Lonea, Vulcan), while other mining perimetres saw their first

opening works, followed by the swift entry into operation of several new mines (Livezeni, Uricani, Bărbăteni, Petrila Sud, Valea de Brazi).

The development of the extractive industry relied almost exclusively on machines manufactured at home. For basic mining operations, the following machines were produced in Romania: scaling hammers, pneumatic and electric drills, gallery loaders, hopper machines for stopes, raise-digging platforms, etc. Extraction machines and various hoists were manufactured, friction and hydraulic pillars for support, various types of push conveyors for mechanical transportation, belt ribbon conveyors, portable belt conveyors, scrapers, electric and Diesel locomotives, etc. Our own machine-building industry was also the one to supply compressors, pumps, ventilators, and the machines for the preparation installations (crushers, mills, flotation cells, filters, etc.).

There are three large mining basins in Romania which hold hard coal, namely: the Schela-Gorj basin—anthracite; the Banat basin—bituminous coal and brown-coal, and the Valea Jiului basin—bituminous coal.

Of the above-named basins, the most important one in terms of the reserves it holds and the level of production attained is the Valea Jiului mining basin. The bituminous coal production in Valea Jiului was constantly on the rise, reaching 11,194,435 tons of gross production in 1988.

The diverse characteristics of the deposits in the Valea Jiului mining basin led to the implementation along the years of a large number of exploitation methods and work technologies for the extraction and efficient use of coal. Supporting and controlling longwall roofs marked a turning point in the changing and modernisation of the work techniques employed in Valea Jiului. In 1960, the Petrila mine saw the introduction of hydraulic pillars of the Klökner-Feromatic type, which served as a basis for the design, construction, and use of autochthonous hydraulic pillars.

The first stopes to become operational and be equipped with powered systems were the ones in E.M. Paroșeni in 1970. The systems that the first stopes in Valea Jiului were equipped with were of soviet manufacturing, of the O.M.K.T. line. The O.M.K.T. powered support elements were used as part of a system in combination with the Polish-made KWB—3 RDS stoping machine.

The first indigenous powered support units (SMA—susțineri mecanizate de abataj) were introduced underground in 1978, while foreign ones were still being imported. During that period, the following types of power support units were brought into the country: Hemscheidt, Fazos and KM-87.

In order to put into action the vast programme of opening and preparation operations for the new faces of workings, it was necessary to increase the speed of heading work. Particular emphasis was placed on the mechanisation of loading, as it was the most exhausting operation and also the most time-consuming when performed manually. Loaders for galleries under construction made in Romania made it possible for the degree of mechanisation of loading operations to increase and, consequently, for the heading speed to rise by approximately 25–30% compared to the manual-loading procedure. Given the characteristics of the Valea Jiului basin, the maximum excavation speed of horizontal mining work reached 250–350 m per double-gallery month.

Romania possesses over 3 billion tons of industrial brown-coal and lignite reserves, found in ten different basins across the country. The most important of them are the mining basins of Rovinari, Motru, Jilț, Albeni-Seciuri, Cerna-Cernișoara, Berbești-Alunu and Husnicioara, which hold over 90% of the country's total lignite reserves.

Of the total approved industrial reserves of lignite, over 80% can be exploited through quarries, while 20% are exploitable through underground mining. In the last years of the period in question, nearly 90% of Romania's lignite production came from Compania Națională a Lignitului Oltenia (the Oltenia National Lignite Company), which coordinated the activity of 18 quarries and 12 underground mines.

Lignite extraction was conducted through both underground and open-cast mining, while brown-coal, which makes up only a small share of the production volume, was extracted exclusively through underground mining. Lignite production grew at a very fast pace from 1950 onwards, reaching over 50 million tons in 1989.

Non-ferrous ore deposits (copper, lead and zinc, gold and silver, and aluminium) are distributed across four geographical areas in Maramureș, the Eastern Carpathians, the Apuseni Mountains, and the mountain areas of Banat.

The thickness of the deposit bodies varies greatly, from a few centimetres in the case of lodes (gold ores) to over 10 m (complex ores). There are numerous ore bodies in the form of stock, deposits, or aggregates. Lately, large accumulations of low-content mineralisations of the 'porphyry copper' type (a mineralisation featuring strong vertical development and fine dissemination into the massif) have been included into the economic network.

Whether eruptive or metamorphic, mineralisations are generally irregular, in both strike and dip orientation. The cases where bodies and lodes are of consistent shape and size are rare.

In Romania, the size of metal-ore deposits varies widely. Many deposits can be deemed small, with ore reserves of under 10 million tons. Others can be considered medium-sized and only a few fit into the category of large-sized deposits. With the exception of the 'porphyry copper' type, large deposits, such as the ones at Bălan, Moldova Nouă, Baia Borșa, Rodna, are, in fact, made up of several separate ore bodies.

## 4 Scientific Research and the Application of Research Results onto Production

The first mining research and design activities were organised as early as 1949 within the former Institut de Proiectări Industriale (Industrial Design Institute) of Bucharest.

Once ministries focused on different industrial sectors had been created, new republican development institutes were founded and organised. Thus, it is in this context that Institutul de Cercetări și Proiectări Miniere și Metalurgice (the Institute for Mining and Metallurgy Research and Design) of Bucharest was founded in 1950.

In the summer of 1951, two research and design institutes dedicated to mining are created: ICEMIN and IPROMIN, which operated in Bucharest until 1973.

In 1974, mining research and design institutes focused on useful mineral substances were founded in Baia Mare, Cluj, Deva, Petroșani, Craiova and Bucharest.

After the year 1960, the organisation of the research institutes and the design ones was regulated, and so was their manning with key and auxiliary staff, while scientific research activities were made mandatory for higher education.

90% of the research funding came from economic contracts with productive units, which were under the obligation to take over and apply the results obtained onto production.

Higher-education scientific research was either fundamental or applicative and was mostly conducted based on contracts with productive units.

This form of organisation and coordination of scientific research in the field of mining led to important results at both regional and national level.

In the second half of the 20th century, over 100 mines and quarries were opened and put into operation in Romania. The production capacity of over 50 mines rose, over 30 preparation installations and plants were built, and more than 15 mining-machinery manufacture and repair plants were designed, built, and made operational.

## 5 The Period After 1990

The Romanian mining industry registered a constant increase until the last decade of the 20th century, but entered a period of profound transformation and adaptation from 1990 onwards, in view of the transition to market economy.

In order to attain that goal, along the years, a series of measures were adopted and several strategic concepts were formulated and put into practice as to the fundamental restructuring of the mining-industry system, which, among others, included:

1. *The restructuring of technology and production*, which resulted in: an increase in the share of quarry-produced lignite and a drop in underground production; the growth of the share of energetic bituminous-coal supplies and a decrease in bituminous coal prepared for coke; an increase in copper and precious-metal ore extraction and preparation; the initiation of the modernisation of the great lignite quarries in the mining basins of Oltenia, etc.;
2. *Organisational and managerial restructuring*, which consisted first and foremost in removing certain complementary or even basic activities from the mining units and organising them into separate companies;
3. *Personnel restructuring within mining units*, particularly in the form of massive reductions by means of three basic methods: removing certain activities and associated personnel and organising them into companies, early retirement, and redundancies with severance payments.

Up until December of 1999, approximately 85,000 miners of a total of 175,000 left the mining industry. Circa 70,000 of them accepted to be made redundant and

receive severance payments, while another 15,000 left the industry either to retire or because their work activities were eliminated from the mining system.

4. *The reduction or discontinuation of productive activities* in certain mines with geological stock on the brink of exhaustion and particularly harsh geological and mining conditions, which incurred high and very high production costs.

The mining-industry restructuring programmes approved by the Romanian governments from 1998 onwards through 11 consecutive Government Decisions, authorised the definitive closing of 556 mining units located on the administrative territory of 28 Romanian counties, combined with post-closing conservation and monitoring of environmental factors.

So far, 250 units have been closed and greened, with the rest to follow in the future, depending on the funds allocated for this purpose.

In the exploitation of the deposits of useful mineral substances on Romanian territory after 1990, for both extraction and preparation, the same classic work methods and technologies perfected for the pre-1990 situation in Romania continued to be employed.

In the past few decades, the use of longwalls with individual support and mechanical cutting, as well as of longwalls equipped with stopping machines expanded into coal mining.

Ore mining on Romanian territory continues to be conducted within quarries and underground mines. The copper, manganese, and iron required by Romania's metallurgical industry are mostly produced by quarries. The mining method applied without exception in all the ore quarries in Romania is the method involving the transportation of gangue to external heaps. All the quarries employ work technology which ensures very high productivity.

Underground mining is mainly associated with lead, zinc, gold, and silver deposits, yet a significant part of the country's copper, manganese, and iron has nevertheless been exploited through underground mining. The mining methods applied underground in the few mines Romania still has are the same ones which were in used before 1990.

The ores extracted from underground units or quarries are processed in preparation plants where the basic technology employed is flotation concentration for non-ferrous ores, cyanidation for most gold ores, gravitational and combined procedures for non-metal ores.

Almost 40 sorts of non-metal ores are extracted from the several hundred deposits of such ores in Romania, to be used especially in the production of cement, glass, porcelain, fine ceramics, sanitary ceramics, stoneware, various fireproof products, enamels, paints, items used in the chemical industry, in metallurgy, or in foundries, etc.

Both dry and wet methods for the exploitation of salt deposits are still well-developed in Romania, the bulk of production being directed towards the chemical industry and household consumption.

The country has over 50 quarries of marble, limestones, granites, sandstones, conglomerates, breccias, calcites, travertines, tufas, gabbros, rhyolites, andesites,

etc., which are extracted, processed and used in construction, as well as in interior and exterior decorative paving.

## 6 Trends in the Mining Industry

Today, Romanian mining is divided into three sectors: the exploitation and efficient use of energetic-substance deposits; the exploitation and efficient use of metal-ore deposits; the exploitation and efficient use of non-metal-ore and useful-rock deposits.

In the last 25 years, no investment has been made in any of the still operating units of the three sectors, the technical equipment has remained at its 1980 level, and activities have been reduced to a minimum.

At present, Romania's production capacity in the field of mining has decreased substantially compared to the period before 1990.

We would like to point out that current useful mineral-substance production is at a fifth of Romania's annual pre-1990 production levels.

In the future, Romania needs to channel its investment efforts into the field of mineral resources, with the particular purposes of: capitalising on low-content, yet high-volume deposits, which are suitable for quarry extraction; reprocessing mining refuse found in dumps and metal-containing sludge beds; reopening the reserves with economic potential using underground extraction methods; reopening the mines containing ore reserves with rare accompanying elements, which have become of great economic interest in the current technological and economic context.

Romania's extant reserves of most useful mineral substances can supply enough production for several decades, as they represent a reliable resource irrespective of the fluctuations on international markets, which justifies investments in the revival of mining and metallurgical activities.

*The mining industry will require well-supported sustainable development in order to meet the necessities of our times without compromising the possibility for future generations to satisfy their own needs. Sustainable development must ensure economic growth, social progress, as well as the protection of the environment and of natural resources.*

Looking at the overall situation of the exploitation and efficient use of solid useful mineral substances, the conclusion which ensues is that, given the new economic circumstances, it is necessary to reconsider the Romanian state's position and involvement in the field of mining, particularly in the way of improving institutional capacity so as to focus on the role of institutions in regulating and promoting the mining sector, while also providing a viable system for private entities to operate in, fund and manage. The state needs to make better and more efficient use of its capacity as owner of the mineral resources by instituting a stable, competent and fair association, taxation, and royalty system.

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